Opinion Dynamics

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Ameren Illinois Company 2018 Building Operator Certification Process Evaluation Report

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Opinion Dynamics

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EXECUTIVE SUMMARY

AIC and MEEA offered two BOC Trainings in 2018

LEVEL I COURSE

PEORIA FROM 10/11/2018 THROUGH 11/29/2018

Classes focused on building systems maintenance

Participants completed

LEVEL II COURSE

BLOOMINGTON FROM 10/31/2018 THROUGH 12/13/2018

Classes focused on equipment troubleshooting & maintenance

Participants completed

Evaluation Findings - Both Level I and Level II courses satisfied all four levels of Kirkpatrick's model.

Participants:

Satisfied with trainings

Retained the information

Altered building operations (i.e., behavior) based on what was learned

Saved energy

Research activities measured Kirkpatrick's four levels of learning.

BASELINE OPERATIONS AND MAINTENANCE (O&M) AND ENERGY EFFICIENCY EQUIPMENT SURVEY:

- Established baseline O&M conditions
- Collected information on existing energy-related equipment

REVIEW OF COURSE MATERIALS:

- Reviewed the results of several in-class activities, a baseline knowledge assessment, exam scores, and homework assignments
- Examined exit surveys for each class in which participants assessed the effectiveness of the class and instructor

PARTICIPANT INTERVIEWS:

- Solicited feedback on course
- Documented changes made to their facilities during the training;
- Recorded any future plans for energy-saving changes to building operations
- Identified the role the training played in future plans

POST-COURSE SAVINGS SURVEY:

- Captured actions taken one-year after BOC completion as a result of what was learned in course
- Included energy efficency projects and modifications to building or equipment operations

ENGINEERING DESK REVIEWS:

- Reviewed the data collected in the post-course savings survey, set up savings calculations
- Identified additional data required to calculate impacts

ON-SITE AUDIT:

- Verified the energy-saving actions indicated in the post-course savings survey
- Gathered additional information to support impact calculations

Participants Very Satisfied with Level I and Level II BOC Courses!

- On a scale of 1 to 5 with 5 as Very Useful, Level I class average = 4.5 and Level II class average = 4.4
- Course content included right balance of review of concepts and new information
- Instructors knowledgeable, helpful, and effective
- Course increased likelihood of company purchasing Energy Efficient equipment and increasing EE practices in the future
- 3 Level I participants experienced challenges with pace of course. A lot of material to digest in a short amount of time
- 2 Level I participants and 1 Level II participant found coursework difficult to balance with job workloads

Kirkpatrick's 1st level
REACTION

TRAINING ENVIRONMENT

Positive learning experience translated to strong performance on course assignments!

Kirkpatrick's 2nd level
LEARNING

Average exam scores across courses

LEVEL I	LEVEL II
87%	92%

Average homework scores across courses

LEVEL I	LEVEL II
92%	97%

TRAINING ENVIRONMENT

Participants applied new information from classes in the facilities they operated!

Kirkpatrick's 3rd level
BEHAVIOR
&
Kirkpatrick's 4th level
RESULTS

- Energy savings actions included lighting replacements, alterations to HVAC equipment scheduling, installation of VSDs, and replacement of inefficient equipment
- Energy savings attributed to BOC include:
  - Electric: 322 MWh
  - Demand: .064 MW
  - Gas: 18,076 Therms

WORK ENVIRONMENT

RECOMMENDATIONS

Consider incorporating new topics into trainings including building infrastructure, occupant education, renewables, and water efficiency

Consider spreading courses over a longer time-frame or altering the schedule of assignments to avoid overburdening students

Explore ways to increase participation in evaluation activities with evaluation team

