February 18, 2015

REPORT #E15-305

BOC-Expansion Initiative Market Progress Evaluation Report #2 Final Report

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Acknowledgements

We wish to thank everyone who contributed to this report. Rita Siong, NEEA's Market Research and Evaluation Project Manager, provided guidance, assistance, and encouragement and showed great patience to help the evaluators navigate a complex landscape. Kim Hughes, NEEA's Senior Initiative Manager, and Cynthia Putnam, Karen Schraven, and Teresa Squillace of the Northwest Energy Efficiency Council responded patiently and thoughtfully to numerous requests for information and clarification. Other NEEA staff, including John Jennings, Kathryn Bae, Sushanah Boston, Ian Barker, and Stacy Blumberg, provided thoughtful review and input on our research products. We also would like to acknowledge the contributions of the five market experts who provided invaluable information about the building operator market to help guide our research activities as well as the numerous individuals within the building industry who answered our emails and phone calls with additional market information. Finally, we wish to thank all of the building operators who took the time to respond to our survey. Without them, this report would not be possible.

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Executive Summary

This is the second Market Progress Evaluation Report (MPER) of the Building Operator Certification Expansion (BOC-E) Initiative. The Northwest Energy Efficiency Council (NEEC), Northwest Water and Energy Education Institute (NWEEI), and the International Building Operators Association (IBOA) have offered BOC training and certification to facility operators in the Northwest since 1997.

In 2012, NEEA established BOC-E to accelerate adoption of BOC and increase its market penetration in the Northwest. Through the development of compelling business cases and coordinated collaboration with northwest utilities, the expanded initiative seeks to build market demand for BOC. Through the development of new partnerships and addition of a new blended online product, the expanded initiative seeks to increase awareness and penetration of BOC among operators of underserved areas[1], Federal employees, and members of the International Union of Operating Engineers (IUOE).

The first BOC-E MPER did not cover Idaho and Montana, as they were not yet part of the initiative. As of July 2013, IBOA became a BOC licensed provider. There is now a consistent curriculum and product offered across the northwest region. In Q2 of 2014 IBOA (Idaho and Montana) was integrated into the BOC Expansion initiative. Now that IBOA is a BOC Licensed Provider and part of the BOC Expansion initiative, this second MPER includes information on the Idaho and Montana market.

This evaluation assessed progress toward Initiative goals, characterized the BOC market – in particular, Idaho and Montana – through primary and secondary research, assessed the revised BOC-E logic model, and estimated BOC per-operator energy savings percentages, a key parameter of the Alliance Cost Effectiveness (ACE) Model. It included a survey of 188 building owners, business owners, and operations and maintenance (O&M) workers located primarily in Oregon and Washington. The survey results provided data on energy savings by non-certified building operators to use as a "control group" for assessing BOC's share of estimated savings by BOC-certified operators, obtained as part of the 2013 BOC-E evaluation (reported in MPER #1). It also provided data on awareness of and attitudes toward BOC training and certification to help shape messaging and build a compelling business case for BOC.

This MPER includes the first NEEA-funded research to make possible a comparison between the energy consumption and savings of non-certified and BOC-certified building operators. The research provided an alternative approach to assessing the BOC share of BOC-certified operator savings, and the results were consistent with the recommended savings assumptions from MPER #1.

[1] "Underserved markets or communities" are defined as markets that BOC serves on an infrequent basis (i.e. once every three to seven years), and generally only with the active engagement of a utility sponsor or larger employer.

In addition to supporting the Initiative's assumptions, goals, and approach and documenting progress toward those goals, the research activities for this MPER produced several important findings.

Conclusions

BOC-E is progressing toward its goals, especially those supporting expanded outreach. BOC has established IUOE as a BOC Approved Provider and trained about 50% more IUOE members in 2013 than 2012. NEEC received U.S. General Services Administration (GSA) notification of its status as a GSA Contract Partner and plans to begin operating in alignment with American National Standards Institute (ANSI) standard 17024 in 2015. The number of students in underserved areas more than doubled since 2012. Five regional utilities recommend or require BOC certification as a criterion for participation in energy efficiency programs, which BOC expects to help increase penetration in underserved markets.

Initiative logic is sound and metrics are generally clear. NEEA's program staff have clarified some links between barriers, activities, and outcomes that were somewhat unclear in an earlier version of the logic model. In this report, we have provided some suggestions for additional revisions regarding the definition of baselines for some metrics.

Findings support Initiative assumptions, goals, and approach. Survey data indicated that non-credentialed building operators are interested in BOC but employer support is critical. Despite reporting, in the abstract, that they support technical training for their operators, however, employers reported low to moderate likelihood of supporting BOC certification and maintenance. Results suggest that utility engagement and focusing messaging on staff retention and on employer-reported benefits of BOC training – more effective problem-solving, increased equipment efficiency, lower energy bills, increased comfort, and longer equipment life – may help increase employer support for BOC certification.

Although the percentage growth in the number of active BOC certificants was lower in 2013 than in 2012, there appears to be a general trend toward a slightly increased rate of growth over the past several years. The number of new certificants decreased from 233 to 165 between 2012 and 2013 while, during that time, the number of trainees who had gone five years since receiving or renewing certification increased from 70 to 114 – NEEA considers the savings as "retired" for those individuals. As a result, the Northwest experienced a net gain of only 51 active BOC certificants in that interval, compared to a net gain of 163 between 2011 and 2012. Yearly fluctuations in the number of new certifications and retirements are not uncommon. Rolling five-year averages in the percentage increase in active certificants show a slight increase from 4% for 2005-09 to 7% for 2008-12 and 6% for 2009-13.

Market penetration is about 18% for the region, but state-specific estimates of market size may be less reliable than for the region as a whole. With additional data, we have revised the estimate of the market size upward to 12,544 operators. With about 2,233 currently employed BOC operators, market penetration is about 18%. Lack of reliable data on the mean building area per operator and on the distribution of building space across size tiers in Idaho and Montana makes estimates of market size and penetration in those states less reliable than for Washington

and Oregon. Nevertheless, penetration appears to be higher in Idaho and Montana (at least 32%) than in Washington and Oregon (15% to 16%).

BOC savings comprise approximately 2% of electricity use, 1.8% of fossil fuel use, or 1.9% of BTU consumption from both electricity and fossil fuels. Data from a survey of non-certified operators' O&M practices provided an alternative baseline for assessment of the BOC share of certified operators' savings. Results support the findings from the 2013 survey of BOC operators.

Certified operators may not achieve superior savings compared to similar non-certified operators across all equipment types. Comparisons of savings from the surveys of certified and non-certified operators show that the certified operators' incremental savings above those of non-certified operators from O&M was greatest for boilers, economizers, fans, and chillers; it was less for compressed air; and demand control ventilation savings were less for certified operators than non-certified operators.

Recommendations

NEEA should assist NEEC in continuing and expanding efforts to increase employer support of certification and renewal to drive both certification and renewal of certification by using messaging that ties O&M training to retention and focuses on employer-reported benefits of BOC training and by increasing awareness of utility support for training.

BOC should review BOC training modules relating to demand-controlled ventilation and compressed air for ways to increase adoption of recommended practices and improve savings from these end-uses.

NEEA should use the ACE Model input assumptions we calculated from the survey that we carried out for MPER #1. Key input assumptions were: mean BOC-influenced per-operator savings of 3.58% for therms[2] and 2.03% for kWh, mean BOC-influenced savings of .315 kWh per square foot per year and .014 therms per square foot per year, and a mean of 432,768 square feet of building space per BOC operator.

NEEA should consider conducting additional research to verify BOC-related savings. Possible avenues of research are: to develop a better comparison between certified and non-certified operators, either by including more non-certified operators that do not manage building operators or by identifying and focusing on the certified operators that do manage other operators; conduct billing analyses of facilities operated by BOC-certified operators and a matched sample of facilities without BOC-certified operators. As discussed elsewhere in this report, surveying non-certified operators that do not manage other operators may be challenging (see Appendix E).

[2] MPER #1 originally reported a mean BOC-influenced per-operator value of 1.79% therm savings. Based on a recent re-analysis of data from the BOC survey that produced that estimate, we have revised that estimate to 3.58%.

NEEA should consider conducting additional research to provide better data on market size and penetration in Idaho and Montana. One possible source is data from the most recent Commercial Building Stock Assessment (CBSA) study.

1. Introduction

From 1997 to 2003, the Northwest Energy Efficiency Alliance (NEEA) funded the Building Operator Certification Program (BOC) to provide education, training, and certification of facility operators to perform energy efficient operations and maintenance (O&M) in commercial buildings. NEEA's original funding for BOC saw the initiative to maturity, with the Northwest Energy Efficiency Council (NEEC) and the International Building Operators Association (IBOA) offering BOC as self-supporting ventures since 2000. NEEC offers training in Washington and, through BOC Licensed Provider, in Oregon. IBOA had offered its own BOC training, independent of NEEC, in Idaho and Montana through 2012 and became a NEEC Licensed Provider in 2013. By 2001, BOC had achieved estimated market awareness of 39% among building operator supervisors and was expected to achieve 50% awareness by 2003.[3]

In 2012, NEEA aimed to accelerate adoption of BOC and increase market penetration of commercial building operators who are BOC certified in the Northwest (Oregon and Washington only). The stated goal was to achieve 46% market penetration of the market, at that time estimated to be 5,856. That equates to 2,694 certified operators, which would represent 21% of the current market size estimate.

The new effort, titled BOC Expansion (BOC-E), seeks to expand the adoption of BOC by addressing the following six market barriers:

1. Lack of time
2. Inability to pay (for unemployed operators and veterans)
3. Lack of service in underserved markets
4. Lack of awareness (among International Union of Operating Engineers (IUOE) and WorkSource)
5. Lack of compliance with Product Performance (does not meet the American National Standards Institute (ANSI), 17024 Standard for certification of personnel, and does not have an online blended learning delivery format)
6. Lack of awareness of value of BOC credential (about renewal and among utilities and decision makers)

The first BOC-E- MPER focused on the Washington and Oregon market, as IBOA was not yet a BOC Licensed Provider when BOC-E was established. Now that IBOA is a BOC Licensed

[3] *Regional Building Operator Certification Venture: Final Market Progress Evaluation Report.* Prepared for the Northwest Energy Efficiency Alliance by Research Into Action, Inc. September 20, 2001.

Provider, this second Market Progress Evaluation Report (MPER) also includes the Idaho and Montana market.

1.1. Short- and Long-Term Market Progress Indicators

The NEEA Initiative staff identified 11 market progress indicators (MPIs) to track its progress toward the short- and long-term project goals. NEEA staff revised the set of MPIs somewhat since MPER #1. Table 1 shows the 11 current MPIs, along with the desired market condition at transition complete and the goal timeframe.

1.2. The BOC-Expansion (BOC-E) "Theory of Change"

NEEA, in collaboration with NEEC, designed the BOC-E initiative to include six activities aimed at addressing each of the market barriers outlined above. Program theory says that these six activities will produce five outputs, which will then lead to each of the 11 outcomes measured by MPIs I through XI. The initiative logic model graphically illustrates the causal links between the theory's activities, outputs, and outcomes (Figure 1).

NEEA's theory of change for BOC-E centers on providing expanded availability and access to BOC training and certification in the Northwest and building market demand for the BOC certification. In its simplest terms, the theory states that if BOC becomes more readily available to a wider set of targeted audiences and develops appropriate messaging to build demand for operator certification among building and business owners, then a greater proportion of the building operator population will become BOC certified. The plan is to make the initiative more readily available via new partnerships with key building operator organizations and through offering blended online course options. The wider set of targeted audiences originally included unemployed operators, veterans, federal building operators, and operators in underserved markets, but the initiative dropped unemployed operators and veterans from its list of targeted audiences in 2014.

Changes in course offerings and delivery approach, the theory continues, will address not only the lack-of-access barrier, but also lack of awareness and lack of time. Messaging that convinces building and business owners of the value of having BOC-certified staff will address the sixth barrier – lack of awareness of the value of the BOC credential. Moreover, the program theory assumes that status as an approved training provider for GSA and achievement of the ANSI 17024 standard will attract Federal employees.

1.3. MPER 2

This Market Progress Evaluation Report (MPER #2) is the second of three planned evaluation reports for the BOC-E initiative. It chronicles Research Into Action's evaluation of the BOC-E initiative in 2013-2014. The evaluation focused on answering the following key research questions:

- What is the current market size of building operators in the Northwest?

- Based on estimated market size, what is the current market penetration of BOC?
- How is BOC-E progressing against its MPIs?
- What barriers do building operators face in obtaining BOC certification?
- What is the perceived value of BOC certification in the market?
- Does the BOC-E Logic Model clearly illustrate the program theory?
- What are the characteristics and size of the Idaho and Montana market?

In addition, this MPER #2 includes a review of the NEEC database of BOC trainees to update regional counts of active BOC operators and a review of the key Alliance Cost Effectiveness (ACE) Model assumptions of per-operator energy savings.

Table 1. BOC-E Initiative Goals and Associated Market Progress Indicators (MPIs)

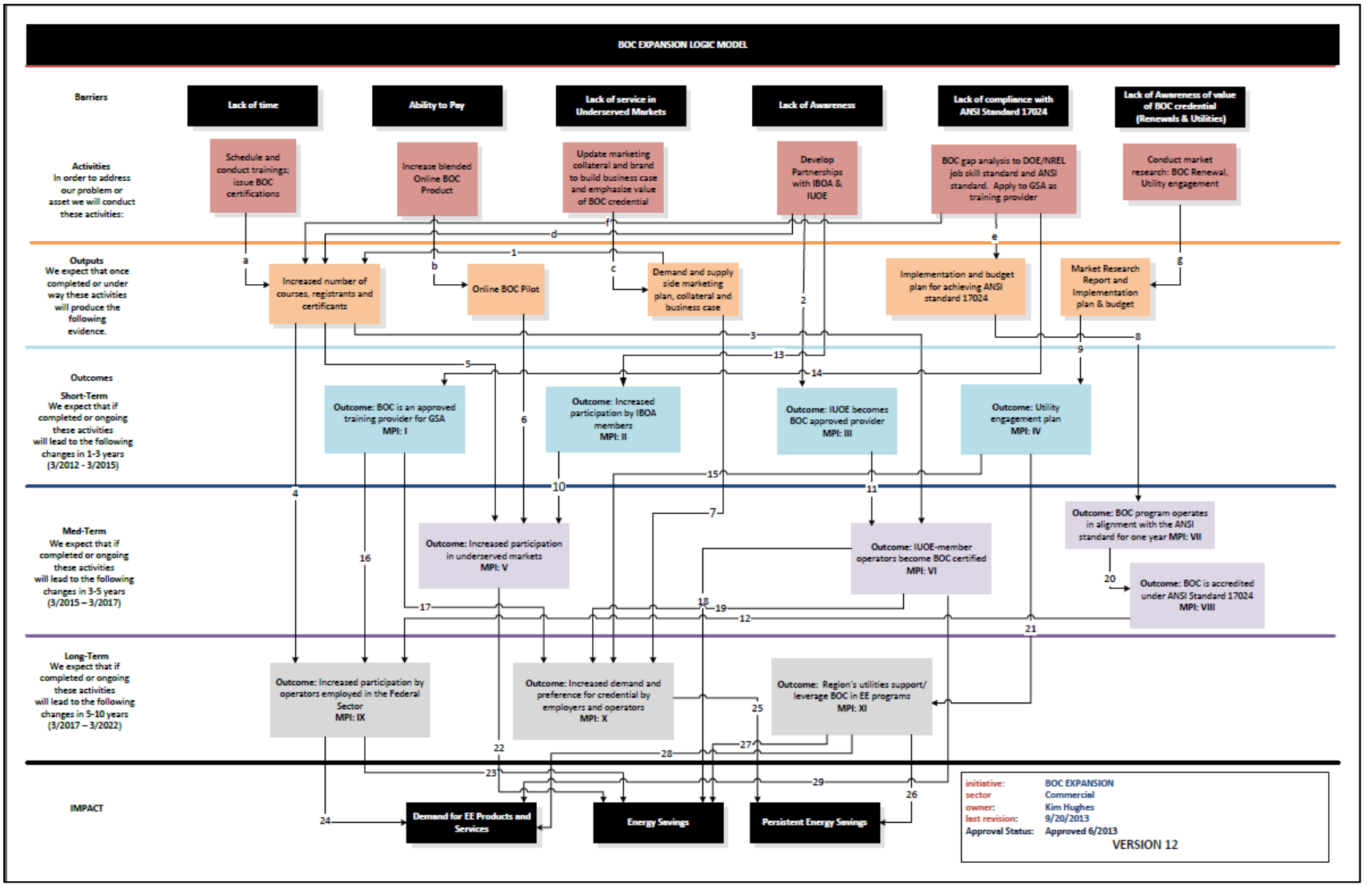
MPI #	Outcome	Time Frame	Market Progress Indicator	Initiative Goal – (desired market condition as of transition complete)
I	BOC is an approved training provider for GSA	Short term (1-3 Years)	BOC listed on GSA training provider roster, by June 30, 2014.[4]	Federal sector building operators participate in two or more BOC courses per year
II	Increased participation by IBOA members	Medium term (3-5 Years)	10% increase in IBOA certificants over 2012 baseline by Dec. 31, 2015	Fifty percent increase (50%) in total number of credentialed BOC operators in the northwest
III	IUOE becomes a BOC Approved Provider (AP)	Short term (1-3 Years)	Signed AP agreement by NEEC and IUOE by June 30, 2014. (Accomplished as of 6/30/2014)	A formal education partnership is established between BOC and a minimum of one IUOE local in the region
IV	Utility Engagement Plan	Short term (1-3 Years)	Utility Engagement Plan established and implemented. (Established UEP on Feb. 1, 2013, but have revised with input from utilities.)	More engagement with Northwest utilities, strengthening knowledge of the credential and increasing the value of the program to key NEEA stakeholders.
V	Increased participation by operators in underserved markets	Medium term (3-5 Years)	10% increase in certifications by operators in underserved markets, over 2012 baseline by Dec. 31, 2015.	BOC courses are available to customers in underserved communities on an ongoing basis.
VI	Increased participation by IUOE-member operators	Medium term (3-5 years)	10% increase in certifications by IUOE-member building operators over 2012 baseline by Dec. 31, 2015.	IUOE-member operators apply for BOC certification through the IUOE Approved Provider agreement with NEEC.
VII	BOC program operates in alignment with the ANSI/ISO/IEC 17024 for one year prior to applying for standard	Medium term (3-5 Years)	Demonstration of a firewall between training and exam at NEEC, in compliance with ANSI/ISO/IEC 17024 requirements, by September 30, 2014. (Develop business Plan for alignment with ANSI)	BOC meets the ANSI 17024 standard which will make it more credible and competitive in the market, particularly for sectors such as Federal and State government operators.

Continued

[4] http://www.gsaelibrary.gsa.gov/ElibMain/searchResults.do;jsessionid=A1C1E0C40BA574C906D41054D83606C2.prd2pweb.

MPI #	Outcome	Time Frame	Market Progress Indicator	Initiative Goal – (desired market condition as of transition complete)
VIII	BOC is an authorized provider under ANSI 17024 Standard	Long term (5-10 years)	Signed letter of authorization by June 1, 2017.	
IX	Increased participation by operators employed in the Federal sector	Long term (5-10 years)	10% increase in certifications by Federal building operators in the Northwest over 2012 baseline by June 30, 2016.	Fifty percent increase (50%) in total number of credentialed BOC operators in the northwest. Federal sector building operators participate in two or more BOC courses per year.
X	Increased demand and preference for credential by employers and operators.	Long term (5-10 years)	Certification rate increases from 75% to 85%, and 70% annual renewal rate, by Dec. 31, 2016.	BOC certification renewal rate increases 10% from strategy approval date.
XI	Region's utilities support/leverage BOC into their EE programs	Long term (5-10 years)	Ten regional utilities leverage/support BOC in their energy efficiency programs by June 30, 2016.	Ten or more utilities in NW include BOC in their portfolios.

Figure 1. BOC-E Logic Model



2. Evaluation Activities

The BOC-E evaluation began in 2012 and will continue into 2015, with three MPERs planned. Chapter 2 presents the schedule of MPER delivery dates, an overview of evaluation activities, and high-level details of the activities we conducted specifically for this report, MPER #2.

2.1. Schedule of Evaluation Reports

Table 2. Schedule of BOC-E MPERs

Evaluation Report	Targeted Delivery Date
MPER #1	Completed
MPER #2	September 2014
MPER #3	September 2015

2.2. Overview of Evaluation Activities

Table 3. Overview of Evaluation Activities

Evaluation Activity*	MPER #1	MPER #2	MPER #3
Review Secondary Data on BOC Market	✓	✓	✓
Review Program Logic Model	✓	✓	✓
Review Program ACE Model Assumptions	✓	✓	✓
Review BOC Program Database	✓	✓	✓
Conduct Market Characterization	✓	✓	✓
INTERVIEWS			
NEEA and BOC Program Staff	✓	✓	✓
Market Informants	✓	✓	✓
CERTIFICANT/NON-CERTIFICANT SURVEY			
BOC Certificants	✓		✓
Non-BOC Certificants		✓	
INVESTIGATE QUANTIFIABLE DIFFERENCES BETWEEN			
Classroom-based and blended (classroom + blended online) training			✓
Impacts between BOC and BOC-E certificants			✓
Impacts between NEEC and IBOA certificants			✓

2.3. Data Collected for MPER #2

To answer the key research questions outlined in Chapter 1, Research Into Action focused on seven core research activities (Table 4).

Table 4. MPER #2 Evaluation Activities, Data Sources, and Achieved Sample Sizes

Activity	Data Source	Achieved Sample Size
Communication with staff	NEEA and NEEC staff members	4
Market informant interviews	NEEA-provided market informant contacts	5
Logic Model review	BOC Expansion Logic Model, graphical version; and	N/A
	MS Excel tables of market progress indicators and initiative activities	
BOC database review	NEEC and IBOA databases of BOC certificants	N/A
BOC non-certificant survey	NEEC contact list and trade association distribution list	188
Market Characterization	NEEA program documents	N/A
	BOC non-certificant survey	188
	Market informant interviews	5
	Secondary data, including:	N/A
	Previous reports by NEEA contractors (including the Commercial Building Stock Assessment, or CBSA)	
	Other publicly available sources, such as the U.S. Census Bureau	
ACE Model review	Data from BOC non-certificant survey	84*
	Market informant interviews	5
	Various engineering sources	N/A
	Previous NEEA memoranda and reports	N/A

* A subset of 84 O&M workers, from the full sample of 188 survey respondents, provided data for analysis of per-operator savings.

Communication with Staff. For MPER #1, we conducted in-depth interviews with one NEEA and two NEEC staff members and a contracted BOC instructor/facilitator to familiarize us with BOC-E, including initiative design, how the expanded product differs from the original BOC product, and the theory of market transformation. For MPER #2, we maintained ongoing communication with one NEEA and three NEEC staff members by telephone, email, and in-person meetings from fall 2013 through summer 2014. This ongoing communication served to keep us informed about initiative progress, including any changes to the initiative. We used the information gathered during this communication to inform the design of various data collection instruments, including the market informant interview guides and the BOC non-certificant survey.

Logic Model Review. The BOC-E initiative's logic model graphically describes its theory of change. For MPER #1, we carefully reviewed both the logic model and the accompanying MPI tables to assess the clarity of the causal linkages between activities, outputs and intended outcomes. For MPER #2, we reviewed the revised logic model and set of tables to determine whether the revised model and tables addressed our findings. Section 4.1 summarizes our findings, and Appendix A provides additional detail.

BOC Database Review. Our review of the NEEC database, which now includes records of IBOA certificants, includes a description of database contents and updates counts of new certificants, certificants whose certifications expired at least five years before (and for whom NEEA no longer claims savings), and current, active certificants (those for whom NEEA continues to claim savings). It also includes counts of building operators who have obtained their BOC certificate as part of BOC-E. Section 4.2 summarizes our findings and Appendix B provides additional detail.

BOC Non-Certificant Survey. In January and February 2014, we conducted an online survey of 188 building owners, business owners, and operations and maintenance (O&M) workers located primarily in Oregon and Washington. The purpose of the survey was to provide market data from building and business owners and managers with O&M staff as well as from the O&M employees themselves. The survey collected data on characteristics of the survey respondents and their workplace; O&M practices; and attitudes and perceptions relating to key research questions. Section 4.3 summarizes our findings, and Appendix C provides additional detail.

Market Characterization. In May and June 2014, we interviewed five market informants representing varying aspects of building efficiency, including BOC course instruction, utility program management, building/facility management associations, and the university and healthcare sectors. We incorporated feedback from these market informants into a market characterization memo. The memo also includes a revised estimate of the number of building operators in the region, based on data from the 2013 survey of BOC operators combined with data from the 2014 survey of non-certified operators, and a summary of secondary research on the distribution of buildings by end-use type and ownership. Section 3 summarizes our findings, and Appendix D provides additional detail.

ACE Model Review. For MPER #1, we reviewed input assumptions of the BOC-E ACE Model, including electric consumption per square foot, percentage of savings for participating buildings, average square footage per operator, and other parameters derived from these statistics (e.g., calculated savings per operator). For the current MPER, we used the energy consumption and savings analysis from surveyed non-certified operators as a control group for the comparable analyses from BOC-certified operators, providing an alternative approach to estimating BOC's share of savings from the certified operators. Section 5 summarizes our findings, and Appendix E provides additional detail.

The staff and market informant interview guides and the BOC certificant survey instrument are included as Appendix F. Appendix G lists evaluation sources.

3. Market Characterization

For MPER #2, our BOC-E market characterization revisited the estimated size of the building operator market in the Northwest and BOC's penetration into that market, providing separate estimates for Oregon/Washington and Idaho/Montana and reported on characteristics of the BOC market in Idaho and Montana. To provide a benchmark for renewal, we attempted, but were unable to obtain comparable information on renewal rates for other related training curricula. We have attached the market characterization memorandum that we submitted to NEEA (Appendix D).

3.1. Data Sources

We used several sources of data and information to update our picture of the building operator market: 1) interviews we conducted with five market informants who are knowledgeable about the building operation market in Idaho and Montana; 2) the 2009 Commercial Building Stock Assessment (CBSA)[5]; and 3) other publicly available sources, such as the U.S. Census Bureau. The market informants were building supervisors, utility staff, instructors for BOC and the International Facility Management Association (IFMA), and the Co-Executive Director of IBOA. We provide details on these sources in Appendix G.

3.2. Characteristics of Idaho and Montana Market

Information from market informants and secondary data sheds light on the Idaho and Montana markets in comparison to Washington and Oregon.

Market informants reported that building stock in Idaho and Montana is "older" and faces efficiency challenges but that recent benchmarking and the entrance of a younger generation of technology savvy and sustainability-minded workers has been a "huge" improvement. With many building operators nearing retirement, market informants indicated that it is becoming increasingly important to train the younger staff.

Informants said that few buildings are greater than 100,000 square feet in size but the vast majority of buildings of that size have in-house operators on staff. Informants reported the types of buildings *most* likely to have an in-house operator were hospitals, schools, government buildings, industrial buildings and airports: industries where downtime or failures of equipment have a larger impact on revenues/production.

[5] *Northwest Commercial Building Stock Assessment: Final Report.* Prepared by The Cadmus Group, Inc. for the Northwest Energy Efficiency Alliance, December 21, 2009.

Data from CBSA and the U.S. Census Bureau[6] suggests that the distribution of building square footage by end-use type in Idaho and Montana is similar to that in Washington and Oregon, although the percentage of properties that are vacant is higher in Idaho and Montana (10%) than in Washington and Oregon (2%). Although the distribution by end-use may be similar, the percentage of building square footage that is owned or controlled by the Federal government is more than twice as great in Idaho and Montana (11.9%) as in Washington and Oregon (4.8%).

3.3. Barriers to BOC Training in Idaho and Montana

Market informants all said that general awareness of BOC in Idaho and Montana has been low. This represents a key barrier – for both operators who do not know about training and certification opportunities, as well as for building owners and "decision makers" who lack an understanding of the benefits BOC training and certification could provide to their facilities. However, informants also noted that BOC outreach has been very active recently, which may have increased awareness.

Informants also identified cost as a barrier. In light of the above comments, lack of awareness of the benefits of BOC training and certification and of utility financial assistance may lead some building and business owners to consider the training and certification too costly.

Four of the five informants indicated that the time commitment required to complete the BOC training may be a barrier. Most of the informants were skeptical of the plan to offer "blended online training," saying that online learning is not as effective as classroom learning for BOC content.

3.4. Building Operator Market Size

We used new data and a revised method to update the MPER #1 estimate of 10,020 in-house building operators in the Northwest. Sources documented in MPER #1[7] suggested that in-house operators are common in applicable buildings[8] of at least 100,000 square feet but that only about 5% of buildings 5,000 to 99,999 (and no buildings less than 5,000 square feet) have in-house operators. This suggested different approaches for estimating market size in the two building size tiers.

For the large square footage tier, we used the following methodology. We used data based on 183 cases from our 2013 survey of BOC operators to calculate the mean square footage per operator and used data from the CBSA to calculate the total market square footage for that tier.

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6 See Appendix D for details.

7 *BOC-Expansion Initiative Market Progress Evaluation Report #1 (Report #E14-277).* Prepared by Research Into Action, Inc. for Northwest Energy Efficiency Alliance, April 24, 2014. Available at: *http://neea.org/docs/default-source/reports/boc-expansion-initiative-market-progress-evaluation.pdf?sfvrsn=4. See Appendix D, pp. D-2 to D-7.*

8 We excluded groceries and restaurants, which typically use service providers to manage equipment.

We then divided the mean square footage into the total market square footage, and multiplied the result by 75% (the estimated percentage of building area with in-house operators). This produced an estimate of 7,609 operators in that tier.

From CBSA data, we estimated that there are 48,217 buildings in the smaller tier. Based on the assumption that about 5% of buildings in this tier have building operators, we estimated that there are 2,411 buildings in this tier with operators. We conservatively assumed one operator per building, or 2,411 operators in that tier and, thus, a total of 10,020 in-house operators in the regional market.

Our 2014 survey of non-certified operators added data for 73 buildings of at least 100,000 square feet. The combined sample produced a lower mean of 64,967 square feet per operator[9], increasing the estimate of operators in the large tier to 8,549. The estimate of operators in the small tier remained at 2,411, for a total estimate of 10,960 operators in the region.

The assumption of only one operator per building in the small tier possibly under-estimated the total number of operators, as most of the buildings with in-house operators are more likely to consist of at least 50,000 square feet. Therefore, we produced an alternative estimate for the combined sample by redefining the large tier as buildings at least 50,000 square feet and the small tier as those from 5,000 to 49,999 square feet.

Redefining the large tier produced a new mean of 57,280 square feet per operator and an estimate of 13,973 operators in that tier. Redefining the small tier reduced the estimated number of buildings in that tier to 42,772. Since that likely excluded most of the buildings with in-house operators, we reduced the assumed percentage of buildings with in-house operators to 3%.[10] This produced an estimate of 1,283 operators in that tier, for a total of 15,256 operators in the region.

Based on the revised method, we calculated that the percentage of buildings smaller than 100,000 square feet with in-house operators must be at least 6% to 10%, not 5% as several converging lines of evidence suggests (see Appendix D). **Therefore, we recommend a compromise estimate of 11,261 operators in the large tier (representing the mid-point between the two methods' estimates) and 1,283 in the small tier, for a total of 12,544 in-house operators.**

For MPER #1, we estimated that there were approximately 1,000 building operators in the "facility services" sector, which provide outsourced O&M services. This was based on an estimate of 20 such operators with the BOC credential and the estimate (from market informants) that no more than 2% of such operators have the BOC credential. The current BOC database shows 21 certified and active operators in the facility services sector. Therefore, we continue to estimate 1,000 operators in that sector.

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[9] We weighted the data from certified and non-certified operators to account for the fact that the two samples represented different proportions of the applicable populations.

[10] Assuming a minimum of 1% of and maximum of 5%, the 3% figure comes with a possible error of ± 850.

3.5. BOC Market Penetration

Together, NEEC and IBOA have certified 2,351 BOC operators through 2013, of whom we estimate up to 5% are retired or deceased, leaving about 2,233 currently employed certified operators. That figure constitutes about 18% of the estimated 12,544 in-house building operators, slightly lower than we estimated for MPER #1.

We estimated penetration separately for Idaho/Montana and Washington/Oregon. CBSA indicates that Washington/Oregon account for 87% of the regional building area, but it is likely that those two states account for a higher percentage than that of all large-tier buildings (see Appendix D for details). Under the assumption that Washington/Oregon accounts for 87.5% to 90% of large-tier square footage, we estimated penetration in Washington/Oregon to be 15% to 16% and that for Idaho/Montana to be 32% to 38%.

4. Findings

This section summarizes key findings from our review of the program logic model and database as well as data collection activities other than those presented in Section 3, *Market Characterization, and* Section 5, *ACE Model Assumptions*. Following the discussion of those key findings, this section summarizes the evaluation's findings to date relative to the BOC-E MPIs.

The data sources for these findings are the initiative logic model and associated tables, the NEEC BOC database, our survey of non-certified building operators and building and business owners, and personal communication with BOC implementation staff.

4.1. Review of Program Theory and Metrics

As part of our activities for MPER #1, we reviewed the initiative logic model. To help us understand the model, we also reviewed other program documentation. Based on our initial review of the logic model, we submitted a draft and revised memo to NEEA, which we incorporated as Appendix B of MPER #1. In response to our input, NEEA initiative staff revised the logic model and logic model tables.

For this MPER #2, we examined the revised logic model and tables and current documentation (see Appendix A for details). The goal of the review was to assess how Initiative staff responded to our prior recommendations about the program logic model into the BOC-E logic model; and whether any aspects of the revised BOC-E logic model needed further clarification.

We believe all of NEEA's responses were appropriate and improved the logic model. However, we do note that four MPIs are stated in terms of a 10% increase in a given student type over the 2012 baseline. Those are MPIs II (increase in IBOA students), V (increase in students in underserved areas), VI (increase in IUOE-member students), and IX (increase in students that are federal employees). The concern regarding using a single year's participation levels as the baseline is that some year-to-year fluctuation is to be expected: if participation by any of those groups in 2012 was higher than expected from previous trends, that it would be more difficult for BOC-E to meet the MPI. On the other hand, if participation was lower than expected, BOC-E might meet the strict definition of the MPI even if it did not have an actual impact.

The regional BOC database does not consistently identify participation in underserved areas, by IUOE members, and by federal employees before 2012.[11] Therefore, there is no alternative to

[11] NEEC began tracking this information in 2012. However, some students that NEEC identified as from underserved areas or as IUOE members or federal employees based on 2012 certifications (usually Level 2) had received another certification (usually Level 1) before 2012. However, any students that did not receive any certification in 2012 or later would not be identified as coming from any of those groups. Therefore, we can identify some pre-2012 students as belonging to one or more of these groups, but we cannot do so consistently.

using 2012 as the baseline, but NEEA should take into consideration the possibility of higher-than-average or lower-than-average participation in 2012 when interpreting findings.

In the case of IBOA students, an alternative approach would be to define the baseline as the average over the few years (e.g., five years) up to 2012. We have adopted this approach in Section 4.4. Note, however, that the database does not consistently identify the education provider. Instead, we must assume that students with work addresses in Idaho or Montana are IBOA students. (This may not always be the case, as the most convenient training location for some Idaho or Montana operators may be in Oregon or Washington.)

4.2. Review of Program Database

For this evaluation, Research into Action developed a combined dataset of NEEC and IBOA certificants, containing records on the 2,351 individuals employed in NEEA territory that had received certification since 1996.

4.2.1. Methods

From datasets that NEEC and IBOA had provided up to February 10, 2014, we created a combined dataset. Together, with staff from NEEA and NEEC, we carried out an extensive QA/QC review, which included identifying and removing duplicate records. The final combined 2013 dataset included records of 2,351 individuals employed in NEEA territory that had received certification since 1996.

Each record in the combined regional BOC database includes information about the certificant and his/her employer as well as the years of certification and expiration of BOC Level 1 and Level 2 certifications. As maintaining certification requires annual renewal, the year of "expiration of certification" is the year following the last year of renewal or the year of certification if the certificant did not renew certification.

We calculated the number of new and retired BOC certificants for each year from 1997 through 2013. For any given year, new BOC certifications are those certified for the first time in that year and retired certificants are those who have not received certification or renewal (Level 1 or Level 2) within the previous five years (the assumed measure life of the certification). We calculated year-by-year cumulative totals of active BOC certificants as the sum of those that had received certification up to and including that year minus the total number of retired certificants up to and including that year. (Appendix B provides details on the database analysis.)

4.2.2. 2013 New and Total Active Certificants and Renewals

In 2013, we identified 165 individuals that received certification (111 through BOC-E) for the first time and 114 certificants whose savings had retired. In addition, there were 17 individuals who reported work retirement or were deceased before their savings would have retired and eight who were unemployed. We did not count those 25 individuals as currently active certificants. In all, BOC has certified 2,351 individuals in the Pacific Northwest since 1996, of whom 1,420 can

currently be counted as active certificants. Table 5 shows the counts of total certified, total inactive, and total active certificants by state.

Table 5. Count of Total Certified, Total Inactive, and Total Active through 2013, by State

State	Total Certified	Total Inactive*	Total Active
Washington	1,330	506	824
Oregon	492	202	290
Montana	304	93	211
Idaho	225	130	97
Total	2,351	931	1,420

* Inactive included those whose savings have retired because it has been at least five years since their certification expired as well as those who retired from work or were deceased before their savings retired and those who were unemployed in 2013.

The number of new certificants decreased from 233 to 165 between 2012 and 2013 while, in that time period, the number of certificants with retired savings increased from 70 to 114. As a result, the Northwest experienced a net gain of 51 active BOC certificants in that interval, compared to a net gain of 163 between 2011 and 2012. Yearly fluctuations in the number of new certifications and retirements are not uncommon. Figure 2 shows the annual percent increase in the number of active certificants together with a rolling five-year average in the annual increase. The rolling five-year averages show a slight increase from 4% over the five years ending in 2009 to 7% for the five years ending in 2013.[12]

[12] As noted above, there were 25 BOC certificants who withdrew from the workforce at some point before 2013. We could not determine exactly when each one withdrew, so we assumed for the purpose of this analysis that five withdrew from the workforce in each of the five years from 2018 to 2012.