2. Introduction

This report presents the evaluation team's process findings from the 2019 evaluation of the 2018 Building Operator Certification (BOC) Training.[1] These findings are meant to accompany the impact results presented in the 2019 impact evaluation report. As noted in the impact report, we leveraged an innovative approach to quantifying impacts for the BOC Training; including capturing baseline O&M practices, facility equipment, and knowledge prior to training interventions; capturing energy-saving actions; and quantifying the resulting savings attributable to the BOC Training. To do so, we conducted several research activities that allowed us to evaluate the training based on Kirkpatrick's Four-Level Training Model--the gold standard for evaluating adult training interventions. This framework evaluates trainings on four levels: (1) Reaction, (2) Learning, (3) Behavior, and (4) Results. Since the process and impact activities are intertwined in this evaluation approach, we have also included impact results in this report with the goal of illustrating the connections between each of Kirkpatrick's four levels and to demonstrate how a positive training experience can ultimately result in energy savings.

3. Kirkpatrick's Levels

The following sections provide detailed results for the assessment of each of Kirkpatrick's four levels.

3.1 Reaction and Learning

This section includes the results of the evaluation team's analysis of Kirkpatrick's first two levels as they relate to the BOC Training: Reaction and Learning. We present the results of the BOC Level I and Level II courses separately.

3.1.1 Level I Course

Overall, the BOC Level I course participants reported positive reactions to the course. Each participant was asked to complete an "exit survey" after each class to evaluate the instructor, content, and overall usefulness of the class. For each class, the participants reported high ratings for all the components (Table 1). Additionally, all respondents reported the course was a valuable use of their time (n=5), and nearly all respondents reported they would recommend each of the classes to others in their network. Notably, four participants reported their company would make equipment purchase decisions within the next two years (n=5), with two reporting that such decisions would take place within the next six months. However, just two respondents said they planned to start energy efficiency projects at their facility in the near future (n=5).

[1] Given that most large commercial projects have very long lead times, we designed this process to calculate the 2019 BOC Training evaluation based on the actions of 2018 BOC Training participants. Therefore, we refer to the 2018 BOC Training throughout this memo, though the associated impacts were claimable in the 2019 program year.

Table 1. BOC Level I Course Exit Survey Results

Question	Average Rating for Each Class							
	1001 n=9	1002 n=8	1003 n=9	1004 n=9	1005 n=8	1006 n=7	1007 n=6	All Classes
How would you rate the instructor's time management?[a]	4.89	4.13	4.33	4.89	4.63	4.43	4.83	4.59
How would you rate the instructor's organization?[a]	4.67	4.38	4.33	4.89	4.63	4.43	5.00	4.62
How would you rate the instructor's clarity?[a]	4.78	4.25	3.78	4.78	4.88	4.29	5.00	4.53
How would you rate the instructor's in-class exercises?[a]	4.67	4.38	4.00	4.89	4.75	4.43	4.80	4.56
How would you rate the opportunity for questions?[a]	4.89	4.38	4.33	4.89	4.75	4.43	5.00	4.67
In general, how useful was today's BOC class?[b]	4.89	4.13	4.22	4.89	4.63	4.14	4.83	4.53
How much of the information presented was new?[c]	3.67	4.38	4.11	3.78	3.88	4.00	4.67	4.07
How would you rate the technical level of the content presented?[d]	3.11	3.38	3.33	3.11	3.00	3.29	3.50	3.25
Do you feel that today's course provided proper instruction and preparation to complete the on-site project (homework)?[e]	4.38	4.75	4.00	4.38	4.57	N/A	N/A	4.41
To what extent do you think this course information will increase the likeliness that you/your company will purchase energy-efficient equipment or energy efficiency practices in the future?[f]	3.75	4.25	3.86	3.88	4.29	4.00	4.40	4.06

[a] Scale of 1 to 5, where 1 = “Needs improvement” and 5 = “Excellent”

[b] Scale of 1 to 5, where 1 = “Not useful”, 3 = “Somewhat useful”, and 5 = “Useful”

[c] Scale of 1 to 5, where 1 = “None”, 3 = “Some”, and 5 = “All”

[d] Scale of 1 to 5, where 1 = “Too basic”, 3 = “Comprehensive”, and 5 = “Too technical”

[e] Scale of 1 to 5, where 1 = “No”, 3 = “Maybe”, and 5 = “Yes”

[f] Scale of 1 to 5, where 1 = “Very unlikely” and 5 = “Very likely”

The evaluation team also completed interviews with each of the participants following the completion of the course. Table 2 contains the detailed results of these interviews. Overall, participants reported they were impressed by the instructors and pleased with the content covered in the classes. Participants noted that the course covered a lot of material in a short amount of time which sometimes made it difficult to digest all the information. Some participants also reported it was difficult to complete the course and homework assignments on top of the responsibilities of their jobs. However, participants noted the homework assignments were useful because they had to apply the course material in a practical way that helped them gain a deeper understanding of the material. Participants also felt the value of the course was worth the challenging workload. Based on the results of the exit surveys and interviews, the evaluation team found that the BOC Level I course successfully addressed Kirkpatrick’s first level (Reaction).

Table 2. BOC Level I Course Interview Results

Component	Participant Experience
Schedule and Pace	▪ Participants noted that the course covered a lot of content in a short amount of time, and classes moved fast so you had to be sure to keep up. ▪ Some participants found completing the course and homework assignments on top of a full-time job to be a lot of work. One participant suggested having previous participants spread the word about the value of the course, which they perceived to be extremely useful, relative to the workload. They felt this would encourage future participants to overcome the perception that the course is "too much work".

Component	Participant Experience
	▪ Two participants suggested that the course be spread out over a longer timeframe to allow more time to digest the materials and complete the homework assignments. Another participant suggested that each class be broken out into two days per week to allow for more time to digest. ▪ One participant suggested that BOC 1007 "Facility Electrical Systems" should have been held earlier in the course. They felt the content overlapped with the other topics, which all seemed to relate in one way or another to electricity. They also suggested that BOC 1005 "Indoor Environmental Quality" be combined with another class because there was not much content to cover in the 1005 class.
Homework and Tests	▪ Participants found the homework assignments to be time-consuming but useful and worthwhile in bringing the coursework to life and making participants think about the coursework in relation to their facilities. ▪ Participants had mixed reactions to the tests. Two found the tests to be stressful and tricky. One liked that the tests reiterated the key material covered each day. Another took a more neutral stance but felt that the homework assignments were generally more useful than the testing.
Content	▪ Participants said they picked up new ideas, and/or were reminded of concepts they had heard before but had not thought about in a while. ▪ Participants generally felt the content was the right technical level for them. Multiple participants noted entering the class with a base knowledge of the concepts discussed is critical. They felt someone without any experience would struggle to comprehend some of the concepts, and result in wasted money for AIC. ▪ One of the participants who was in a managerial position noted that they did not have hands-on experience with the technical tasks discussed during the course, and instead managed a team of technicians. Because they were not able to go back to their facility and directly apply the course learnings through hands-on-work, some of the content was a bit more challenging for them to digest compared to other participants. On the one hand, they wished there was more of a managerial component to the course, but on the other, they felt they walked away from the course better able to converse with their team about tasks.
Instructors	▪ Participants were impressed by the quality of the instructors who they felt were invaluable to the success of the course. ▪ Participants were impressed by the experience and knowledge of the instructors. They also found instructors to be relatable, and good at helping them digest the course materials by sharing relevant real-world examples. ▪ Participants described instructors as involved and were impressed that instructors offered their phone numbers to the class in the event anyone had questions after the course. A few participants took the instructors up on this offer. ▪ Two participants mentioned that one of the instructors was not very good. This instructor mainly read from his PowerPoint presentation and talked about their own experience, but in a way that was difficult to apply to multiple scenarios. Because everyone in the class came from different industries, sharing experiences that were applicable to a myriad of scenarios seemed to be important to participants.
Other Participants	▪ Participants described their classmates as a diverse group, with participants coming from different industries. They also found their classmates to be engaged in the material.
Miscellaneous	▪ One participant mentioned that the instructors' coursebook appeared to be a bit outdated and did not always match the content in the participant book. ▪ One participant mentioned that there were a few technical difficulties with equipment which prevented the class from starting on time. ▪ One participant mentioned an interest in additional content on water, geothermal, and solar.