Figure 2. Annual Percent Increase (Year-by-Year and Five-Year Rolling Average) in Number of Active Certificants, 2004-2013

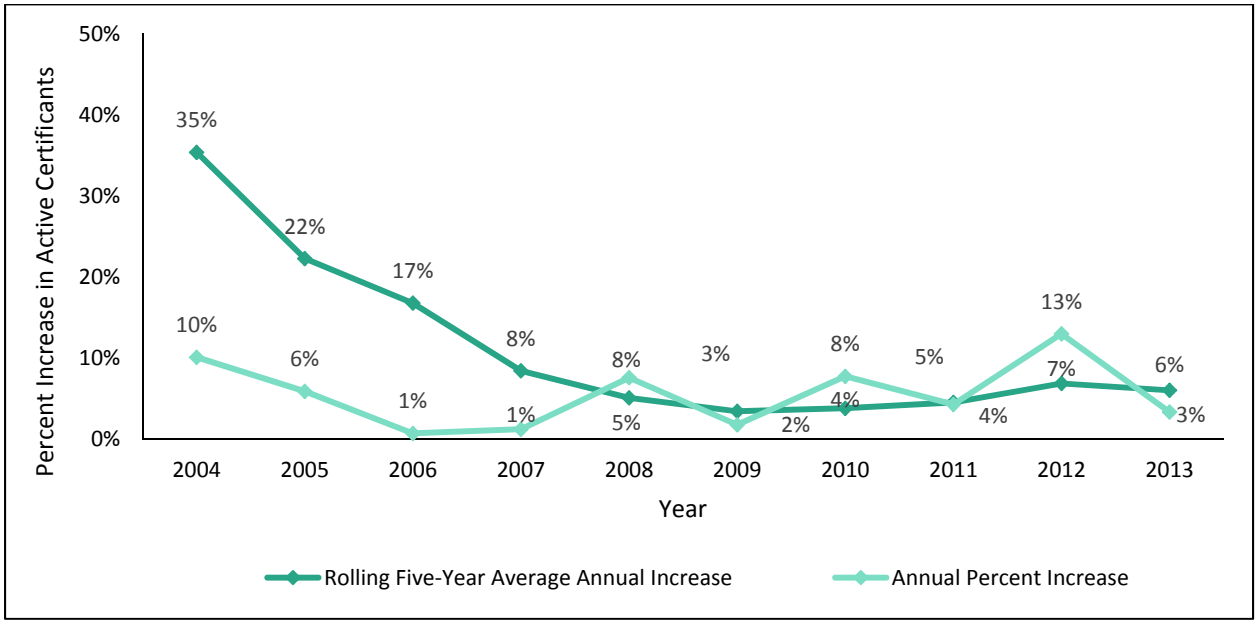
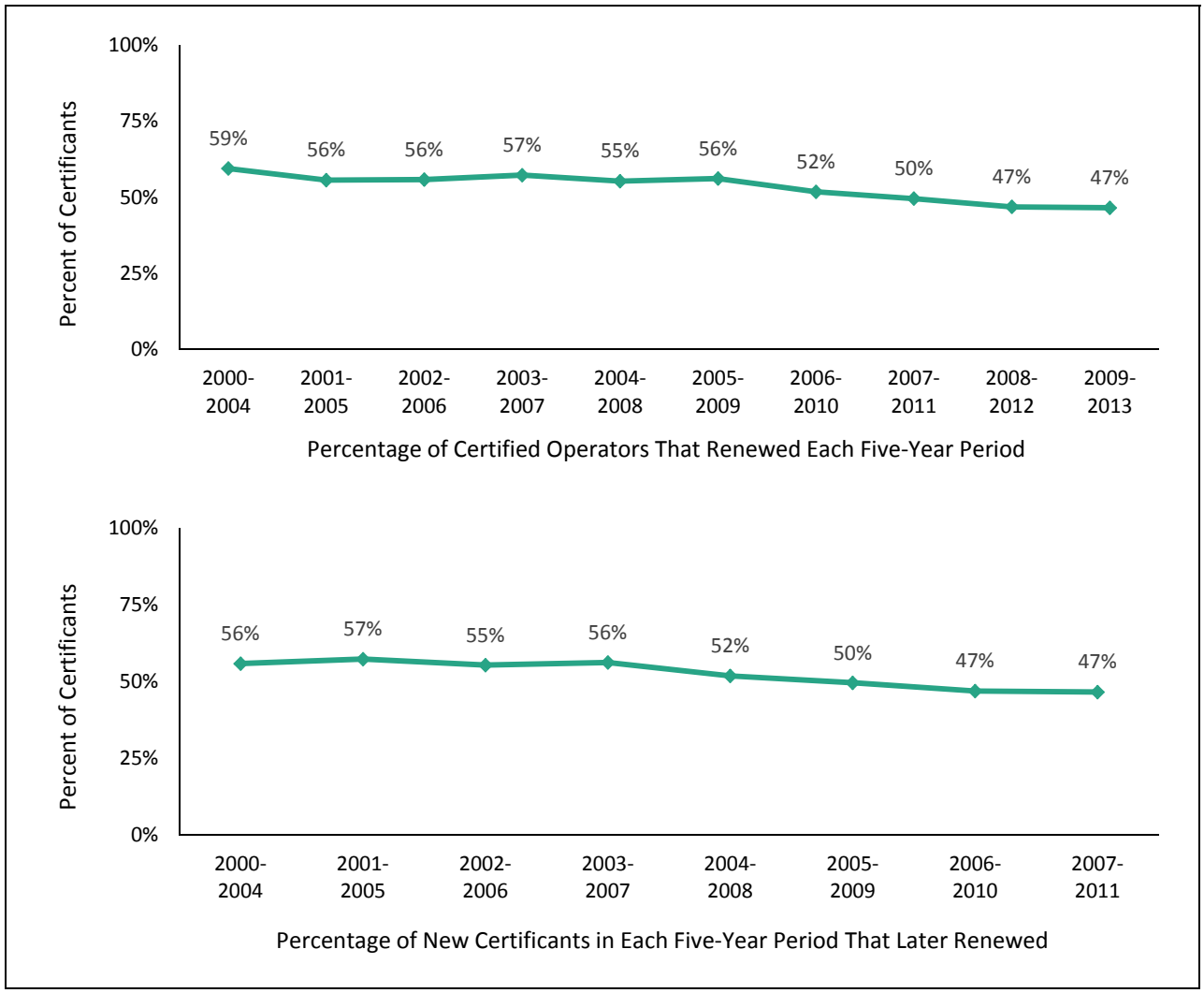


Figure 3 shows trends in renewal rates, again using five-year rolling averages. The first graph shows the renewal rate of all certificants that were eligible to renew in each five-year period. For example, of all certificants that might have renewed in 2000 through 2004, 59% did so. This graph shows a downward trend, with lower percentages of certificants renewing in later years than in the earlier years. The second graph shows total renewal rates for each five-year certification cohort. This graph shows lower renewal rates for more recent certificants, compared to those that received certification in the earlier years. Thus, the downward trend in renewal rates appears to have resulted from lower renewal among recent graduates (rather than, say, a recent change in the renewal rates of continuing certificants). This suggests that efforts to communicate the importance of renewal among new graduates may be more important than efforts targeting repeated renewal among continuing certificants.

Figure 3. Five-Year Rolling Average Renewal Rates – By Renewal Years and Certification Years*



* The second graph ends with the 2007-2011 cohort because it is not possible to determine whether or not someone from the 2012 class renewed until after the end of 2014.

4.2.3. Attributes of BOC-E Certificants

The 2013 BOC database includes information on membership in one of three BOC-E special classes and one of four initiative-targeted or -tracked groups – collectively, referred to as BOC-E "attributes." The three special classes are those formed through the Initiative's outreach to large employers (*Large Employer*); those held in previously underserved areas (*Underserved*); and those that incorporate online modules (*Online*). The four targeted or tracked groups are: certificants that received training from the International Union of Operating Engineers (IUOE); returning veterans who served in Afghanistan or Iraq (2001 to 2012); federal employees; and the unemployed. (When NEEA launched the BOC-E initiative, it targeted veterans and unemployed trainees. Currently, BOC-E does not target these two groups but still tracks them in the BOC database.) NEEA initiated a strategy change based on the priority of building market demand for

BOC and exiting the market one year earlier than planned. The strategy around returning veterans and unemployed was a lower priority and thus was dropped.

As of 2013, a total of 221 individuals fit into one or more of the above special classes or groups, of whom 197 received BOC certification for the first time in 2012 or 2013. The other 31 had received BOC certification prior to 2012 but received an additional certification through BOC-E (typically Level 2) in 2012 or 2013.

Table 6 shows counts for the various attributes of BOC-E certificants, including the percentage that certificants with each attribute comprise of all BOC-E students, the percentage they comprise of all 2012-2013 NEEC students and of all 2012-2013 regional BOC students. As individuals may possess more than one of the attributes found in the table, the total of the line items may exceed the total of unique BOC-E certificants.

Table 6. BOC Expansion Attributes; Multiple Selections Allowed

Attribute Type	Count	Percent of BOC-E Students* (*n* = 221)	Percent of All 2012-2013 NEEC Students (*n* = 326)	Percent of All 2012-2013 BOC Students (*n* = 398)
Large Employer	126	57%	39%	32%
Underserved	76	34%	23%	19%
Online Class	12	5%	4%	3%
Any Special Class	187	85%	57%	47%
IUOE is Education Provider	10	5%	3%	3%
Returning Veteran (2001-2012)	8	4%	2%	2%
Federal Employee	4	2%	1%	1%
Unemployed	24	11%	7%	6%
Any Targeted Group	45	20%	14%	11%
Any BOC-E Attribute	221	100%	68%	56%

*All BOC-E students were in the 2012-2013 cohort.

4.3. Survey of Non-Certified Operators and Building/Business Owners

In January and February 2014, Research Into Action conducted an online survey of 188 building owners, business owners, and building operators located primarily in Oregon and Washington. The purpose was to provide market data from building and business owners and managers with building operations staff as well as from the operators themselves. As Table 7 shows, some building operators supervised other operators, while some surveyed owners and officers did not directly supervise building operators.

Table 7. Distribution of Survey Respondents by Position and Management/Supervision of O&M Staff

	Managed or Supervised O&M Staff	Did Not Manage or Supervise O&M Staff	Total
Owners and Officers	55	11	66
O&M Staff	103	19	122
Total	158	30	188

The survey assessed job descriptions and firmographics; awareness and familiarity with BOC; training received; factors affecting decisions about training staff; attitudes toward BOC certification and maintenance and staff retention; and perceived barriers to taking BOC training.

Results indicated that building operators are interested in the certification but employer support is critical for them to take action. Employers generally support technical training for their building operator staff but were not likely to support BOC certification and maintenance. Three possible avenues for increasing employer support for BOC certification are: 1) utility engagement; 2) tying training to staff satisfaction and retention; and 3) developing messaging that cites the employer-reported benefits of BOC training. Moderate knowledge transfer from BOC-credentialed staff to others suggests an additional benefit of BOC training while also suggesting that supporting BOC training and certification for additional staff can produce increased benefits.

We presented our findings in a memo to NEEA on February 28, 2014, included in this MPER as Appendix C.

4.3.1. Methods

Research Into Action staff drafted the survey to assess the research questions identified in consultation with NEEA staff.

We implemented the survey through email invitations to a subset of the Northwest Energy Efficiency's Council (NEEC) BOC contact list and to a media organization's subscriber list. The NEEC list of 7,488 building operations and facilities management contacts was the largest and most comprehensive list of building operations and facility management contacts we could identify. We removed BOC students and duplicate records from the list, leaving 3,013 names.

Trade Press Media Group, Inc., a media company serving the building operations and facility management industry, sent the invitation once to a list of 1,851 Pacific Northwest subscribers to two of the company's professional journals. To address likely overlap in the NEEC and Trade Press lists, we first sent the email invitation and two reminders to the NEEC list. We then asked Trade Press to send the invitation to its list with a statement that they should not take the survey if they already responded to our invitation. Trade Press sent no additional reminders. We then sent a third reminder to the NEEC list.

A total of 188 respondents completed the survey. All but eight of the responses came from the NEEC contact list, and most responses were from Washington and Oregon.

4.3.2. Respondent Roles and Responsibilities

Of the 188 survey respondents, 66 were building or business owners or officers and 122 were employees below the level of company officer ("building operators").

- Of the 66 owner or officers, 55 said they manage building operations staff; the other 11 reported either that they did all the O&M work themselves (6) or they used an O&M service provider (5).[13]
- Of the 122 operators, 103 said they manage other O&M staff.

Between the 55 owner/managers and 122 building operators who manage other operators, a total of 158 respondents (84% of the total sample) managed O&M staff.

One-third of the 158 "owner/managers" (n = 54) reported that at least one building operator they managed had the BOC credential. Information on respondents' roles and responsibilities and BOC status of employees allowed the survey to target specific questions appropriately.

The sample sizes for the owner/managers without BOC staff (n = 104) and for the building operators (n = 122) provide responses with greater than 10% precision at greater than 90% confidence.[14] The sample size for owner/managers with BOC staff (n = 54) is smaller, but so is the pertinent population. We estimate the survey sample provides at least 11% precision at 90% confidence (see Appendix C for details).

The 122 operators provided additional information on job descriptions. As Table 8 shows, two-thirds indicated they were a property or facility director, manager, or supervisor.

[13] A total of 19 of the 66 owners and officers reported that they themselves did O&M work, with additional staff (13) or by themselves (6). As such, they can be considered building operators as well. For the purpose of describing survey results, however, we are not referring to them as building operators.

[14] When drawn from an infinite population, a sample of at least 68 provides 10% precision at 90% confidence for data expressed in percentages or proportions, which describes nearly all the data from this survey.

Table 8. Employee Job Descriptions (Multiple Responses Allowed; *n* = 122)

Job Description	O&M Managers (*N* = 103)	Other Employees (*N* = 19)	All Employees (*N* = 122)	
			Count	Percent
Property or facility director, manager, or supervisor	77	4	81	66%
Electrician or other mechanical/technical staff	20	12	32	26%
Other manager, team leader, supervisor position	27	2	29	24%
Custodial Manager or Supervisor	21	1	22	18%
Engineer	19	3	22	18%
Custodian/ Custodial staff	3	2	5	4%
General contractor	2	1	3	2%

Survey question: Building operations and maintenance staff have a wide range of job titles or descriptions. Which of the following describe your job or are included in your job title? Please check all that apply.

4.3.3. Work Environment

Respondents represented a wide range of employer types, with Government and K-12 School the most commonly identified. As Figure 4 shows, the distribution of employer types was similar to that in the list of 3,013 NEEC contacts that we invited to take the survey. The sample also was similar to the regional population of BOC-certified operators. Two notable differences is that the survey sample had relatively fewer government employees than the BOC population (21% vs. 30%) and relatively more operators in the "other" employer category, which includes office, retail, warehouse, mixed use, and miscellaneous employer types (22% vs. 9%).

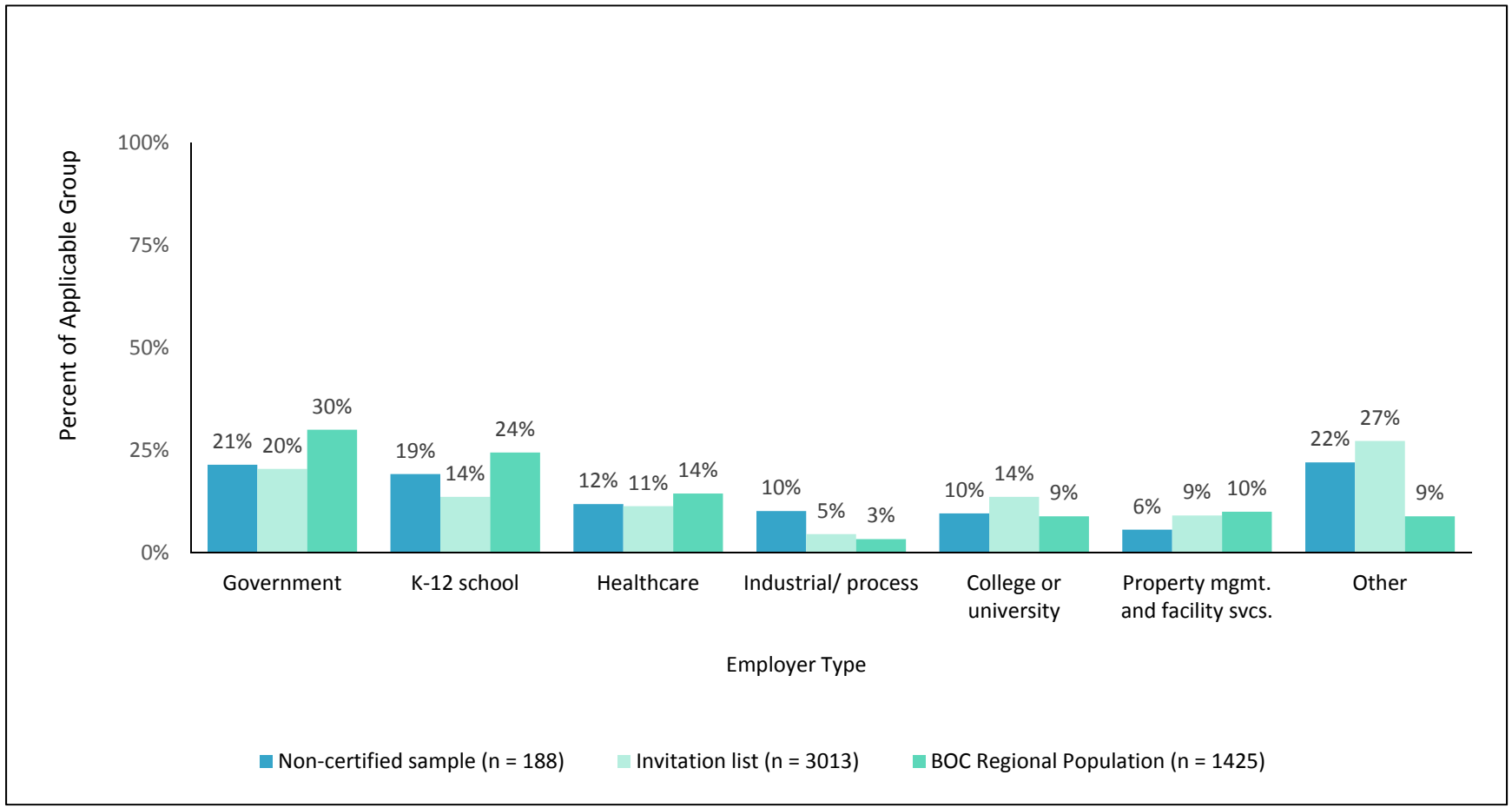
The 122 surveyed operators reported working mainly in large (more than 50,000 square feet) buildings and were largely "in-house" operators rather than a third-party service provider.[15] Two-thirds reported that the building or buildings they worked in comprised at least 100,000 square feet of conditioned space, half of whom reported the workplace (including multiple buildings[16]) comprised at least 500,000 square feet.

Respondents varied in terms of the number and distribution of buildings they worked in: about two-fifths reporting multiple locations of often more than 10 buildings, while about one-third reported a complex of usually 10 or fewer co-located buildings and about one-fifth reported working in a single building.

[15] Of the 122 building operators, 47 (39%) responded "yes" to the question: "Does your business or organization provide operations and maintenance services to other businesses and buildings?"

[16] The survey first asked which of several options best (single building, complex of buildings at a single location, buildings at multiple locations, etc.) described their work environment. If a respondent reported working in a complex or multiple locations, the survey asked how many buildings the respondent worked in.

Figure 4. Comparison of Non-Certified Operator Sample (*n* = 188), Sample Frame (n = 3,013), and BOC Regional Population (n = 1,425) on Type of Employer[a]



[a] "Other" employer types included office, mixed use, retail, warehouse, and a variety of other types that each represented a small percentage of respondents.

Respondents also varied regarding how many other building operators they reported at their worksites: about one-third reported five or fewer operators, with the remainder equally split between those reporting six to 10, 11 to 25, and more than 25.

About two-thirds of the 66 surveyed business owners or officers reported the number and size of buildings their company owns or leases and the number of building operators they employ. Of those, about half reported their company owns or leases more than 10 buildings and about two-thirds reported total building area of at least 100,000 square feet.

4.3.4. Awareness, Familiarity, and Experience with BOC

One goal of the survey was to assess the perceived value of the BOC credential among those with certified staff. Therefore, the survey asked respondents whether they themselves had such training or certification and, if they managed O&M staff, whether any staff had it: 12% of all respondents (n = 188) reported they had the credential and 18% of those who managed operators (n = 158) reported a staff member had it. In all, 28% of all respondents reported either they or a staff member had the credential.

Among respondents that did not have the credential or have staff with the credential, about three-quarters (73%) said they had heard of BOC: 60% reported they knew at least some details about BOC and about one-quarter said they knew a lot about it.

One-fifth of the 54 respondents who employed or managed operators with BOC training reported they did not know a lot about BOC. There may thus be value in working to improve awareness and understanding of BOC even among those with BOC-trained staff.

4.3.5. Non-BOC Training and Certifications

The survey investigated the types of non-BOC training and/or certifications that respondents or their staff had received in the previous five years. Three-fifths (61%) of the 188 respondents reported taking non-BOC training or receiving a certification or other type of credential in that time frame. The training they reported was fairly evenly distributed across a range of topics covering general maintenance or sustainability as well as specific equipment types (most frequently electrical equipment, systems and controls, boilers, and HVAC).

Fewer respondents (n = 55) identified a specific training source or credential, such as a specific certification (e.g., Certified Energy Manager) or licensure; of those, about half (15% of all respondents) identified training or a credential from a professional association, such as the U.S. Green Building Council, BOMI International, or the Association of Energy Engineers. Two-fifths (12% of all respondents) reported having a specific State licensure. About one-sixth (5% of respondents) identified a federal government agency (the U.S. Environmental Protection Agency, the Occupational Safety and Health Administration, the U.S. Department of Transportation) as the source of their training or credential. Finally, nine percent of respondents identifying a specific training (three percent of all respondents) identified private organizations, including utilities.

4.3.6. Support for O&M Certification and Maintenance

Asked about the types of support their company provides building operators to obtain and maintain appropriate certifications, about three-quarters said they encourage certification, would pay at least part of the expenses, and would allow paid time off for the training. They were slightly less likely to say they encourage maintenance of certification, but about as likely to say they would pay expenses and provide paid time off for maintenance-related activities.

To follow up, the survey identified eight skill areas covered by BOC training, and asked owners/managers how important each area *would be* in a decision to send a member of their building operations staff to BOC training or, for those with BOC-credentialed staff, how important they *were* in the decision to send staff for training. Respondents rated each item on a scale of 1 (not at all important) to 5 (extremely important).

From 61% to 75% of respondents gave a high rating (a 4 or 5 rating) to each item, indicated that they generally valued all of these skill areas. The most highly rated training areas related to HVAC and identification of low-cost operations improvements, suggesting possible areas of focus in marketing of BOC. Responses did not differ by whether or not the respondent had BOC-certified staff.

However, despite indicating that they value the skills that BOC provides, only about one-quarter of owners/managers *without* BOC staff indicated it was highly likely they would provide support for BOC certification and maintenance, and about half reporting a low likelihood they would pay fees or travel expenses.[17] Similarly, only 13% indicated it was likely that they or one of their O&M staff would undertake BOC training within the next 12 months, compared to 57% who rated it unlikely.

Three-quarters said they would be more likely to send staff to BOC training if their utility paid 50% of the training fee, and nearly half said they would be "significantly more likely" to do so.

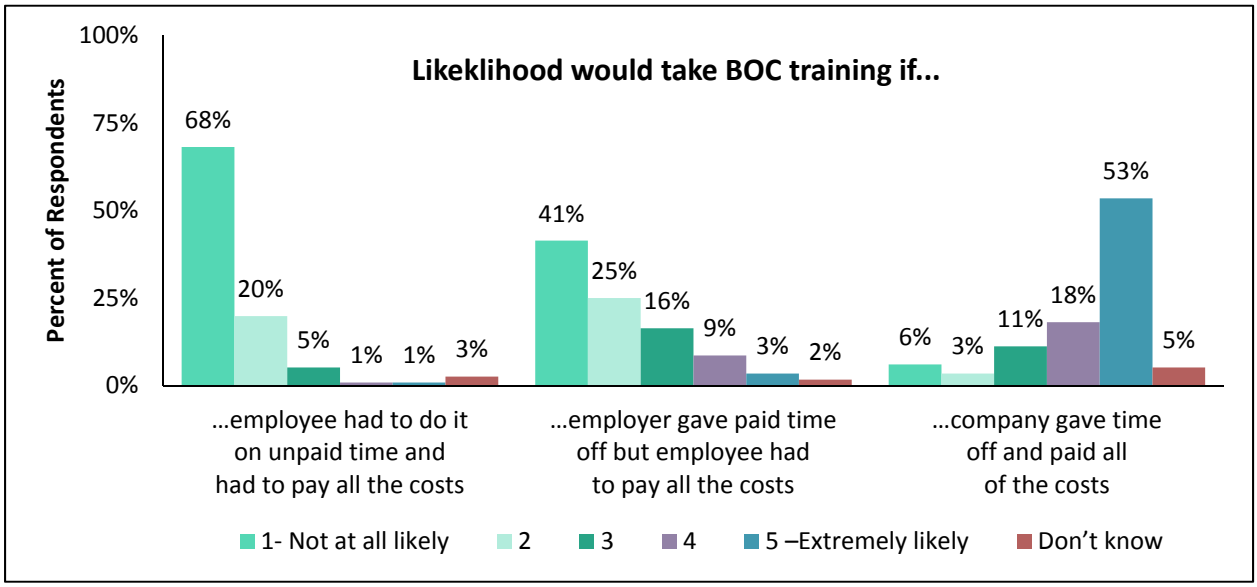
4.3.7. Employee Likeliness of Attending BOC Training

The survey briefly described the BOC training and certification process to building operators *without* the credential ($n = 116$). Respondents were then asked how likely they would be to take the training under three scenarios: 1) they had to do it on unpaid time and had to pay all the expenses themselves; 2) their employer gave them paid time off to take the training but they still were responsible for all costs; and 3) their employer gave them paid time off and paid all the costs.

As Figure 5 shows, two-thirds of these respondents said they would be not at all likely to take the training if they had to do it on unpaid time and pay all the costs, while about half said they would be extremely likely to take the training if their company gave them time off for the training and paid all the costs.

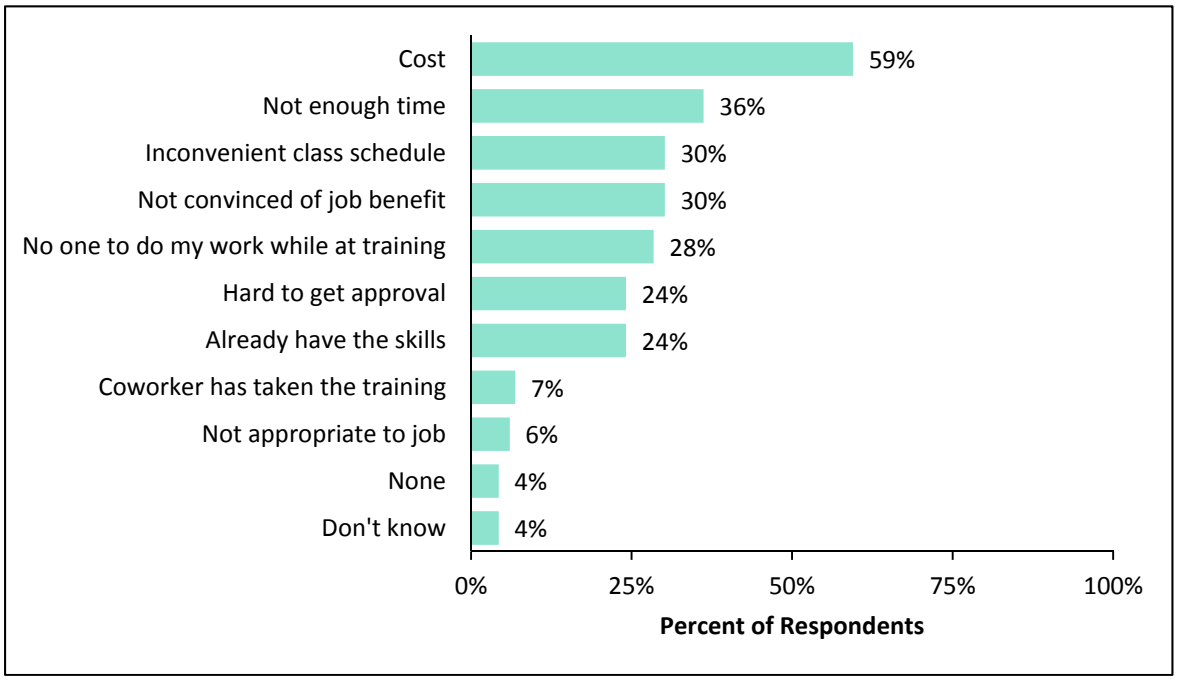
[17] Respondents rated the likelihood of providing each type of support from 1 (not at all likely) to 5 (very likely).

Figure 5. Likelihood of Taking BOC Training – Non-BOC Employees (*n* = 116)



When asked what factors would most likely prevent them from taking the training, their answers mirrored the above: cost and lack of time to take the training were the most frequently reported barriers (Figure 6). However, about one-third of respondents indicated that they were not convinced that BOC training would provide any job benefit and about one-quarter said they already had the skills that BOC training would provide.

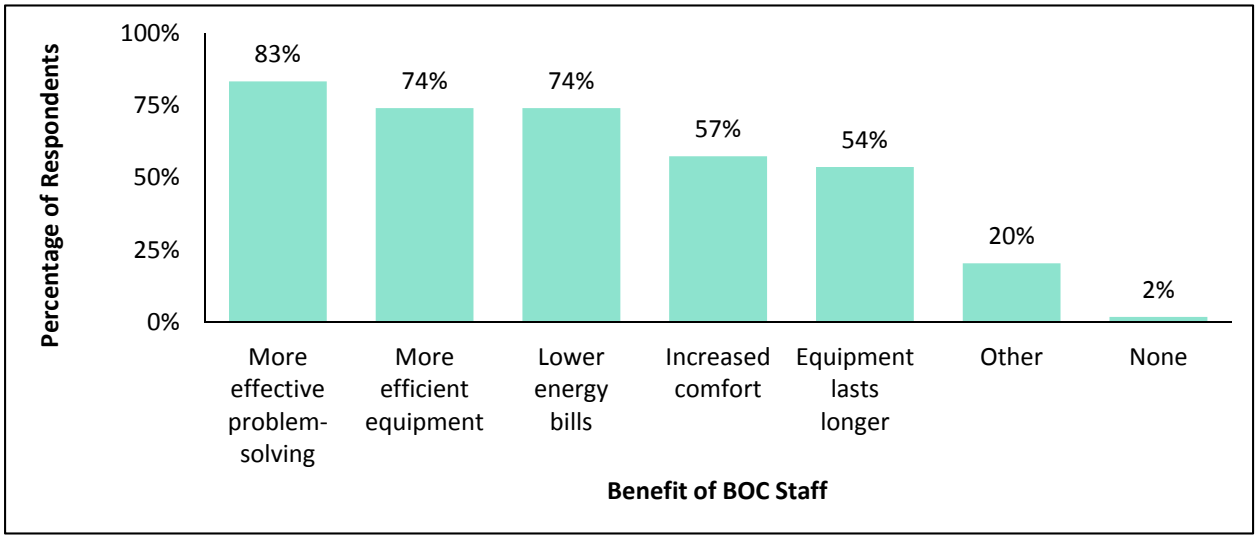
Figure 6. Barriers to Taking BOC Training – Employees without BOC (*n* = 116)



4.3.8. Benefits of BOC Training

The survey asked the 54 respondents who reported they had staff with the BOC credential about the benefits of BOC training and the degree to which their certified staff had transferred the knowledge gained from training to other O&M staff. The most commonly identified benefit (selected from a list) was more effective problem-solving, followed closely by increased equipment efficiency and lower energy bills (Figure 7). This suggests a chief benefit is the ability to respond to emerging problems rather than just performing better at "business as usual."

Figure 7. Benefits of Employing BOC Credentialed Staff (*n* = 54)



Nearly three-quarters of respondents indicated that BOC-credentialed staff transferred their knowledge to other staff at least "somewhat," about one-quarter reporting they had transferred knowledge "to a large degree." The fact that just one-quarter of respondents reported a large degree of knowledge transfer may suggest receptivity to the idea of having multiple staff trained.

4.3.9. Staff Retention

Finally, since much research has linked employee training either directly or indirectly with staff retention, the survey addressed the value of staff retention.[18] The survey asked all respondents who reported they supervised any O&M staff (*n* = 158) how problematic it would be to lose a senior O&M employee and, if that happened, how long it would take to replace the lost

[18] Research shows that employers often use training programs as a staff retention mechanism (CIPD, 2009; Mulder 2001; Hallier and Butts, 1999). Tseng and Wallace (2009), Brum,(2007), Martin (2003), Ranft and Lord (2000) reported evidence of a direct relationship between providing training opportunities and staff retention, while Acton and Golden (2002) reported an indirect relationship, with training positively related to job satisfaction, which is positively related to retention. Tharenou et al. (2007) reviewed 14 studies, four of which found a direct relationship between training and staff retention, while the others found indirect relationships. See Appendix G for full citations.

employee. Respondents rated the impact of losing a senior O&M employee on a scale from 1 (not at all problematic) to 5 (extremely problematic).

For about two-thirds of respondents, losing a senior O&M employee would be problematic (a 4 or 5 on the 1-to-5 scale; Figure 8). Half the respondents could not say how long it would take to replace a senior O&M employee, but more than half of the remaining respondents said it would take more than two months (Figure 9). Taken together, these findings suggest that a message effectively tying BOC certification to employee retention may induce owners and managers to offer the training to their staff.

Figure 8. How Problematic Losing a Senior O&M Employee Would Be (*n* = 158)

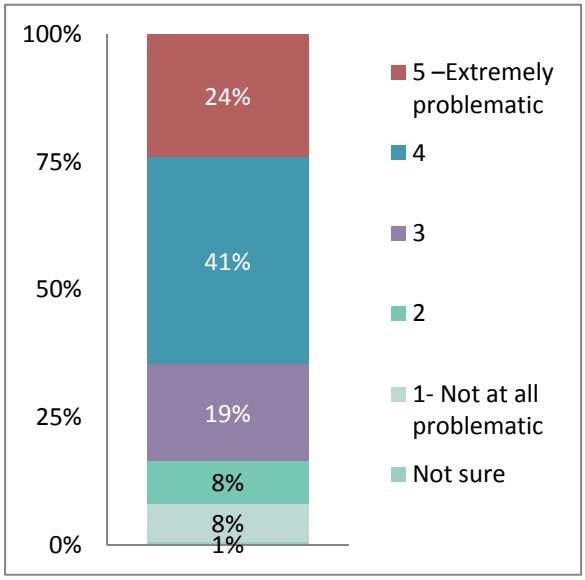
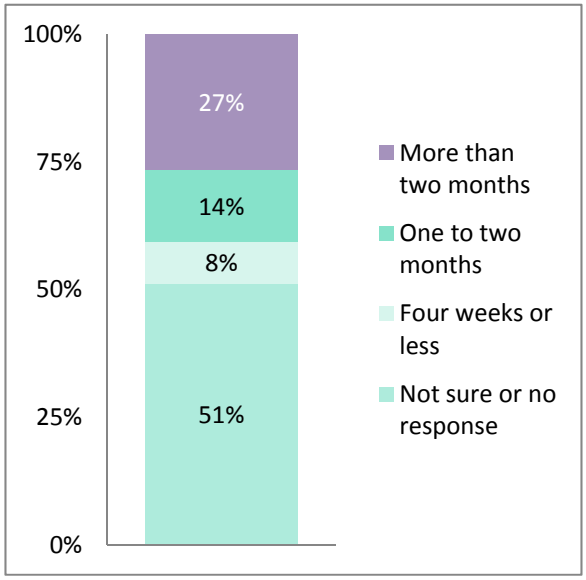


Figure 9. How Much Time It Would Take To Replace a Senior O&M Employee (*n* = 158)



4.3.10. Survey Summary and Conclusions

Respondents represented a range of work environments, employer types and sizes. Generally, they appear to be similar to the population of BOC-credentialed operators. Most respondents were at least somewhat familiar with BOC, and about one-quarter either had or had staff with the credential.

Results indicated that, in general, employers support technical training and certification for their O&M staff. Majorities reported support for O&M certification and maintenance and described training histories that covered a variety of general maintenance or equipment-specific topics, offered through professional associations, state licensure agencies, federal agency, or private providers. Similar majorities also indicated that most of the BOC training topics (particularly low-cost operations and HVAC-related) would factor in decisions about sending staff to BOC training.

Staff would be very likely to take the training if the company provided time off and paid costs, but not otherwise. Other factors, like inconvenient class schedule, lack of someone to take on their work responsibilities, and lack of belief in the job benefit, offer moderate barriers.

Despite the general support for training and certification, however, owners' and managers' responses suggested that those without BOC staff were not highly likely to support BOC certification and maintenance. Two possible interpretations are that: a) the respondents have some particular reason for not wanting to support BOC certification and maintenance; or b) respondents found it easier to state that they (or their companies) supported training when we worded the question in the abstract than to commit to a particular training program. It may be that, in answering the more generally worded question, respondents envisioned briefer (e.g., one- or two-day) training events, rather than BOC's seven day-long modules.

Three findings suggest possible ways to encourage owners and managers to support BOC certification and maintenance. First, owners and managers said they would be much more likely to provide the support if their utility covered half the training fee, so broadening utility support for training may be important. Second, findings suggest that staff retention is an important issue. As noted above, much research ties provision of training opportunities to employee satisfaction and retention. Therefore, messaging that effectively communicates the training-satisfaction-retention link may motivate employers to support BOC training. Third, large majorities of owner/managers with BOC staff endorsed several benefits of BOC training, particularly more effective problem-solving, suggesting possible messaging content for marketing.

A final finding of interest is that owners and managers with BOC staff reported that knowledge transfer was moderate. While this points to an additional benefit of supporting BOC training, the fact that respondents generally did not report high levels of knowledge transfer suggests that there may be added benefit of training additional staff. This suggests a possible opportunity to appeal to current employers of BOC-credentialed operators to increase their benefits by supporting training and certification for additional staff.

4.4. Market Progress Indicators (MPIs)

This subsection summarizes the evaluation's findings to date relative to the 11 BOC-E MPIs. The initiative has so far achieved, or is near to achieving, three MPIs:

- IUOE became a BOC Approved Provider in February of 2013 (MPI III). It is near to achieving two others:
  - NEEA staff completed a Utility Engagement Plan (MPI IV) in 2013, and has revised it in 2014 with input from utilities.
  - GSA has notified NEEC of its status as a GSA Contract Partner (MPI I).

Progress on other MPIs so far includes:

- MPI V: 45 students from underserved markets in 2013, 41 from Washington and Oregon and four from Idaho and Montana.

- MPI VI: 10 students who are IUOE members in 2013, 8 from Washington and Oregon and two from Idaho and Montana.

- MPI XI: At least five regional utilities now support or leverage BOC in their energy efficiency programs.

Four MPIs, including two of the above, are stated in terms of a 10% increase in a given student type over the 2012 baseline: II (increase in IBOA students), V (increase in students in underserved areas), VI (increase in IUOE-member students), and IX (increase in students that are federal employees). As noted in Section 4.1, year-to-year fluctuation in participation by any group is to be expected: if 2012 participation by any groups was unusually high or low, then it would not be an appropriate baseline for comparison. A better approach would be to define the baseline using data for the years up to 2012, but this is possible only for MPI II, as explained in Section 4.1.

With the above caveat, the 2013 participation by students in underserved areas was nearly double that in 2012, but the 2013 participation by IUOE members was at about the 2012 level.

We will work with initiative staff to resolve these issues and to establish appropriate baselines.

Table 9 shows the 11 MPIs, the outcome associated with each, the timeframe in which the BOC implementation team expects the outcome to occur, the data source the program logic model specifies for assessing progress, and a brief summary of the evaluation's findings so far.

Table 9. BOC-E Initiative Market Progress Indicators (MPIs)

MPI #	Outcome	Time Frame	MPI	Data Source	Evaluation Findings
I	BOC is an approved training provider for GSA	Short term (1-3 years)[1]	BOC listed on GSA training provider roster.	GSA's published list of approved training providers	NEEC is a GSA Contract Partner.[19]
II	Increased participation by IBOA members	Medium term (3-5 years)	10% increase in IBOA certificants over 2012 baseline by Dec. 31, 2015	NEEC database & IBOA data for baseline	The number of 2013 known or assumed IBOA trainees (16) is just over one-third of the 2012 number (45).[20] It is possible that the available BOC dataset does not include all IBOA trainees from 2013.
III	IUOE becomes a BOC Approved Provider	Short term (1-3 years)	Signed AP agreement by NEEC and IUOE.	NEEC's signed agreement	IUOE became a BOC Approved Provider on February 28, 2013 (Source: "IUOE Approved Provider Letter_RTC," on the NEEA SharePoint folder.)
IV	Utility Engagement Plan	Short term (1-3 years)	Utility Engagement Plan accepted by NEEA management	NEEA Sharepoint BOC E page (link to utility engagement plan)	Completed in 2013, and revised with input from utilities.
V	Increased participation by operators in underserved markets	Medium term (3-5 years)	10% increase in certifications by operators in underserved markets, over 2012 baseline, by Dec. 31, 2015	NEEC student database: count students associated with "underserved markets"	There were 45 underserved students in 2013, 41 from Washington and Oregon, compared to 25 in 2012 and 6 before 2012 (all from Washington and Oregon).
VI	IUOE-member operators become BOC certified	Medium term (3-5 years)	10% increase in certifications by IUOE-member building operators over 2012 baseline by Dec. 31, 2015	NEEC student database: year over year count of students associated with "IUOE" association type	There were 10 IUOE-member students in 2013, 8 from Washington and Oregon, compared to 13 in 2012 and 8 in 2011 (all from Washington and Oregon).

Continued

[19] Source: https://intranet.neea.org/Initiatives/BOCE/Lists/InitiativeDocuments/2014-15%20ANSI%20Milestones.docx.

[20] The available BOC data does not identify whether IBOA or NEEC is the trainer for 18 2012-2013 BOC trainees with ID/MT work addresses and 70 with WA/OR work addresses. The data file identifies identifies IBOA as the trainer in 59% of all other cases with ID/MT work addresses and 0.6% of cases with WA/OR work addresses; applying those percentages to the 88 records with unidentified trainer, we estimated that that IBOA was the trainer for 11.

MPI #	Outcome	Time Frame	MPI	Data Source	Evaluation Findings
VII	BOC program operates in alignment with ANSI/ISO/IEC 17024 for one year prior to applying for standard	Medium term (3-5 years)	Demonstration of a firewall between training and exam at NEEC by September 30, 2014.	NEEC Organizational Chart and business plan: evaluator to review to determine whether in alignment.	The NEEC Board of Directors approved the formation of an Advisory Board for BOC alignment with and application for ANSI/ISO/IEC Accreditation in its September 10, 2013 meeting.
VIII	BOC exam is authorized under ANSI 17024 standard	Long term (5-10 years)	Signed letter of authorization by June 1, 2017	ANSI-authorized providers posted on ANSI website (give URL)	NEEC will continue seeking ANSI accreditation for BOC (Source: "ANSI Legal Issues Memo," dated March 25, 2013, located on the NEEA SharePoint folder.)
IX	Increased participation by operators employed in the Federal sector	Long term (5-10 years)	10% increase in certifications by Federal building operators over 2012 baseline by June 30, 2016.	NEEC student database: year over year count/comparison of students associated with "Federal" association type	As of 2013, there were 6 "Federal" students in the NEEC database (2% of the 2012-2013 BOC Cohort).
X	Increased demand and preference for credential by employers and operators	Long term (5-10 years)	Certification rate increases from 75% to 85%. 70% annual certification renewal rate, by 12/31/2016.	NEEC student database: count renewals	71% of BOC students certified through 2013. 54% of certificants that might have renewed through 2013 did so.
XI	Region's utilities support/leverage BOC into their EE portfolios	Long term (5-10 years)	Ten region utilities leverage/support BOC in their EE programs	NEEC to survey NW region utilities for leverage/support of BOC in EE programs OR query from NEEC database.	As of 2013, five regional utilities supported or leveraged BOC in their programs.