This positive learning experience translated to strong performance on the course assignments. Average exam scores for each of the classes generally fell in the mid-to-high eighties; performance on the projects was slightly

better (Table 3). Notably, the average score on the pre-assessment fielded by MEEA at the beginning of the first class was a 74 (n=6).

Table 3. BOC Level I Course Average Exam and Project Grades

Class	Topic	Average Exam Grade	Average Project Grade
1001A	Energy-Efficient Operation of Building HVAC Systems	88.9	88.6
1001B		85.0	
1002	Measuring and Benchmarking Energy Performance	83.3	87.4
1003	Efficient Lighting Fundamentals	86.1	94.8
1004	HVAC Control Fundamentals	87.8	86.7
1005	Indoor Environmental Quality	95.6	100.0
1006	Common Opportunities for Low-Cost Operational Improvement	81.7	N/A
1007	Facility Electrical Systems	N/A	N/A

[a] N/A indicates the class did not include this assignment.

> *"IT WAS REALLY AN EYE-OPENING EXPERIENCE FOR ME, BECAUSE NOW I CAN HAVE NOTEWORTHY CONVERSATIONS WITH OUR MAINTENANCE GUYS AND WITH OUR HEAD DAY CUSTODIANS WHO CONTROL THOSE SYSTEMS. IF IT'S TOO HOT, [I CAN ASK] 'HOW MUCH OUTSIDE AIR ARE YOU BRINGING IN?' 'WHAT PERCENTAGE IS YOUR DAMPER OPENING FOR OUTSIDE AIR?' 'WHAT ABOUT THE DAMPER FOR MIXED AIR?'…THERE'S JUST SO MANY THINGS THAT I NOW UNDERSTAND" – PARTICIPANT*

Participants also reported in the interviews that they learned new concepts in the course about how to operate their buildings better. Additionally, participants noted the course reviewed important base concepts, which refreshed participants' memories on key information. One participant mentioned they had never heard of scheduling HVAC equipment to match building occupancy until attending the BOC Training. This participant said they made alterations to their HVAC programming during the course. They also were coordinating with departments in their building to understand when staff are typically in the building to assist in matching system scheduling to building activity. A different participant said they learned about the benefits of staggering start times for different components of their HVAC system. They implemented this practice in their facility to limit demand charges. This participant also installed variable speed drives (VSDs) on blowers to assist with limiting run times. The participant said these changes were a direct result of the BOC Training. A third participant altered an existing lighting project based on learnings from the training. This participant was in the process of converting lighting in a school gymnasium and auditorium to LEDs. They insisted on adding occupancy sensors to the new fixtures based on learnings about arc flash—electrical explosions that can lead to serious injuries. Students and faculty had become accustomed to manually turning breakers on and off in these spaces to turn on lighting, which can result in arc flash. The participant wanted to eliminate this practice by installing occupancy sensors and locking breaker boxes. The same participant also gained a greater understanding of how to optimize the programming of HVAC equipment using a Building Management System (BMS). This allowed the participant to provide their staff with more detailed feedback and assistance about building conditions. Based on the feedback provided in the interviews and the average grades for the exams and projects, the evaluation team found that the BOC Level I course successfully addressed Kirkpatrick's second level (Learning).

3.1.2 Level II Course

The BOC Level II course participants also reported positive reactions to their course. For each class, the participants reported high ratings for all components covered in the exit surveys (Table 4 and Table 5).[2] Additionally, all respondents reported they would recommend each of the classes to others in their network.

Table 4. BOC Level II Course Exit Survey Results – Classes 202, 214, and 216

Question	Average Rating for Each Class			
	202 n=4	214 n=4	216 n=4	All Classes
How would you rate the instructor's time management?[a]	5.00	4.75	4.75	4.83
How would you rate the instructor's organization?[a]	5.00	4.75	4.75	4.83
How would you rate the instructor's clarity?[a]	5.00	4.75	4.50	4.75
How would you rate the instructor's in-class exercises?[a]	5.00	4.50	4.75	4.75
How would you rate the opportunity for questions?[a]	5.00	4.75	4.75	4.83
In general, how useful was today's BOC class?[b]	5.00	4.50	3.75	4.42
How much of the information presented was new?[c]	3.50	3.75	3.25	3.50
How would you rate the technical level of the content presented?[d]	3.00	3.00	3.00	3.00
Do you feel that today's course provided proper instruction and preparation to complete the on-site project (homework)?[e]	5.00	4.75	5.00	4.92
To what extent do you think this course information will increase the likeliness that you/your company will purchase energy-efficient equipment or energy efficiency practices in the future?[f]	3.50	3.75	2.75	3.33

[a] Scale of 1 to 5, where 1 = "Needs Improvement" and 5 = "Excellent"

[b] Scale of 1 to 5, where 1 = "Not useful", 3 = "Somewhat useful", and 5 = "Useful"

[c] Scale of 1 to 5, where 1 = "None", 3 = "Some", and 5 = "All"

[d] Scale of 1 to 5, where 1 = "Too basic", 3 = "Comprehensive", and 5 = "Too Technical"

[e] Scale of 1 to 5, where 1 = "No", 3 = "Maybe", and 5 = "Yes"

[f] Scale of 1 to 5, where 1 = "Very unlikely" and 5 = "Very likely"

[2] Two different exit survey forms were used in the BOC Level II classes. Classes 202, 214, and 216 used one form and classes 2001A, 2001B, and 2002 used a different form.

Table 5. BOC Level II Course Exit Survey Results – Classes 2001A, 2001B, and 2002

Question	Average Rating for Each Class			
	2001A n=4	2001B n=4	2002 n=4	All Classes
In general, how useful was today's BOC class?[a]	8.75	8.5	9.25	8.83
How much of the information presented was new?[b]	7.5	8.5	7.25	7.75
How would you rate the technical level of the content presented?[c]	6.75	6.25	5.5	6.17
Do you feel that you can complete the on-site project based on today's presentation?[d]	7.5	9.25	9.5	8.75

[a] Scale of 1 to 10, where 1 = "Not Useful", 4 = "Somewhat Useful", 7 = "Useful", and 10 = "Very Useful"

[b] Scale of 1 to 10, where 1 = "None" and 10 = "All"

[c] Scale of 1 to 10, where 1 = "Too Basic", 5 = "About Right", and 10 = "Too Technical"

[d] Scale of 1 to 10, where 1 = "No" and 10 = "Yes"

In addition to the responses shown in Table 5, all respondents agreed or strongly agreed that the instructional methods used by the instructors of classes 2001A, 2001B, and 2002 were effective at conveying key material, the instructors were well prepared, and the pace of the course was adequate.

Table 6 contains detailed results from the interviews we completed with BOC Level II course participants. Similar to the BOC Level I course, Level II course participants felt the instructors were experienced and knowledgeable. They also felt the course sequencing was effective, and the tests helped to reinforce the key material from each class. Further, participants were pleased with the technical level of the material and noted the course included a good balance of new material and review of familiar concepts. One participant felt two classes on consecutive days to begin the course produced a challenging workload. However, the other participants felt the pacing of individual classes worked well. Based on the results of the exit surveys and interviews, the evaluation team found that the BOC Level II course successfully addressed Kirkpatrick's first level (Reaction).