5. ACE Model Assumptions

For MPER #1, we used data from a survey of BOC-credentialed building operators to estimate per-operator electric and gas savings to compare with the input assumptions of the BOC-E ACE Model. A recent re-analysis of data from that survey indicated that BOC operators, on average, save 4.27% in electricity consumption and 6.26% in natural gas. Operators' self-reports of the influence of BOC training on their O&M practices indicated that, on average, BOC training was responsible for just over half of that reduced energy consumption. Thus, we estimated that BOC training was responsible for a 2.03% reduction in electricity and a 3.58% reduction in gas.

For the current MPER, we used the energy consumption and savings analysis from surveyed non-certified operators as a control group for the BOC-certified operators, providing an alternative approach to estimating BOC's share of savings from the certified operators. We presented our findings in a memo to NEEA on April 25, 2014, included in this MPER as Appendix E.

Our findings demonstrated that BOC training results in electricity savings for several equipment types and likely produces overall electricity savings, compared to the savings achieved by non-certified operators. Overall, the results indicated BOC-attributable savings for natural gas and electricity were close to those we reported in BOC-E Market Progress Evaluation Report #1 (MPER #1).[21] Based on that finding, we recommend no changes to the current ACE Model assumptions. The study also found that BOC training produces greater savings for some equipment types than others, which may suggest areas to investigate possible adjustments in training.

The sections that follow present: the methodology for the current research, including survey implementation, survey data preparation and analysis, and the research results.

5.1. Methods

Research Into Action conducted an online survey of building owners, business owners, and operations and maintenance (O&M) workers. As part of that survey, we assessed the O&M practices of 84 O&M workers, and the impact of those practices on energy consumption, using the same methods that we used in the 2013 survey of BOC certificants. We summarize the methods below; details are in Appendix E.

[21] *BOC-Expansion Initiative Market Progress Evaluation Report #1 (Report #E14-277).* Prepared by Research Into Action, Inc. for Northwest Energy Efficiency Alliance, April 24, 2014. Available at: *http://neea.org/docs/default-source/reports/boc-expansion-initiative-market-progress-evaluation.pdf?sfvrsn=4*

5.1.1. Survey Implementation

We implemented the survey through email invitations to a subset of the Northwest Energy Efficiency's Council (NEEC) building operators contact list and to a media organization's subscriber list. The NEEC list of 7,488 building operations and facilities management contacts was the largest and most comprehensive list of building operations and facility management contacts we could identify. We removed BOC students and duplicate records from the list, leaving 3,013 names.

Trade Press Media Group, Inc., a media company serving the building operations and facility management industry, sent the invitation once to a list of 1,851 Pacific Northwest subscribers to two of the company's professional journals. To address likely overlap in the NEEC and Trade Press lists, we first sent the email invitation and two reminders to the NEEC list. We then asked Trade Press to send the invitation to its list with a statement that they should not take the survey if they already responded to our invitation. Trade Press sent no additional reminders. We then sent a third reminder to the NEEC list.

5.1.2. Survey Responses

In total, 114 O&M workers from Washington or Oregon responded to the survey, all but three coming from the NEEC contact list. There were no duplicate responses. As the goal was to compare estimated savings to those from the survey of BOC certificants, all of whom worked in Oregon and Washington, we removed the few responses we received from Idaho and Montana.

Ten respondents reported being BOC-certified. We reclassified them as BOC-certified operators for the purposes of calculating energy savings. Of the remaining 104 non-certified O&M workers, 84 provided sufficient data to assess energy savings (therms, kWh, or both). Those who provided usable data were similar to the overall O&M worker sample in reported work title, employer type, and number of O&M at their workplace. The final sample size delivers at least 90/10 confidence/precision for the descriptions of individual O&M practices.

5.1.3. Calculating Respondents' Energy Savings

The Research Into Action team estimated energy savings for each survey respondent with the methods we established for the 2013 survey of BOC-certified operators, documented in detail in MPER #1 and summarized here. We did not re-analyze the savings for the individual BOC-certified respondents from the previous survey, but we added the 10 survey identified respondents as BOC-certified operators to the certified operator sample.

The survey assessed building or facility size, location, and end-use type. For each respondent, we calculated a baseline energy consumption value based on those characteristics and energy usage intensity (EUI) data from the 2009 CBSA.[22] The baseline represented what the building or

[22] The 2009 CBSA data were the most recent available at the time of analysis.

facility's energy consumption would be if it were operated with standard building operations practices.[23]

The survey asked respondents about their O&M practices relating to nine equipment types that the BOC curriculum addresses: boilers; chilled water systems; economizers and ventilation control; compressed air; fans and air distribution; domestic water heaters; lighting; pumps; and motors. The survey first asked which of the types they were responsible for and then asked a series of questions about their O&M practices for each equipment type that a respondent identified.

Our team used engineering analyses, together with a savings database built from extensive retrocommissioning evaluation experience, to calculate the energy savings (electricity as well as natural gas) that would result from respondent's self-reported O&M practices.[24]

We identified outliers in both the certified and non-certified operator group based on calculated therm and kWh savings percentages. Since respondents reported responsibility for varying numbers of equipment types, we identified outliers for each equipment type and excluded respondent from fuel-specific savings analyses if *any* of the equipment-specific savings values for a fuel type were outliers. In total, we excluded six non-certified respondents from kWh savings, one of whom we also excluded from therm savings. We excluded nine BOC-certified respondents as outliers for kWh savings and one as an outlier for therm savings.

5.1.4. Controlling for Possible Confounding Factors

The certified and non-certified operator samples differed in several respects: 1) a high percentage (82%) of non-certified operators reported they managed other O&M staff, while just under half the certified operators did so; 2) non-certified respondents were somewhat less likely to have government employers and they tended to have smaller workplaces; and 3) the non-certified operators reported responsibility for more equipment types, on average, than certified ones and so had more opportunities to report energy savings. These differences could affect the savings estimates, complicating the interpretation of a direct comparison of savings.

We addressed these potential confounding factors by, first, restricting analyses to operators classified as managers and then weighting the data based on employer type and facility size, effectively removing the employer type and size differences between the two groups. We then compared the two groups on equipment-specific savings percentages and used those comparisons to estimate the relative difference between the two groups over all equipment types. Finally, we used that relative difference to estimate what the savings would be for non-certified operators if they had the same equipment responsibilities as the certified operators.

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[23] The baseline is based on CBSA data, which are the product of a representative sample of buildings. Therefore, by definition, the CBSA-based consumption represents "standard" (or average) building operations practices.

[24] See Appendix E for details of the methodology.

5.2. Results

Table 10 shows the results of the analyses described in the preceding section. Columns A and C of the table show the mean equipment-specific energy savings for each fuel type, calculated for the BOC-certified and non-certified operators, respectively. In calculating these percentages, we included only those respondents who reported responsibility for the relevant equipment type. For each comparison, we calculated the mean savings percentage as the total calculated savings for that equipment type divided by the total estimated baseline energy consumption for the entire building.

Columns B and D show the summed equipment-specific savings for each fuel type, again for the BOC-certified and non-certified operators, respectively. These *are not* the actual mean savings percentages for each group, so calculating the deltas between certified and non-certified operators for these figures would not be meaningful. These represent the mean savings that each group of operators would have *if all respondents were responsible for all equipment types*. As explained above, the purpose of calculating these figures is to control for differences between the certified and non-certified operators in the reported areas of equipment responsibilities, allowing us to establish what the relative difference (ratio) between the two groups would be if they had the same equipment responsibilities. Column E shows those ratios.

Based on *actual reported areas of equipment responsibility*, we calculated that certified operators save, on average, 9.68% in therms and 3.71% in kWh (Column F). Applying the ratios in Column E to these figures shows that non-certified operators would save, on average, 6.62% therms and 2.30% kWh if they had the same equipment responsibilities as the certified operators reported (Column G). Therefore, the certified managers' therm and kWh savings would exceed those of non-certified managers by 3.06% and 1.42%, respectively (Column H).

The analysis of savings by equipment type showed that BOC operators showed the greatest savings advantage over non-certified operators for boilers, fans, and economizers, suggesting that these are areas where the BOC training may be most effective.

By contrast, while certified operators showed high savings for demand-controlled ventilation (DCV), non-certified operators actually showed higher DCV savings for that measure. Of the surveyed certified operators with related equipment responsibility, 40% had not implemented DCV. BOC therefore may consider whether to review the BOC training modules related to DCV with an eye to increasing its adoption.

Certified operators showed no appreciable savings for compressed air. About half of the certified operators who reported compressed air responsibilities said they do not perform regular compressed air leak surveys, and when they did, their most common method was to listen for audible sound rather than using an ultrasonic leak detector or infrared camera. Most of those respondents reported non-industrial work settings, where compressed air applications are less energy-intensive than in industrial settings. Nevertheless, BOC may consider whether to review the BOC training modules related to compressed air O&M with an eye to increasing the adoption of best practice O&M for that equipment type.

Table 10. Energy Savings by Equipment Type and for All Equipment Types

	BOC-Certified			Non-Certified						
		Savings %			Savings %					
Equipment Type	Count	(A) Equipment Type	(B) Total If Responsible for All Equipment	Count	(C) Equipment Type	(D) Total If Responsible for All Equipment	(E) Ratio, Non-Cert. to Cert. (D / B)	(F) Certified Operator Mean Savings	(G) Non-Certified Operator Estimated Savings (E * F)	(H) Delta – Certified Minus Non-Certified (F – G)
Therms										
Boilers	51	4.38%	13.51%	42	1.68%	9.24%	.684	9.68%	6.62%	3.06%
Economizers	69	1.01%		60	0.44%					
Fans	68	1.80%		66	1.68%					
DCV[a]	77	6.33%		68	5.45%					
kWh										
Economizers	63	2.32%	5.55%	56	0.96%	3.43%	.618	3.71%	2.30%	1.42%
Fans	62	1.82%		62	1.01%					
Chillers	35	0.23%		34	0.00%					
Pumps and motors	54	0.13%		59	0.04%					
Compressed air	33	0.02%		45	0.01%					
Lighting	79	0.02%		64	0.03%					
DCV[a]	70	1.00%		64	1.37%					

[a] Demand-controlled ventilation (DCV).

5.3. Conclusion

By comparing the savings of certified and non-certified operators across the range of specific equipment types, we determined that the non-certified operators in this survey would save about 68% as many therms and about 62% as many kWh as the certified operators with the same areas of equipment responsibility.

We calculated certified operators' actual therm and kWh savings based on their reported equipment responsibilities, as 9.68% and 3.71%, respectively. Applying 68% and 62%, respectively, to those values, we estimated that non-certified operators with the same responsibilities would save 6.62% in therms and 2.30% in kWh. Therefore, certified operators' therm and kWh savings would exceed those of non-certified ones with the same equipment responsibilities by 3.06% and 1.42%, respectively.

The figures of 3.06% and 1.42% represent estimates of the therm and kWh savings advantages of certified operator managers over similar non-certified operator managers. Given that these figures are similar to those we calculated using the method reported in MPER #1 (3.58% and 2.03%, respectively), and that they are mathematically derived rather than based on direct comparisons, we believe they should not be used in place of the previous values. Rather, they support the previous values.

The current analyses may not be applicable to "line" operators that do not have managerial/ supervisory responsibilities. We do not know whether BOC training provides a relatively greater advantage to managerial/supervisory or non- managerial/supervisory operators. In the 2013 survey of BOC operators, the mean rated influence of BOC training was very similar for managerial/supervisory and other operators (5.4 vs. 5.2, on a scale of 0 to 10). Thus, BOC training appears to have had a similar level of relative influence on the O&M practices of both groups. Further research is needed to determine whether BOC-certified line operators have the same relative advantage over their non-certified counterparts that the current research indicates exists for certified managerial/supervisory operators.

See Appendix E for a discussion of possible research avenues.

6. Conclusions and Recommendations

This evaluation assessed progress toward Initiative goals; used information from market expert interviews and secondary research to characterize the BOC market, with special emphasis on Idaho and Montana; assessed the revised BOC-E logic model; and estimated BOC per-operator energy savings percentages, a key parameter of the Alliance Cost Effectiveness (ACE) Model. It included a survey of 188 building owners, business owners, and operations and maintenance (O&M) workers located primarily in Oregon and Washington. The survey provided data on awareness of and attitudes toward BOC training; it also generated data on energy savings by non-certified building operators to compare to estimates of savings by BOC-certified operators, obtained as part of the 2013 BOC-E evaluation.

This MPER includes the first NEEA-funded research to allow a comparison between the energy consumption and savings of non-certified and BOC-certified building operators. The research provided an alternative approach to assessing the BOC share of BOC-certified operator savings, and the results were consistent with the recommended savings assumptions from MPER #1.

In addition to supporting the Initiative's assumptions, goals, and approach and documenting progress toward those goals, the research activities for this MPER produced several important findings.

Conclusions

BOC-E is progressing toward its goals, especially those supporting expanded outreach. BOC has established IUOE as a BOC Approved Provider and trained about 50% more IUOE members in 2013 than 2012; NEEC received GSA notification of its pending status as a GSA Contract Partner and plans to begin operating in alignment with American National Standards Institute (ANSI) standard 17024 by the end of September 2014; the number of students in underserved areas more than doubled since 2012; and at least five regional utilities support or leverage BOC in their energy efficiency programs, which BOC expects to help increase penetration in underserved markets.

Initiative logic is sound and logic and metrics are generally clear. NEEA's program staff have clarified some links between barriers, activities, and outcomes that were somewhat unclear in an earlier version of the logic model. In this report, we have provided some suggestions for additional revisions to the definition of baselines for some metrics.

Findings support Initiative assumptions, goals, and approach. Survey data indicated that non-credentialed O&M employees are interested in BOC but employer support is critical. Despite abstract support for technical training for their O&M staff, however, employers reported low to moderate likelihood of supporting BOC certification and maintenance. Results suggest that utility engagement and focusing messaging on staff satisfaction and retention and on employer-reported benefits of BOC training may help increase employer support for BOC certification.

Although the percentage growth in the number of active BOC certificants was lower in 2013 than in 2012, there appears to be a general trend toward a slightly increased rate of growth over the past several years. The number of new certificants decreased from 233 to 165 between 2012 and 2013 while, in that time period, the number of savings retirements (individuals who had gone five years since receiving or renewing certification) increased from 70 to 114. As a result, the Northwest experienced a net gain of only 51 active BOC certificants in that interval, compared to a net gain of 163 between 2011 and 2012. Yearly fluctuations in the number of new certifications and retirements are not uncommon. Rolling five-year averages in the percentage increase in active certificants show a slight increase from 4% for 2005-09 to 7% for 2008-12 and 6% for 2009-13.

Market penetration is about 18% for the region, but state-specific estimates of market size may be less reliable than for the region as a whole. With additional data we have revised the estimate of the market size upward to 12,544 operators. With about 2,233 currently employed BOC operators, market penetration is about 18%. Lack of reliable data on the mean building area per operator and on the distribution of building space across size tiers in Idaho and Montana makes estimates of market size and penetration in those states less reliable than for Washington and Oregon. Nevertheless, penetration appears to be higher in Idaho and Montana than in Washington and Oregon.

BOC savings comprise approximately 2% of electricity use, 1.8% of fossil fuel use, or 1.9% of BTU consumption from both electricity and fossil fuels. Data from a survey of non-certified operators' O&M practices provided an alternative assessment of the BOC share of certified operators' savings. Results support the findings from the 2013 survey of BOC operators.

Certified operators may not achieve superior savings compared to similar non-certified operators across all equipment types. Comparisons of savings from the surveys of certified and non-certified operators show that the certified operators' savings advantage from O&M was greatest for boilers, economizers, fans, and chillers; it was weak or nonexistent for pumps and motors and compressed air; and demand control ventilation savings were less for certified operators than non-certified operators.

Recommendations

BOC should continue and expand efforts to increase employer support of certification and renewal to drive both certification and renewal of certification by investigating messaging that ties employee satisfaction through O&M training to retention and on employer-reported benefits of BOC training and by increasing awareness of utility support for training.

NEEA should consider conducting additional research to verify BOC-related savings. Possible avenues of research are: attempt to develop a better comparison between certified and non-certified operators, either by including more non-certified operators that do not manage O&M staff or by identifying and focusing on the certified operators that do manage other O&M staff; or conduct billing analyses of facilities operated by BOC-certified operators and a matched sample of facilities without BOC-certified operators.

NEEA should consider conducting additional research to provide better data on market size and penetration in Idaho and Montana. One possible source is data from the most recent CBSA study.

BOC should review BOC training modules relating to DCV and compressed air for ways to increase adoption of recommended practices and improve savings from these end-uses.

NEEA should continue to use the ACE Model input assumptions that we recommended in MPER #1.

Appendix A. Logic Model Memo

Memorandum

To: Rita Siong, NEEA

From: Mersiha McClaren, Ryan Bliss, Marjorie McRae, Research Into Action

Date: October 25, 2013

Re: Review of Revised 2012 BOC-E Program Logic Model and MPIs

This memo provides a review of the revised program logic model for the Building Operator Certification Expansion (BOC-E) Initiative. We previously reviewed the program logic model (version 9), assumptions tables, and supporting documentation[25] and presented our findings to NEEA on April 18, 2013.[26] For this review, we have examined the revised graphic BOC Expansion Logic Model, version 11 (last revision 9/20/2013), the revised logic model tables contained in MS Excel workbook BOC 2 Logic Model Assumption Tables_v11,[27] and current documentation.[28] The goal of this review is to assess:

- How Initiative staff responded to our prior recommendations about the program logic model into the BOC-E logic model; and,
- Whether any aspects of the revised BOC-E logic model need further clarification.

Brief Description of the Initiative and the Logic Model

From 1997 to 2003, NEEA funded the Building Operator Certification Program (BOC) educates, trains, and certifies facility operators to perform energy-efficient operations and maintenance.

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[25] The "Strategy Approval Milestone Document," dated March 2, 2012. (https://intranet.neea.org/sites/initiatives/boce/ BOCE%20Documents/BOC-E_SA_Doc_SA%20Milestone%20Document_BOC2.docx)

[26] "2012 BOC-E Program Logic Model and MPIs," memorandum prepared for the Northwest Energy Efficiency Alliance by Research Into Action, April 18, 2013. The memorandum was included as Appendix B to the report, "BOC-Expansion Initiative Market Progress Evaluation Report #1," prepared for the Northwest Energy Efficiency Alliance by Research Into Action, August 21, 2013 (not yet finalized as of December 9, 2013). (*https://intranet.neea.org/sites/initiatives/boce/BOCE%20Documents/Evaluation%20BOC%20E%20MPER%201/NEEA%20BOC-E%20MPER1.docx*)

[27] There was no "last revision" date indicated on the Logic Model Assumption Tables workbook.

[28] "Initiative Review (IR1, IR2…) Milestone Document," dated July 9, 2013. (https://intranet.neea.org/sites/initiatives/boce/BOCE%20Documents/BOC%20E_IR%20Milestone%20Document%20V4.docx)

NEEA's original funding for BOC saw the initiative to maturity, achieving market awareness of 39% among building operator supervisors, with awareness expected to reach 50% by 2003.

In 2012, NEEA aimed to accelerate adoption of BOC and increase market penetration of commercial-building operators who are BOC certified in the Northwest. This new effort, titled BOC Expansion (BOC-E), seeks to address the following six market barriers:

1. Lack of time
2. Ability to pay
3. Lack of service in underserved markets[29]
4. Lack of awareness (of the BOC credential among members of the International Union of Operating Engineers, IUOE)
5. Lack of compliance with ANSI 17024 Standard for certification of personnel
6. Lack of awareness of value of BOC credential (about renewal and among utilities)

The program logic model describes the activities, outputs, and outcomes the implementation team (the team) will employ to address each of the above barriers and contribute to meeting program goals.

Review of BOC-E Logic Model

Table 11 shows the recommendations we made in our prior review of the logic model, together with summaries of the actions that NEEA took in response to our recommendations and our comments on those actions. As this table indicates, we believe all of NEEA's responses have been appropriate and have improved the logic model. We have no further recommendations at this time.

[29] "Underserved markets or communities" are defined as markets that BOC serves on an infrequent basis (i.e. once every three to seven years), and generally only with the active engagement of a utility sponsor or larger employer.

Table 11. NEEA Response to Recommendations After Initial Review of Program Logic Model (PLM)

PLM Element	Item	Recommendation	NEEA Action	Comment
Graphic	Activity 6 (conduct market research)	Revise language to reflect decision to exclude RTF after "utility interest."	NEEA dropped the reference to RTF from the PLM.	NEEA response is appropriate.
Graphic	Activity 6 (conduct market research)	If NEEA is intending to explore non-RTF-dependent approaches to increasing utility awareness and interest, revise linked output (g) to clarify desired utility-related output.	NEEA revised the linked output to reference the implementation plan and budget, which links to the utility engagement plan.	NEEA response is appropriate.
Graphic	Activity 6 (conduct market research)	Suggest adding "Promote advantages to utilities" to description of activity.	Other revisions make this unnecessary.	NEEA response is appropriate.
Graphic	Long-Term Outcome: Region's utilities incorporate BOC into their EE portfolios (MPI: X)	If NEEA is intending to explore non-RTF-dependent approaches to encouraging the region's utilities to incorporate BOC into their EE portfolios, consider revising the linked output (9) to clarify the non-RTF steps that will achieve this outcome.	NEEA revised the PLM to reference the utility engagement plan, which links to MPI X.	NEEA response is appropriate.
Graphic	Medium-term outcome: RTF accepts unitized savings for BOC (MPI: V)	Revise MPI V to reflect NEEA's updated desired outcome with respect to utility awareness and interest, if one exists. If one does not exist, delete MPI V and revise subsequent MPI numbering scheme.	NEEA has dropped the goal to have RTF accept unitized savings and has revised the PLM.	NEEA response appropriate.
Graphic	Long-Term Outcome: Maintenance and certification is valued by employers and operators (MPI: IX)	Ensure the language is consistent with program intention…. We suggest the following phrasing: "Employers and operators value up-to-date BOC certification."	NEEA revised the language to reference "increased demand and preference."	NEEA response appropriate.
Supporting documentation	Medium- and Long-term outcomes describing "increased" activity	The documentation does not indicate the success threshold, such as percentage increase or number of federal sector buildings that send operators for training.	The documentation now includes success thresholds.	NEEA response appropriate.

Continued

PLM Element	Item	Recommendation	NEEA Action	Comment
Tables	Barriers/Activities Matrix	Review the matrix and update as necessary to describe accurately how the activities will address the barriers. For example, it was not clear how "promoting scheduled courses" addresses tuition affordability.	NEEA revised the matrix, but it still is not clear how two activities ("develop blended online BOC product" and "develop partnerships with IBOA and IUOE") will reduce the barrier associated with ability to pay.	The matrix is a working chart to inform ongoing evolution of the logic model graphic, so this observation is for information only and does not require a response.
Graphic and Tables	Barriers	There is not an exact correspondence between the barriers identified in the graphic and those in the table. Review barriers and bring them into greater alignment.	NEEA has revised the tables document to bring the barriers into alignment with those in the graphic.	NEEA response appropriate.

Appendix B. BOC Database Review Memo

Memorandum

To: Rita Siong, Project Manager, Northwest Energy Efficiency Alliance (NEEA)

From: Ryan Bliss, Research Into Action

Date: February 28, 2014

Re: 2013 BOC Program Database

This memo documents Research Into Action's analysis of the Northwest Energy Efficiency Council (NEEC) Building Operator Certification (BOC) program database as of 2013. The primary goal of this analysis was to describe the 2013 new BOC certificants and update the count of active BOC certificants as February 10, 2014. Certificants classified as active are all individuals who have received or renewed the BOC credential since 2008. These are individuals for whom NEEA counts energy savings for 2013.

Methods

NEEC created an Excel database of BOC certificants in 2006 from existing paper copies of BOC records. Since then, NEEC has continued to update the electronic database with new certifications, renewals, retirements, and other pertinent information (such as address changes). In 2013, NEEC began to integrate information on BOC certifications from the International Building Operators Association (IBOA) into the NEEC database.

Each record in the NEEC database includes information about the certificant and his/her employer as well as the years of certification and expiration of BOC Level 1 and Level 2 certifications. As maintaining certification requires annual renewal, the year of "expiration of certification" is the year following the last year of renewal or the year of certification if the certificant did not renew certification.[30]

On February 10, 2014, NEEC provided Research into Action with a dataset that contained records on individuals that had received certification through NEEC and IBOA and worked in Oregon, Washington, Idaho, or Montana to that date (the "*February 10 2014 dataset*").

[30] Note that certificants that do not renew certification in a given year may renew in a later year if they complete all the continuing education requirements for the missed years. BOC considers those individuals to have maintained certification continuously. However, if in a given year a certificant did not renew in the previous year, BOC considers the certification to have expired in the previous year.

We carried out an initial quality assurance (QA) review of the *February 10 2014* dataset by comparing its contents to the contents of the datasets that we had used in 2013 for the count of 2012 certificants. The datasets that we had used for the 2013 count of 2012 certificants were: a dataset that NEEC provided in January 2013; and a dataset of IBOA certificants that Research Into Action compiled from NEEA tracking records, updated with 2012 class lists from IBOA.

Our QA review revealed that the *February 10 2014* dataset did not include records from the 2012 IBOA dataset for anyone whose certification had expired before 2010 (n = 347). We added those 347 records to the 2013 NEEC dataset and saved it as a new, combined 2013 dataset. We also were able to identify, from additional files that NEEA and NEEC provided after our initial QA review, three certificants that were not listed in either the *February 10 2014* dataset or in any of the datasets we used in 2012. We also added those records to the combined 2013 dataset.

The combined 2013 dataset included 44 records for individuals in NEEA territory that had achieved certification in 2012 or earlier *but were not in* the earlier datasets and, therefore, not represented in our previous counts.[31]

The final combined 2013 dataset included records of 2,351 individuals employed in NEEA territory that had received certification since 1996.

To update the count of active BOC certificants from 2012, we calculated the number of new and retired BOC certificants for each year from 1996 through 2013. For any given year, we identified new BOC certificants as those certified for the first time in that year and retired certificants as those who have not received certification or renewal within the previous five years (the assumed measure life of the certification).[32]

The dataset identified some certificants as retired from work or deceased without indicating the date of work retirement or death. Thus, we could not determine whether the work retirement or death was earlier than the date of savings retirement. If the date of savings retirement was 2013 or earlier, we retained that date; however, if the date of savings retirement was later than 2013, we added those cases to the count of 2013 savings retirements.

We calculated the total number of active BOC certificants in any given year as the total number that have ever received certification up to and including that year, minus the total number of retired certificants up to and including that year.

Using the same approach used in previous years, we calculated year-by-year totals of active BOC certificants by adding the number of new certificants for each year to the previous total and subtracting the number of that year's retired certificants from that sum.

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[31] We were unable to determine why these 44 records were not included in previous databases and found no reason to exclude them from the 2013 counts.

[32] NEEA established this assumption in 2005 (source: RLW Analytics, Inc (2005). Subsequent research has supported the assumption: Research Into Action, Inc. (2014). See Appendix G.

We identified 486 individuals that had both BOC Level 1 and Level 2 certification, with different certification and expiration years for the two levels. For each individual, we assigned a single "first year certified" as the earlier year in which the individual received Level 1 or Level 2 certification; and we assigned a single "last year certified" as the last year in which that individual was certified at either level – i.e., the year before the first year in which both levels were expired. Table 12 provides an example to illustrate this.

Table 12. Example Computation of First Year Certified and Last Year Certified

Level	Certified	Expired	First Year Cert.	Last Year Cert.
Level 1	2001	2005	2001	2006
Level 2	2003	2007		

BOC Expansion Attributes

The 2013 BOC database includes information relevant to the BOC expansion (BOC-E) efforts, specifically membership in one of three BOC-E special classes or in one of four other groups that the Initiative has targeted. The three special classes are: *Large Employer* – that is, classes formed through the Initiative's outreach to large employers; *Underserved* – that is, classes held in previously underserved areas; and *Online* – that is, classes that incorporate online modules. The other four groups are: certificants that received training from the International Union of Operating Engineers (IUOE); returning veterans who served in Afghanistan or Iraq (2001 to 2012); federal employees; and the unemployed. For the purpose of brevity, this memo refers to membership in the three special classes and the other four groups as BOC-E "attributes."

As of 2013, a total of 221 individuals fit into one or more of the above special classes or groups. Of those individuals, 197 received BOC certification for the first time in 2012 or 2013 ("new certificants") and 31 had received BOC certification prior to 2013 (typically Level 1) but received an additional certification through BOC-E (typically Level 2) in 2012 or 2013 ("continuing certificants").[33] Table 13 shows counts for various attributes of BOC-E certificants.[34] When NEEA launched the BOC-E initiative, it targeted veterans and unemployed trainees. Currently, BOC-E does not target these two groups but still tracks them in the BOC database. Table 14 shows other tracked associations.

[33] Some certificants are both "new" and "continuing" as they received a level 1 certification in 2012 and Level 2 in 2013 – therefore they were counted as "new" for the Level 1 certification and as "continuing" for Level 2. Also, one certificant originally received Level 1 certification in 1999 but recertified as Level 1 in 2013 after having allowed certification to lapse. For both the current counts and the year-to-year counts of active participants (see Table 15), we counted this certificant as a continuing certificant in 2013.

[34] As individuals may possess more than one of the attributes found in the table, the total of the line items may exceed the total of unique BOC-E certificants.

Table 13. BOC Expansion Special Class Type (Multiple Selections Allowed; *n* = 221)

	New Certificants [a]			Continuing Certificants [b]			All Certificants		
Attribute Type	**2012**	**2013**	**Total**	**2012**	**2013**	**Total**	**2012**	**2013**	**Total**
Large Employer	38	70	108	0	19	19	38	89	126
Underserved	25	45	70	0	10	10	25	55	76
Online Class	0	12	12	0	0	0	0	12	12
Any Special Class	62	101	163	0	28	28	62	129	187
IUOE is Education Provider	0	10	10	0	0	0	0	10	10
Veteran (2001-2012)	3	4	7	0	2	2	2	6	8
Federal Employee	1	2	3	0	1	1	1	3	4
Unemployed	24	0	24	0	3	3	24	3	24
Any Tracked Group [c]	28	16	44	0	5	5	28	21	45
Any BOC-E Attribute [d]	87	110	197	0	31	31	87	141	221

[a] These are individuals who received their initial BOC certification in 2012 or 2013.

[b] These are individuals who: a) received their initial BOC certification before 2012 and then received a second certification in 2012 or 2013; or b) received their initial BOC certification in 2012 and then received a second certification in 2013.

[c] Includes IUOE as education provider, veteran (2001-2002), federal employee, and unemployed.

[d] Includes large employer, underserved, online class, IUOE as education provider, veteran (2001-2002), federal employee, and unemployed. Some respondents were in more than one of these groups; therefore, this count is not the sum of the various other counts.

Table 14. Other Tracked Associations (Multiple Selections Allowed; *n* = 70)

Association	**Pre-2012**	**2012**	**2013**	**Total**
Returning Veteran (pre-2001)	1	20	21	42
IUOE Other Than as Education Provider	8	13	9	30
Either of the above	9	32	29	70

2013 Count of Active Certificants

In 2013, we identified 165 individuals that received certification (111 through BOC-E) for the first time and 114 certificants whose savings had retired. In addition, there were 17 individuals who reported work retirement or were deceased before their savings would have retired and 8 who were unemployed. We did not count those 25 individuals as currently active certificants. We could not determine the year they first left the work force, so we could not determine the point(s) at which they first affected the year-by-year counts of active operators – only that they affect the current counts. In all, BOC has certified 2,351 individuals in the Pacific Northwest since 1996, of whom 1,420 can currently be counted as active certificants.

Table 15 shows the year-by-year counts from our 2013 BOC database analysis. The table shows counts separately for certificants that do and do not show BOC-E attributes in the database. Counts include the 44 new records that were not in the 2012 datasets. Therefore, the count of total active 2012 certificants is greater than the count we previously reported.

Table 16 (second page following) shows the year-by-year counts of new, retired, and total active certificants by the state the certificant reported working in.

Table 17 (third page following) shows the year-by-year counts of new, retired, and total active certificants grouped into those that that work in Washington or Oregon and those that work in Idaho or Montana.

The dataset does not provide comprehensive information on training provider, so we assumed that all certificants that work in Oregon or Washington received certification through NEEC and those that work in Idaho or Montana received IBOA certification.

Table 15. Market Status of Active Certified Building Operators [a]

Year	Annual New		Annual Retired		New Minus Retired
	BOC	BOC-E [b]	BOC	BOC-E	
1996	8	0	0	0	8
1997	1	0	0	0	9
1998	62	0	0	0	71
1999	141	1	0	0	213
2000	152	0	0	0	365
2001	103	0	0	0	468
2002	202	0	1	0	669
2003	165	0	3	0	831
2004	93	0	9	0	915
2005	146	0	92	0	969
2006	101	0	94	0	976
2007	104	0	92	0	988
2008	192	1	118	0	1,063
2009	120	0	96	0	1,087
2010	179	1	91	0	1,176
2011	165	16	126	0	1,231
2012	141	92	70	0	1,394
2013	55	110	114	0	1,445
Sub total	**2,130**	**221**	**906**	**0**	**1,445**
Work retired or deceased before savings retired	--	--	17	0	--
Unemployed	--	--	0	8	--
Total Inactive [c]	**--**	**--**	**923**	**8**	**--**
Total Active [d]	**--**	**--**	**--**	**--**	**1,420**

[a] Annual New= certified in that year. Annual Retired = did not receive a new certification or renewal within the previous five years. Total Active (present year) = Total Active (previous year) + Annual New – Annual Retired.

[b] The year-by-year counts in this column reflect the earlier year of any certification for individuals that became BOC-E students in 2012 or 2013. This shows that 19 individuals achieved some certification before 2012, when the Initiative began, and then achieved a second certification through the Initiative in 2012 or 2013.

[c] Total inactive is the sum of savings retired (906), work retired or deceased before savings retired (17), and unemployed (8).

[d] Total active is the sum of total new (2,129 plus 222) minus total inactive (923 plus 8).

Table 16. Market Status of Active Certified Building Operators, by State [a]

	Annual New				Annual Retired				New Minus Retired			
Year	**OR**	**WA**	**ID**	**MT**	**OR**	**WA**	**ID**	**MT**	**OR**	**WA**	**ID**	**MT**
1996	0	0	8	0	0	0	0	0	0	0	8	0
1997	0	1	0	0	0	0	0	0	0	1	8	0
1998	0	49	13	0	0	0	0	0	0	50	21	0
1999	45	78	14	5	0	0	0	0	45	128	35	5
2000	53	76	22	1	0	0	0	0	98	204	57	6
2001	38	58	0	7	0	0	0	0	136	262	57	13
2002	33	123	31	15	0	0	1	0	169	385	87	28
2003	12	93	47	13	0	0	3	0	181	478	131	41
2004	21	38	2	32	0	1	7	1	202	515	126	72
2005	30	88	16	12	20	61	11	0	212	542	131	84
2006	16	64	8	13	36	44	13	1	192	562	126	96
2007	28	61	8	7	23	49	15	5	197	574	119	98
2008	21	121	12	39	19	68	25	6	199	627	106	131
2009	18	67	21	14	19	54	7	16	198	640	120	129
2010	15	96	4	65	16	41	20	14	197	695	104	180
2011	52	101	10	18	26	69	15	16	223	727	99	182
2012	69	112	0	52	20	50	0	0	272	789	99	235
2013	41	104	9	11	23	69	13	34	290	824	95	212
Sub total	**492**	**1,330**	**225**	**304**	**200**	**486**	**128**	**92**	**292**	**844**	**97**	**212**
Work retired or deceased	--	--	--	--	1	13	2	1	--	--	--	--
Unemployed	--	--	--	--	1	7	0	0	--	--	--	--
Total Inactive [b]	--	--	--	--	**202**	**506**	**130**	**93**	--	--	--	--
Total Active [c]	--	--	--	--	--	--	--	--	**290**	**824**	**95**	**211**

[a] Annual New= certified in that year. Annual Retired = did not receive a new certification or renewal within the previous five years. Total Active (present year) = Total Active (previous year) + Annual New – Annual Retired.

[b] For each column, total inactive is the sum of savings retired, work retired or deceased before savings retired, and unemployed.

[c] For each column, total active is the sum of total new minus total inactive.

Table 17. Market Status of Active Certified Building Operators, by State of Certification (Washington/Oregon vs. Idaho/Montana)[a]

	New		Retired		New Minus Retired	
Year	**WA/OR**	**ID/MT**	**WA/OR**	**ID/MT**	**WA/OR**	**ID/MT**
1996	0	8	0	0	0	8
1997	1	0	0	0	1	8
1998	49	13	0	0	50	21
1999	123	19	0	0	173	40
2000	129	23	0	0	302	63
2001	96	7	0	0	398	70
2002	156	46	0	1	554	115
2003	105	60	0	3	659	172
2004	59	34	1	8	717	198
2005	118	28	81	11	754	215
2006	80	21	80	14	754	222
2007	89	15	72	20	771	217
2008	142	51	87	31	826	237
2009	85	35	73	23	838	249
2010	111	69	57	34	892	284
2011	153	28	95	31	950	281
2012	181	52	70	0	1,061	333
2013	145	20	70	44	1,136	309
Sub total	1,822	529	686	220	1,136	309
Work retired or deceased	--	--	14	3	1,122	306
Unemployed	--	--	8	0	1,114	306
Total Inactive[b]	--	--	708	223	--	--
Total Active[c]	--	--	--	--	1,114	306

[a] Annual New= certified in that year. Annual Retired = did not receive a new certification or renewal within the previous five years. Total Active (present year) = Total Active (previous year) + Annual New – Annual Retired.

[b] For each column, total inactive is the sum of savings retired, work retired or deceased before savings retired, and unemployed.

[c] For each column, total active is the sum of total new minus total inactive.

Appendix C. BOC Nonparticipant and Owner Survey

Memorandum

To: Rita Siong, NEEA Project Manager

From: Ryan Bliss, Research Into Action

Date: February 28, 2014

Re: BOC Nonparticipant and Owner Survey: Awareness of and Attitudes Toward BOC Training

In January and February 2014, Research Into Action conducted an online survey of 188 building owners, business owners, and operations and maintenance (O&M) workers located primarily in Oregon and Washington. The purpose of the survey was to provide market data from building and business owners and managers with O&M staff ("owner/managers") as well as from the O&M employees ("employees") themselves. These groups may overlap, as some individuals may supervise O&M staff and have direct O&M responsibilities themselves.

With all respondents, the survey assessed firmographics, awareness and familiarity with BOC, and training received. With owner/managers, the survey also assessed factors influencing decisions about staff training, attitudes toward BOC certification and maintenance, and the importance of staff retention. The survey assessed the benefits of employing BOC staff and the transfer of knowledge acquired through BOC training among owners/managers who reported having BOC-credentialed staff. In addition, the survey obtained job descriptions and perceived barriers to undertaking BOC training from respondents who were not owner/managers.

Respondents represented the BOC target market. Results indicated that, in general, O&M employees are interested in the certification but employer support is critical. While employers generally support technical training for their O&M staff, those without BOC staff indicated they were not likely to support BOC certification and maintenance. Results suggest three avenues for increasing employer support for BOC certification: 1) utility engagement; 2) tying training to staff satisfaction and retention; and 3) developing messaging that cites the employer-reported benefits of BOC training. Finally, reports of moderate knowledge transfer from BOC-credentialed staff to other staff point to an additional benefit of BOC training while also suggesting that employers of BOC-credentialed operators may be able increase their benefits by supporting training and certification for additional staff.

Methods

Research Into Action staff drafted the survey to assess the research questions identified in consultation with NEEA staff. After NEEA approved the survey questions, experienced Research Into Action staff members programmed and tested the survey using the Qualtrics© online survey software platform.

We implemented the survey through two channels with separate (but likely overlapping) survey frames: 1) through email invitations, with multiple reminders, we sent to a list we developed from the Northwest Energy Efficiency's Council (NEEC) BOC contact list; and 2) through a single email blast by a private media organization to its subscriber list.

Survey Channel 1: The Northwest Energy Efficiency Council (NEEC) provided a list of 7,488 building operations and facilities management contacts that it had developed over several years from a wide range of sources. The primary sources for this contact list were:

- Contact lists obtained from other building operations and facility management service providers.
- The regional memberships of several organizations to which NEEC belongs: the Building Owners and Managers Association (BOMA), the International Facility Management Association (IFMA), APPA (formerly the Association of Physical Plant Administrators), the Washington Association of Maintenance and Operations Administrators (WAMOA), and the American Society for Healthcare Engineering (ASHE).
- Attendees of NEEC-supported regional conferences, events, and webinars.
- BOC-specific contacts, including BOC supervisors and students and individuals that have contacted NEEC to get information about BOC.

The NEEC list was the largest and most comprehensive list of building operations and facility management contacts we could identify for Washington and Oregon. Those two states accounted for 98% of the contacts in the list.

We removed BOC students from the above list. However, as one goal of the survey was to assess the value of having BOC-credentialed operators to building and business owners who employ the, we did not remove BOC supervisors from the list. We removed duplicate records for the remaining names. The final list consisted of 3,013 names. Of those, about 80% had been on the list fewer than five years.

We sent an email survey invitation to each person on the above list. The email explained the purpose of the survey and assured the recipient of confidentiality. It included a link to the survey and a respondent-specific identification number. We sent up to three reminders over a two-week period.

Survey Channel 2: The second channel was a similar email invitation sent via Trade Press Media Group, Inc., a media company serving the building operations and facility management industry. Trade Press sent the invitation to a list of subscribers to two of the company's

professional journals: *Building Operations Management* and *Facility Maintenance Decisions*. The Trade Press list consisted of 1,851 names in the four Pacific Northwest states – 22% of the names in that list were from Idaho or Montana. Trade Press sent the invitation once, with no additional reminders.

We considered it possible that the Trade Press list would have many of the same names as those on the NEEC list. We were not able to de-duplicate the lists, however, as Trade Press did not provide us access to the list, but rather sent our survey invitation to its list. To avoid confusion on the part of the survey invitees, we did the following. We sent the email invitation to the NEEC list first, followed by two reminder emails. After the second reminder email to the NEEC list, we asked Trade Press to send the invitation to its list. That email was similar to the one we sent to the NEEC list, except that it included a statement explaining that, because of the survey's importance, we were implementing the survey through two channels and that if they received invitations from two sources, they should take the survey only once. We sent a third reminder to the NEEC list, which included the same statement.

We merged the responses from the two lists and checked for duplicate responses based on name and IP address. There were no duplicate responses.

A total of 188 respondents completed the survey. All but eight of the responses came from the first survey channel.

Respondent Roles and Responsibilities

The survey asked a short series of questions to determine each respondent's roles and responsibilities. This was important not just for descriptive purposes but also to ensure that the survey asked the appropriate questions of each respondent. The survey included some questions for all respondents (awareness, familiarity, and experience with BOC) as well as questions specific to owners and managers and to employees; if a respondent was an employee that managed other O&M staff, that respondent would see the questions for both groups.

The survey first asked whether the respondent was a building owner, a business owner or officer, or an employee below the level of officer. For respondents that were owners or officers, the survey asked whether they did their own O&M, had other O&M staff, or used an outside O&M provider. For respondents that were non-officer employees, the survey asked whether or not they managed other O&M staff.

As Table 18 shows, of 188 respondents who completed the survey, 66 were building or business owners or officers and 122 were employees below the level of company officer. Of the 66 owners, 55 said they manage O&M staff; the other 11 reported either that they did all the O&M work themselves or they used an O&M service provider. Of the 122 non-officer employees, 103 said they manage other O&M staff. Therefore, a total of 158 respondents (84% of the total sample) managed O&M staff.

Table 18. Respondent Roles and Responsibilities (*n* = 188)

	Owner/Officer	Non-officer Employee	Total
Manage O&M staff	55	103	158
Do not manage O&M staff	11	19	39
Do O&M work	*6*	*19*	*25*
Use O&M service provider	*5*	*0*	*5*
Total	66	122	188

Survey questions:

A1. Which of the following best describes you? (1) Owner or top officer of a business or organization that leases building space from others; (2) Owner or top officer of a business or organization that owns its building space; (3) Owner of a commercial building or buildings that I lease to tenants; (4) Employee of a business or organization.

[*If answer to A1 is 1, 2, or 3*] A3. Which of the following best describes how you manage operations and maintenance? (1) I personally perform all the operations and maintenance; (2) I perform some operations and maintenance but also employ other operations and maintenance staff; (3) I employ operations and maintenance staff and do little or none of it myself; (4) I contract out the majority of the operations and maintenance work in the building(s).

[*If answer to A1 is 4*] A4. Which of the following best describes your responsibilities? (1) I am in charge of or manage other employees who perform building operations and maintenance services and I also perform building operations and maintenance myself; (2) I am in charge of or manage other employees who perform building operations and maintenance services but I do not perform building operations and maintenance myself; (3) I am an employee who performs building operations and maintenance services but I am not charge of other employees involved in building operations and maintenance; (4) I am the only employee who performs building operations and maintenance services for my employer.

As described more fully below, the survey asked questions of such "owner/managers" about training that their staff had received as well as their own attitudes toward O&M training and staff retention.

The survey further asked the 158 owner/managers whether any of their O&M staff had the BOC credential. This allowed the survey to target separate sets of questions to those with and without such staff. For example, the survey asked those with BOC-credentialed staff about the benefits of having such staff and about transfer of the knowledge gained through that certification. On the other hand, the survey asked those without BOC staff about support provided for O&M certification and maintenance and likelihood of support BOC credentialing; there was less need to address these topics with those who already had BOC staff. One-third of the 158 owner/managers (*n* = 54) reported that at least one staff member had the BOC credential.

We could not exclude BOC-credentialed operators from the survey frame, so the survey asked respondents whether they had the BOC credential. A total of 16 respondents (10 owner/manager and 6 non-officer employees) reported the credential. The survey asked the non-officer employees (*n* = 122), including those who managed other O&M staff, about their training experience and employer support for training.

The sample sizes for the owner/managers without BOC staff (n = 104) and for the O&M staff (n = 122) provide greater than 10% precision at greater than 90% confidence. Although the sample size for owner/managers with BOC staff (n = 54) is half the size of the other samples, the pertinent population also is much smaller and the finite population correction (*fpc*) factor applies to the calculation of precision and confidence. For MPER #1, we identified 678 unique employers in the database of BOC certificants. Assuming the number of unique employers has not yet exceeded 1,200, the survey sample of provides at least 11% precision at 90% confidence.

The survey further assessed the job responsibilities of the 122 respondents that were *not* owners. Respondents selected, from a list, the job descriptions closest to their own – respondents could select more than one job description.[35] About two-thirds of respondents selected a single job description, and, as Table 19 shows, two-thirds indicated they were a property or facility director, manager, or supervisor.

Table 19. Employee Job Descriptions (Multiple Responses Allowed; *n* = 122)

Job Description	O&M Managers (*n* = 103)	Other Employees (*n* = 19)	All Employees (*n* = 122)	
			Count	Percent
Property or facility director, manager, or supervisor	77	4	81	66%
Electrician or other mechanical/technical staff	20	12	32	26%
Other manager, team leader, supervisor position	27	2	29	24%
Custodial Manager or Supervisor	21	1	22	18%
Engineer	19	3	22	18%
Custodian/ Custodial staff	3	2	5	4%
General contractor	2	1	3	2%

Survey question: "Building operations and maintenance staff have a wide range of job titles or descriptions. Which of the following describe your job or are included in your job title? Please check all that apply."

Work Environment

The survey also asked respondents about their work environment – whether they worked in a standalone building, a complex, or multiple sites; the number and size of buildings they worked in or owned; the type of business; and the number of O&M staff they work with. The responses indicate the surveyed operators were similar to the current population of BOC-credentialed

[35] The results of our previous survey of BOC-credentialed operators, conducted for BOC-E MPER #1, informed the current assessment. The previous survey asked respondents to select the single job title from a precoded list that was closest to their own or to record an open-ended "other" response. About two-fifths of respondents selected the other option, suggesting they did not think the items in the precoded list adequately described their job. For the current survey, we attempted to remedy the situation by, first, basing the precoded list on the most common responses to the previous survey and, second, allowing respondents to select multiple job descriptions.

operators: they work mainly in large (more than 50,000 square feet) buildings other than grocery stores and restaurants and generally work for the building owner rather than a third-party service provider.

About three-quarters of the 122 surveyed employees reported working in multiple buildings (Table 20). Of those reporting multiple work buildings, two-fifths said the buildings were within a single campus or complex of buildings and about three-fifths said they were in separate locations. Those who reported working in a building complex most frequently said the complex consisted of two or three buildings, while a large majority of those who said they worked at multiple separate sites reported at least six buildings.

Table 20. Number of Buildings and Type of Environment Respondents Work In (*n* = 122)[a]

			Type of Environment		
Number of Buildings	Percentage of All Respondents (*n* = 122)	All Respondents	Complex of Buildings	Multiple Locations	Standalone Building
One	29%	35	8	0	26
Two or three	14%	17	12	5	-
Four or five	7%	8	3	5	-
Six to 10	16%	19	9	10	-
More than 10	30%	37	6	31	-
No response	5%	6	0	1	0
Total	100%	122	38	52	26

Survey questions:

"Which of the following best describes your work environment? (1) I work mainly in a single standalone building; (2) I work mainly in a single building that is part of a campus or complex of buildings in a central location; (3) work in more than one building in a complex of buildings in a central location; (4) work in multiple buildings that are in separate locations; (5) Other environment (specify); (6) I'm not sure."

"How many buildings do you work in?" Or, if reported working in a complex of building: "How many buildings are in the complex you work in?"

[a] Six respondents reported neither the number of buildings nor the type of environment. All but one respondent that indicated the type of environment also reported the number of buildings.

Two-thirds of surveyed employees reported that the building or buildings they worked in comprised at least 100,000 square feet of conditioned space (Figure 10). The number of reported O&M staff at their worksites was more evenly distributed, but somewhat skewed toward lower counts (Figure 11).

Figure 10. Total Square Footage of Work Site Building or Buildings (*n* = 122)

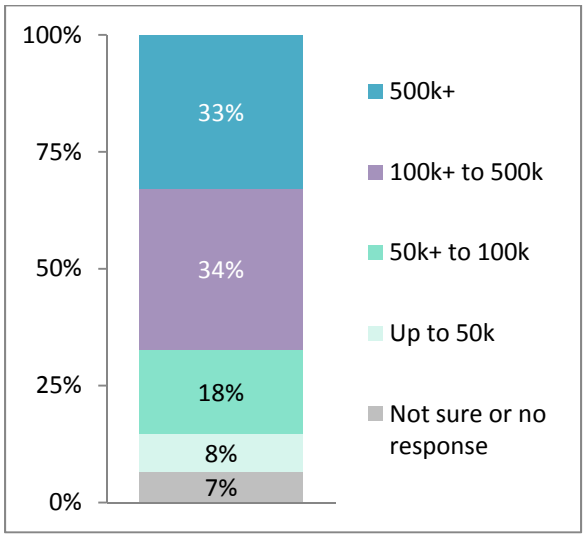
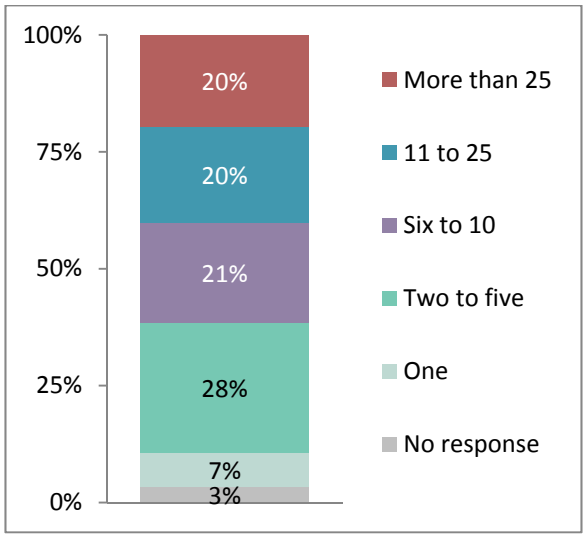


Figure 11. Number of Operations and Maintenance (O&M) Staff at Work Site (*n* = 122)



Survey questions:

"How many total square feet of conditioned space do the building or buildings you work in have? (By 'conditioned' we mean that the space is reached by the facility's heating or air conditioning methods and excludes garages, decks, plazas, patios, and so forth.)"

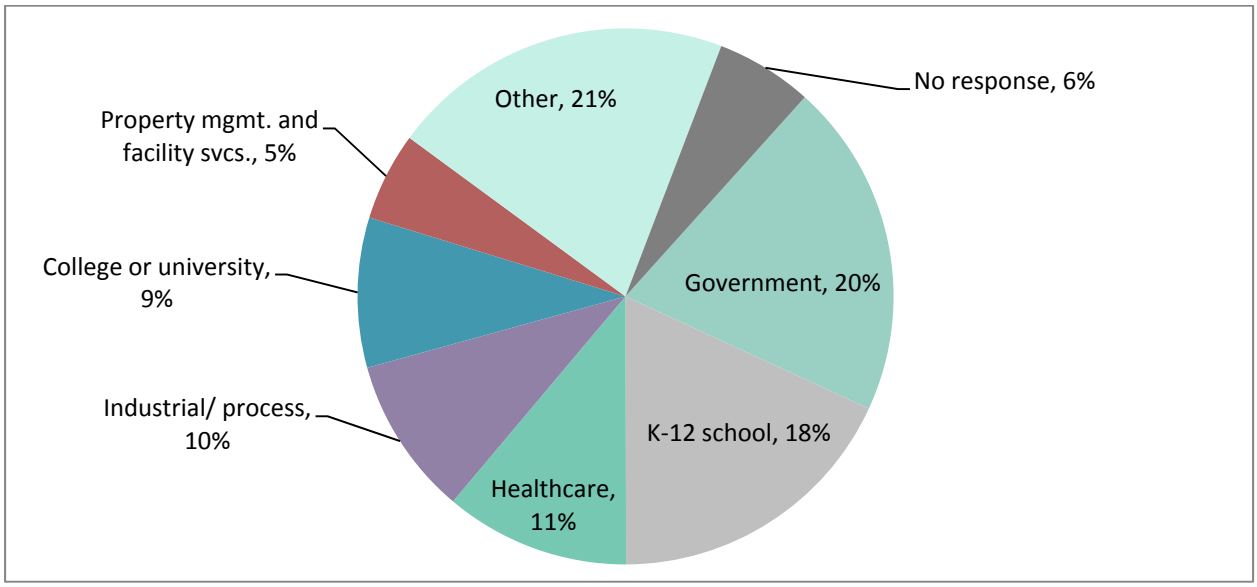
"How many people perform building operations and maintenance services in the building or buildings you work in, excluding yourself?"

The survey also asked building or business owners or officers (*n* = 66) about the number and size of buildings their company owns and the number of O&M staff they employ. More than one-third of these respondents left those questions unanswered. Of those who responded, about half reported their company owns more than 10 buildings. Two-fifths reported total building area of more than 500,000 square feet, and one-quarter reported a total of 100,000 to 500,000 square feet.

Given the large percentage that did not report number or size of buildings, the above findings may not represent the entire sample. For example, it is possible that respondents that did not answer these questions represented large employers and they were not sure of the number and total square footage of the buildings they own. In that case, the surveyed owners/officers may, on average, represent more buildings and building area than these findings reflect.

Respondents represented a wide range of employer types (Figure 12). "Government" and "other" employer types constituted about twice the percentage of the survey sample as they do of the BOC population; all other types were represented slightly lower percentages of the sample than of the BOC population. "Other" employer types included office, mixed use, retail, warehouse, and a variety of other types that each represented only one or two respondents.

Figure 12. Type of Employer (*n* = 188)[a]



Survey question: "Which of the following best describes your organization's type of business?"

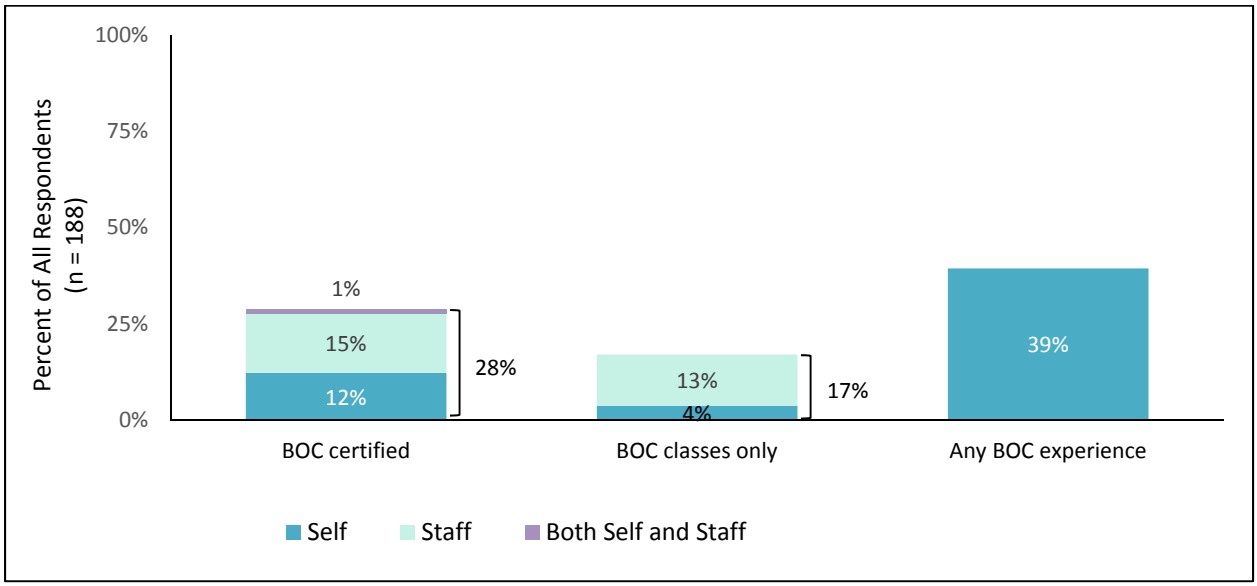
[a] "Other" employer types included office, mixed use, retail, warehouse, and a variety of other types that each represented only one or two respondents.

Awareness, Familiarity, and Experience with BOC

The survey assessed awareness and familiarity with BOC among all respondents. As one goal of the survey was to assess the perceived value of the BOC credential among those with certified staff, the survey asked respondents whether they themselves had such training or certification and, if they managed O&M staff, whether any staff had it. A total of 70 respondents reported that they (*n* = 30) and/or an operator under their supervision (*n* = 54) had at least taken BOC classes.

Figure 13 shows that just over one-quarter of respondents (*n* = 52) reported that they and/or a staff member had the credential – they were somewhat more likely to report certified staff than that they had the certification. Of the 114 respondents who reported neither they nor their staff had BOC training, 73% reported they had heard of BOC.

Figure 13. BOC Training and Certification



Survey question: 'Have you or any of your building operations and maintenance staff received the BOC certification or completed the course without certifying?"

Since even those respondents with BOC staff could have varying levels of familiarity with BOC, the survey asked *all* 188 respondents about their level of familiarity with BOC. Table 21 shows that, of those who reported neither they nor their staff had BOC training, about three-fifths reported knowing at least some details about BOC, and about one-quarter said they knew a lot about it. As would be expected, nearly all of those who reported that they or their staff had BOC training said they knew at least some details about BOC.

Table 21. Level of Familiarity with BOC (*n* = 188)

	Percent	
Level of Familiarity	**No BOC Experience (*n* = 114)**	**BOC Experience (*n* = 70)**
Had not heard of BOC	17%	0%
Had heard of BOC but did not really know what it was	6%	0%
Knew it had to do with building operations training, but did not know details	17%	1%
Knew some details about BOC, but did not know a lot	37%	16%
Knew a lot about BOC	23%	83%
Not sure	1%	0%

Survey questions:

"Have you ever heard of Building Operator Certification, also called BOC?"
"Which of the following best describes your familiarity with BOC before today?"

Note, however, that 17% of those with BOC experience – 12 respondents – reported not knowing "a lot" about BOC. In all but one case, those were respondents who did not themselves have the credential but employed or managed an operator who at least had taken BOC classes.[36] Thus, 11 of the 54 respondents who reported they employed or managed BOC-trained operators (20%) did not know a lot about BOC. There may thus be value in working to improve awareness and understanding of BOC even among those with BOC-trained staff.

Non-BOC Training

To provide information on sources that O&M staff and their employers rely on to develop their needed skills, the survey asked all respondents what types of non-BOC training they or, if applicable, their staff had received. Of the 188 respondents, 115 (61%) reported any non-BOC training. Respondents provided varying amounts of information about the training. We coded all training described based on the topics covered and the training source. The following analyses consider all training reported, regardless of whether the respondent took the training or said a supervisee had done so.

About three-quarters of the respondents provided some information on the training topic. The topics covered general maintenance or sustainability as well as a range of equipment types, with responses fairly evenly distributed across the types (Table 22).

Table 22. Training Topics Reported (n = 115)

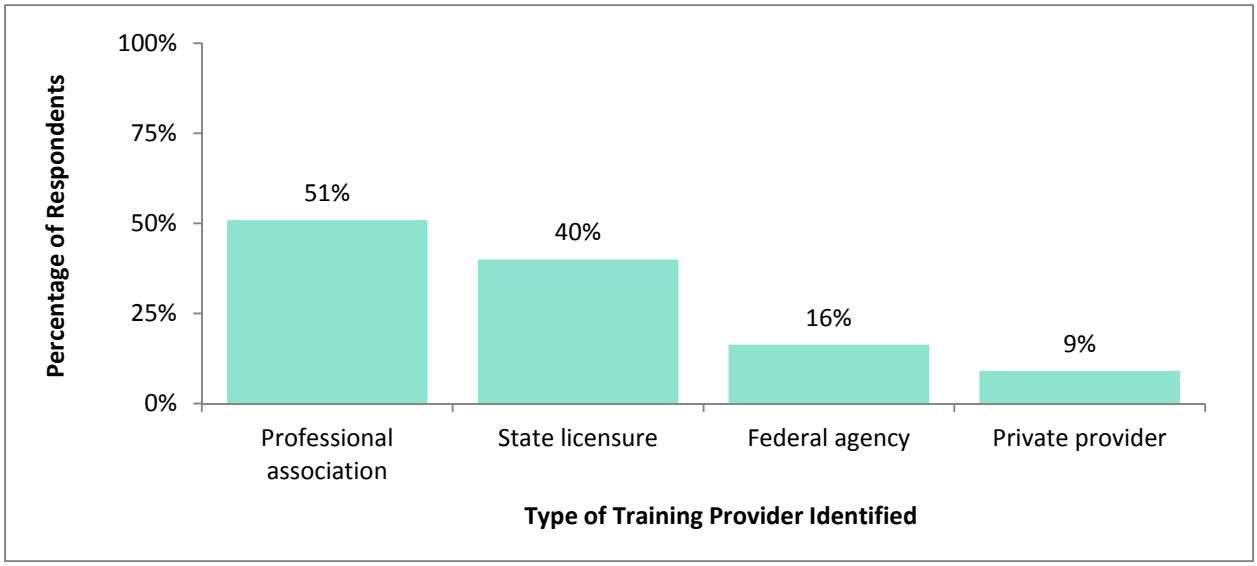
Training Topic	Count	Percent
General maintenance or sustainability	26	14%
Electrical, electronic	24	13%
Systems and controls	22	12%
Safety and health	16	9%
Boilers	15	8%
HVAC	13	7%
Engineering	11	6%
Other specified equipment types	23	12%
Topic not specified	39	21%
Unknown	4	2%

Survey question: "What non-BOC technical training and certification(s) have you or your employees or supervisees received in the past five years?"

[36] The one exception was an operator who reported having taken some, but not all, of the BOC classes.

Fewer respondents (n = 55) identified a specific training source or credential, such as a specific certification (e.g., Certified Energy Manager) or licensure. Of those, about half identified training or a credential from a professional association, such as the U.S. Green Building Council, BOMI International, or the Association of Energy Engineers. Two-fifths reported having a specific State licensure. About one-sixth identified a federal government agency (the U.S. Environmental Protection Agency, the Occupational Safety and Health Administration, the U.S. Department of Transportation) as the source of their training or credential. Finally, 9% identified private organizations, including utilities (Figure 14).

Figure 14. Types of Training Source (n = 55)

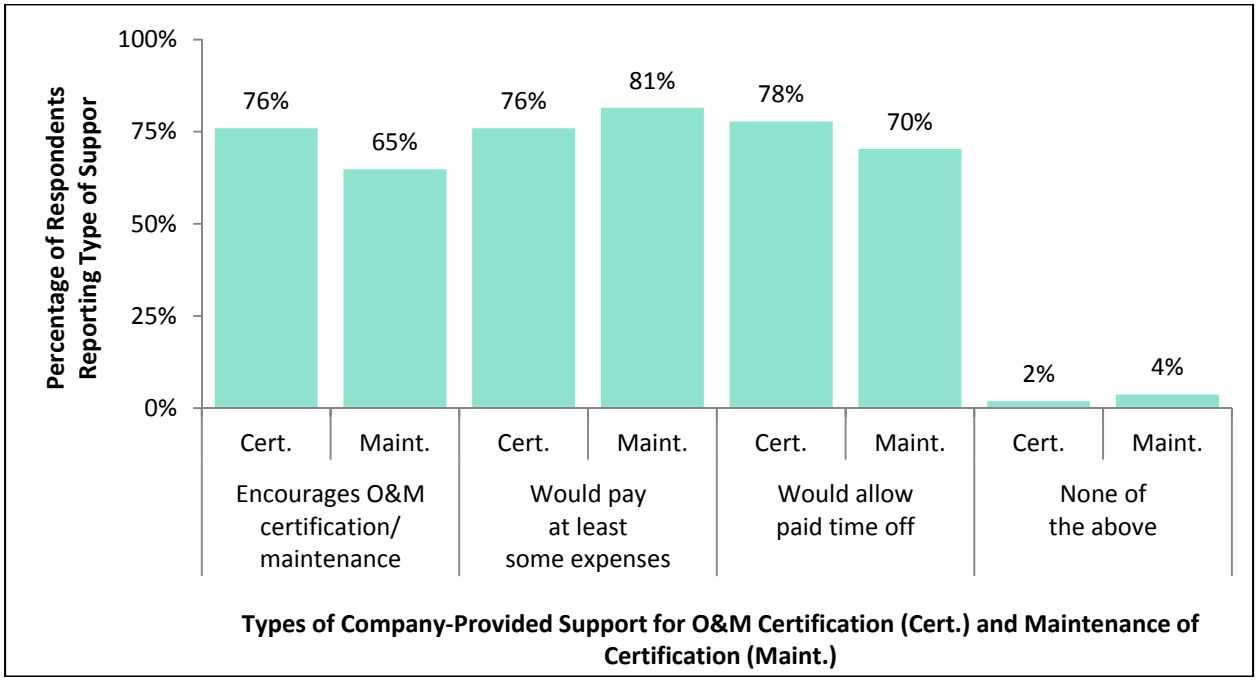


Survey question: "What non-BOC technical training and certification(s) have you or your employees or supervisees received in the past five years?"

Support for O&M Certification and Maintenance

The survey asked O&M managers about the types of support their company provides O&M staff to obtain and maintain appropriate certifications. These questions addressed only respondents who did not already have BOC staff. Responses indicated willingness to support certification and maintenance. As Figure 15 shows, two-thirds to four-fifths of respondents said their company encourages certification and maintenance, would pay at least some related expenses, and would allow paid time off to take courses or obtain continuing education credits.

Figure 15. Support for O&M Certification and Maintenance – Owners/Managers without BOC Staff (*n* = 104)



Survey question: "Which of the following are true of your business regarding O&M-related certifications for staff? Your business: Encourages O&M staff to get O&M-related certifications; Considers O&M-related certifications when hiring O&M staff; Would pay at least some of the expenses associated with O&M-related certification for O&M staff; Would allow O&M staff to attend O&M-related training during paid working hours; None of the above.

Value of BOC Training: Owners/Managers Without BOC Staff

A primary survey objective was to gauge the value of BOC training to owners and managers. To do so, the survey assessed the importance to owners/managers of the following skill areas covered in BOC training:

- Energy-efficient operation of HVAC or related systems
- HVAC controls
- Efficient lighting
- Indoor air quality
- Building electrical systems
- Measuring energy use to identify possible savings
- Low-cost improvements to operations
- Comfort of building occupants

The survey asked owners/managers without BOC staff (n = 104) to indicate how important each area would be in a decision whether or not to send a member of their O&M staff to BOC training. Similarly, the survey asked those with BOC-credentialed staff (n = 54) how important each area was in the decision to send staff for training. Respondents rated each item on a scale of 1 (not at all important) to 5 (extremely important).

Responses did not differ for the two groups. As Figure 16 shows, 61% to 75% of respondents gave a high rating (a 4 or 5 rating) to each item, indicating that they generally valued all of these skill areas. The most highly rated training areas related to HVAC and identification of low-cost operations improvements, suggesting possible areas of focus in marketing of BOC.

Despite indicating that they value the skills that BOC provides, owners/managers without BOC staff indicated it was not likely they would provide support for BOC certification and maintenance (Figure 17).

Similarly, when asked to rate how likely they or one of their O&M staff would undertake BOC training within the next 12 months, 13% indicated it was likely (a 4 or 5 on a 1-to-5 scale), compared to 57% who rated it unlikely (a 1 or 2).

To assess the value of utility support for BOC, the survey asked these owner/managers whether they would be "significantly more likely," "somewhat more likely," or "not at all more likely" to send staff to BOC training if their utility paid 50% of the training fee. Three-quarters said they would be more likely to send staff to BOC training in that case – nearly half said they would be "significantly more likely" to do so.

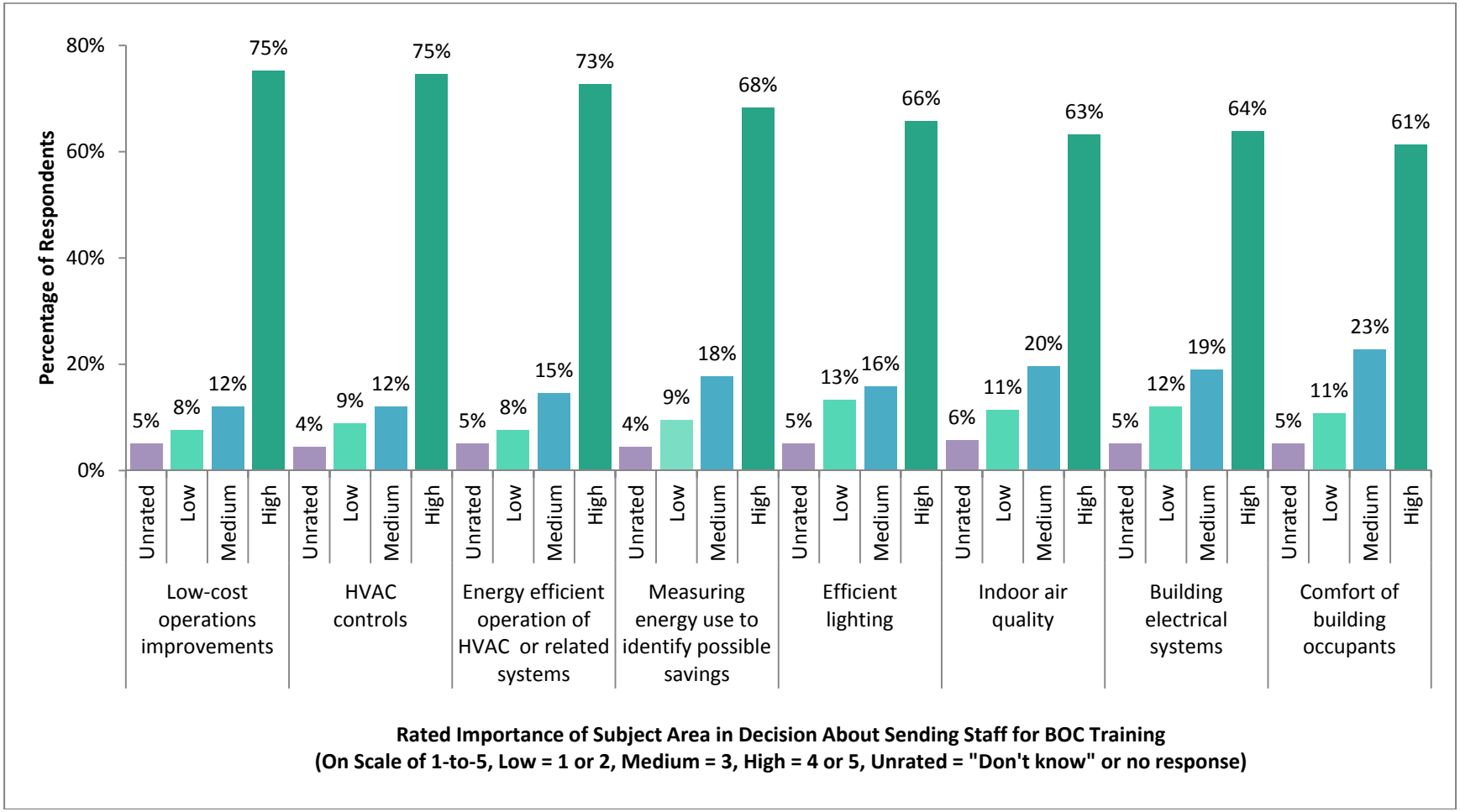
Attitude Toward BOC Training: Employees Without BOC

The survey briefly described the BOC training and certification process to employees without the credential (n = 116) and asked two questions to assess their attitude toward the training. Respondents saw the following description:

> Becoming BOC certified requires attending seven day-long modules on energy and resource-efficient operation of buildings over the course of three to seven months. Training is offered in multiple locations in Oregon, Washington, and Montana as well as in Boise, Idaho. The course fee is about $1000 in Montana and Idaho and about $1,700 in Oregon and Washington. All modules require some in-class time, but up to 15% of coursework is online.

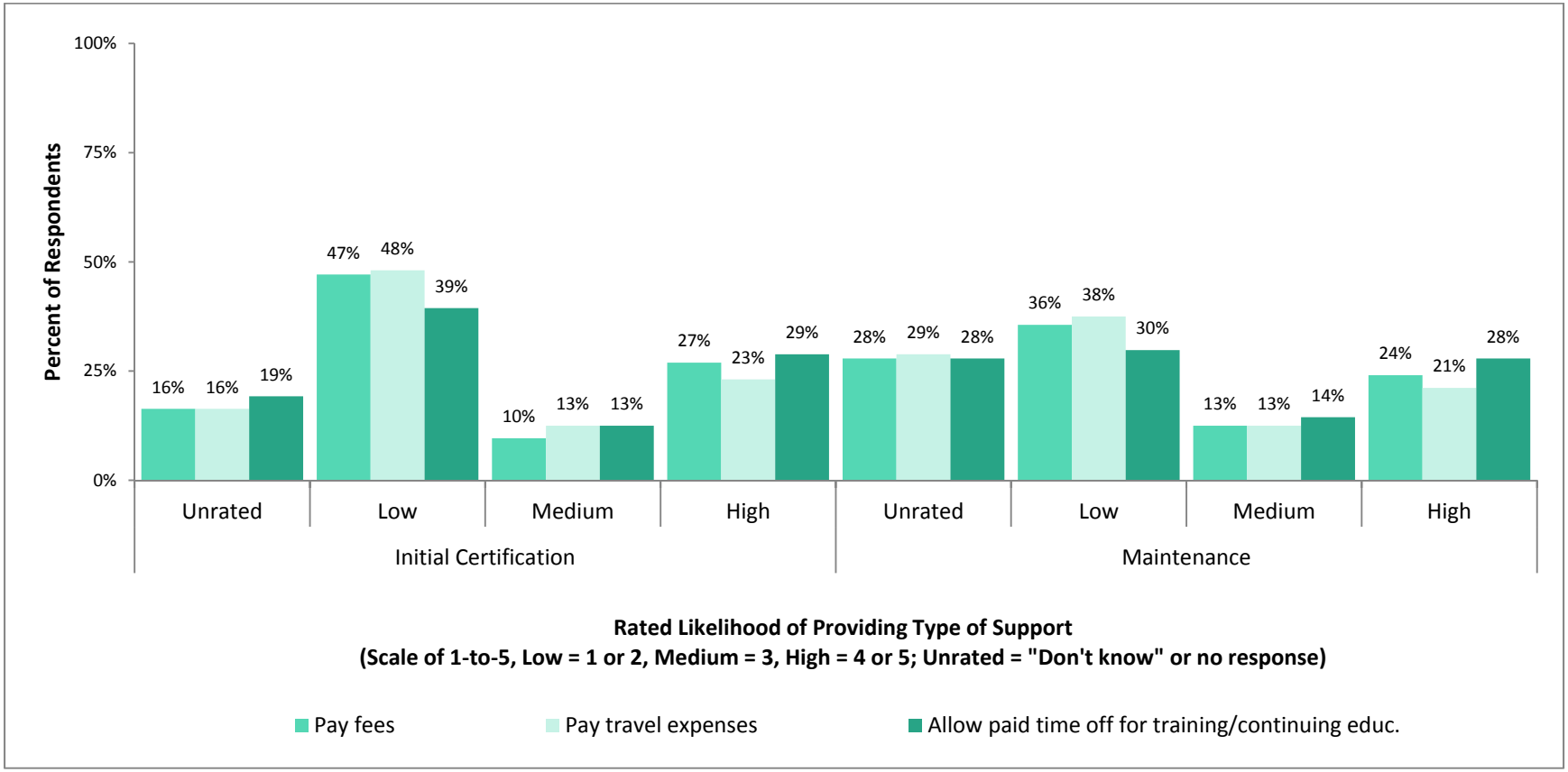
Respondents then rated the likelihood that they would take the training under each of three scenarios: 1) they had to take the training on their own, unpaid, time and had to pay all the costs themselves; 2) their company gave them paid time off to take the training but they had to pay all the costs themselves; and 3) their company gave them paid time off to take the training and paid all the costs.

Figure 16. Importance of Training Subject Area in Decisions About BOC Training (n = 134)



Survey question: "Building operations and maintenance training may cover a variety of areas." [Respondents with BOC staff:] "How important were each of the following in your decision to send members of your operations and maintenance staff to BOC training?" [Respondents without BOC staff:] "How important would each of the following areas be in your decision whether or not to send a member of your operations and maintenance staff to BOC training?"

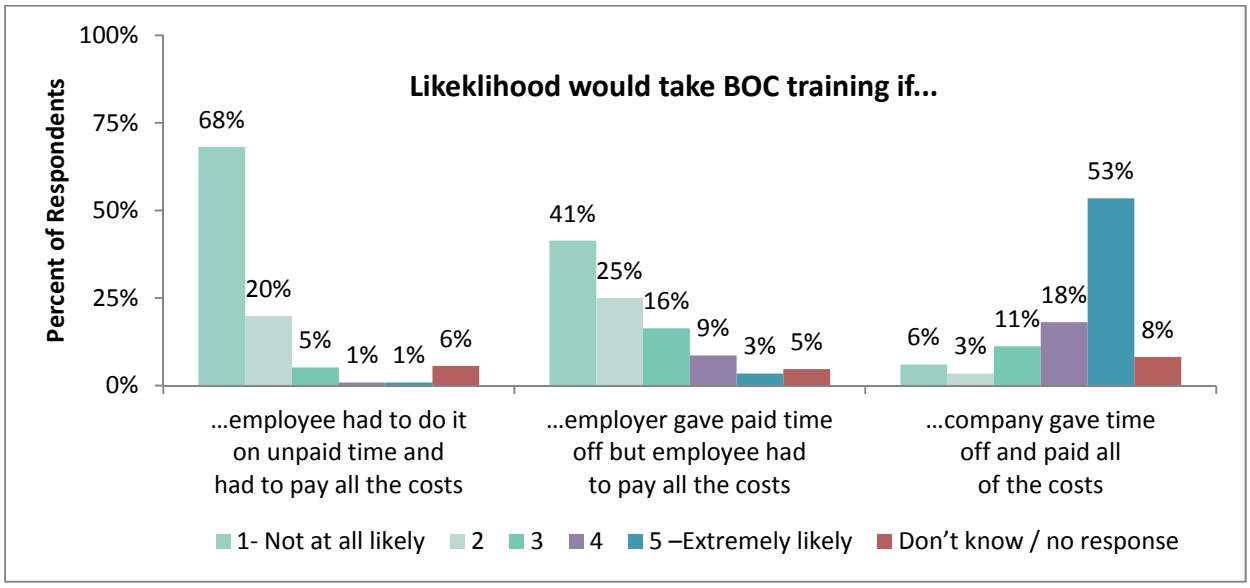
Figure 17. Likelihood of Providing Support for BOC Certification and Maintenance – Owners/Managers without BOC Staff (*n* = 104)



Survey question: "How likely would you be to provide the following types of support for a member of your O&M staff to obtain and maintain BOC certification?"

Figure 18 illustrates the importance of employer support in employee decisions about BOC training. Two-thirds of these respondents said they would be not at all likely to take the training if they had to do it on unpaid time and pay all the costs. By contrast, about half said they would be extremely likely to take the training if their company gave them time off for the training and paid all the costs.