Table 6. BOC Level II Course Interview Results

Component	Participant Experience
Schedule and Pace	▪ Participants generally felt the pace and class sequencing worked well. ▪ One participant did not like how the first two classes were back to back. They found that starting the course out with a heavy load and without a weekend in between to work on assignments (back to back homework assignments, plus an additional MEEA assignment) was frustrating. Others did not share this sentiment, stating they thought the structure worked fine. One participant liked having the first two classes back to back because it meant the back end of the course was a bit lighter.
Homework and Tests	▪ Participants did not have strong feelings about the homework assignments or tests. ▪ Participants thought the homework assignments were fine, and the tests helped reinforce the class content each day. One participant felt that a debriefing discussion at the end of each class to make sure everyone understood the main points would have been more effective than a test.
Content	▪ Participants said the content was a mix of review and new content and, in general, the right technical level. The content was most useful in providing a high-level view of systems, which allowed participants to have more informed conversations with team members and contractors.
Instructors	▪ Participants were impressed by the quality of the instructors; specifically, their experience and knowledge. The participants noted the instructors were invaluable to the success of the course. ▪ Participants also found the instructors to be relatable and good at helping them digest the course materials by sharing relevant real-world examples.

Component	Participant Experience
	▪ Participants described instructors as involved and were impressed that instructors offered their phone numbers to the class in the event anyone had questions after the course. A few participants took the instructors up on this offer.
Other Participants	▪ Participants described their classmates as a diverse group, with participants coming from different industries. They also found their classmates to be engaged in the material. ▪ Participants liked the small size of the class which produced an informal teaching environment and inspired discussion among the group. This was notable for some who had taken the BOC Level I course with a much larger class size which included participants who did not appear to be engaged in the material.
Miscellaneous	▪ One participant mentioned that the course materials (specifically around controls) were a bit dated, but the instructors made up for this by clarifying outdated material and providing feedback on updates.

The average exam score for most of the Level II classes was in the low nineties, and performance on the projects was even better (Table 7). These results indicate that the participants understood the material presented in each class and successfully applied the material in a practical context.

Table 7. BOC Level II Course Average Exam and Project Grades

Class	Topic	Average Exam Grade	Average Project Grade
2001A	Building Scoping for Operational Improvements	85.0	93.3
2001B		93.8	95.8
2002	Optimizing HVAC Controls for Operational Improvements	91.3	100.0
201	Preventative Maintenance & Troubleshooting Principles	95.0	N/A
202	Advanced Electrical System Diagnostics	96.3	100.0
214	Building Commissioning	91.3	N/A
216	Enhanced Automation and Demand Reduction	90.0	N/A

[a] N/A indicates the class did not include this assignment.

The feedback shared in the participant interviews also indicate the BOC Training resulted in successful learning outcomes. One participant learned that the BMS utilized at their facility lacked functionality typically included in newer systems; such as the ability to compare current usage to historical usage and develop consumption trends. This participant planned to speak with decision-makers about implementing a new system. Another participant felt the most important learning they took away from the training was an understanding of the benefits to implementing regular maintenance schedules. They planned to develop a consistent maintenance schedule and utilize opportunities when buildings are empty to complete detailed equipment checks. A third participant planned to take an in-depth look at equipment scheduling to try and reduce energy consumption and reduce the load on equipment. Based on these results, the evaluation team found that the BOC Level II course successfully addressed Kirkpatrick's second level (Learning).

"[I AM] DEFINITELY BEING MORE ENERGY EFFICIENT MINDED AS FAR AS WHEN WE NEED TO RUN EQUIPMENT AND WHEN WE DON'T. [I CAME AWAY WITH] NEW IDEAS ON HOW WE CAN SCHEDULE OUR EQUIPMENT MORE EFFICIENTLY SO THAT WE CAN SAVE ON EQUIPMENT LIFE AND SAVE ENERGY FOR THE COMPANY. YOU KNOW, 'WHAT LIGHTING REALLY TRULY HAS TO BE ON AND WHAT CAN WE SHUT OFF AT NIGHT?', THINGS OF THAT NATURE." – PARTICIPANT

3.2 Behavior and Results

This section includes the results of the evaluation team's analysis of Kirkpatrick's third and fourth levels as they relate to the BOC Training: Behavior and Results. The results of the BOC Level I and Level II courses are presented separately.