Figure 18. Likelihood of Taking BOC Training – Non-BOC Employees (*n* = 116)



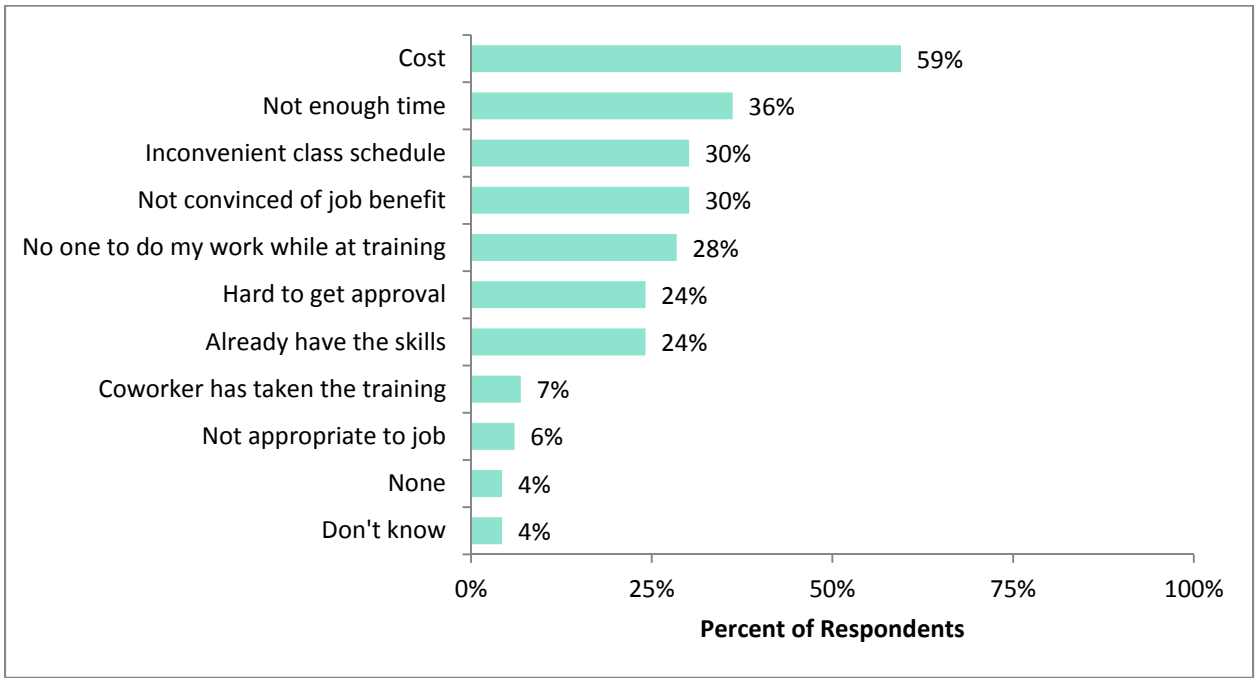
Survey question: "How likely is it that you would take the BOC training if…: …you had to do it on your own (unpaid) time and had to pay all the costs yourself; …your company gave you paid time off to do it but you had to pay all the costs yourself; …your company gave you time off to do it and paid all of the costs?"

When asked what factors would most likely prevent them from taking the training, their answers mirrored the above: cost and lack of time to take the training were the most frequently reported barriers (Figure 19). Between one-quarter and one-third of respondents reported the related barriers of inconvenient class schedule and absence of anyone to do the respondent's job while the respondent was at training.

Other responses indicated different types of barriers. About one-third of respondents indicated that they were not convinced that BOC training would provide any job benefit, about one-quarter said they already had the skills that BOC training would provide, and an additional seven indicated the training was not appropriate to their job or situation.[37] Half the respondents gave one or more of those three answers.

[37] This included two cases in which the respondents were facing retirement.

Figure 19. Barriers to Taking BOC Training – Employees without BOC (*n* = 116)



Survey question: "What would keep you from taking a Building Operator Certification course? (Please select all that apply.)"

Of the 116 respondents to the above question (employees who do not have the BOC credential), 68 had reported they themselves do O&M work (with or without supervised staff) while 48 reported they supervise others but do not themselves do O&M work. It is possible that different barriers may affect those two subgroups. For example, the perception that one is already sufficiently skilled may be more of a barrier for those who do O&M work than for those who only supervise O&M staff. By contrast, the perception that BOC training would not necessarily provide a job benefit may be more of a barrier for the latter subgroup.

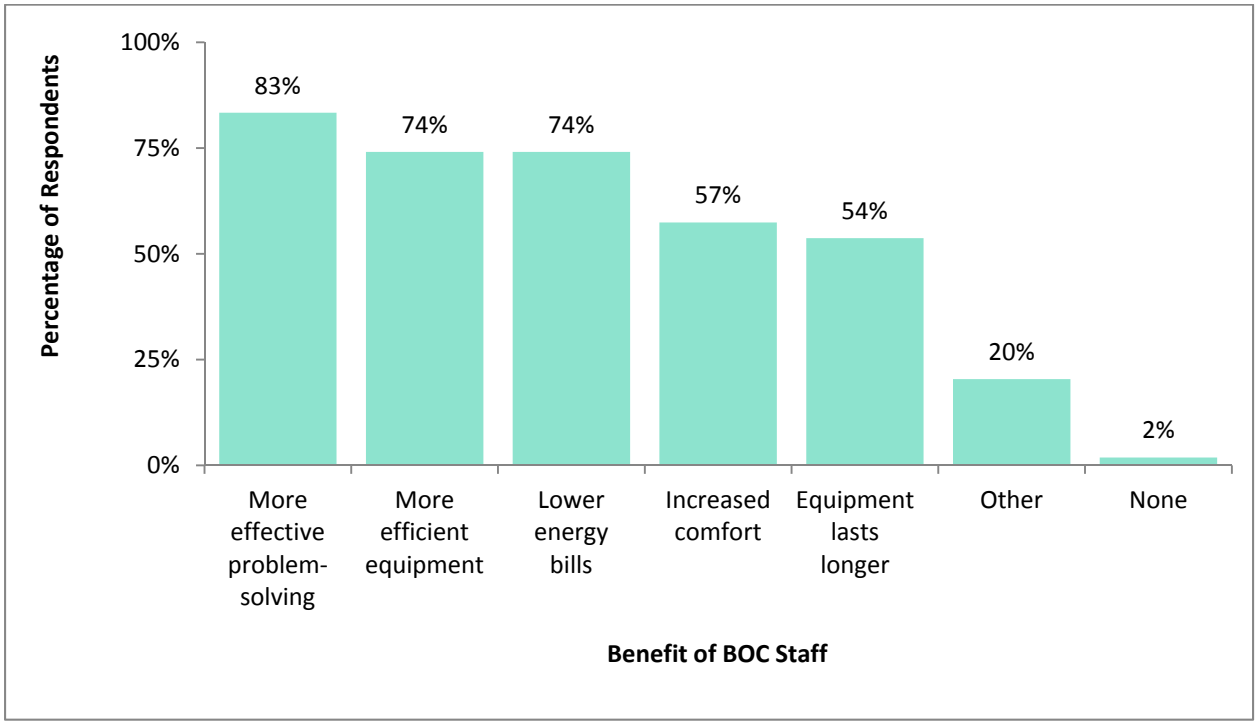
To test this hypothesis, we examined whether the two groups differed in the barriers cited. Only one difference was statistically significant: those who do O&M work were more likely than those who only supervise O&M staff to say that it would be hard to get approval for certification (32% vs. 13%; $p = .014$ by *chi-square*). This may simply indicate that those who supervise O&M staff may themselves have the authority to make decisions about training; therefore, they would be less likely to face difficulty in getting approval for certification.

Benefits of BOC Training

Of the 158 respondents who were owners or managers with O&M staff, 54 reported they had staff with the BOC credential. The survey asked those respondents about the benefits of BOC training and the degree to which their certified staff had transferred the knowledge gained from training to other O&M staff.

When asked to select from a list of possible benefits of employing BOC staff, the most commonly identified benefit was more effective problem-solving, followed closely by increased equipment efficiency and lower energy bills (Figure 20). Thus, for many of these respondents, the chief benefit is the ability of staff to respond to emerging problems rather than simply to perform better at "business as usual."

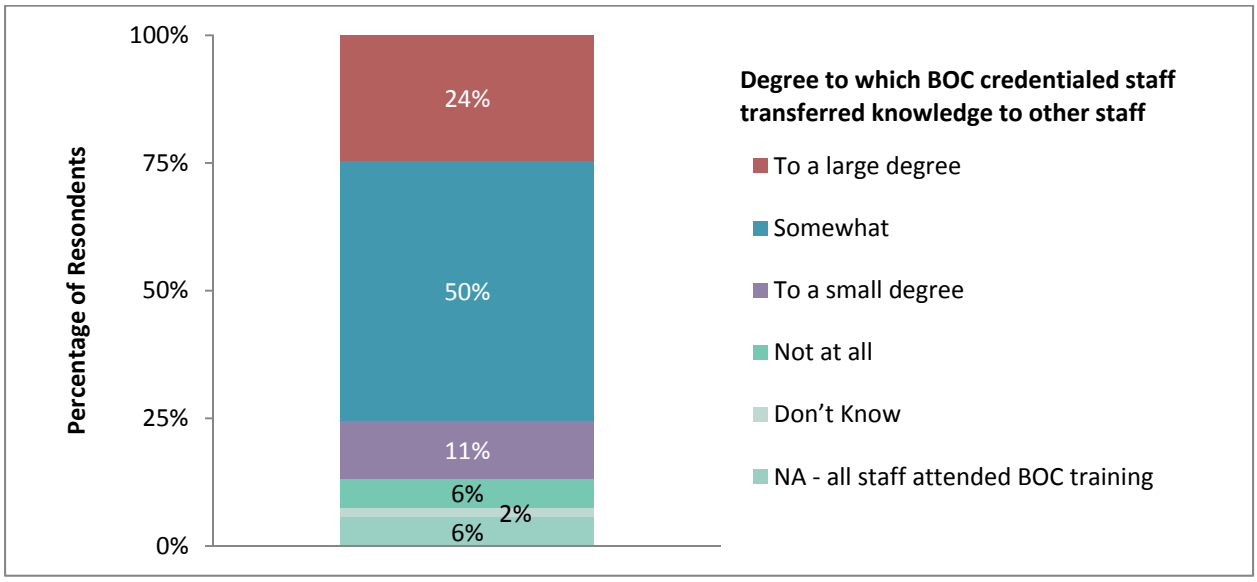
Figure 20. Benefits of Employing BOC Credentialed Staff (*n* = 54)



Survey question: "What are the benefits of employing building O&M staff who attended the BOC training? Please select all that apply."

As Figure 21 shows, nearly three-quarters of respondents indicated that BOC-credentialed staff transferred their knowledge to other staff at least "somewhat." The fact that fewer than one-quarter of respondents reported a large degree of knowledge transfer may suggest receptivity to the idea of having multiple staff trained.

Figure 21. BOC Knowledge Transfer (*n* = 54)



Survey question: "Thinking of your staff who attended the BOC training, to what degree have they transferred knowledge gained from that training to other operations or maintenance staff?"

Staff Retention

A final topic addressed was staff retention. The survey asked all respondents who reported they supervised any O&M staff (*n* = 158) how problematic it would be to lose a senior O&M employee and, if that happened, how long it would take to replace the lost employee. Respondents rated the impact of losing a senior O&M employee on a scale from 1 (not at all problematic) to 5 (extremely problematic).

For about two-thirds of respondents, losing a senior O&M employee would be problematic (a 4 or 5 on the 1-to-5 scale; Figure 22). Half the respondents could not say how long it would take to replace a senior O&M employee, but more than half of the remaining respondents said it would take more than two months (Figure 23). Taken together, these findings suggest that a message effectively tying BOC certification to employee retention may induce owners and managers to offer the training to their staff.

Figure 22. How Problematic Losing a Senior O&M Employee Would Be (*n* = 158)

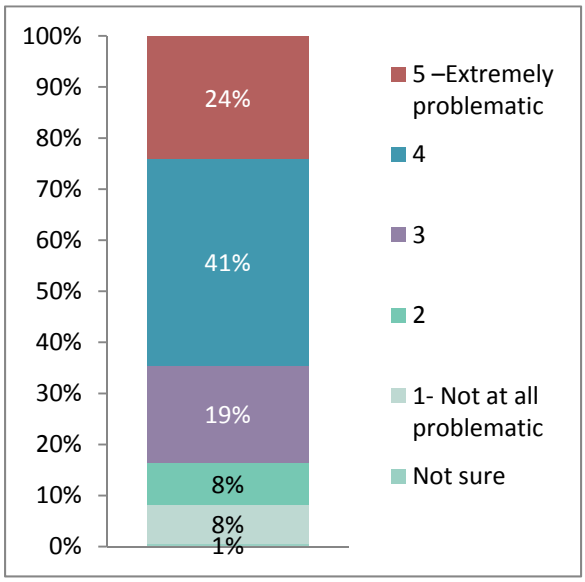
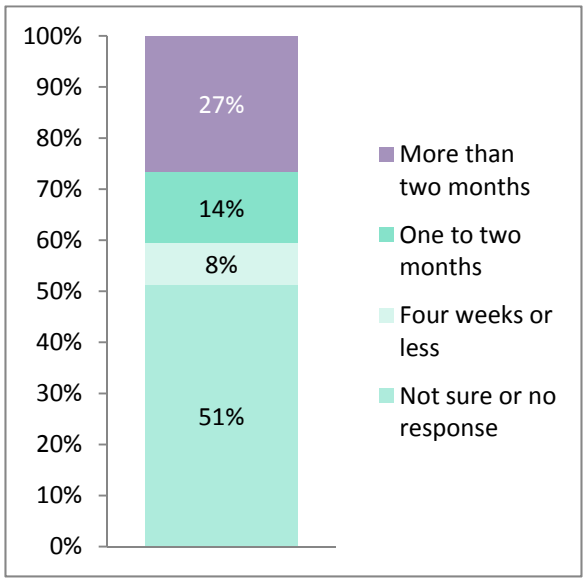


Figure 23. How Much Time It Would Take To Replace a Senior O&M Employee (*n* = 158)



Survey questions:

"How problematic would losing a senior operations and maintenance employee be for your organization?"

"If you did lose a senior operations and maintenance employee, how long would it take, on average, to replace that person and train the new one to the required level of skill?"

Summary and Conclusions

Respondents represented a range of work environments, employer types and sizes. Generally, they appear to be similar to the population of BOC-credentialed operators. Most respondents were at least somewhat familiar with BOC, and about one-quarter either had the credential or had staff with it.

Results indicated that, in general, employers support technical training for their O&M staff. Majorities reported support for O&M certification and maintenance and described training histories that covered a variety of general maintenance or equipment-specific topics, offered through professional associations, state licensure agencies, federal agency, or private providers. Similar majorities also indicated that most of the BOC training topics (particularly low-cost operations and HVAC-related) would factor in decisions about sending staff to BOC training.

Staff would be very likely to take the training if the company provided time off and paid costs, but not otherwise. Other factors, like inconvenient class schedule, lack of someone to take on their work responsibilities, and lack of belief in the job benefit, offer moderate barriers.

Despite the general support for training and certification, owners' and managers' responses suggested that those without BOC staff were not highly likely to support BOC certification and maintenance.

Three findings suggest possible ways to encourage owners and managers to support BOC certification and maintenance. First, owners and managers said they would be much more likely to provide the support if their utility covered half the training fee, so broadening utility support for training may be important. Second, findings suggest that staff retention is an important issue, which possibly could be made a strong motivator for training staff if messaging effectively tied training to staff satisfaction and retention. Third, large majorities of owner/managers with BOC staff endorsed several benefits of BOC training, particularly more effective problem-solving, suggesting possible messaging content for marketing.

A final finding of interest is that owners and managers with BOC staff reported that knowledge transfer was moderate. While this points to an additional benefit of supporting BOC training, the fact that respondents generally did not report high levels of knowledge transfer suggests that there may be added benefit of training additional staff. This suggests a possible opportunity to appeal to current employers of BOC-credentialed operators to increase their benefits by supporting training and certification for additional staff.

Appendix D. Market Characterization Memo

Memorandum

To: Rita Siong, Project Manager

From: Ryan Bliss, Research Into Action

Date: June 27, 2014

Re: Characterization of Idaho and Montana Building Operator Market

This memo documents findings from several research activities that Research Into Action carried out from January through June, 2014, to provide information on the regional building operator market. Research Into Action conducted this research to inform Market Progress Evaluation Report (MPER) # 2 for the Northwest Energy Efficiency Association's (NEEA's) Building Operator Certification Expansion (BOC-E) Initiative.

Prior to 2014, BOC-E did not cover Idaho and Montana, and so the market characterization for MPER #1 did not cover those states. NEEA has identified Idaho and Montana as an area to increase future BOC efforts. Therefore, this memo focuses on Idaho and Montana, including any differences from Washington and Oregon that our research indicated.

For this memo, we conducted the following research activities:

- We interviewed five individuals who work in and are knowledgeable about the building operator market in Idaho and/or Montana. We asked those informants about operator qualifications, characteristics of buildings with in-house building operations staff, energy efficiency trends, BOC expansion potential, market value of BOC training and certification, and market awareness of and barriers to BOC certification.
- We developed revised estimates of the number of regional building operators and of BOC penetration, by combining data from the survey of BOC-certified operators we conducted for MPER #1 with data from a new survey of non-certified operators that we conducted in 2014.
- We carried out secondary research to provide information on the distribution of commercial buildings by end-use in Idaho and Montana, as compared to Oregon and Washington.
- We contacted BOMI International to obtain information about renewal rates for several certifications that BOMI provides (Property Administrator Certificate, Property Management Financial Proficiency Certificate, Facilities Management Certificate, Building Systems Maintenance Certificate, High Performance Certificate).

The BOMI representative we contacted was not able to provide any information on certification renewal rates. We discuss the findings from our other research activities below.

Market Informant Feedback

As part of our market characterization research, we conducted a qualitative assessment of the Idaho and Montana experience with BOC training by speaking with five "market informants" – people who have experience in some capacity with BOC training in the two states.[38] These individuals include BOC trainers, a utility manager, and a health care facility manager who has attended BOC training.

NEEA initiative staff provided a list of six "high priority" contacts – those expected to be most knowledgeable about the building operator market in Idaho and Montana – plus 16 "medium" and "low" priority contacts in case we could not interview the high priority ones. We were able to reach and interview all but one of the high priority contacts. Three were based in Idaho and two in Montana.

The interviews, which took place in May and June 2014, aimed to gain a better understanding of the market for BOC training in these two states, which comprise a less densely populated area than Washington and Oregon, where BOC training first began. Discussion topics included general BOC awareness, training barriers and opportunities, building types most likely to have in-house operators, key trends in building operations in recent years, the potential role of online training, and more. Highlights from these conversations are presented below.

Idaho and Montana Building Stock

By all accounts, the building stock in these two states is "older" and faces efficiency challenges. Informants said that few buildings are greater than 100,000 square feet in size; however, of those larger buildings, informants believed the vast majority have one or more in-house operators on staff. Informants thought the types of buildings *most* likely to have an in-house operator were hospitals, schools, government buildings, industrial buildings and airports. One respondent said, "Industries where downtime or failures of equipment have a larger impact on revenues/ production [are most likely to have in-house operators]." Informants thought that the building types *least* likely to have in-house operators were grocery stores, restaurants, and office buildings.

Key Trends in Building Operations

We asked market informants to identify any key trends in building operations in recent years. They mentioned that benchmarking has been a "huge" improvement recently, as well as the entrance of a younger generation of workers who are more technology savvy and interested in

[38] Per the work plan for 2014, Research Into Action was to interview up to four market informants. Therefore, we exceeded the requirement.

sustainability than their predecessors. One informant said he's noticing a shift taking place in emphasis from a reactive to a proactive approach to building operations, and another mentioned an influx of technology happening quickly ("You can use an app on your iPhone to shut down your HVAC").

Who Should Attend Training?

Although the market informants agreed that it is advantageous to train all operators at a given facility, when asked to identify priorities, they repeatedly mentioned an impending retirement wave (dubbed the "silver tsunami") that has people in the industry concerned. With many building operators nearing retirement age, market informants said they believe training younger staff is becoming increasingly important. In further elaborating on the question "who should be trained?" one informant replied that it would be beneficial to send "hands-on" staff (e.g. those who work with HVAC, lighting, motors), and another informant said sending the "first responder" would be most beneficial (e.g. the custodian in a school).

Barriers to Training

Although all informants said it is highly valuable to send building operators to BOC training, they acknowledged that this is often easier said than done. They identified two key barriers – lack of awareness about BOC and lack of time and money.

Low Awareness

Market informants all said that general awareness of BOC in Idaho and Montana has been low, and that this has been a key barrier – for both operators who do not know about training opportunities, as well as for building owners and "decision makers" who lack an understanding of the benefits BOC training could provide to their facilities. At first blush, this finding seems inconsistent with our relatively high market penetration estimate for Idaho and Montana (see Table 31 and Table 32).

However, while three of the informants gave responses of "low" and "pretty low" in response to the question, "What is your sense of the general level of awareness of BOC among building operators and their employers in Idaho and Montana?," other comments were more nuanced and suggested that recent outreach efforts by IBOA, the utilities, and IFMA had improved awareness of BOC. One informant in Montana commented that, "The efforts of the utility have been advancing awareness of the certification locally." Another, who performs outreach in both states, commented:

> I've been here a short time. I don't think before me there was much awareness. … Now we pound them all the time. It's all about the marketing. I go back to the utilities – they are so big for me. They're willing to do anything for us.

A third informant noted that the IBOA Executive Director has been "living on the road and he's been doing a great job at conferences and conventions, and I think it is growing…." That informant also credited IFMA with raising awareness of BOC in the region but nevertheless indicated that awareness was still "pretty low."

One informant's comments captured the sense that awareness is improving but still not sufficient to drive a high level of participation:

> I know what I have to do to fill a class, but I think if more people were aware of the program, I wouldn't have to be pounding the pavement to get people to training.

There are other possible reasons for the seeming inconsistency between the informants' observations and our market penetration rates. Those informants that were least nuanced in their observations (and most directly suggested low awareness) may not be aware of the number of BOC-certified operators in their region. They may, for some reason, be mainly familiar with commercial building segments where BOC awareness is lowest.

Another possibility is that our informants are simply applying a relatively high standard, by which the current market penetration still indicates low awareness. None of the informants estimated the percentage of building operators that know about BOC.

It also is possible, as we note below, that the market penetration estimates shown below are incorrect. We may have over-estimated the percentage of operators credentialed in Idaho and Montana that are currently working in those two states or under-estimated the population of building operators in those states. It would require a large adjustment in both of those parameters, however, to produce a market penetration rate that is consistent with "low" awareness.

Money and Time

The other prevailing barrier to BOC training in Idaho and Montana is a shortage of both money and time, according to the informants. Although Northwestern Energy offers to cover full costs for some participants, and Idaho Power covers partial costs, BOC training still often requires a monetary investment of some kind. The bigger issue may be, though, the large time commitment required to complete the BOC certificate (8 days). Four of the five informants stated that 8 days away from the job is a hardship – one respondent said, "Even the thought of missing one or two days puts you behind," and another said, "Losing a guy for eight days is a hard pill to swallow."

Informant Suggestions for Expanding BOC's Reach

When we asked the market informants what else can BOC do to expand its reach in Idaho and Montana, three primary themes emerged:

1) Get the word out
2) Offer classes with shorter durations
3) Target decision makers with a compelling business case for BOC

All the informants mentioned that increasing awareness is key to furthering the uptake of BOC training. Specific recommendations for how to do this included putting up simple billboards, partnering with various entities (utilities, manufacturers such as Trane) to give "tech talks" and do other forms of direct outreach, targeting "decision makers" with a BOC value proposition, and a general call for "more marketing."

When asked to comment on BOC's plans to offer "blended online training" in its courses, informants were mixed, but most said that online learning is not as effective as classroom learning for BOC content. One informant (self-identified as young) was in favor of online training, saying, "That's the world we live in," but the others were highly skeptical of its effectiveness. One informant said "In-class is preferable. The instructor can read students and gauge whether they are 'getting it' or not."

All of the market informants were enthusiastic about BOC's value and felt that it could benefit their states greatly. They indicated that with a variety of different efforts to increase awareness and accessibility to training, BOC has the potential to expand in Idaho and Montana.

Revised Market Size and BOC Penetration Estimates

For MPER #1, we estimated the number of building operators in NEEA territory to be about 10,020. We based that estimate largely on an estimate of mean square footage of building space per building operator, which we calculated from our survey of BOC-certified operators. From that estimate, we calculated BOC penetration to be about 20% of the market.

For this memo, we have updated the estimate of the building operator population with additional data from our 2014 survey of non-certified operators but using the same method as used in MPER #1. In addition, we have provided an alternative update using a modified method.

In the following subsections, we review the methodology we used for MPER #1, we then show the new population size and penetration estimates we obtained from applying the new data to that methodology and to the revised method, for the region as a whole and separately for Oregon/Washington and Idaho/Montana.

Review of Method for Estimating Operator Population and Penetration Rate

We based our previous estimate of the regional building operator population on three assumptions:

- About 75% of the square footage of applicable buildings[39] of at least 100,000 square feet has in-house operators.
- About 5% of applicable buildings of at least 5,000 square feet but less than 100,000 square feet have in-house operators, and any such building with an in-house operator has only one. (In other words, the number of in-house operators in the below-100,000-square-feet tier is equal to 5% of the number of buildings in that tier.)
- About 0% of buildings smaller than 5,000 square feet have an in-house operator.

We document the reasons for the above assumptions in MPER #1.[40]

[39] As explained in the previous memo, we excluded groceries and restaurants, as they typically use service providers to manage energy-using equipment.

To estimate the number of operators in the large (at least 100,000 square feet) tier, we calculated the mean number of building square feet per operator and divided that figure into the total regional building area for applicable buildings of 100,000 square feet or larger, as identified in the CBSA. We calculated the mean building square footage per operator from data from our survey of BOC-certified operators. That survey asked respondents to report the total number of operations and maintenance staff in their buildings, regardless of whether or not the possessed the BOC credential. For each building in the sample, we divided that figure into the reported building square footage. We then calculated a weighted mean of the building square footage per operator across all respondents who reported a building size of at least 100,000 square feet and who reported the number of operators employed there (n = 177).[41] The weighted mean accounted for the fact that our sample included a higher proportion of very large buildings (at least 500,000 square feet) than the regional building population as a whole (Table 23).

Table 23. Calculation of Weights for Square Footage per Operator for MPER #1

Facility Size (Square Feet)	Number of Facilities in Sample	Percent of Facilities Sample	Percent of Buildings in Region (CBSA)	Weight
100,000 to 500,000	81	44%	97%	2.20
>500,000	102	56%	3%	0.05
Total	183	100%	100%	n/a

Our analyses resulted in a mean of 72,935 square feet per operator in the large tier. CBSA reports a total of somewhat more than 740 million square feet of building space in that tier.[42] Dividing that total by the mean square footage per operator gave an estimate of 7,609 operators in that tier. From CBSA data, we also estimated that there are approximately 48,217 buildings in the smaller tier[43]; multiplied by 5%, this yielded an estimate of 2,411 operators in that tier. Thus, we estimated a population of 10,020 operators overall (Table 24).

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[40] *BOC-Expansion Initiative Market Progress Evaluation Report #1 (Report #E14-277).* Prepared by Research Into Action, Inc. for Northwest Energy Efficiency Alliance, April 24, 2014. Available at: *http://neea.org/docs/default-source/reports/boc-expansion-initiative-market-progress-evaluation.pdf?sfvrsn=4. See Appendix D, pp. D-2 to D-7.*

[41] We excluded two cases for which the calculated square footage per operator was a statistical outlier. We defined statistical outlier as a case that exceeds the mean value by at least 3.1 standard deviations, which would include 0.1% of the expected distribution.

[42] CBSA does not provide estimates of number of buildings in each size tier. However, we calculated estimates from data on the total floor area by building type and the percentage of floor space of each building type by size tier. For each tier, we divided the total floor space for each tier by the presumed mean value for that size tier. The presumed mean values were not the midpoint, nor were they the same for each tier; rather, we chose a different value for each tier to approximate the skewed distribution of building size across all tiers. From this method, we estimated there are about 3,300 buildings of at least 100,000 square feet in the region. In practice, the results were relatively insensitive to the presumed mean value of each tier.

[43] This estimate comes from the method described in the previous footnote. The total area for that tier (excluding restaurants and grocery stores) was 1,196,300,000 square feet.

Table 24. Estimated Size of Building Operator Market for MPER #1

Facility Size (Square Feet)	Parameter Used to Estimate Number of Operators in Tier	Parameter Value	How Number of Operators in Tier Calculated	Number of Operators
5,000 to 99,999	Number of Buildings in Tier	48,217	5% of buildings, one operator per building	2,411
≥ 100,000	Total Square Footage of Buildings in Tier	740,478,400	72,935 square feet per operator, 75% of square footage has operators	7,609
Total	n/a	n/a	n/a	10,020

Together, NEEC and IBOA had certified 2,147 BOC operators through 2012.[44] The NEEC database identified about 1% of the operators as retired or deceased, but about 5% of operators have asked not to be contacted, some of whom may also have been retired or no longer doing building operations work. Thus, we estimated that the percentage who were retired from work or deceased could be up to 5%. This yielded a count of about 2,000 then-employed building operators in the Northwest that ever received certification, or about 20% of the estimated population.

Revised Estimate of Operator Population – Using Same Method as For MPER #1

In 2014, we conducted a survey of non-certified building operators from which we collected comparable data on building size and number of operators employed.[45] A total of 79 survey respondents to that survey reported a building size of at least 100,000 square feet and reported the number of operators employed there.[46] We used this additional data, combined with the data from the 2013 survey of BOC-certified operators, to recalculate the mean square footage per building operator.

Each record in the combined data set of 255 certified (n = 176) and non-certified operators (n = 79) provided workplace square footage and number of operators employed for a single, unique workplace. For each record, we calculated the square footage per operator. Since combining the datasets resulted in slightly changed distribution of facility size, we recalculated the weights to adjust for differences from the population (Table 25).

[44] *2013 BOC Program Database*. Memorandum prepared for the Northwest Energy Efficiency Alliance by Research Into Action, February 28, 2014.

[45] We describe the methodology for this survey in detail in *BOC Nonparticipant and Owner Survey: Awareness of and Attitudes Toward BOC Training*. Memorandum prepared for the Northwest Energy Efficiency Alliance by Research Into Action, February 28, 2014.

[46] As with the certified operator sample, this excludes statistical outliers.

Table 25. Recalculation of Weights for Square Footage per Operator for Combined Certified and Non-certified Operator Dataset

Facility Size (Square Feet)	Number of Facilities in Sample	Percent of Facilities Sample	Percent of Buildings in Region (CBSA)	Weight
100,000 to 500,000	124	50%	97%	2.00
500,000	131	50%	3%	0.05
Total	255	100%	100%	n/a

We also calculated weights to adjust for the fact that the certified operators represented a much larger percentage of the combined sample (69%) than they did of all operators in buildings of at least 100,000 square feet. We can only estimate the latter percentage. For MPER #1, we estimated that BOC had achieved about 20% overall market penetration. Therefore, we used that assumption (Table 26).

Table 26. Calculation of Weights to Adjust for Different Sampling Ratios of Certified and Non-certified Operators

Group	Population %	Sample %	Weight
Certified	20%	69%	0.29
Non-certified	80%	31%	2.59
Total	100%	100%	n/a

Applying the above weights to the combined sample produced a mean of 64,967 square feet per operator – lower than that produced from the sample of certified operators only. As Table 27 shows, this resulted in an increased estimate of 8,549 operators in the large building tier, for a total estimate of 10,960 operators in the region – somewhat above the estimate from MPER #1.

Table 27. Estimated Size of Building Operator Market, Using Combined Certified and Non-certified Operator Dataset

Facility Size (Square Feet)	Parameter Used to Estimate Number of Operators in Tier	Parameter Value	How Number of Operators in Tier Calculated	Number of Operators
5,000 to 99,999	Number of Buildings in Tier	48,217	5% of buildings, one operator per building	2,411
≥ 100,000	Total Square Footage of Buildings in Tier	740,478,400	64,967 square feet per operator, 75% of square footage has operators	8,549
Total	n/a	n/a	n/a	10,960

Revised Estimate of Operator Population – Using Modified Method

The above method for estimating the operator population possibly under-estimated the number of operators in the small tier. Even if only 5% of buildings in that tier have in-house operators, it is likely that most of those buildings are at least 50,000 square feet, and those buildings may have more than one operator, on average.

Therefore, we produced an alternative estimate by redefining the large tier as buildings at least 50,000 square feet and the small tier as those from 5,000 to 49,999 square feet. Redefining the large tier added 35 cases to the calculation of square feet per operator, and changed the proportion of buildings across the two sub-tiers for both the sample and population, requiring a recalculation of sample weights (Table 28).

Table 28. Recalculation of Weights for Square Footage per Operator for Combined Certified and Non-certified Operator Dataset, Facilities 50,000 Square Feet and Larger

Facility Size (Square Feet)	Number of Facilities in Sample	Percent of Facilities Sample	Percent of Buildings in Region (CBSA)	Weight
50,000 to 500,000	159	55%	99%	1.81
500,000	131	45%	1%	0.02
Total	255	100%	100%	n/a

Applying the new weights to the expanded combined sample produced a new mean of 57,280 square feet per operator. Dividing that into the total market square footage for the redefined large tier (and multiplying by 75% as before) produced an estimate of 13,973 operators in that tier.

Redefining the small tier reduced the estimated number of buildings in that tier from 48,217 to 42,772.[47] Since the tier now excludes most of the buildings expected to have operators, we also reduced the assumed percentage of buildings with in-house operators to 3%.[48] This produced an estimate of 1,283 operators in that tier, for a total of 15,256 operators in the region.

[47] One NEEA staff member suggested that 10,000 square feet may be a better lower bound than 5,000 square feet for the small tier. We selected 5,000 square feet simply because it corresponds to the way CBSA partitions the building size distribution (<5,000, 5,000-19,999, 20,000-49,999, 50,000-99,999, 100,000-499,999, and 500,000+ square feet). Estimating the proportion of buildings in the 5,000-19,999 range that are at least 10,000 would require knowledge of the shape of the distribution of the count of buildings within that range. The distribution is likely skewed, with relatively more buildings below than above 10,000, but we do not know the level of skew. Moreover, the method for estimating the number of operators in the small tier is based on evidence (reported in MPER #1) of the percentage of buildings *at least 5,000 square feet* and smaller than 100,000 square feet, that have operators.

[48] This is, admittedly, an arbitrary assumption. The difference between assuming 1% of and 5% of buildings with operators is about 1,700 operators, so assuming a possible range of 1% to 5%, the 3% figure comes with a possible error of ± 850.

Table 29. Estimated Size of Building Operator Market, Using Combined Certified and Non-certified Operator Dataset, Redefined Large Tier

Facility Size (Square Feet)	Parameter Used to Estimate Number of Operators in Tier	Parameter Value	How Number of Operators in Tier Calculated	Number of Operators
5,000 to 49,999	Number of Buildings in Tier	42,772	3% of buildings, one operator per building	1,283
≥ 50,000	Total Square Footage of Buildings in Tier	1,067,155,300	57,280 square feet per operator, 75% of square footage has operators	13,973
Total	n/a	n/a	n/a	15,256

Which Estimate Is Better?

The two new estimates of regional market size range from 10,960 operators – less than 10% more than the MPER #1 estimate – to 15,256 operators – half again as many, using the revised method. As noted above, we revised the method because of concerns that the original method may have under-estimated the number of operators in facilities smaller than 100,000 square feet.

One way to examine the question is to ask what the revised method does to the estimated number of buildings with operators in the 5,000-to-99,999-square-feet range. Recall that the original method assumes 5% based on several converging lines of evidence. By including buildings of 50,000 to 99,999 square feet in the large tier, the revised method increased the estimate of operators in the large tier from 8,549 to 13,973 – an increase of 5,425. Not all of those are necessarily in the 50,000-to-99,999-square-feet range, but most are. Assuming 5,000 operators, the calculated mean of 57,280 square feet per operator, and a mean building size of 60,000 square feet[49] produces an estimate of about 4,800 buildings with operators in the 50,000-to-99,999-square-feet range, which by itself is about 10% of the estimated number of buildings in the entire 5,000-to-99,999-square-feet range. Assuming any additional number of buildings smaller than 50,000 square feet with operators increases that percentage.

The above analysis is slightly sensitive to the assumed number of operators in the 50,000-to-99,999-square-feet range. For example, it would require a 20% decrease in the assumed number of operators (to 4,000) to decrease the estimated percentage of buildings with operators to 8%. It is also sensitive to the assumed mean square feet per operator – the calculated mean was for the entire large tier, but operators in buildings smaller than 100,000 square feet may, on average, have responsibility for less square footage. Assuming 45,000 square feet per operator, for 4,000 operators, decreases the estimated percentage of buildings with operators to 6% – but this still does not include any buildings smaller than 50,000 square feet.

[49] The mean building size comes from the total square footage (given by CBSA) divided by the estimated number of buildings.

Two conclusions are possible: that the revised method overestimates, by 1,000 or so, the number of operators in buildings of 50,000 square feet or more; or that the percentage of buildings smaller than 100,000 square feet with building operators is closer to 10% than to 5%. Without more to go on, we suggest modifying the revised method by assuming that redefining the large tier to include buildings of 50,000 to 99,999 square feet increases the number of operators in that tier by half the amount that the revised method estimates (2,712 instead of 5,425). This produces the estimate shown in Table 30.

Table 30. Compromise Estimated Size of Building Operator Market

Facility Size (Square Feet)	Number of Operators
5,000 to 49,999	1,283
≥ 50,000	11,261
Total	12,544

Additional Considerations

For both the survey of BOC-certified operators and the survey of non-certified operators, nearly all of the respondents worked in Oregon or Washington. Therefore, the above estimate of total operator population will be inaccurate to the extent that the mean square footage per operator is different for Idaho/Montana than for Oregon/Washington. Given that only 13% of total regional square footage for buildings at least 100,000 square feet is in Idaho or Montana, however, a reasonable amount of variation between the two areas in the mean square footage per operator would have little impact on the overall mean or the resulting population estimate.[50]

Revised Estimates of BOC Market Penetration Rate

Together, NEEC and IBOA have certified 2,351 BOC operators through 2013.[51] As noted above, at least 1%, but as many as 5%, of the operators are retired or deceased. Taking the higher percentage yields an estimate of 2,233 currently employed, BOC-certified operators. With the revised estimate of market size shown in Table 30, this represents a market penetration rate of 18%, slightly lower than we estimated for MPER #1.

[50] As a sensitivity analysis, we estimated the operator population under the assumption that the mean square footage per operator in Idaho/Montana is 20% lower than in Oregon/Washington and under that assumption that the mean for Idaho/Montana is 20% higher. These assumptions changed the estimated operator population by -2.0% and +1.3%, respectively.

[51] *2013 BOC Program Database*. Memorandum prepared for the Northwest Energy Efficiency Alliance by Research Into Action, February 28, 2014.

Operator Population and Penetration Rate for Oregon/Washington and Idaho/Montana

To estimate the operator populations separately in Oregon/Washington and Idaho/Montana is challenging. Our original and revised methods both use the total square footage of buildings in the large size tier and the total number of buildings (derived from the total square footage) in the small tier. CBSA provides this information for the region as a whole and provides the total square footage by state, but it does not show totals for building size tier by state.

Oregon and Washington account for about 87% of the total regional building area, but the distribution of total building area across size tiers may not be the same for Oregon/Washington and Idaho/Montana. In fact, as noted above, our market informants noted that few buildings in Idaho and Montana were larger than 100,000 square feet. Data from the U.S. Census suggest that the Oregon/Washington share of large-tier buildings may be slightly higher than its share of all buildings. The Census data do not show building size, but they show number of employees, which may be used as a proxy. While 78% of all regional business establishments are in Oregon and Washington, the Oregon/Washington share of establishments with at least 100 employees is slightly higher – 81%.[52] Applying the same ratio (.81/.78, or 1.04) to the building area percentage suggests that the Oregon/Washington share of regional large-tier buildings may be closer to 90% than 87%.

We therefore calculated a range of estimates based on varying assumptions about differences between Oregon/Washington and Idaho/Montana in the distribution of total building area. Specifically, we calculated three sets of estimates based on the assumptions that Oregon and Washington account for 87.5%, 90%, or 92.5% of buildings of at least 50,000 square feet. Those assumptions gave us three sets of estimates of the total square footage in the two size tiers. From each set of estimates, we calculated the number of operators in the large tier by dividing the mean square footage per operator by the estimated total square footage, as we did for the regional estimate. Since we had estimated the number of operators in the smaller tier based on the number of buildings, rather than the square footage, we allocated the estimated regional total number of operators for that tier based on the respective percentages, for Oregon/Washington and Idaho/Montana, of total square footage in that tier. The results are in Table 31.

[52] U.S. Census Bureau, Statistics of U.S. Businesses: 2008. "U.S. - All industries - by Employment Size of Enterprise." (Source: https://www.census.gov/epcd/susb/latest/us/US--.HTM.) The Census defines a business "establishment" as a single business location of a business entity.

Table 31. Estimated Size of Building Operator Market in Oregon/Washington and Idaho/Montana

Area	Percentage of Total Square Footage, Buildings At least 50k SF	Operators in Buildings At least 50k SF	Percentage of Buildings 5k to 50k SF	Operators in Buildings 5k to 50k SF	Total Number of Operators
Oregon/Washington	87.5%	9,854	87%	1,114	10,967
Idaho/Montana	12.5%	1,408	13%	169	1,577
Total	100%	11,261	100%	1,283	12,544
Oregon/Washington	90.0%	10,135	85%	1,091	11,225
Idaho/Montana	10.0%	1,126	15%	192	1,318
Total	100%	11,261	100%	1,283	12,544
Oregon/Washington	92.5%	10,416	83%	1,068	11,484
Idaho/Montana	7.5%	845	17%	215	1,060
Total	100%	11,261	100%	1,283	12,544

The BOC database shows that, through 2013, BOC has certified 1,822 operators with Oregon and Washington work addresses and 529 with Idaho and Montana work addresses. If we again assume that 5% of those are retired from work or deceased, we estimate that the current working counts of certified operators are 1,731 in Oregon/Washington and 503 in Idaho/Montana.

We calculated BOC penetration rates separately for Oregon/Washington and Idaho/Montana based on each set of operator population estimates shown above in Table 31. The estimated penetration rate for Oregon/Washington was not sensitive to the assumed percentage of large-tier buildings that Oregon/Washington account for – it was 15% to 16% under each assumption. However, the penetration rate for Idaho/Montana was sensitive to the assumption used, ranging from 32% to 47% (Table 32).

Table 32. Estimates of BOC Penetration in Oregon/Washington and Idaho/Montana

	Oregon/ Washington		Idaho/ Montana		Total	
BOC-Certified[a]	**1,731**		**503**		**2,280**	
Percentage Large-Tier Buildings in Oregon/Washington	**Operator Population**	**Penetration Rate**	**Operator Population**	**Penetration Rate**	**Operator Population**	**Penetration Rate**
87.5%	10,967	16%	1,577	32%	12,544	18%
90%	11,255	15%	1,318	38%	12,544	18%
92.5%	11,484	15%	1,060	47%	12,544	18%

[a] Number of currently employed BOC-certified operators

The penetration rate for Idaho and Montana seems high, particularly in light of the fact that our market informants reported that general awareness of BOC was low in those states. One reason that the penetration rate would be higher in Idaho/Montana than Oregon/Washington is that IBOA appears to have certified all course graduates without requiring a separate certification test. However, it seems unlikely that this would account for a doubling of the penetration rate.

Recall that the estimate of number of operators in the large tier (now defined as at least 50,000 square feet) assumes in-house operators for 75% of the square footage in that tier. If in-house operator coverage in the large tier is more than 75% of the building square footage in Idaho and Montana, then the operator population may be larger in those states than our estimate. We cannot assume, however, that the proportion of such buildings with in-house operators is greater in Idaho/Montana than in Oregon/Washington.

Other possible reasons for the high penetration rate in Idaho/Montana may exist. For example, the estimate assumes that, of the credentialed operators with Idaho or Montana work addresses, 95% are still working. This may be an overestimate – more than 5% may be unemployed, retired from work, or deceased and some may no longer work in Idaho or Montana but not have provided an updated work address. However, even assuming that only 80% of credentialed operators with Idaho or Montana work addresses are still working in those states, the population estimates shown in Table 32 would produce penetration estimates of 27% to 40%.

We cannot speculate on other possible reasons for the high penetration rate.

Secondary Research

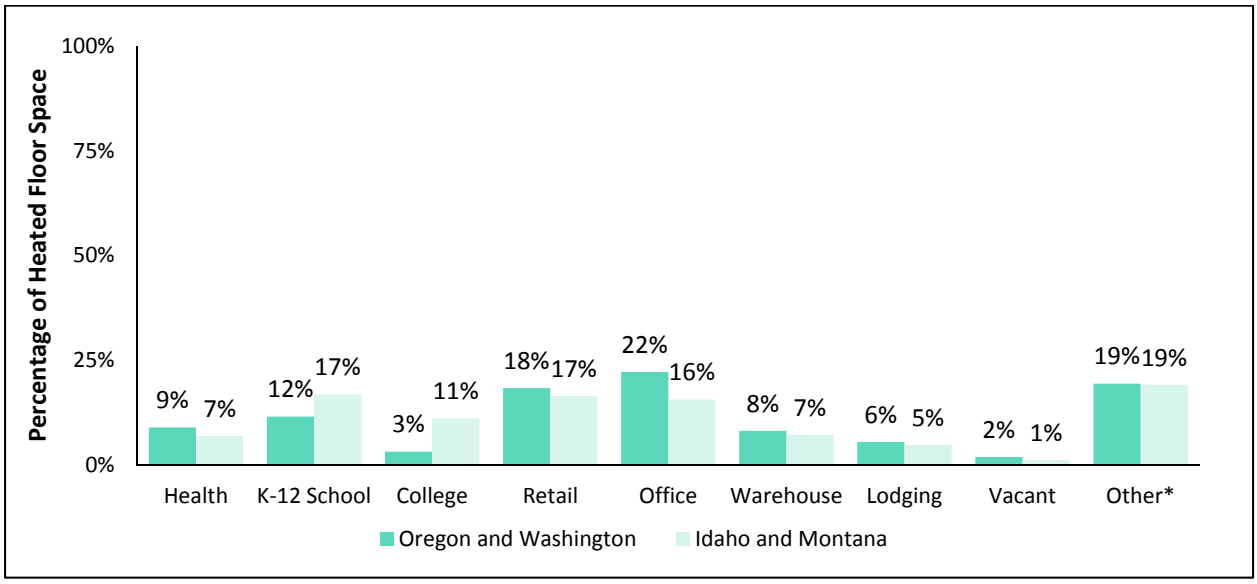
We sought information on how the commercial building market in Idaho and Montana may differ from that in Oregon and Washington. Below, we present information relating to the distribution of buildings by end-use type and on the proportion of government-owned buildings.

Distribution by End-Use Type

We used data from the Commercial Building Stock Assessment (CBSA) to compare the distributions of building square footage across end-use types, separately for Idaho and Montana and for Oregon and Washington. For this analysis, we included only heated floor space. Total commercial buildings in Idaho and Montana comprised approximately 278 million square feet (MSF) of space, compared to 1.87 billion square feet in Oregon and Washington.

For most end-uses, the proportions of square footage for various building end-uses in Idaho and Montana were similar to those in Oregon and Washington. However, K-12 schools and colleges occupied greater shares of building space in Idaho and Montana than in Oregon and Washington – the proportion was more than one-third higher for K-12 schools and nearly four times as high for colleges (Figure 24).

Figure 24. Proportion of Building Square Footage, by End-Use and Region



* Other includes building end-uses such as assembly, church, fire station, miscellaneous retail, prison, and assisted living.

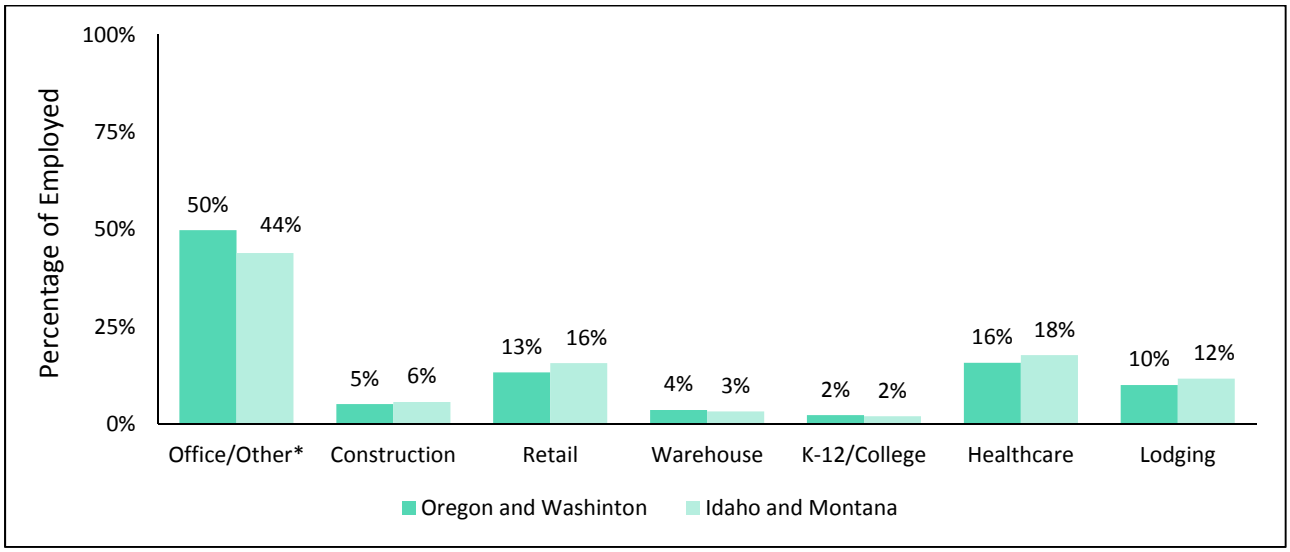
Our Idaho and Montana market informants indicated that the K-12 schools and college end-uses were among those most likely to have in-house operators. Therefore, if those end-uses represent a larger proportion of total building space in Idaho and Montana than in Oregon and Washington, there may be particular opportunities for BOC recruitment in those areas.

There is reason to question the CBSA estimates for colleges, however. The square footage designated as colleges in Oregon was lower than what we would expect. CBSA data show that Oregon has 6.2 MSF of college buildings, which is considerably less than Idaho (19.7 MSF) and Montana (13.6 MSF). To investigate further, we obtained data from the Oregon University System (OUS),[53] which revealed a combined total square footage for all public universities in Oregon of 25.8 MSF. However, substituting the OUS figure for the CBSA Oregon college figure increased colleges' proportion of total building square footage in Oregon and Washington only from 3% to less than 5%, still less than half the 11% figure in Idaho and Montana. We do not have a comparable independent source of data on private colleges and universities. If the total square footage for private colleges and universities is equal to that for public ones, the combined percentage for colleges and universities in Oregon and Washington would be about 6%.

[53] The Oregon University System consists of Portland State University, Western Oregon University, Oregon State University, University of Oregon, Oregon State University Cascades, Eastern Oregon University, Southern Oregon University, and Oregon Institute of Technology.

We also looked at data from the 2012 Economic Census[54] to compare to findings from our analysis of the CBSA data. This analysis showed only small differences between Idaho/Montana and Oregon/Washington in the distributions of establishments and employees by sector. Figure 25 shows that the proportion of individuals employed at K-12 schools and colleges in Idaho and Montana is approximately the same as Oregon and Washington. (The comparison was similar for number of establishments; not shown.)

Figure 25. Proportion of Paid Employees, by End-Use and Region



* Other includes building end-uses such as assembly, church, fire station, miscellaneous retail, prison, and assisted living.

If there were in fact a greater proportion of building square footage designated as K-12 schools and colleges, as suggested by CBSA data, we might expect there also to be a greater proportion of employees in these sectors. In fact, using the CBSA and Economic Census data together, we calculated the mean square footage per employee for the education sector in the two areas.[55] The mean for Oregon/Washington (3,478) was about three-quarters that of the mean for Idaho/Montana (4,774). These findings further suggest that the CBSA may be underrepresenting the square footage of designated as educational buildings in Oregon, and perhaps Washington.

[54] The U.S. Census Bureau conducts the Economic Census every five years with the purpose providing information on American businesses and the economy, including the number of business establishments and number of employees, by sector.

[55] The Census data showed employment for "educational services," and did not show separate data for K-12 schools and colleges. This employment category may also include individuals employed outside of K-12 schools and colleges, such as in educational testing firms and tutoring services.

Government Ownership

We found another area where the CBSA data is at variance with another source. CBSA shows about 38.2 MSF of federal-government-owned buildings in Oregon/Washington and 4.5 MSF in Idaho/Montana. Those figures amount to about 2% and 1%, respectively, of the total building square footage in the two areas. This, however, is not consistent with data we obtained from the 2009 Federal Real Property Statistics (FRPS), which shows about 93.3 MSF of federal-government-owned buildings in Oregon/Washington and 34.0 MSF in Idaho/Montana – comprising about 4% and 10%, respectively, of total building square footage (Table 33).[56] The federal government also leases or otherwise manages another 19.0 MSF in Oregon/Washington and 6.7 MSF in Idaho/Montana.

Table 33. Square Footage of Federally Owned and Managed Buildings

	Oregon / Washington			Idaho / Montana		
Legal Interest	**Square Footage**	**Percent of Total Owned, Leased, Etc.**	**Percent of Total Building Square Footage**	**Square Footage**	**Percent of Total Owned, Leased, Etc.**	**Percent of Total Building Square Footage**
FEDERAL REAL PROPERTY STATISTICS						
Owned	93,300,000	83%	3.9%	34,000,000	84%	10.0%
Leased	14,800,000	13%	0.6%	5,200,000	13%	1.5%
Otherwise Managed*	4,200,000	4%	0.2%	1,500,000	4%	0.4%
Total	112,300,000	100%	4.8%	40,700,000	100%	11.9%
COMMERCIAL BUILDING STOCK ASSESSMENT (CBSA)						
Owned	38,200,000	n/a	1.7%	4,500,000	n/a	1.4%

* "Otherwise managed" indicates that a U.S. state government holds title to the real property asset but has granted rights for use to a federal government entity in a method other than a leasehold arrangement.

Determining the correct total of federally owned and controlled building square footage and explaining the discrepancy between the CBSA and FRPS data are important, given that the BOC-E initiative targets that sector.

One possibility is that the CBSA figure for some reason does not include military property. The FRPS data showed that 63% of building square footage held by the federal government in the U.S. is for military purposes (Army, Air Force, and Navy). The FRPS does not show the military and non-military percentages by state, but if non-military square footage is about one-third of total federally owned square footage in Idaho and Montana, the non-military total would be close to the CBSA total. On the other hand, the non-military total for Oregon and Washington would still be more than twice what CBSA shows.

[56] Source: http://www.gsa.gov/graphics/ogp/FY2009_FRPR_Statistics.pdf

We could not determine from the CBSA report whether the total square footage reported for federally owned property included or excluded military property. If it does exclude military property, that would explain part, but not all, of the discrepancy between the CBSA and FRPS totals.

In any case, the FRPS data suggest that federally owned building square footage, including that for military uses, is substantially greater in the region as a whole than CBSA would indicate. Further, if that extra square footage is not otherwise classified in CBSA, then CBSA may undercount total building square footage in the region, which would have implications for the estimated size of the building operator market and BOC market penetration.

Summary and Conclusions

We carried out multiple research activities to identify key characteristics of the building operator market, particularly for Idaho and Montana. We present key findings relating to building stock, awareness of and interest in BOC, and the estimated building operator population and BOC penetration.

Building Stock

- The building stock in Idaho/Montana may be older than in Oregon/Washington and is facing efficiency challenges. However, the use of benchmarking has been a "huge" improvement recently.
- Informants cited hospital, school, government, industrial, and airport as the building end-use type as most likely to have in-house operators.
- Analysis of secondary data suggests that the distribution of building stock across end-uses is similar in Idaho/Montana and Oregon/Washington. CBSA data suggest that K-12 schools and colleges represent a higher proportion of the total building stock in Idaho/Montana than in Oregon/Washington, but other secondary data suggest that the CBSA undercounts education-related building space in Oregon.
- Data from the U.S. General Services Administration also suggest that the amount of federally owned property is greater across the region than the CBSA indicates. Therefore, the CBSA should not be the source for estimating the opportunity for BOC expansion in the federal sector.

Awareness of and Interest in BOC

- Informants identified low awareness of BOC and limitations of money and time as key barriers to BOC training in Idaho and Montana, confirming the assumptions that underlie the BOC-E initiative.

- Informants identified as key groups for BOC recruitment "hands-on" staff, "first responders," such as school custodians, and younger building operations workers who are more technology savvy and interested in sustainability than their predecessors. Additional comments suggested that the latter group may be most amenable to on-line training.

Building Operator Population and BOC Penetration

- We used new data from our 2014 survey of non-certified operators to update our estimate of the size of the building operator population, from 10,020 (reported in MPER #1) to 12,923. That estimate relies on a mean building square footage per operator based mainly on operators working in Oregon and Washington, but the mean square footage per operator for Idaho and Montana would have to differ by more than 20% from the Oregon/Washington mean to change the estimated operator population by more than 2.6%.

- Based on the revised population estimate, we now estimate BOC market penetration to be about 18% regionally. Our effort to estimate penetration separately for Idaho/Montana and Oregon/Washington yielded estimates of at least 37% for the former area, which seems to contradict our market informants' observation of low BOC awareness in that area. Our separate penetration estimates for the two areas required making some assumptions based on limited data, however, and so should require cautious interpretation.

Appendix E. ACE Model Review Memo

Memorandum

To: Rita Siong, NEEA Project Manager

From: Ryan Bliss, Research Into Action

Date: April 25, 2014

Re: 2014 BOC-E ACE Model Inputs

As part of our activities to evaluate the Northwest Energy Efficiency Association's (NEEA's) Building Operator Certification Expansion (BOC-E) Initiative, this memo documents findings from a 2014 survey of the operations and maintenance (O&M) practices of building operators without the Building Operator Certification (BOC) credential ("non-certified operators") but with O&M management responsibilities.

Our findings demonstrated that BOC training results in electricity savings for several equipment types and likely produce overall electricity savings, compared to the savings achieved by non-certified operators. Overall, the results indicated BOC-attributable savings for natural gas and electricity were close to those we reported in BOC-E Market Progress Evaluation Report #1 (MPER #1).[57] Based on that finding, we recommend no changes to the current ACE Model assumptions. The study also found that BOC training produces greater savings for some equipment types than others, which may suggest areas to investigate possible adjustments in training.

This is the first time that NEEA has funded research to compare the energy consumption and savings of non-certified building operators with those of BOC-certified operators. In 2001, Research Into Action surveyed supervisors of BOC-certified and non-certified operators about efficiency practices, but the study was not designed to assess actual energy consumption and savings.[58]

The sections that follow present: 1) the background for the current research, including a discussion of our previous research on BOC-certified operators and the purpose of carrying out research with non-certified operators; 2) the methodology for the current research, including survey implementation and survey data preparation and analysis; 3) the research results; and 4) conclusions and recommendations.

[57] Research Into Action, Inc. (2014). See Appendix G.

[58] Research Into Action, Inc. (2001). See Appendix G.

Background

Previous Research on BOC-Certified Operators

In April 2013, Research Into Action conducted a survey of Oregon and Washington[59] BOC-certified operators, which collected detailed data on the O&M practices of those operators. The purpose was to estimate the total savings per operator (kWh and therms) and the percentage savings per operator for buildings with BOC-certified operators.

The survey assessed self-reported O&M practices across nine equipment types[60] as well as facility[61] size, location, and end-use type, where that information was not available from the Northwest Energy Efficiency Council's (NEEC's) database of BOC-certified operators.[62]

For each respondent, we calculated a baseline energy consumption value based on facility end-use, size, and climate zone and recently published energy usage intensity (EUI) data (see below). Specifically, we identified the appropriate EUI for each facility based on its end-use and climate zone. Since EUI is expressed in terms of energy usage (kWh or therms) per square foot, we could estimate baseline consumption by multiplying the EUI by the facility size. That baseline value represented what that facility's energy consumption would be with standard building operations practices.

Our team subcontractor, Nexant Inc., then applied engineering analyses to survey respondents' self-reported O&M practices and facility characteristics to calculate how much energy (electricity as well as natural gas) each respondent's facility saved through the self-reported O&M practices, as compared to standard building operations practices. Nexant based the algorithm for calculating savings, including the assumption of what constituted standard practices, on measure libraries it had developed from building retrocommissioning, building tune-up, and O&M program implementation work.

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59 NEEC's database, at that time, only contained Oregon and Washington BOC-certified operators.

60 The equipment types were boiler systems, chilled water systems, economizers and ventilation control, compressed air systems, fans and air distribution systems, domestic water heaters, lighting, pumps, and motors.

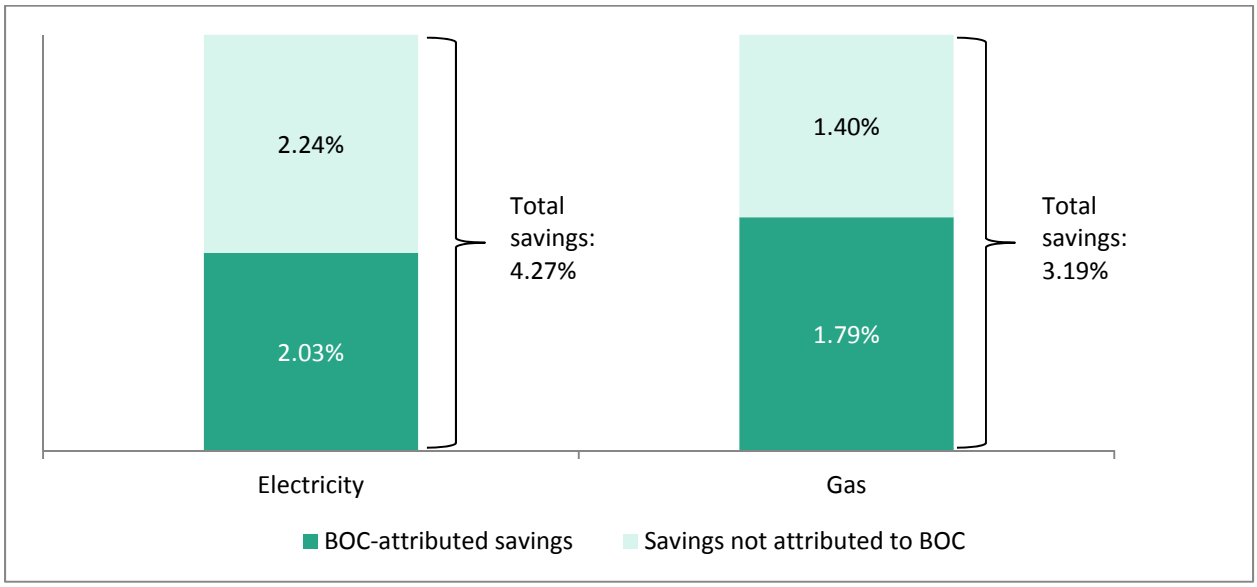
61 The 2013 survey of BOC-certified operators did not assess whether respondents were responsible for a single building or multiple buildings, and that information was not available from the BOC database. Throughout the 2013 survey, we used the word "facility" rather than "building" when asking about workplace characteristics. In the spirit of continuous improvement based on learnings from the last study, the 2014 survey of non-certified operators asked about the number of buildings, and total square footage, that each respondent was responsible for. Therefore, in our discussion of the 2014 survey results, we use the expression "building or facility."

62 The Northwest Energy Efficiency Council (NEEC) administers BOC certification.

For each fuel type, we calculated mean energy savings as the total estimated energy saved divided by the total estimated baseline consumption. We conducted the above analysis twice: once using EUI data from both the U.S. Energy Information Administration's Commercial Buildings Energy Consumption Survey (CBECS)[63] database, and once using EUI data from NEEA's Commercial Building Stock Assessment (CBSA).[64] The two sources provided similar results.

Our prior research estimated that buildings with BOC-certified operators use, on average, 4.27% less electricity and 3.19% less natural gas than would result from the application of standard building operations practices in such buildings. Based on the survey respondents' ratings of the influence of BOC training on their reported O&M practices, we estimated that, on average, just over half of that reduced energy consumption was attributable to BOC training. Thus, we estimated that BOC training was responsible for a 2.03% reduction in electricity and a 1.79% reduction in gas compared to the consumption that would result from standard building operations practices (Figure 26). The survey did not seek to determine what factors were responsible for the energy savings that the respondents did not attribute to BOC training.

Figure 26. Attribution of Energy Savings in to BOC Training



As Table 34 shows, the 2013 study, described above, provided the most comprehensive research to date on the O&M practices of BOC-certified operators and of the resulting energy savings. Based on our research, we submitted a memo to NEEA that reviewed the input assumptions for the BOC-E Initiative's ACE Model. We incorporated that memo into BOC-E Market Progress Evaluation Report #1 (MPER #1).

63 Source: http://www.eia.gov/consumption/commercial/.

64 *Northwest Commercial Building Stock Assessment: Final Report.* Prepared by The Cadmus Group, Inc. for the Northwest Energy Efficiency Alliance, December 21, 2009.

Table 34. Studies of BOC Savings

Report Title & Year	Sample	O&M Assessment		Savings Estimate Includes Capital Upgrades?	Assessment of BOC Attribution	Estimated O&M Savings (ft^2/year)	
		Number of Equipment Areas	Assessment details			kWh	Therms
BOC-Expansion Initiative Market Progress Evaluation Report #1. Prepared by Research Into Action, Inc. for Northwest Energy Efficiency Alliance, 2014.	212	9 areas	~50 questions on nature of actions taken	No	0-10 scale, converted to % attribution	.315	.007
Impact and Process Evaluation: Building Operator Training and Certification (BOC) Program. Prepared for Northeast Energy Efficiency Partnerships by RLW Analytics, 2005.	94	7 areas	Assessed whether or not maintenance performed, but not detailed maintenance activities	Yes	Dichotomous – yes/no influence question	.15 to .20*	.028 to .035*
Evaluation of MN BOC Training. Prepared for Midwest Energy Efficiency Alliance and Minnesota Office of Energy Security by Navigant Consulting Inc., 2011.	50	6 areas	Not provided	No	0-10 scale, no savings for 3 or less	.237	.018
Program Year 3 DCEO Building Operator Certification (BOC) Program Evaluation. Presented to the Illinois Department of Commerce and Economic Opportunity (DCEO) by Navigant Consulting, 2012.	30	7 areas	Not provided	Yes	0-10 scale, no savings for 3 or less	.374	.001
Evaluation of Kansas City Power and Light's Building Operator Certification Program. Prepared for Kansas City Power and Light by Opinion Dynamics Corporation, 2009.	26**	7 areas	Not provided	Yes	Dichotomous – yes/no influence question	.02	N/A

* The authors reported separate results for respondents from schools (n = 45) and from other workplace types (n = 49).

** 26 respondents, but 10 unique sites.

Purpose of Research on Non-Certified Operators

Operators' rated influence of BOC may not provide an accurate estimate of the BOC-attributable portion of their savings.[65] Comparing the energy consumption of BOC-certified operators with a group of operators that are similar other than having the credential is an alternative approach to (missing the rest of this sentence).

Methods

In January and February 2014, Research Into Action conducted an online survey of building owners, business owners, and operations and maintenance (O&M) workers. In addition to assessing O&M practices, the survey collected market data from building and business owners as well as their O&M managers and staff. Specifically, the survey assessed employer and workplace characteristics; awareness and familiarity with and attitudes toward BOC; training history; and the importance of staff retention. We present the findings from the market data in detail in a separate memo. This memo focuses on the analysis of energy savings from the O&M practices of the O&M workers who responded to the survey.

The survey used the same questions to assess O&M practices as we used in the 2013 survey of BOC certificants, reported in MPER #1. Briefly, the section of the survey that assessed O&M practices first asked respondents which of nine equipment types they were responsible for: boiler systems; chilled water systems; economizers and ventilation control; compressed air systems; fans and air distribution systems; domestic water heaters; lighting; pumps; and motors. For each equipment type that a respondent identified responsibility for, the survey asked a series of questions about O&M practices related to that equipment type.

As with the previous survey, Research Into Action implemented the survey using the Qualtrics© online survey software platform.

The following discussion covers our methods for survey implementation, preparation of the survey data, calculation of energy savings for individual respondents, and comparison of savings percentages for certified and non-certified operators.

[65] This observation is not based on the often-cited argument that self-report does not provide reliable data. In fact, research evidence suggests that self-report of behaviors and attitudes generally is reasonably reliable. (See, for example, *Other Topics – Self-Report Data*, from the website of the National Social Norms Institute at the University of Virginia, accessed on June 2, 2014 at: *http://www.socialnorms.org/Research/SelfReports.php*.) What is at issue here is whether a mean BOC influence rating of 5 means that 50% of savings are attributable to BOC.

Survey Implementation

We implemented the survey through two channels with separate (but likely overlapping) survey frames: 1) through email invitations, with multiple reminders, we sent to a list we developed from the Northwest Energy Efficiency's Council (NEEC) BOC contact list; and 2) through a single email blast by a private media organization to its subscriber list.

Survey Channel 1

The Northwest Energy Efficiency Council (NEEC) provided a list of 7,488 building operations and facilities management contacts that it had developed over several years from a wide range of sources. The primary sources for this contact list were:

- Contact lists obtained from other building operations and facility management service providers.
- The regional memberships of several organizations to which NEEC belongs: the Building Owners and Managers Association (BOMA), the International Facility Management Association (IFMA), APPA (formerly the Association of Physical Plant Administrators), the Washington Association of Maintenance and Operations Administrators (WAMOA), and the American Society for Healthcare Engineering (ASHE).
- Attendees of NEEC-supported regional conferences, events, and webinars.
- BOC-specific contacts, including BOC supervisors and students and individuals that have contacted NEEC to get information about BOC.

The NEEC list was the largest and most comprehensive list of building operations and facility management contacts we could identify for Washington and Oregon. Those two states accounted for 98% of the contacts in the list.

We removed BOC students from the above list. However, as one goal of the survey was to assess the value of having BOC-certified operators to building and business owners who employ them, we did not remove BOC supervisors from the list. We removed duplicate records for the remaining names. The final list consisted of 3,013 names. Of those, about 80% had been on the list fewer than five years.

We sent an email survey invitation to each person on the above list. The email explained the purpose of the survey and assured the recipient of confidentiality. It included a link to the survey and a respondent-specific identification number. We sent up to three reminders over a two-week period.

Survey Channel 2

The second channel was a similar email invitation sent via Trade Press Media Group, Inc., a media company serving the building operations and facility management industry. Trade Press sent the invitation to a list of subscribers to two of the company's professional journals: *Building Operations Management* and *Facility Maintenance Decisions*. The Trade Press list consisted of 1,851 names in the four Pacific Northwest states. Trade Press sent the invitation once, with no additional reminders.

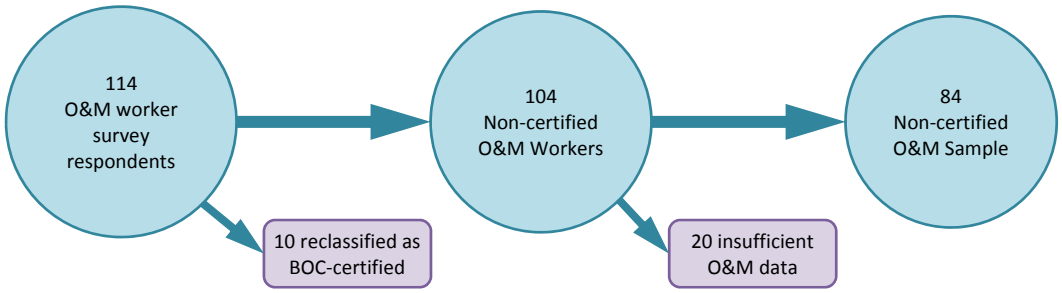
We considered it possible that the Trade Press list would have many of the same names as those on the NEEC list. We were not able to de-duplicate the lists, however, as Trade Press did not provide us access to the list, but rather sent our survey invitation to its list. To avoid confusion on the part of the survey invitees, we did the following. We sent the email invitation to the NEEC list first, followed by two reminder emails. After the second reminder email to the NEEC list, we asked Trade Press to send the invitation to its list. That email was similar to the one we sent to the NEEC list, except that it included a statement explaining that, because of the survey's importance, we were implementing the survey through two channels and that if they received invitations from two sources, they should take the survey only once. We sent a third reminder to the NEEC list, which included the same statement.

Preparation of Survey Data

We merged the responses from the two lists and checked for duplicate responses based on name and IP address. There were no duplicate responses. Since our goal was to compare the savings from non-certified operators to the savings from BOC-certified operators from the 2013 survey, all of whom worked in Washington or Oregon, we excluded responses from anyone whose work location was outside those two states.

In total, 114 O&M workers from Washington or Oregon responded to the survey, all but three coming from the NEEC contact list. Ten of those respondents reported being BOC-certified. We reclassified those respondents as BOC-certified operators for the purposes of calculating energy savings. Of the remaining 104 non-certified O&M workers, 20 (24%) did not provide sufficient data to assess baseline energy consumption or savings, leaving 84 respondents with sufficient data to assess energy savings (therms, kWh, or both). Figure 27 summarizes the above. The final sample size delivers at least 90/10 confidence/precision for the descriptions of individual O&M practices.

Figure 27. Sample Disposition



Representativeness of the Sample

We conducted analyses to determine whether the 104 non-certified survey respondents were representative of the sample frame from which they were drawn and to determine whether the final sample of 84 O&M workers with usable data were representative of the sample frame and of the 104 survey respondents.

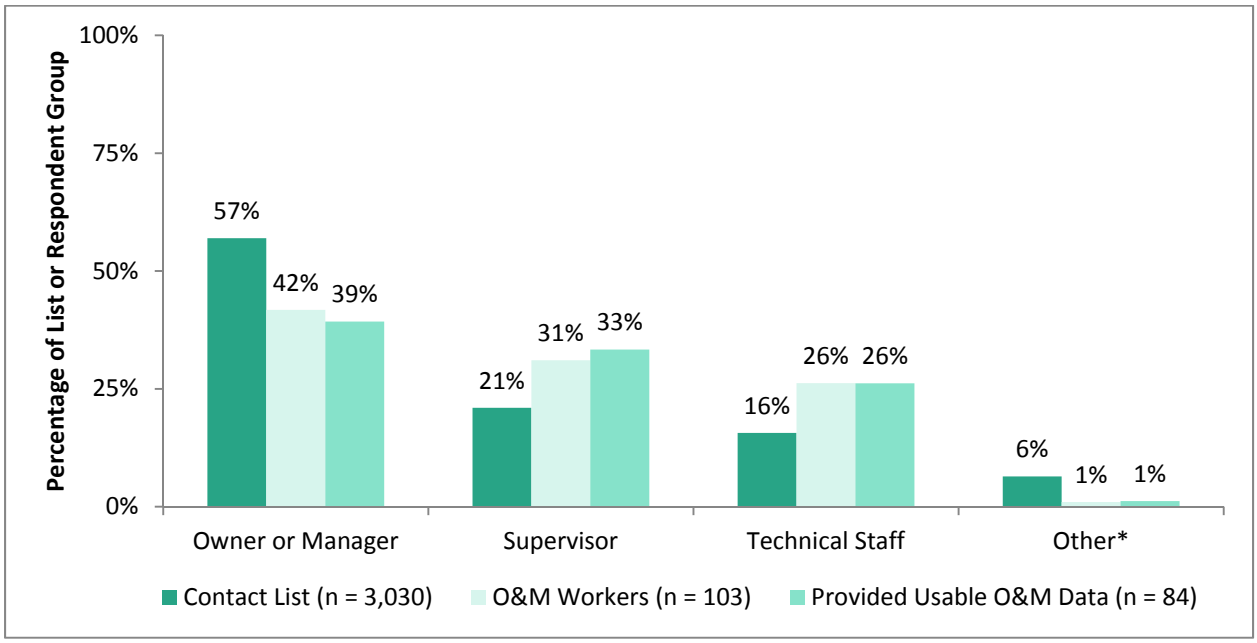
The NEEC contact list (from which nearly all survey responses came) did not provide detailed information on the characteristics of list members. However, it included job titles, which allowed us to examine whether operators with certain types of job title were more or less likely than others to respond to the survey. We grouped the job titles into four categories:

- *Owners or managers* were those identified as an owner, a company officer or a director or a manager of technical activities.[66]
- *Supervisors* were those identified as a supervisor, lead, or chief of technical activities.
- *Technical staff* had titles that included the terms technical, mechanical, maintenance, engineer, or electrician or whose titles referred to specific equipment types, but who were not owners, managers, or supervisors.
- *Other* respondents were largely administrative or marketing.

As Figure 28 shows, the survey attracted relatively higher numbers of supervisor-level and technical staff, relative to their representation in the contact list, than owners, officers, directors, and managers. Those who provided usable data were similar to the overall O&M worker sample.

[66] In fact, only 2% of the survey frame and 1% of respondents were owners or officers, so the great majority of those in the first category were directors or managers.

Figure 28. Job Categories for Contact List and Survey Respondents



* *Other* consisted largely of administrative and marketing staff.

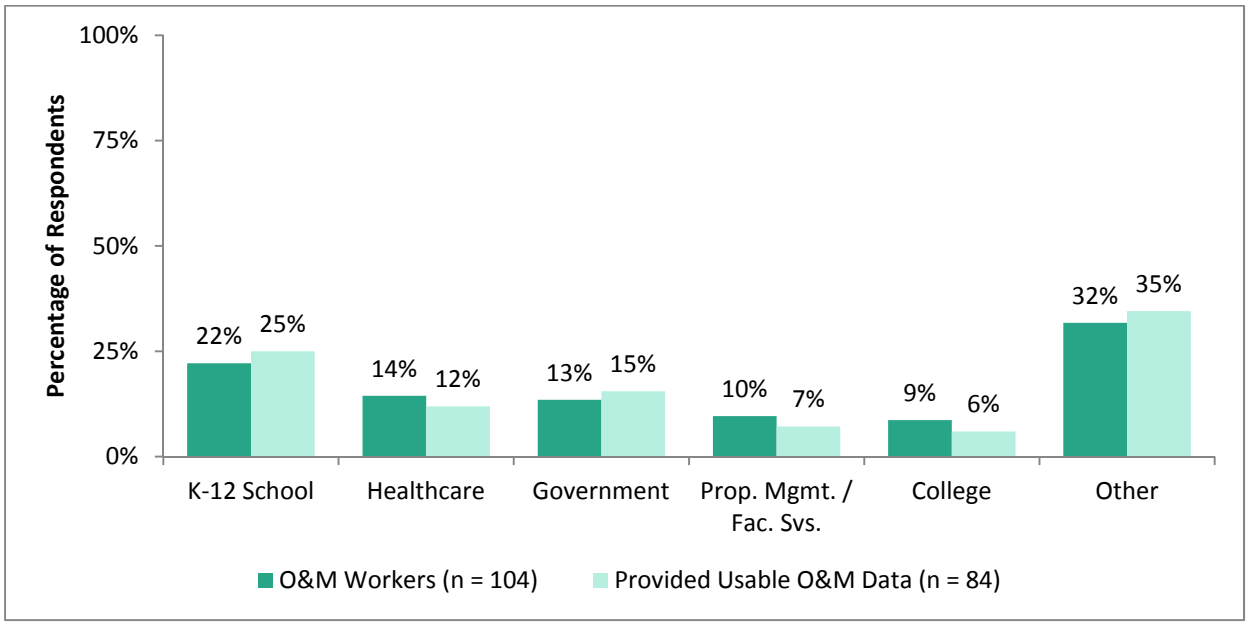
Figure note: One O&M worker did not provide a job title. Therefore, the sample size is 103 for this comparison.

We also examined whether the subset of 84 respondents with usable O&M data were comparable to the total sample of 104 O&M workers on two company characteristics: reported number of O&M staff reported and employer type.[67]

The total sample reported a mean of 15.6 O&M staff. Among just those with usable data, the mean was 13.1. As Figure 29 shows, the respondents with usable data were similar to the total sample across employer types.

[67] We did not compare on reported facility size, as 21% of the total sample did not report that information.

Figure 29. Employer Type of All Certified O&M Workers and Sample with Usable O&M Data



Survey question: "Which of the following best describes your organization's type of business?"

"Other" includes industrial/manufacturing, office, mixed use, and warehouse/distribution, none accounting for more than nine respondents, plus several miscellaneous types reported by one respondent each.

Thus, the attrition of the 20 respondents who did not provide usable O&M data did not have a large impact on the sample in terms of these company characteristics. The fact that the respondents with usable data differed somewhat from the entire sample, particularly in mean number of O&M staff reported, is not a great concern, as the purpose of this research was to compare the savings of non-certified operators with those of BOC-certified respondents. Therefore, the primary concern is the comparability of the non-certified and certified samples. As discussed below, in comparing the savings of these non-certified survey respondents with those of the BOC-certified respondents, we took several measures to maximize comparability.

Calculating Respondents' Energy Savings

The Research Into Action team estimated energy savings for each survey respondent, following the methods described immediately below. We did not re-analyze the savings for the individual BOC-certified respondents from the previous survey. However, since we identified 10 survey respondents as BOC-certified operators, we added those to the sample of certified operators; as described below, we also excluded some of the previously surveyed BOC operators from the analyses based on a more systematic approach to identifying outliers.

We estimated survey respondents' energy savings with the methods we established for the 2013 survey of BOC-certified operators, documented in detail in MPER #1 and summarized above. However, for this analysis, we calculated baseline consumption using energy usage intensity (EUI) data only from CBSA, comparing the savings for non-certified operators to that for certified operators based on CBSA data.

For each survey respondent, we used building size, type, and climate zone to calculate how much energy that respondent's building(s) used compared to a baseline value representing what the energy consumption would be with standard building operations practices. We then applied engineering analyses, together with the same building characteristics data, to respondents' self-reported O&M practices to calculate how much energy those practices would save in a building with those characteristics. Finally, for each respondent, we calculated energy savings as a percentage of total baseline consumption.

Identifying and Eliminating Outliers

We adopted a more systematic approach to identifying and eliminating cases with outlier savings values than we used previously. In the analysis of BOC-certified operators for MPER #1, we identified outliers based on unusually high boiler capacities relative to the building size, which always were associated with unusually high savings values. In the current analysis, rather than rely on boiler capacity, we identified outliers in both the certified and non-certified operator group based on calculated therm and kWh savings percentages. Since respondents reported responsibility for varying numbers of equipment types, and we would expect responsibility for more equipment types to result in greater overall savings, we identified outliers for each equipment type.[68] We excluded a respondent from therm savings analyses if *any* of that respondent's equipment-specific therm savings values were outliers; similarly, we excluded someone from kWh savings analyses if *any* of that respondent's equipment-specific kWh savings values were outliers. We conducted the outlier analysis separately for certified and non-certified respondents.

In total, we excluded six non-certified respondents, based on outlier values, from either therm or kWh analyses – all six of them from kWh savings and one of them also from therm savings.

We applied the same new outlier analysis to the previously certified BOC operators as well as the BOC-certified operators in the current survey. Of 195 BOC-certified operators that provided sufficient data for analyses, we identified nine as outliers for kWh savings and one as an outlier for therm savings.

Assessment of Possible Confounds

Before comparing the certified and non-certified operators, we assessed possible confounds in the data – that is, differences between the two groups in factors *other* than the credential that could account for some differences in energy savings. We identified possible confounds relating to the **operators' level and type of responsibility** and to **employer and workplace characteristics**, which we further elaborate below.

[68] For each equipment type, we identified a respondent as an outlier if that respondent's calculated savings were at least 3 standard deviations different from the mean savings percentage for all respondents who reported responsibility for that equipment type.

Level and Type of Responsibility

One possible confound was level of responsibility. Of the non-certified operators, 82% reported they managed other O&M staff. The 2013 survey of BOC-certified operators did not ask whether they managed other O&M staff, but both surveys asked respondents their titles. We categorized all self-reported titles as either "manager" or "non-manager." By this classification, 85% of the 84 non-certified operators with usable O&M data were managers, compared to 47% of the comparable certified operators.

We addressed this confounds by restricting subsequent analyses to operators that we classified as managers. Because there were only 13 non-managers in the non-certified operator sample, we could not carry out a reliable comparison of certified and non-certified operators among non-managers.[69] Below, in the discussion of the results, we address the impact this has on the generalizability of the findings.

The non-certified operators also reported more areas of equipment responsibility than certified ones: among those with usable O&M data, non-certified operators reported a mean of 6.1 areas of responsibility, compared to 5.2 for certified operators. Even when we restricted the comparison to the operators that we classified as managers, non-certified ones reported more areas of responsibility, on average (6.3 vs. 5.1). Therefore, the non-certified operators had more opportunities, on average, to report energy savings.

Because the non-certified managers were responsible for more equipment types, on average, than the certified operators, it would not be meaningful to directly compare the two groups on overall savings. We addressed this confound by comparing the two groups on equipment-specific savings percentages and using the relative difference between the two groups over all the equipment types to calculate an adjusted mean savings percentage value for the non-certified operators that is comparable to that for the certified operators. We describe this approach in more detail below.

Employer and Workplace Characteristics

Differences between the two groups in employer and workplace characteristics could influence the comparison of certified and non-certified operators. For example, if the two samples differed in the proportion of operators with a specific employer type that tends to have greater energy savings than others, then we could see group differences in energy savings that are actually the result of the employer type rather than the credential.

Facility size is a particular concern in the comparison of the BOC-certified and non-certified operators. As documented in MPER #1, BOC operators tend to work in large facilities: 84% of the facilities represented in the survey of BOC operators were 100,000 square feet or larger,

[69] Although Figure 28 indicates that we classified 26% (22 of 84) of the sample with usable O&M data as "technical staff" based on the job title information in the contact list, we re-classified 9 of them as managerial based on self-reported titles from the survey.

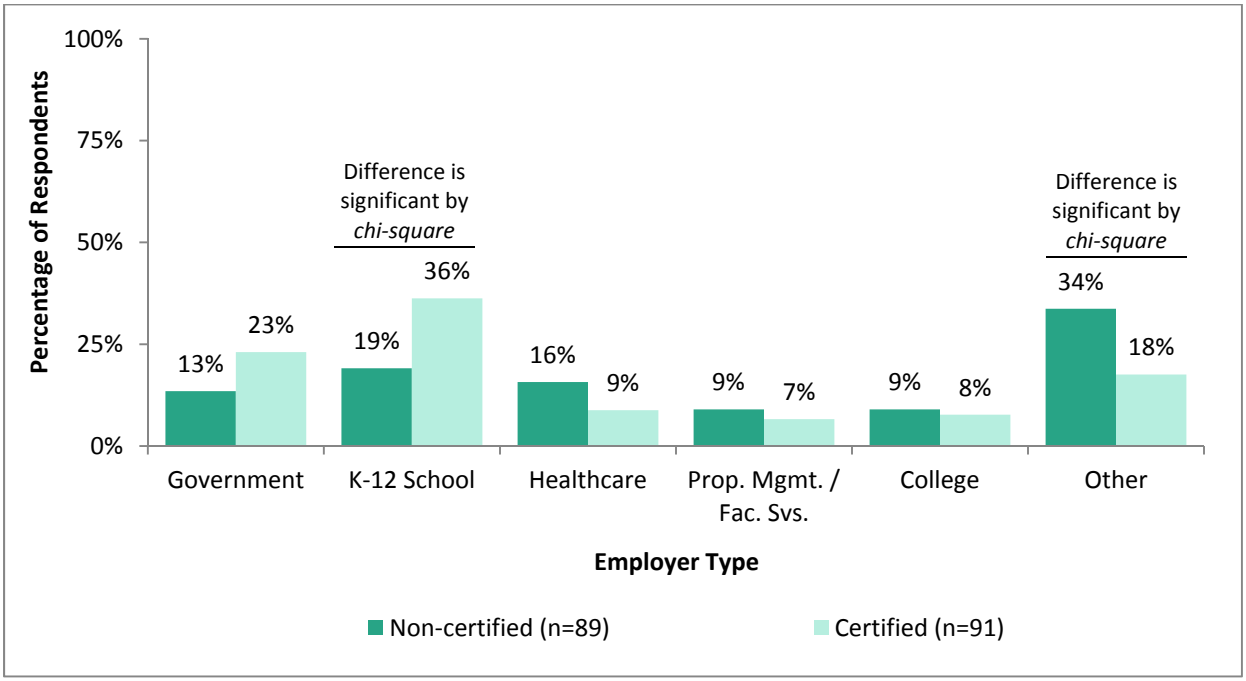
compared to 6% of commercial buildings in the region. Because of the greater energy demands, and greater resources to address energy, owners and managers of large facilities may seek and attract more skilled operators, who are able to deliver better savings. If facility size is related to savings, then differences in facility size between the two samples could result in differences in savings, irrespective of the effect of BOC training.

The survey included questions on employer type as well as the size of the building or buildings where the respondent worked and the total number of O&M staff there. We compared the non-certified operators on these variables with the BOC-certified operators we surveyed in 2013. In all such comparisons, we omitted the non-certified operators that did not provide sufficient O&M data for analyses. Further, since we had already decided to restrict savings analyses to respondents who had staff management responsibility, we restricted the comparisons on employer and workplace characteristics to those respondents.

Figure 30 shows that, compared to certified operator managers, the non-certified ones in the savings analyses were less likely to report government employers and more likely to report "other" employer types ($\chi^2 = 6.69$ and 6.34, $p \leq .01$ in both cases).[70] There were no other statistically significant differences relating to employer type.

[70] All statistical significance tests that we report incorporate the finite population correction (*fpc*) factor. Tests of statistical significance (as well as formulas for calculating precision) assume a sample drawn from an infinite population. When the population is finite (as is the case with building operators), statistical tests underestimate precision, which may lead to failure to reject the null hypothesis of no difference (Type II error). The *fpc* is a correction factor based on the relative size of the sample and population, which, when applied to the statistical test, provides a more accurate test of the null hypothesis. See: http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.

Figure 30. Comparison of Non-Credential Operators, with and without O&M Data, with BOC-Certified Operators on Employer Type

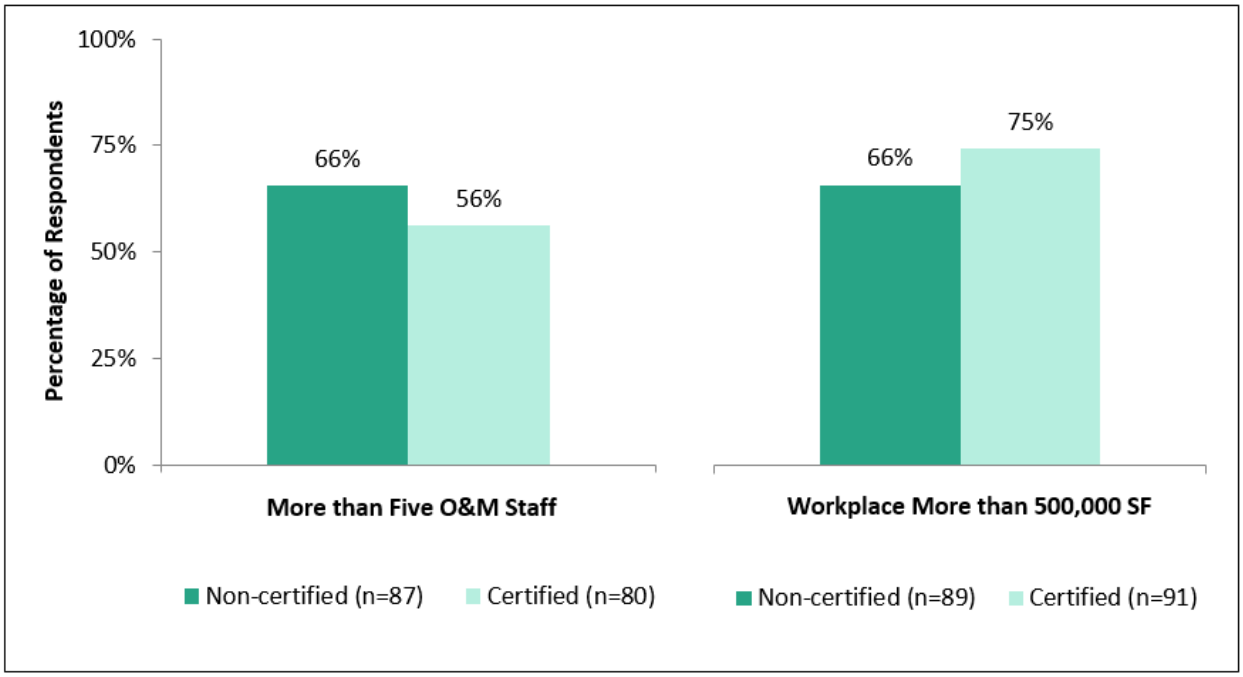


Survey question: "Which of the following best describes your organization's type of business?"

"Other" includes industrial/manufacturing, office, mixed use, warehouse/distribution, and several miscellaneous types reported by no more than one respondent each.

Compared to the BOC-certified respondents, the non-certified ones were slightly more likely to report more than five O&M staff at their workplace and slightly less likely to report a workplace with more than 500,000 square feet of space (Figure 31). Neither of those differences was statistically significant.

Figure 31. Comparison of Non-Credential Operators, with and without O&M Data, with BOC-Certified Operators on Number of O&M Staff and Facility Size



Survey questions:

"How many people perform building operations and maintenance services in the building or buildings you work in, excluding yourself?"

"How many total square feet of conditioned space do the building or buildings you work in have? (By 'conditioned' we mean that the space is reached by the facility's heating or air conditioning methods and excludes garages, decks, plazas, patios, and so forth.)"

As shown above, the distribution of employer types, number of O&M staff, and workplace size differed somewhat for the BOC-certified and non-certified operators in this sample. Although most of the differences were not statistically significant, the statistical power of this sample for detecting significant differences of these magnitudes was not very high. Therefore, we decided to err on the side of caution and treat these differences as potentially significant.

If employer type and facility size are related to energy savings on a percentage basis, then differences between certified and non-certified operators on those characteristics could affect the savings comparison between the two groups. In other words, differences between the two groups in employer type and/or facility size could create the appearance of differences in savings rates. To control for that possibility, we weighted the data for each respondent based on employer type and facility size. As described below, the effect of the weighting was to remove the employer type and size differences between the two groups.

Calculation of Weights

We calculated separate sets of weights for employer type and building size; and for each of those, we calculated weights separately for therms and kWh. For employer type, we calculated the percentage of certified and non-certified operators, and the percentage of the combined sample, associated with each employer type. For building size, we similarly calculated the percentage of each group, and the combined sample, at each of several building size levels.

For each employer type or building size, we calculated the respective weight as the ratio of the percentage in the combined sample to the percentage for the group (certified or non-certified) in question. The following example shows how we calculated the weight for certified operators that work for in healthcare:

$$\text{Weight}_{\text{healthcare-certified}} = \%\ \text{Healthcare – All Respondents} / \%\ \text{Healthcare – Certified Operators}$$

Of all respondents, 14.4% worked in healthcare, but the percentage was higher for certified operators (15.5%) than non-certified operators (12%). Therefore, the weights for certified and non-certified operators in healthcare were:

$$\text{Weight}_{\text{healthcare-certified}} = .144 / .155 = 0.93$$

$$\text{Weight}_{\text{healthcare-non-certified}} = .144 / .120 = 1.20$$

The calculation of therm weights excluded therm outliers and the calculation of kWh weights excluded kWh outliers. Table 35 and Table 36 show the weights for employer type and building size, respectively.

For each survey respondent – BOC-certified and non-certified – we computed weighted baseline and savings value for therms as follows:

(1) $\text{Baseline}_{\text{weighted-therms}} = \text{Calculated baseline} \times \text{Weight}_{\text{employer-therms}} \times \text{Weight}_{\text{building size-therms}}$

(2) $\text{Savings}_{\text{weighted-therms}} = \text{Calculated savings} \times \text{Weight}_{\text{employer-therms}} \times \text{Weight}_{\text{building size-therms}}$

Similarly, we calculated weighted baseline and savings values for kWh as:

(3) $\text{Baseline}_{\text{weighted-kWh}} = \text{Calculated baseline} \times \text{Weight}_{\text{employer-kWh}} \times \text{Weight}_{\text{building size-kWh}}$

(4) $\text{Savings}_{\text{weighted-kWh}} = \text{Calculated savings} \times \text{Weight}_{\text{employer-kWh}} \times \text{Weight}_{\text{building size-kWh}}$

We then calculated the weighted mean savings percentages, separately for certified and non-certified operators, as:

(5) $\text{Mean Savings Percentage}_{\text{weighted-therms}} = \text{Savings}_{\text{weighted-therms}} / \text{Baseline}_{\text{weighted-therms}}$

(6) $\text{Mean Savings Percentage}_{\text{weighted-kWh}} = \text{Savings}_{\text{weighted-kWh}} / \text{Baseline}_{\text{weighted-kWh}}$

Finally, we calculated the differences between the certified and non-certified sample in the mean savings percentages for therms and kWh.

Table 35. Weights for Employer Type*

	Percentage			Weight	
Employer Type	**Certified**	**Non-Certified**	**Combined**	**Certified**	**Non-Certified**
		THERMS			
K-12 School (*n* = 70)	26%	23%	25%	0.96	1.10
Healthcare (*n* = 40)	15%	12%	14%	0.93	1.20
Other (*n* = 74)	21%	41%	27%	1.30	0.65
Government (*n* = 65)	26%	17%	23%	0.89	1.39
Property Mgmt. / Facility Services (*n* = 5)	2%	1%	2%	0.88	1.50
College (*n* = 23)	9%	6%	8%	0.89	1.38
		KWH			
K-12 School (*n* = 69)	27%	25%	27%	0.92	1.02
Healthcare (*n* = 40)	16%	13%	15%	0.88	1.11
Other (*n* = 65)	20%	38%	25%	1.36	0.71
Government (*n* = 61)	26%	18%	23%	0.91	1.29
Property Mgmt. / Facility Services (*n* = 5)	2%	1%	2%	0.83	1.39
College (*n* = 20)	9%	5%	8%	0.95	1.60

* In calculating each set of weights, we excluded respondents with savings percentages that we identified as outliers. Therefore the sample sizes differ slightly for therms and kWh.

Table 36. Weights for Building Size*

	Percentage			Weight	
Size (Square Feet)	**Certified**	**Non-Certified**	**Combined**	**Certified**	**Non-Certified**
			THERMS		
Up to 50,000 (27)	8%	14%	10%	1.26	0.67
50,001 to 100,000 (43)	14%	19%	16%	1.12	0.81
100,001 to 250,000 (62)	21%	27%	22%	1.09	0.84
250,001 to 500,000 (49)	19%	16%	18%	0.95	1.13
500,001 to 1,000,000 (50)	20%	14%	18%	0.92	1.25
More than 1,000,000 (46)	20%	10%	17%	0.85	1.72
			KWH		
Up to 50,000 (26)	8%	14%	10%	1.19	0.68
50,001 to 100,000 (40)	15%	17%	15%	1.05	0.92
100,001 to 250,000 (55)	19%	26%	21%	1.17	0.86
250,001 to 500,000 (49)	20%	17%	19%	0.90	1.05
500,001 to 1,000,000 (48)	20%	16%	18%	0.92	1.16
More than 1,000,000 (42)	19%	10%	16%	0.89	1.60

* In calculating each set of weights, we excluded respondents with savings percentages that we identified as outliers. Therefore the sample sizes differ slightly for therms and kWh.

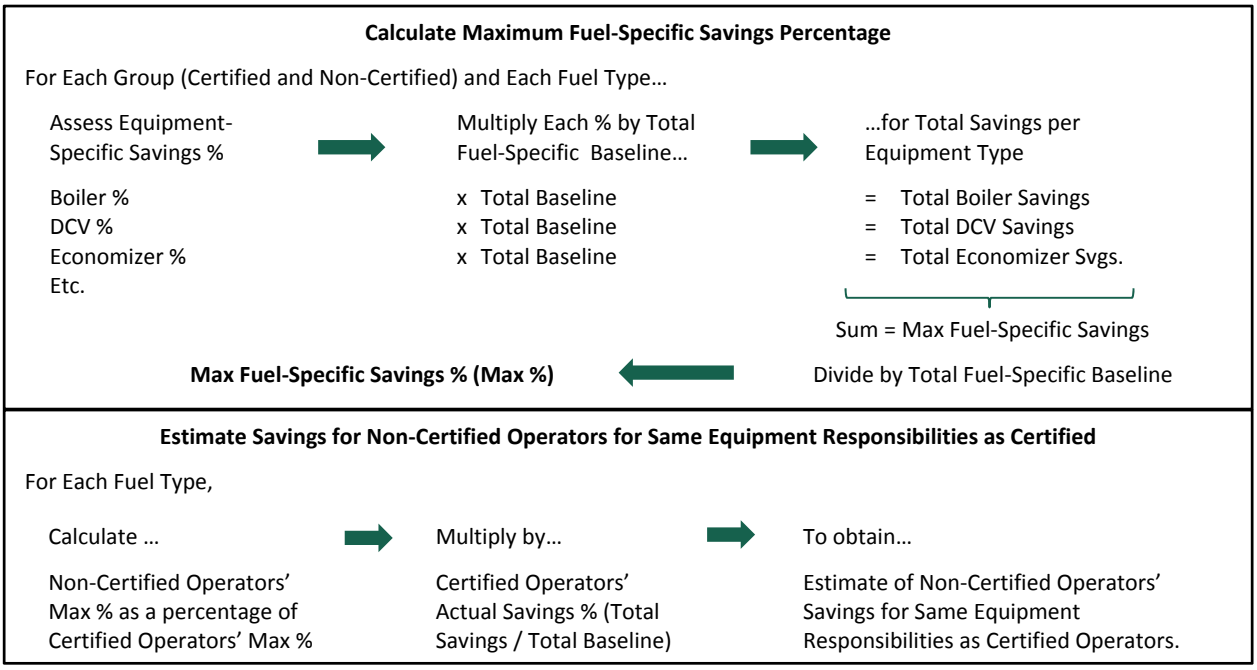
Comparing Certified and Non-Certified Operators

Since certified and non-certified operators differed in equipment responsibility, directly comparing the two groups on the overall mean savings percentages would not be meaningful. We developed the following set of analyses to control for that difference, allowing us to compare certified operators' savings with an estimate of what non-certified operators' savings would be if they reported the same areas of equipment responsibility:

- We first compared the two groups on equipment-specific savings.
- Based on the equipment-specific analyses, we calculated maximum mean savings percentages (therms and kWh) for each group, reflecting what the percentages would be if all survey respondents were responsible for every equipment type.
- We calculated the ratio of non-certified to certified operators' maximum mean savings percentage for each fuel type.
- For each fuel type, we calculated the *actual* mean savings percentages for certified operators (as total savings across all equipment types and operators, divided by total baseline consumption across all operators).
- Finally, we applied the maximum mean savings percentage ratios to the *actual* mean savings percentages for certified operators.

Figure 32 summarizes the above steps. We provide additional detail in the results, below.

Figure 32. Multi-Stage Approach to Comparing Savings for Certified and Non-Certified Operators



Results

Below, we present the results from each of the above stages of the analysis approach described above, culminating in a comparison of certified operator savings with an estimate of what the savings would be for non-certified operators with the same equipment responsibilities. Again, we restricted the analyses to the respondents we identified as those who manage or supervise other O&M staff.

Equipment-Specific Savings

We compared the certified and non-certified operators on the mean savings percentage for each equipment type, with each comparison including only those respondents who reported responsibility for that equipment type. For each comparison, we calculated the percentage as the total calculated savings for that equipment type divided by the total estimated baseline energy consumption for the entire building. Thus, for example, we calculated certified operators' therm savings percentage from boiler O&M as:

$$\frac{\Sigma \text{ Boiler-related therm savings for all certified operators with boilers}}{\Sigma \text{ Boiler-related therm consumption for all certified operators with boilers}}$$

We excluded data from operators whose overall savings percentage values we had already determined to be outliers. This analysis shows how much, on average, each set of equipment-specific O&M practices reduced energy consumption.

Certified operators had consistently higher therm savings percentages than non-certified operators and had higher kWh savings for five of the seven measure types (although differences were small for chillers and DCV; Table 37).

The analysis of savings by equipment type also allowed us to look more closely at BOC operator savings relative to the CBSA baseline, without respect to non-certified operator savings. The BOC operators showed the highest savings percentages for boilers, DCV, economizers, and fans. The BOC operators also showed the greatest savings advantage over non-certified operators for three of those four equipment types – boilers, economizers, and fans – suggesting that these are areas where the BOC training may be most effective.

Neither certified nor non-certified operators showed appreciable savings over the CBSA baseline for lighting, pumps and motors, and compressed air. This is not completely surprising with respect to lighting and pumps and motors, as most savings from those equipment types come from equipment replacements or upgrades rather than from O&M activities, and we calculated savings only from O&M activities.

Table 37. Energy Savings, by Fuel and Equipment Type

	BOC-Certified Operators		Non-certified Operators		
Equipment Type	**Count**	**% Savings**	**Count**	**% Savings**	**Difference**
			THERMS		
Boilers	51	4.38%	42	1.68%	2.71%
Economizers	69	1.01%	60	0.44%	0.56%
Fans	68	1.80%	66	1.68%	0.12%
DCV [a]	77	6.33%	68	5.45%	0.88%
			KWH		
Economizers	63	2.32%	56	0.96%	1.36%
Fans	62	1.82%	62	1.01%	0.80%
Chillers	35	0.23%	34	0.00%	0.23%
Pumps and motors	54	0.13%	59	0.04%	0.09%
Compressed air	32	0.02%	45	0.01%	0.01%
Lighting	79	0.02%	64	0.03%	-0.01%
DCV [a]	70	1.00%	64	1.37%	-0.37%

[a] Demand-controlled ventilation (DCV) savings included respondents who reported economizer or fan responsibilities.

A review of survey responses of the certified operators who reported compressed air responsibilities showed that about half said they do not perform regular compressed air leak surveys. Of those who reported performing regular leak surveys, about one-third said they did it less frequently than annually, and the most common method of leak detection was by listening for audible sound as opposed to using an ultrasonic leak detector or infrared camera. The non-certified operators in the sample were somewhat less likely to report regular leak surveys or to do them annually when they do them, but the differences were not statistically significant.

Considering the above findings, NEEA and BOC may consider whether to review the BOC training modules related to compressed air O&M with an eye to increasing the adoption of best practice O&M for that equipment type.

Maximum Mean Savings

We used the equipment-specific mean savings percentages to calculate the maximum mean savings that certified and non-certified operators would have if all respondents were responsible for all equipment types. Specifically, we did the following separately for certified and non-certified operators:

- For each equipment type, we multiplied the mean savings percentage by the fuel-appropriate baseline summed across all respondents. For example, we multiplied the mean boiler savings percentage by the summed baseline therm consumption and the mean chiller savings percentage by the summed baseline kWh consumption. The results

represent what the summed therm or kWh savings would be for those equipment types if all respondents were responsible for those equipment types.

- We then summed the total therm savings and total kWh savings across equipment types.
- Finally, we divided the summed therm savings value by the summed therm baseline consumption and divided the summed kWh savings value by the summed kWh baseline consumption.

Again, for this analysis, we excluded data from operators whose overall savings percentages values we had already determined to be outliers.

Table 38 summarizes the analysis of maximum mean savings for certified and non-certified operators. These analyses indicate that if all certified and non-certified operators were responsible for all equipment types, the mean therm savings for certified operators would be 13.51%, compared to 9.24% for non-certified operators; similarly, the mean kWh savings for the two groups would be 5.55% and 3.43%, respectively.

Table 38. Estimate of Maximum Mean Savings, by Fuel and Equipment Type

	BOC-Certified Operators		Non-Certified Operators	
Fuel and Equipment Type	**% Savings**	**% Savings x Baseline**	**% Savings**	**% Savings x Baseline**
Boilers	4.38%	906,135	1.68%	341,558
Economizers	1.01%	208,058	0.44%	90,469
Fans	1.80%	372,312	1.68%	341,700
DCV[a]	6.33%	1,308,216	5.45%	1,110,440
Max Therm Savings (Sum of % Savings x Baseline)		*2,417,177*		*1,884,167*
Total Baseline therms		*20,681,671*		*20,385,839*
Max Therm Savings % (Max Savings / Baseline)		*13.51%*		*9.24%*
Economizers	2.32%	13,323,465	0.96%	4,376,097
Fans	1.82%	10,415,226	1.01%	4,602,571
Chillers	0.23%	1,343,339	0.00%	14,222
Pumps / motors	0.13%	747,320	0.04%	165,202
Compressed air	0.02%	113,829	0.01%	61,106
Lighting	0.02%	114,481	0.03%	146,551
DCV[a]	1.00%	5,748,654	1.37%	6,231,005
Max kWh Savings (Sum of % Savings x Baseline)		*31,806,313*		*15,596,754*
Total Baseline kWh		*573,311,505*		*454,703,909*
Max kWh Savings % (Max Savings / Baseline)		*5.55%*		*3.43%*

[a] Demand-controlled ventilation (DCV) savings included respondents who reported economizer or fan responsibilities.

Estimate of Non-Certified Operator Savings

From the above results, we calculated the non-certified-operators-to-certified-operators savings ratios for both therms and kWh:

$$\text{Ratio, max non-certified to max certified (therms)} = \frac{9.24\%}{13.51\%} = 68.4\%$$

$$\text{Ratio, max non-certified to max certified (kWh)} = \frac{3.43\%}{5.55\%} = 61.8\%$$

Simply put, the analysis of maximum mean savings suggests that the surveyed non-certified operators would save about 68% as many therms, relative to the CBSA baselines, as would the surveyed certified operators; they would save about 62% as many kWh.

Applying the above ratios to the actual computed mean savings percentages for certified operators yields an estimate of what non-certified operators' savings percentages would be if they were responsible for the same equipment types as were the certified operators. For each fuel type, we calculated the actual mean savings percentages of certified operators as total savings, summed across all equipment types and across all operators, divided by total baseline consumption, summed across all operators.

As Table 39 shows, the actual calculated therm and kWh savings for BOC-certified operators (managers only) were 9.68% and 3.71%, respectively. When we applied the above ratios to those figures, we estimated that the corresponding savings for non-certified operators (managers only) that were responsible for the same equipment types would be 6.62% and 2.30%. Thus, the certified managers' therm and kWh savings would exceed those of non-certified managers by 3.06% and 1.42%, respectively.

Table 39. Overall Energy Savings, by Fuel Type, Based on BOC-Certified Operators' Areas of Equipment Responsibility

	Basis of Estimate		Therms		kWh
BOC-certified	Mean savings, based on reported areas of equipment responsibility		9.68%		3.71%
Non-certified	Estimate for BOC-certified, times ratio of max-certified to max-non-certified	9.68% x 68.4% =	6.62%	3.71% x 61.8% =	2.30%
Difference	BOC-certified minus non-certified		3.06%		1.42%

Conclusion

Using data from our 2013 survey of BOC-certified operators, we calculated that the respondents' self-reported O&M practices reduced electricity and natural gas consumption by 4.27% and 6.26%, respectively, compared to standard building operations practices. Based on those respondents' rated influence of BOC training on their practices, however, just over half of the savings (2.03% and 3.58%, respectively) were attributable to the training. As an alternative approach to assessing BOC-attributable energy savings, we conducted a survey of non-certified operators and compared their savings, again relative to standard practices, with those of the certified operators.

After a brief summary of methodological issues, we summarize the main findings, and then present conclusions and recommendations.

Nearly 90% of the non-certified operators from the current survey reported manager or supervisory titles, compared to about half the respondents to our 2013 survey of BOC-certified operators. Therefore, we restricted comparisons to those with manager or supervisory titles. Unfortunately, there were not enough non-manager/supervisory respondents to the current survey of non-certified operators to allow a statistically reliable comparison with those from the survey of BOC operators.

Even when we restricted the comparison of certified and non-certified operators to those with manager/supervisory titles, the non-certified operators reported responsibility for more equipment types, on average, than did the certified operators. Thus, they had more opportunities to report O&M practices that would save energy, making a direct comparison with the energy savings of the certified operators less meaningful. To carry out a meaningful comparison in spite of this difference, we first compared certified and non-certified operators on equipment-specific savings. We then used the equipment-specific data to estimate what the maximum mean therm and kWh savings would be for each group if all operators were responsible for all equipment types. From that analysis, we determined the ratio of non-certified operators' savings to those for certified operators, for each fuel type. We then applied those ratios to the certified operators' actual calculated savings percentages to estimate what the non-certified operators' savings would be if they were responsible for the same equipment types as were the certified operators.

In the above analyses, we statistically controlled for differences between the certified and non-certified operators on facility size and employer type.

In addition to providing an alternative approach to assessing BOC-attributable savings, the equipment-specific comparisons of BOC-certified operators with non-certified operators provided additional information on the impacts of BOC training.

Key findings were:

- In equipment-specific comparisons, certified operators had generally higher kWh savings percentages than non-certified operators, although many of the differences were small. The differences were less consistent for therm savings.

- The study also found that BOC training produces greater savings percentages, relative to standard practices, for some equipment types than others. Savings were greatest for boilers, DCV (therms), economizers (kWh), and fans (both therms and kWh).

- From the equipment-specific data, we estimated that, with areas of equipment responsibility held constant, the non-certified operators in this survey would save about 68% as many therms and about 62% as many kWh as the certified operators. We used those figures to estimate that, if we were to compare the certified operators to non-certified ones with the same equipment responsibilities, the therm and kWh savings of the certified operators would exceed those of the non-certified ones by 3.06% and 1.42%, respectively.

The figures of 3.06% and 1.42% represent, respectively, estimates of the therm and kWh savings advantages of certified operator managers over similar non-certified operator managers. Given that these figures are similar to those calculated from the MPER #1 survey data (3.58% and 2.03%, respectively), and that they are mathematically derived rather than based on direct comparisons, we do not believe they should be used in place of the previous values. Rather, they support the previous values.

The fact that the study found that BOC training produces greater savings for some equipment types than others may reflect greater savings potentials for those areas; however, it also may suggest areas to investigate possible adjustments in training.

One possible concern is that the current analyses may not be applicable to operators that do not have managerial/supervisory responsibilities – the "line" operators. We do not know whether BOC training provides a relatively greater advantage to managerial/supervisory or non-managerial/supervisory operators. We can note that, in the 2013 survey of BOC operators, the mean rated influence of BOC training was very similar for managerial/supervisory and non-managerial/supervisory operators (5.4 vs. 5.2, on a scale of 0 to 10). Thus, BOC training appears to have had a similar level of relative influence on the O&M practices of BOC-certified managerial/supervisory and line operators. It is thus possible that the relative savings advantage of certified operators over non-certified ones is similar for managerial/supervisory and line operators, but this cannot be known for certain without further research.

Based on the above findings and conclusions, we offer the following recommendations:

- **Recommendation:** NEEA should consider conducting additional research to verify BOC-related savings. Possible avenues of research are: attempt to develop a better comparison between certified and non-certified operators, either by including more non-certified operators that do not manage O&M staff or by identifying and focusing on the certified operators that do manage other O&M staff; or conduct billing analyses of facilities operated by BOC-certified operators and a matched sample of facilities without BOC-certified operators.

- **Recommendation:** BOC should review BOC training modules relating to compressed air for ways to increase adoption of recommended practices.

- **Recommendation:** NEEA should continue to use the ACE Model input assumptions that we recommended in MPER #1.

Surveying non-certified operators that do not manage other operators may be challenging. Technical staff without managerial or supervisory titles made up only 16% of the NEEC contact list, which supplied nearly all survey respondents. Moreover, three individuals that we invited to respond to the survey indicated plans to forward the survey to their supervisors: we cannot tell how many did so without notifying us, as the survey did not ask respondents to verify their names.[71] An alternative approach may be to contact supervisors and ask them to have a non-supervisory operator respond to the survey.

[71] We wrote all three back to encourage them to take the survey themselves. In future surveys, we will ask respondents to confirm their names.

Appendix F. Interview Guides and Survey Instrument

F.1. BOC-E MPER #2 Staff Interview Guide

F.1.1. Key Objectives and Target Audience

The key objectives of this interview guide are to:

- Identify and clarify changes in PLM and/or program theory.
- Clarify the definition of the BOC market.
- Assess barriers and opportunities for BOC/BOC-E in Idaho and Montana.
- Clarify evaluation needs.
- Obtain additional details on when and where BOC has held trainings in the NW.
- Identify utility contacts for later interviews.

F.1.2. Program Theory and PLM

We have reviewed the new program logic model and compared it against the previous one. First, it looks like you've made several positive changes and cleared some things up. (If asked: activities linked to overcoming "ability to pay" better make more sense; addition of "utility engagement plan"; addition of specific progress metrics.) I'd just like to clarify some of the changes and new elements.

1. One thing we noted is that the new model includes "increasing participation by IBOA members" as a short-term outcome, which makes sense. Can you clarify whether BOC will do anything other than adding IBOA as an Approved BOC Provider to achieve this? If so, what will it do?

   Probes:

   What outreach will IBOA do to its members that do not already have the BOC credential?

   Is this any different from what IBOA always has done to recruit members to take the credential?

2. The revised PLM assumption tables indicate a goal of 10% increase in certification by IBOA members, but the time frame is unclear. Is it the same as for IUOE? If not, what is the time frame?

3. Can you give me an update on activities with utilities?

   Probes:

   What kinds of support or leverage are regional utilities providing BOC in their energy efficiency programs?

   How many utilities provide incentives for BOC training and/or certification?

      Which ones are they?

      How does that number compare with before 2013?

      How much incentive to they normally give – average or range?

   How many are holding trainings or otherwise supporting trainings in their service territories? Which ones are they? How does that number compare with before 2013?

4. The revised PLM tables link utility engagement plan to the long-term outcome "increased demand and preference for credential by employers and operators." Can you briefly explain the theory behind that?

   Probes:

   Utility incentives create demand?

   Utility's backing lends credence?

   Other factor?

5. What other changes has NEEA made to the Initiative theory since we last reviewed the logic model?

6. What other changes do you anticipate?

7. I'd like to clarify how the 25% online module is actually implemented. Is it always the same 25% of the course or can an applicant determine which part he/she wants to do on line?

F.1.3. BOC Market, Barriers and Opportunities

8. As you know, we and others have developed estimates of the number of building operators that have ranged widely, from fewer than 6,000 to 90,000 (BOC MPER 3), which may be influenced by how "BOC market" is defined. What do you think is the definition of the "BOC market," for the entire NW and specifically for Idaho and Montana?

   Probe:

   Does it include all worker types we identified previously as operators or only those that are considered likely candidates for BOC training?

9. What do you see as the opportunities for expanding BOC-E into Idaho and Montana?

   Probes:

   What specific areas – geographic, market segment, or other – provide the best opportunities?

   What are NEEA and/or IBOA doing to create opportunities?

   How is that working so far?

   What else might NEEA and/or IBOA do?

10. What do you see as the barriers to expanding BOC-E into Idaho and Montana?

11. What are you plans for addressing those barriers?

12. Which of those barriers, if any, do you think will be most difficult to overcome?

13. What else might you do to try to overcome them?

14. What are the unknowns that might keep you from fully understanding all the barriers?

F.1.4. Evaluation Needs

15. Our activities also will include a survey of non-certified building operators to investigate operator professional characteristics, workplace characteristics, awareness of and interest in BOC and BOC-E, employer support, barriers, and O&M activities. Is there anything else you think we should cover?

    [Clarification of specific topics, if needed:] Job responsibilities and their training, certifications, and professional affiliations; assess awareness of and interest in BOC and BOC-E blended online training, employer/ owner support for training, and perceived barriers to BOC training; and collect data on workplace characteristics (including employer and facility type and facility size) and their O&M activities.

16. We also survey building owners and managers that do not have certified operators to learn what might influence owners to require or support certification by their operators. Is there anything in particular you think we should address or ask about?

17. What else, if anything, do you think should be a priority in this evaluation?

18. We have talked about developing an estimate of regional baseline energy consumption in buildings with operators. Since we already use CBSA data for the calculation of baseline energy consumption of survey cases, is there any reason not to use it for a regional estimate?

F.1.5. Other

19. Can you provide a list of all BOC trainings, including the location, date, and number of attendees, since the start of 2010?

20. About how much time, on average, does an operator need to devote in a year to earn the continuing education credits needed for BOC renewal?

21. Our research activities this year will include contacting some utility representatives in Idaho and Montana to assess barriers and opportunities for BOC-E in that segment. Do you have any suggestions for who we should contact?

F.2. NEEA BOC-E MPER #2 Market Informants Interview Guide

F.2.1. Introduction

Hi, I'm [NAME], from Research Into Action. The Northwest Energy Efficiency Alliance, or NEEA, has hired us to evaluate the progress of its Building Operator Certification Expansion initiative, or BOC-E, and has identified you as someone who is knowledgeable about the building operator marketplace in Idaho and Montana.

As you may know, NEEA is supporting the Northwest Energy Efficiency Coalition, or NEEC, and the International Building Operator Association, or IBOA, in their efforts to increase participation in BOC training and getting BOC certification across the northwest. I'd like to hear your perspective on a range of topics related to the operator market in your area to give NEEA the information it needs to provide the best possible support to NEEC and IBOA.

I'm estimating this interview will take about 20 minutes. Is now a good time to talk? If not, could we schedule another time at your convenience?

F.2.2. Understanding the Market

Before we go into any questions, let me note a few things. First, for building operator, let's use the following definition:

> a professional who manages commercial and laboratory buildings by maintaining, operating, and repairing HVAC, life safety, electrical, and plumbing systems, and performing general building maintenance to optimize equipment performance, maintain the building's operability, and ensure the comfort and safety of occupants

Second, throughout our interview, any reference to buildings will mean commercial buildings.

Finally, unless I specify otherwise, any questions I ask you will pertain to Idaho and/or Montana.

F.2.2.1. Respondent Background

I'd like to start with some information about you.

[Fill in title and organization from list on Sharepoint]

1. My information says that you are the [TITLE] for [ORGANIZATION]. Is that correct?
    a. [If not]: What is your current position and who is your employer?
2. How long have you had that position?
3. Can you briefly give me a sense of your range of responsibilities?

F.2.2.2. Describing the Building Operators Market

I'd like to continue with some descriptive information about the building operator market in your area.

4. First, we'd like to get a sense of how common it is for buildings of various sizes to have in-house building operations staff.

    a. About what percentage of buildings of at least 100,000 square feet have building operators?

    b. How about buildings between 50,000 and 100,000 square feet?

    c. How about buildings between 5,000 and 50,000 square feet?

5. What types of buildings are most likely to have in-house building operator staff?

    [Probe]

    Are there any specific building uses, such as grocery or restaurant, that would not have in-house operators?

6. If an employer had several in-house building operators at a given building or group of buildings, would it generally be advantageous for more than one of those operator to have BOC training or certification?

    [Probe]

    Under what circumstances would it be most advantageous?

    Under what circumstances would it be least advantageous?

    At what point or in what circumstances would there be diminishing returns on having more operators trained and certified?

7. Thinking about the various types of building operations staff, for which ones would BOC training and certification provide the most benefits to their employers?

    [Probe]

    Would it be better to train more senior operations staff or more junior staff?

    In what ways might it depend on the range or types of equipment they are responsible for?

F.2.2.3. Trends and Current State of Energy Efficiency in Building Operations

Now I'd like to talk a little about any recent trends you see in building operations.

8. Thinking back over your career, what key trends and changes in the field of building operations have you seen in…

   [Probe]

   a. …how owners and employers handle building management and maintenance?

   b. … the skill sets of the people who do this work? For example, any changes in minimal qualifications?

9. What do you think is the overall state of energy efficiency in commercial buildings with respect to the types of measures that BOC training addresses?

   [Probe]

   Does it vary by public/private sector?

   Does it vary by building type?

10. What do you think are the best sources for information on current "state-of-the-art" or "best practices" for building operation and maintenance activities?

F.2.2.4. BOC Expansion Potential

The next topic I'd like to explore is how much of the commercial space in Idaho and Montana has potential for employing in-house, BOC-certified operators.

11. About what portion of commercial space do you think is managed by outsourced building operations staff (e.g. to Johnson Controls, etc.)?

12. How do owner-occupied buildings compare to tenant-occupied buildings in terms of interest in BOC certification?

13. How should BOC administrators approach outreach to these two occupant types to build awareness of BOC?

F.2.2.5. Market Value of BOC

14. Have you dealt directly with employers of BOC certified building operators?

15. [If Yes to Q14:] What benefits have they indicated come from having BOC-trained staff?

    [Probe]

    Energy savings, equipment life, faster or better equipment repair, comfort

16. [If Yes to Q14:] Does the actual certification provide any value to them above and beyond the training?

17. Have you dealt directly with BOC certified building operators?

18. [If Yes to Q17:] How valuable an asset is BOC training to the building operators?

19. [If Yes to Q17:] Does the actual certification provide any value to them above and beyond the training?

20. What evidence, if any, have you seen of market value for BOC certification?

    [Probe]

    Job postings?

21. What might improve employers' perceived value of BOC certification?

22. What might improve building operators' perceived value of BOC certification?

F.2.3. Market Awareness of, and Barriers to, BOC Training

Now I'd like to shift gears from understanding how the market works to understanding specific factors affecting the prevalence of BOC certification in the market.

23. What is your sense of the general level of awareness of BOC among building operators and their employers in Idaho and Montana?

24. What are your thoughts on the most effective strategies and methods to inform building operators about BOC training opportunities?

25. The International Union of Operating Engineers, or IUOE, recently has become a BOC Approved Provider. Do you anticipate that this will help increase awareness of BOC?

26. Will it increase enrollment in BOC training?

27. What types of things stand in the way of getting building and business owners and employers to support BOC certification for their building operators?

28. What types of things might keep building operators from getting BOC certification even if their employer does not support it?

F.2.3.1. Underserved Markets

NEEA defines "underserved markets or communities" as those that BOC serves on an infrequent basis, no more than once every three years, and generally only with the active engagement of a utility sponsor or larger employer. These are markets where the population is small and enrollment is not sufficient to cover training delivery costs.

29. About what proportion of the building operator market in Idaho and Montana do you think falls under the definition of underserved?

30. How well is BOC working with utilities and large employers in Idaho and Montana to reach underserved markets?

31. What else might BOC do?

32. Do you think the BOC needs to use different strategies for reaching different subsets of the underserved markets? If so, what does BOC need to do differently for what different subsets?

    [Probe]

    BOC content, structure, delivery, promotion, outreach, teaming

33. BOC has begun offering "blended online" training, with part of the curriculum available online and part classroom-delivered. Currently, about 12% to 15% of the curriculum is available online, and BOC plans to offer up to 35% online but every module will require some classroom time. How well do you think this will reduce barriers to taking BOC training in Idaho and Montana?

F.2.3.2. Federal Sector

34. Are you familiar with BOC's strategies for increasing the number of Federal employees that get BOC certification?

35. [If Yes:] How well do you think BOC's strategies for increasing certification of Federal employees will work in Idaho and Montana? Why?

36. What do you think are the key barriers to increasing certification by Federal employees in Idaho and Montana?

37. What are some methods that you think would be effective at increasing Federal sector participation?

    [Probe]

    Would becoming an ANSI authorized provider help BOC reach this sector?

F.2.3.3. Final Thoughts

38. Is there anything else you'd like to add regarding expanding BOC certification in the Idaho and Montana building operations market?

Thank you very much for taking the time to speak with me today.

F.3. NEEA BOC-E MPER #2 Owner and Operator Survey

F.3.1. A. Screening

[DISPLAY SECTION A TO ALL RESPONDENTS]

Most of the following questions are about how your company or organization manages building operations and maintenance, also called O&M. By O&M, we are referring to operating, maintaining, or repairing HVAC, life safety, electrical, or plumbing systems, or performing general building maintenance to optimize equipment performance and maintain the buildings operability.

First, I'd like to ask you a few questions about your job.

A1. Which of the following best describes you?
- () Owner or top officer of a business or organization that leases building space from others
- () Owner or top officer of a business or organization that owns its building space
- () Owner of a commercial building or buildings that I lease to tenants
- () Employee of a business or organization
- () Unemployed →SKIP TO TERMINATION SECTION

A2. Does your business or organization provide operations and maintenance services to other businesses and buildings?
- () Yes
- () No

[A3: EMPLOYERS (A1=1, 2 OR 3)]

A3. Which of the following best describes how you manage operations and maintenance?
- () I personally perform all of the operations and maintenance
- () I perform some operations and maintenance but also employ other operations and maintenance staff
- () I employ operations and maintenance staff and do little or none of it myself
- () I contract out the majority of the operations and maintenance work in the building(s)
- () [DISPLAY OPTION ONLY IF A1=1 (LANDLORD)] The tenants of the buildings I lease are responsible for the building's operation and maintenance. →SKIP TO TERMINATION SECTION
- () Not applicable, the buildings I lease do not require operations and maintenance →SKIP TO TERMINATION SECTION

[A4, A5: EMPLOYEES (A1 = 4)]

A4. Which of the following best describes your responsibilities?

() I am in charge of or manage other employees who perform building operations and maintenance services and I also perform building operations and maintenance myself

() I am in charge of or manage other employees who perform building operations and maintenance services but I do not perform building operations and maintenance myself

() I am an employee who performs building operations and maintenance services but I am not in charge of other employees involved in building operations and maintenance

() I am the only employee who performs building operations and maintenance services for my employer.

() I am not involved in managing operations and maintenance staff or performing operations and maintenance services →SKIP TO TERMINATION SECTION

A5. Building operations and maintenance staff have a wide range of job titles or descriptions. Which of the following describe your job or are included in your job title? Please check all that apply.

[] Property or facility director, manager, or supervisor
[] Custodial Manager or Supervisor
[] Other manager, team leader, supervisor position
[] Custodian/ Custodial staff
[] Engineer
[] Electrician or other mechanical/technical staff
[] General contractor
[] Other – please specify: _____

[A6: EMPLOYEES WHO ARE NOT SOLE O&M STAFF (A4=1, 2, or 3)]

A6. How many people perform building operations and maintenance services in the building or buildings you work in, excluding yourself?

_____ number of people performing building operations and maintenance services, excluding yourself.
DK

[A7: EMPLOYERS WITH O&M STAFF (A3=2 or 3),
SERVICE PROVIDERS (A2 = 1),]

A7. How many people at your company perform building operations and maintenance services, excluding yourself?

_____ number of employees performing building operations and maintenance services, excluding yourself.

F.3.2. B1. BOC Awareness

[B1, B1a: ALL]

B1. Have you ever heard of Building Operator Certification, also called BOC?
() Yes
() No
() I am not sure

B1a. Building Operator Certification, or BOC, is a program that certifies building operation and maintenance personnel in energy and resource-efficient operation of building systems. Individuals earn BOC certification by attending training classes on a variety of topics, including facility electrical and lighting systems, HVAC, sustainability, and energy conservation.

Which of the following best describes your familiarity with BOC before today?
() I had not heard of BOC
() I had heard of BOC but I didn't really know what it was before now
() I knew that BOC had to do with building operations training, but I didn't know any details about it
() I knew some details about BOC, but there was still a lot I didn't know
() I knew a lot about BOC
() I am not sure

F.3.3. B2. Training & Certification – Employers & Managers

[B2: EMPLOYERS WITH O&M STAFF (A3 = 2 OR 3) OR SUPERVISORS OF O&M STAFF (A4 = 1 OR 2)
AND AT LEAST SOMEWHAT AWARE OF BOC (B1a = 2, 3, 4, or 5)]

B2. Have you or any of your building operations and maintenance staff received the BOC certification or completed the course without certifying?

	1-Myself only	2-Staff only	3-Myself and staff	4-Neither	5-DK
a. Received BOC certificate	()	()	()	()	()
b. Completed all required BOC classes but have not received BOC certificate	()	()	()	()	()

[B3, B4: EMPLOYERS WITH O&M STAFF (A3 = 2 OR 3)
OR EMPLOYEES WHO MANAGE O&M STAFF (A4 = 1 OR 2)]

B3. In the past five years, have you or any of your building operations and maintenance staff received technical training or certification(s) not provided by BOC?

() Myself only
() Staff only
() Myself and staff
() Neither myself nor staff
() DK

[B4: IF B3 = 1, 2, OR 3]

B4. What non-BOC technical training and certification(s) have you or your employees or supervisees received in the past five years?

You: _____

Staff: _____

F.3.4. B3. Training & Certification – Employees and Employers Who Do Their Own O&M

[B5, B5a: EMPLOYEES WHO PERFORM O&M AND DO NOT MANAGE OTHER O&M STAFF (A4 = 3 OR 4), AND ARE AWARE OF BOC (B1a = 2, 3, 4, or 5)

EMPLOYERS WHO DO THEIR OWN O&M (A3=1)] AND ARE AWARE OF BOC (B1a = 2, 3, 4, or 5)

B5. Which of the following is most true of you?

() I have received BOC certification
() I have completed all required BOC classes but have not received BOC certification
() I have completed some of the required BOC classes but not all of them
() I have not taken any BOC classes

[B5a: B5 = 2]

B5a. Why have you not received BOC certification? (Please select all that apply)

() I took the training just so I would know what it covers, but I don't need it for my job
() I needed the training for my job but do not need the certification
() I have not had time to complete the paperwork
() My company would not pay the fee
() Other reason (please specify): [OPEN END]

[B6, B7: EMPLOYEES WHO PERFORM O&M AND DO NOT MANAGE OTHER O&M STAFF (A4 = 3 OR 4). (AWARENESS OF BOC IS NOT RELEVANT)

EMPLOYERS WHO DO THEIR OWN O&M (A3=1)]

B6. In the past five years, have you received technical training or certification(s) related to building operations and maintenance that is not provided by BOC?
() Yes
() No
() DK

B7. What non-BOC technical training and certification(s) have you received in the past five years?

_____

F.3.5. B4. Business Owners' Contracting Firm Training & Certifications

[B8, B8a: EMPLOYERS WHO CONTRACTS OUT O&M WORK (A3 = 4)
AND ARE AT LEAST SOMEWHAT AWARE OF BOC (B1a = 2, 3, 4, or 5)]

B8. To your knowledge, have the employees of your building operations and maintenance service provider received the BOC training or certificate?
() Yes
() No
() DK

B8a Did you use BOC training or certification as a criterion for selecting your building operations and maintenance service provider?

() Yes
() No
() DK

[B9: EMPLOYERS WHO CONTRACTS OUT O&M WORK (A3 = 4)
(AWARENESS OF BOC IS NOT RELEVANT)]

B9. To your knowledge, have the employees of your building operations and maintenance service provider received energy-efficiency-related technical training or certification(s) other than BOC?
() Yes
() No
() DK

F.3.6. C1. Importance of O&M Training: Building Owner and/or Employers without BOC staff

[C1: EMPLOYERS WHO CONTRACT OUT O&M WORK (A3 = 4)
(AWARENESS OF BOC IS NOT RELEVANT)]

C1. Building operations and maintenance training may cover a variety of areas. How important was level of skill in each of the following areas in your selection of your operations and maintenance service provider?
[PROGRAMMER: RANDOMIZE CHOICES]
[PROGRAMMER: INSERT 1-5 SCALE WHERE 1=Not at all important AND 5=Extremely important (add "Don't know" option) FOR EACH ITEM BELOW]
a. Efficient lighting options
b. HVAC controls
c. Energy-efficient operation of HVAC or related systems
d. Indoor air quality
e. Measuring energy use to identify energy savings opportunities
f. Low cost building operation improvements
g. Building electrical systems
h. Comfort of building occupants

[C2-C5: EMPLOYERS WITHOUT BOC STAFF (A3 = 2 OR 3 AND B1A = 1 OR 6) OR (B2A = 4 OR 5 AND B2B = 4 OR 5)]

C2. Next, we have a few questions about the importance of building operations and maintenance training in your business or building(s), including your thoughts on various aspects of the BOC training courses and costs.
Building operations and maintenance training may cover a variety of areas. How important would each of the following areas be in your decision whether or not to send a member of your operations and maintenance staff to BOC training?
[PROGRAMMER: RANDOMIZE CHOICES]
[PROGRAMMER: INSERT 1-5 SCALE WHERE 1=Not at all important AND 5=Extremely important (add "Don't know" option) FOR EACH ITEM BELOW]
a. Efficient lighting options
b. HVAC controls
c. Energy-efficient operation of HVAC or related systems
d. Indoor air quality
e. Measuring energy use to identify energy savings opportunities
f. Low cost building operation improvements
g. Building electrical systems
h. Comfort of building occupants

C3. To become BOC certified, staff must attend seven day-long modules over three to seven months, at a cost of about $1000 in Montana and Idaho and about $1,700 in Oregon and Washington. Classes are in multiple locations in those four states. All modules require some in-class time, but up to 15% of coursework is online. Annual maintenance of BOC certification requires at least 5 hours of approved continuing education training or equivalent professional activities, at an average cost of about $750 per person.
How likely would you be to provide the following types of support for a member of your O&M staff to obtain and maintain BOC certification?

Type of Support	Initial Certification	Maintenance
Pay course or continuing education fees	1-5 scale w DK	1-5 scale w DK
Pay associated travel expenses	1-5 scale w DK	1-5 scale w DK
Allow paid time off for training or continuing education	1-5 scale w DK	1-5 scale w DK

[PROGRAMMER: SET UP AS MATRIX, WITH 1-5 SCALE WHERE 1=Not at all likely AND 5=Very likely FOR EACH ITEM ABOVE, AND DK]

C4. If your utility offered to pay 50% of the tuition cost, how much more likely would you be to send staff to attend BOC training?
() Not at all more likely
() Somewhat more likely
() Significantly more likely
() I don't know

C5. Based on what you know now about the BOC training, how likely are you or your staff to attend a BOC class in the next 12 months?
() 1- Not at all likely
() 2
() 3
() 4
() 5 –Extremely likely
() Don't know

F.3.7. C2. Importance of O&M Training: Building Owner and/or Employers with BOC Staff

[C6-C9: EMPLOYERS OR SUPERVISORS WITH BOC STAFF (B2A = 2 OR 3 OR B2B = 2 OR 3)]

C6. Next, we have a few questions about the importance of building operations and maintenance training and certifications for your business or building(s).
Building operations and maintenance training may cover a variety of areas. How important were each of the following in your decision to send members of your operations and maintenance staff to BOC training?
[PROGRAMMER: RANDOMIZE CHOICES]
[PROGRAMMER: INSERT 1-5 SCALE WHERE 1=Not at all important AND 5=Extremely important (add "Don't know" option) FOR EACH ITEM BELOW]

a. Efficient lighting options
b. HVAC controls
c. Energy-efficient operation of HVAC or related systems
d. Indoor air quality
e. Measuring energy use to identify energy savings opportunities
f. Low cost building operation improvements
g. Building electrical systems
h. Comfort of building occupants

C7a. Which of the following are true of your business regarding O&M-related certifications for staff? Your business ... (Select all that apply)

[] ...encourages O&M staff to get O&M-related certifications
[] ...considers O&M-related certifications when hiring O&M staff
[] ...would pay at least some of the expenses associated with O&M-related certification for O&M staff
[] ...would allow O&M staff to attend O&M-related training during paid working hours
() ...None of the above

C7. Which of the following are true of your business regarding <u>maintenance</u> of O&M-related certifications? Your business ... (Select all that apply)

[] ...encourages building O&M staff to maintain O&M-related certifications
[] ...would pay fees for continuing education classes needed to maintain O&M-related certifications
[] ...would pay at least some of the expenses associated with maintenance of O&M-related certification
[] ...would allow staff to attend continuing education classes needed to maintain O&M-related certifications during paid working hours
() None of the above

C8. What are the benefits of employing building O&M staff who attended the BOC training? Please select all that apply.

[] Equipment operates more efficiently
[] More effective equipment problem-solving
[] Equipment lasts longer
[] Increased comfort
[] Energy bills are lower
[] Other – please, specify:_____
() No Benefits

C9. Thinking of your staff who attended the BOC training, to what degree have they transferred knowledge gained from that training to other operations or maintenance staff?

() To a very great degree
() To a large degree
() Somewhat
() To a small degree
() Not at all
() Don't Know
() NA - all my staff attended the BOC training

F.3.8. C3. Importance of Staff Retention: All Building Owners and/or Employers

[C10 & C11: EMPLOYERS (A1 = 1, 2 OR 3]

C10. How problematic would losing a senior operations and maintenance employee be for your organization?

() 1- Not at all problematic
() 2
() 3
() 4
() 5 –Extremely problematic
() Not sure

C11. If you did lose a senior operations and maintenance employee, how long would it take, on average, to replace that person and train the new one to the required level of skill?

() A few days or less
() One to two weeks
() Three to four weeks
() One to two months
() More than two months
() Not sure

F.3.9. D. Working Environment & Employee Profile

[D1-D5**:** EMPLOYEES (A1=4)]

D1. Becoming BOC certified requires attending seven day-long modules on energy and resource-efficient operation of buildings over the course of three to seven months. Training is offered in multiple locations in Oregon, Washington, and Montana as well as in Boise, Idaho. The course fee is about $1000 in Montana and Idaho and about $1,700 in Oregon and Washington. All modules require some in-class time, but up to 15% of coursework is online.

D1a. How likely is it that you would take the BOC training if…
…you had to do it on your own (unpaid) time and had to pay all the costs yourself?
…your company gave you paid time off to do it but you had to pay all the costs yourself?
…your company gave you time off to do it and paid all of the costs?

[PROGRAMMER: INSERT 1-5 SCALE FROM 1 = NOT AT ALL LIKELY TO 5 = VERY LIKELY, WITH DK OPTION]

D1b. What would keep you from taking a Building Operator Certification course? (Please select all that apply.)
[] Cost
[] The class schedule is inconvenient
[] It would be hard getting authorization or approval
[] I don't have enough time
[] My supervisor would not support it
[] Someone else at my company already has taken the training
[] I already have the skills the training provides
[] I'm not convinced it would benefit me professionally
[] There would not be anyone to do my work while I was at training
[] None
[] Other, specify: _____
[] Don't know

D2. Which of the following are true of your company? Your company... (Select all that apply)
[] ...encourages O&M-related certification for building O&M staff that do not have such certification
[] ...pays at least some of the costs associated with O&M-related certification
[] ...allows O&M staff to attend O&M-related training during paid working hours
[] None of the above
[] Don't know

D3. Now, I'd like to ask you about your workplace environment.

Which of the following best describes your work environment?

() I work mainly in a single standalone building
() I work mainly in a single building that is part of a campus or complex of buildings in a central location
() I work in more than one building in a complex of buildings in a central location
() I work in multiple buildings that are in separate locations
() Other environment _____
() I'm not sure

[D4: IF D3 = 2 OR 3]

D4. How many buildings are in the complex you work in?
() Two or three
() Four or five
() Six to 10
() More than 10
() Other response: _____
() I'm not sure

[D4a: IF D3 = 4]

D4a How many buildings do you work in?
() Two or three
() Four or five
() Six to 10
() More than 10
() Other response: _____
() I'm not sure

D5. How many total square feet of conditioned space do the building or buildings you work in have? (By 'conditioned' we mean that the space is reached by the facility's heating or air conditioning methods and excludes garages, decks, plazas, patios, and so forth.)
_____ total square feet (please provide your best guess to the nearest 10,000 square feet)
() Don't know or not sure

[IF D5 = 'Don't know or not sure']

D5a. Which of the following size ranges do the building or buildings you work in fall in? (Again, we are asking only about heated or air conditioned space, excluding garages and outdoor areas.)

() Up to 5,000 square feet
() 5,001 to 20,000 square feet
() 20,001 to 50,000 square feet
() 50,001 to 75,000 square feet
() 75, 001 to 100,000 square feet
() 100,001 to 500,000 square feet
() More than 500,000 square feet
() I'm not sure
() Other response: _____

F.3.10. E. Establishment Characteristics

[E1: ALL RESPONDENTS]

E1. Which of the following best describes your organization's type of business?

() Office
() Retail
() Grocery
() K-12 School
() College/University
() Restaurant
() Hospital / Medical
() Warehouse
() Industrial / Process
() Hotel / Motel
() Residential / Apartment
() Government
() Mixed Use
() Other – please, specify:_____

[E2, E3: EMPLOYER (A1 = 1, 2, OR 3)]

E2. How many buildings does your organization own in the Pacific Northwest (OR, WA, ID, or MT)? Your best estimate is fine.
RECORD NUMBER OF BUILDINGS: _____ Don't Know

E3. How many total square feet of conditioned space are in those buildings? (By 'conditioned' we mean that the space is reached by the facility's heating or air conditioning methods and excludes garages, decks, plazas, patios, and so forth.)
_____ total square feet (please provide your best guess to the nearest 10,000 square feet)
() Don't know or not sure

[E3a: E3 = 'Don't know or not sure']

E3a. Which of the following size ranges includes the total square footage buildings does your organization own in the Pacific Northwest?
() Up to 5,000 square feet
() 5,001 to 20,000 square feet
() 20,001 to 50,000 square feet
() 50,001 to 75,000 square feet
() 75, 001 to 100,000 square feet
() 100,001 to 500,000 square feet
() 501,000 to 1,000,000 square feet
() More than 1,000,000 square feet
() I'm not sure
() Other response: _____

F.3.11. F. Building Operations & Maintenance

[SECTION FOR EMPLOYEES (A1=3)]

[DISPLAY FOLLOWING TEXT IF CONTRACT SERVICES EMPLOYEE (A2 = 1)]

Now we would like to learn about your operations and maintenance, or O&M practices, including practices of those working under your supervision. Unless otherwise specified, please focus on your practices over the past year. If you have worked in buildings for multiple clients, please focus on your typical practices.

[DISPLAY FOLLOWING TEXT IF IN-HOUSE EMPLOYEE (A2 = 2)]

Now we would like to learn about your operations and maintenance, or O&M practices, including practices of those working under your supervision. Unless otherwise specified, please focus on your practices over the past year.

[DISPLAY F1 IF A1 = 3]

F1. Which of the following are you responsible for operating and/or maintaining? (Check all that apply.)

[] Boiler system
[] Chilled water system
[] Economizers & ventilation control
[] Compressed air systems
[] Fans & air distributions systems
[] Domestic water heaters
[] Lighting
[] Pumps
[] Motors

[DISPLAY FOLLOWING TEXT IF F1 = Boiler system]

Please tell us about your work with boilers, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Boiler system AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F2 TO F6 IF F1 = Boiler system]

F2. Please provide some information about the boiler: (Please provide your best guess if you are not sure)

Fuel Efficiency (%)	Boiler Product	Other Boiler Product	Rated Heating Input	Fuel Type	Other Fuel Type
0-100	Hot water Steam Other Don't know	Text	Numeric	Natural Gas Oil Propane Electricity Other Don't know	Text

F3. How frequently do you or someone working under your supervision perform the following maintenance activities?

	Frequency
Check boiler supply and return temperatures Check boiler stack temperature	1=At least once a day 2=At least once a week 3=At least once a month 4=Less than once a month 5=Only as needed 6=Never have done Don't Know

F4. And how about...?

	1=At least once a quarter	2=2-3 times a year	3=About once a year	4=Less than once a year	5=Only as needed	6=Never have done	Don't Know
Check combustion efficiency							

F5. And the following...?

	1=At least once a year	4=Less than once a year	5=Only as needed	6=Never have done	Don't Know
Check for corrosion or scaling					
Clean fire tubes					
Check and clean heat exchangers					
Replace leaking tubes					
Inspect insulation on piping and boilers					
Clean/replace fuel oil burner tip					
Calibrate sensors					
Inspect steam traps					

F6. Have you implemented hot water reset or cutout controls for any of the boilers at your facilities?
() Yes
() No
() I don't know

[DISPLAY F7 IF F6 = YES]

F7. Is the hot water temperature reset based on outdoor air temperature?
() Yes
() No
() I don't know

[DISPLAY F8-F9 IF F7 = YES]

F8. What are the high and low hot water temperature set points, in degrees Fahrenheit (°F)?
High Temp Set Point (°F)
Low Temp Set Point (°F)
Other response

F9. At what OUTDOOR air temperatures (°F) do hot water temperatures change and does the system shut down?
Other response
OUTDOOR air temperatures (°F) at which hot water temperatures change
OUTDOOR air temperature (°F) at which the system shuts down

[DISPLAY F10 TO F15 IF F1 = Boiler system]

F10. How often do you perform boiler tune-ups?
- () At least once per year
- () Less than once per year
- () Never
- () Other response: _____
- () As needed

F11. What do you typically do as part of a boiler tune-up? (Check all that apply)
- [] Measure flue gas oxygen content
- [] Measure flue gas carbon monoxide content
- [] Measure flue gas combustibles content
- [] Measure flue gas emissions content (NOx)
- [] Measure flue flow rate
- [] Measure flue gas temperature
- [] Measure steam flow rate (if steam boiler)
- [] Adjust combustion control positioning to achieve desired combustion characteristics (targets will generally be in accordance with Manufacturer's Specifications)
- [] Document pre- and post-tune-up conditions as well as any modifications/repairs made
- [] Other – specify: _____

F12. What instrumentation do you use in evaluating boiler operating conditions? (Check all that apply)
- [] Portable combustion analyzer
- [] Infrared thermometer (temperature gun)
- [] Thermocouple Probe
- [] Other – specify: _____

F13. How often do you calibrate boiler controls?
- () At least annually
- () Every one to two years
- () Less frequently than every two years
- () Never
- () Other response: _____
- () As needed

F14. Have you implemented any energy-saving modifications to boiler equipment scheduling? If so, what were they?
- () Yes (please describe): _____
- () No
- () Other response: _____

F15. Have you implemented any other boiler or steam-system-related O&M measures that we have not asked about yet? If so what were they?
() Yes (please describe): _____
() No
() Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Chilled water system]

Please tell us about your work with chilled water systems, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Chilled water system AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F16 TO F19 IF F1 = Chilled water system]

F16. What is the nominal cooling capacity of the chiller(s), EITHER in tons OR BTU/hr of input? (Please record one or the other)
() BTU/hr _____
() Other response: _____
() I don't know
() Tons _____

F17. What is the chiller system's rated operating efficiency? (Provide as many of these as you easily can)
Design efficiency %
Coefficient of Performance (CoP) %
Integrated part-load value (IPLV) %
Non-standard part-load value (NPLV) %
Other response

F18. What O&M practices have you implemented to optimize chiller performance?

F19. Have you implemented chilled-water reset controls at any of your facilities?
() Yes
() No
() I don't know

[DISPLAY F20 TO F21 IF F19 = YES]

F20. What is the normal chilled-water operating temperature (°F) during peak cooling season?
() Temperature (°F) _____
() Other response: _____
() I don't know

F21. By how many degrees (°F) is temperature offset?
() Other response: _____
() Degrees (°F) _____
() I don't know

[DISPLAY F22 IF F1 = Chilled water system]

F22. Do any of your facilities feature cooling towers?
() Yes
() No
() Don't know

[DISPLAY F23 IF F22 = YES]

F23. Have you implemented condenser water supply temperature reset controls at any of these facilities?
() Yes
() No
() Other response: _____

[DISPLAY F24 IF F1 = Chilled water system]

F24. Have you implemented any other chilled-water system-related O&M measures that we have not asked about yet? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Economizers and ventilation control]

Please tell us about your work with economizers and ventilation control, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Economizers and ventilation control AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F25 TO F27 IF F1 = Economizers and ventilation control]

F25. Have you installed carbon monoxide (CO) based ventilation controls at any of your facilities?
() Yes
() No
() Other response: _____

F26. Have you evaluated the amount of outside air supplied by the central HVAC system at any of your facilities?
() Yes
() No
() Other response: _____

F27. Do any of your facilities have HVAC systems equipped with air-side economizers?
() Yes
() No
() I don't know

[DISPLAY F28 TO F31 IF F27 = YES]

F28. Have you added air-side economizers to any of the HVAC systems at your facilities?
() Yes
() No
() Other response: _____

F29. Have you repaired inoperable pre-existing air-side economizers? If so, how did you do it?
() Yes - please briefly describe how _____
() No
() Other response: _____

F30. Have you done anything to optimize pre-existing air-side economizers? If so, what did you do?
() Yes (please briefly describe) _____
() No
() Other response: _____

F31. Have you upgraded pre-existing outside-air dry-bulb economizers to dual-enthalpy economizers?
() Yes
() No
() Other response: _____

[DISPLAY F32 TO F33 IF F1 = Economizers and ventilation control]

F32. Have you implemented supply air temperature reset strategies at any of your facilities? (For example, using free cooling provided by an economizer to increase supply air temperature set points and decrease cooling system operating hours)
() Yes
() No
() Other response: _____

F33. Have you incorporated optimal start algorithms into any of the central HVAC control systems serving the facilities you operate or manage?
() Yes
() No
() I don't know

[DISPLAY F34 TO F35 IF F33 = YES]

F34. Is optimal start being used during heating and cooling seasons?
() Yes
() No
() I don't know

F35. Were nighttime setbacks in place before you implemented optimal start logic?
() Yes
() No
() I don't know

[DISPLAY F36 IF F1 = Economizers and ventilation control]

F36. Have you implemented any other economizer-related O&M measures that we have not asked about? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Compressed air systems]

Please tell us about your work with compressed air systems, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Compressed air systems AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F37 IF F1 = Compressed air systems]

F37. Have you incorporated regular compressed air leak surveys into standard O&M procedures at any of these facilities?
() Yes
() No
() I don't know

[DISPLAY F38 TO F41 IF F37 = YES]

F38. How often do you perform leak surveys?
- () At least annually
- () Less than annually
- () Never
- () Other response: _____
- () As needed

F39. What instrumentation do you use to identify leaks?
- [] Ultrasonic leak detectors
- [] Infrared camera
- [] Audible sound (human ear)
- [] Other - specify: _____

F40. Has this program been successful?
- () Yes
- () No
- () I don't know

F41. How many leaks have you identified and repaired within the past 12 months?
- () Number of leaks _____
- () I don't know
- () Other response: _____

[DISPLAY F42 IF F1 = Compressed air systems]

F42. Have you implemented any other compressed air O&M measures that we have not asked about yet? If yes, what were they?
- () Yes (please describe): _____
- () No
- () Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Fans and air distribution systems]

Please tell us about your work with fans and air distribution systems, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Fans and air distribution systems AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F43 TO F50 IF F1 = Fans and air distribution systems]

F43. How frequently do you clean heat exchangers and/or cooling coils?
() At least once a year
() Less than once a year
() Never
() Other response: _____
() As needed

F44. Do you inspect motor bearings and drive belts at least once a year?
() Yes
() No
() I don't know

F45. What methods do you use to evaluate motor conditions?
() Load measurements
() Vibration analysis
() Other - specify: _____
() None
() I don't know

F46. What types of instrumentation do you use to evaluate motor conditions?
() Multi-meter
() Power meter
() Amprobe
() Vibration analysis
() Other - specify: _____
() None
() I don't know

F47. Do you or those you supervise perform temperature or vibration analyses as part of normal motor maintenance?
() Yes
() No
() I don't know

F48. Have you implemented Demand Controlled Ventilation controls at any of your facilities?
() Yes
() No
() I don't know

F49. Have you evaluated duct static pressure or reduced/reset duct static pressure at any of your facilities?
() Yes
() No
() I don't know

F50. Have you installed variable frequency drives (VFDs) on any fan systems at your facilities? If so, how many?(Again, please provide your best guess)
() Yes - number of VFDs (best guess) _____
() No

[DISPLAY F51 IF F50 = YES]

F51. What is the approximate total CFM (or cubic feet per minute) of the supply fans?
() Total CFM (best guess) _____
() Other response: _____
() I don't know

[DISPLAY F52 TO F54 IF F1 = Fans and air distribution systems]

F52. Have you implemented any energy saving modifications to main air handling units (AHUs)? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

F53. Have you implemented any energy saving modifications to fan-powered box or variable air volume (VAV) box scheduling? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

F54. Have you implemented any other fan optimization/air distribution system related O&M measures that we have not asked about yet? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Domestic water heaters]

Please tell us about your work with domestic water heaters, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Domestic water heaters AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F55 IF F1 = Domestic water heaters]

F55. Have you implemented any hot water O&M energy efficiency measures? If so, what were they?
() Yes (please describe): _____
() No
() Other response: _____

[DISPLAY FOLLOWING TEXT IF F1 = Lighting]

Please tell us about your work with lighting, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Lighting AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F56 TO F57 IF F1 = Lighting]

F56. Have you conducted a lighting system survey and savings opportunity assessment at any of your facilities? If so, in what year?(Your best guess is fine)
() Yes - what year? (best guess) _____
() No
() I don't know

F57. Does your facility include a central energy management system, or EMS?
() Yes
() No
() I don't know

[DISPLAY F58 IF F57 = YES]

F58. Does your facility's EMS automatically turn lights on or off based on time of day?
() Yes
() No
() I don't know
() Other basis - specify: _____

[DISPLAY F59 TO F60 IF F58 = YES]

F59. At what hours does the system turn the lights on and off?

F60. Are these settings modified throughout the year, as days become longer or shorter?
() Yes
() No
() I don't know

[DISPLAY F61 TO F62 IF F57 = YES]

F61. How often are set points changed within the Energy Management System?
- () More than four times a year
- () About four times a year
- () About three times a year
- () About twice a year
- () About once a year
- () Less than once a year
- () Never
- () I don't know
- () As needed

F62. Does the system control all interior and exterior lighting at the facility?
- () Yes
- () No
- () I don't know

[DISPLAY F63 IF F1 = Lighting]

F63. Is lighting at your facility controlled by occupancy sensors?
- () Yes
- () No
- () Don't know

[DISPLAY F64 IF F63 = YES]

F64. What space types are occupancy sensors being used in?
- [] Warehouse
- [] Conference room
- [] Restroom, bathroom
- [] Hallway
- [] Other – specify: _____
- [] I don't know

[DISPLAY F65 IF F1 = Lighting]

F65. Have you made any other modifications to standard O&M procedures at the facility that would have resulted in a reduction in lighting operating hours and/or energy consumption? If so, what were they?
- () Yes (please specify) _____
- () No
- () I don't know

[DISPLAY FOLLOWING TEXT IF F1 = Pumps]

Please tell us about your work with pumps, including the work of others you supervise.

[DISPLAY FOLLOWING TEXT IF F1 = Pumps AND A1 = 3 AND A3 = 1]

If you have worked for multiple clients, please focus on your typical practices.

[DISPLAY F66 IF F1 = Pumps]

F66. Have you implemented any energy saving modifications to pump scheduling? If so, what were they?
() Yes (please describe): _____
() No
() I don't know

[DISPLAY F67 IF F1 = ANY NON-NULL RESPONSE]

F67. Have you implemented any other scheduling-related O&M measures that we have not asked about yet?
() Yes
() No
() Don't know

[DISPLAY F68 IF F67 = YES]

F68. What other scheduling-related O&M measures have you implemented? (Please provide a very brief description in the appropriate space - for example, describe any boiler-related O&M measures you haven't already told us about in the box next to 'Boilers')

Boilers [DISPLAY IF F1 = Boiler system]

Chilled-water system [DISPLAY IF F1 = Chilled water system]

Economizers and ventilation control [DISPLAY IF F1 = Economizers and ventilation control]

Compressed air [DISPLAY IF F1 = Compressed air systems]

Fan optimization / air distribution [DISPLAY IF F1 = Fans and air distribution systems]

Hot water [DISPLAY IF F1 = Domestic hot water]

Lighting [DISPLAY IF F1 = Lighting]

Pumps [DISPLAY IF F1 = Pumps]

Motors [DISPLAY IF F1 = Motors]

Other - please describe

F.3.12. Survey End

Thank you very much for all of your valuable time. We know it was a significant investment, and we appreciate it.

CLICK "SUBMIT" IF YOU ARE FINISHED WITH YOUR SURVEY QUESTIONS.
THANKS AGAIN!

F.3.13. Termination

This survey is targeting individuals currently employed in the managing or performance of building operations and maintenance services. Therefore, we do not need to take up any more of your valuable time.

PLEASE CLICK "SUBMIT" TO SAVE YOUR RESPONSES AND EXIT THE SURVEY.
THANKS AGAIN!

Appendix G. Evaluation Sources

This appendix lists sources used in this MPER and the associated memoranda. We first list general sources, used throughout the MPER and memoranda, followed by sources specific to the market characterization and the ACE Model review.

G.1. General Sources

NEEC BOC Program Database

BOC non-certificant survey

Market informant interviews

G.2. Market Characterization

For the market characterization, in addition to relying on the above-mentioned general sources, we relied on a variety of NEEA reports and memoranda, data from the 2009 Commercial Building Stock Assessment (see reference below), and data from the U.S. Census American Community Survey, the 2009 Federal Real Property Statistics (FRPS), and the Oregon University System.

G.2.1. NEEA Reports and Memoranda

Research Into Action, Inc. 2014. *BOC-Expansion Initiative Market Progress Evaluation Report #1* (Report #E14-277). Portland, OR: Northwest Energy Efficiency Alliance. Retrieved from http://neea.org/docs/default-source/reports/boc-expansion-initiative-market-progress-evaluation.pdf?sfvrsn=4.

Navigant Consulting, Inc. 2012. *Long-Term Monitoring and Tracking Report on 2011 Activities* (Report #E12-239). Portland, OR: Northwest Energy Efficiency Alliance. Retrieved from http://neea.org/docs/reports/long-term-monitoring-and-tracking-report-on-2011-activities.pdf?sfvrsn=16.

RLW Analytics, Inc. 2005. *Impact and Process Evaluation Building Operator Training and Certification Program.* Portland, OR: Northeast Energy Efficiency Partnerships, June, 2005. Retrieved from http://www.theboc.info/pdf/Eval-BOC_NEEP_2005.pdf.

Research Into Action, Inc. 2001. *Market Progress Evaluation Report: Regional Building Operator Certification, No. 7* (Report #E01-088). Portland, OR: Northwest Energy Efficiency Alliance. Retrieved from http://neea.org/docs/reports/market-progress-evaluation-report-no-7-e01-088.pdf?sfvrsn=7.

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Northwest Energy Efficiency Alliance. 2013. *Initiative Review (IR1, IR2…) Milestone Document*. Retrieved from https://intranet.neea.org/sites/initiatives/boce/BOCE%20Documents/BOC%20E_IR%20Milestone%20Document%20V4.docx.

G.2.2. Other Online Data Sources

U.S. Census Bureau, Statistics of U.S. Businesses: 2008. *U.S. - All industries - by Employment Size of Enterprise*. Retrieved from https://www.census.gov/epcd/susb/latest/us/US--.HTM.

FY 2009 Federal Real Property Statistics. Published by GSA Office of Governmentwide Policy. Retrieved from http://www.gsa.gov/graphics/ogp/FY2009_FRPR_Statistics.pdf.

Commercial Buildings Energy Consumption Survey. Retrieved from http://www.eia.gov/consumption/commercial/.

GSA eLibrary. Retrieved from http://www.gsaelibrary.gsa.gov/ElibMain/searchResults.do;jsessionid=A1C1E0C40BA574C906D41054D83606C2.prd2pweb.

National Social Norms Institute at the University of Virginia. Other Topics – Self-Report Data. Retrieved from http://www.socialnorms.org/Research/SelfReports.php.

G.3. Findings

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CIPD (2009). Recruitment, retention and turnover. Annual survey report by the Chartered Institute of Personnel and Development. Retrieved from http://www.cipd.co.uk/binaries/recruitment_retention_turnover_annual_survey_2009.pdf.

Hallier J & Butts S (1999) Employers' Discovery of Training: Self-development, Employability and the Rhetoric of Partnership, Employee Relations, 21 (1), pp. 80-95. Retrieved from https://dspace.stir.ac.uk/handle/1893/11771?mode=full#.VDawaU0tCB8.

HR Council (2008). Job satisfaction and employee retention: what's the connection? HR Council for the Nonprofit Sector. Retrieved from http://www.hrcouncil.ca/documents/LMI_satisfaction_retention.pdf.

Martin, C. (2003). Explaining labour turnover: empirical evidence from UK establishments. Labour, 17(3), 291-412. Abstract retrieved from http://onlinelibrary.wiley.com/doi/10.1111/1467-9914.00246/abstract.

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G.4. Ace Model Review

For the ACE model review, in addition to relying on the above-mentioned general sources and market size estimates from our market characterization, we relied on data from online energy-related sources, a variety of program technical reference manuals, and program data from Nexant-implemented retro-commissioning, building tune-up, and O&M programs, which include project- and measure-specific data for 50 to 60 typical O&M measures.

G.4.1. Online Sources

Commercial Buildings Energy Consumption Survey (CBECS). Retrieved from http://www.eia.gov/consumption/commercial/

The Regional Technical Forum Unit Energy Savings (UES) Measures and Standard Protocols. Retrieved from http://rtf.nwcouncil.org/measures/

G.4.2. Technical Reference Manuals

State of Illinois Energy Efficiency Technical Reference Manual

State of Wisconsin Public Service Commission of Wisconsin – Focus on Energy Evaluation – Business Programs: Deemed Savings Manual V1.0

Pennsylvania Public Utility Commission Technical Reference Manual – State of Pennsylvania Act 129 Energy Efficiency and Conservation Program

Massachusetts Technical Reference Manual

New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Commercial/Industrial Measures

State of Ohio Energy Efficiency Technical Reference Manual prepared for the Public Utilities Commission of Ohio by Vermont Energy Investment Corporation

State of Arkansas Deemed Savings - Quick Start Program – Commercial Measures Final Report