3.2.1 Level I Course

Two Level I course participants (n=6) reported in the interviews that they made changes to their building operations during the training, including adding insulation to ductwork, staggering ramp-up schedules for blowers and motors, and matching HVAC scheduling to building occupancy. Both participants mentioned these were new concepts that they learned about in the BOC Training.

All but one respondent reported that they planned to make energy-saving changes in the future based on what they learned in the training. These changes ranged from minor adjustments like modifying the use of economizers on air-handling units, installing programmable thermostats, refining HVAC scheduling, and performing maintenance on boilers, to more intensive efforts like implementing a new preventative maintenance plan, installing a BMS, converting current lighting to LEDs, replacing blower units, and retro-commissioning an entire facility.

Four of the six participants that completed interviews also completed the post-course savings survey. These respondents reported making several changes to their facilities following the BOC Training, including lighting replacements, installation of VSDs, motor replacements, scheduling and maintenance of HVAC equipment and a boiler replacement. These results indicate the BOC Training successfully resulted in targeted behavior changes (Kirkpatrick's third level). Importantly, these respondents reported that the BOC Training was one of several important factors that influenced their decision to take these energy-saving actions. As is typical for large commercial facilities, decision-makers plan building upgrades well in advance of execution and weigh a range of factors when considering whether to move forward with a major capital improvement.

On average, respondents rated the likelihood they would have taken the action in the absence of the training as an 8 out of 10, where 0= "definitely would not have taken the action" and 10= "definitely would have taken the action." Still, respondents reported that the BOC Training was very important when planning their energy-saving changes. On average, respondents rated the importance of the BOC Training as an 8.5 out of 10, where 0 equated to "very little importance and 10 equated to "a great deal of importance." Further, respondents allocated an average of 64 out of 100 "points of influence" to the BOC Training when considering all factors that influenced their decision to implement energy-saving changes. Expectedly, the respondents reported that other non-program factors were influential in their decision-making process as well—e.g., respondents most commonly cited sustainability initiatives, financial benefits, and increasing occupant comfort as influential factors (Table 8).

Table 8. Influence of Non-BOC Factors on Decision to Take Energy-Saving Actions

Factor	Post-Course Survey Respondents			
	Total	Influence Score[a]		
		0-3	4-6	7-10
Company commitment to going green	3	0	0	3
Reducing operating costs	3	0	0	3
Rate of return	3	0	0	3
Increased comfort	3	0	0	3
Employee, customer or student complaints	3	1	0	2
Other	2	0	1	1

[a] Respondents rated the influence of factors other than the BOC Training on a scale from 0 to 10, where 0 was "very little influence" and 10 was "a great deal of influence."

The energy-saving actions the participants completed following the BOC Training resulted in energy savings (Table 9). Notably, the evaluation team removed savings associated with projects that participants completed through other AIC initiatives. Given the participants allocated an average of 64 out of 100 points of influence to the BOC Training and 36 to all other factors when considering their decision to take energy-saving actions in addition to the other data reviewed above, the evaluation team believes there is a large amount of evidence to suggest that BOC training was influential. The evaluation team attributed savings not claimed by other AIC initiatives to the BOC Training as level four results under Kirkpatrick's framework.

Table 9. 2019 BOC Level I Course Energy Savings by Enduse

Enduse Category	Descriptions	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Cooling tower optimization	VSDs on chiller cooling tower	109	0.021	0
Boiler/hot water/steam system	High-efficiency boiler	65	0.000	16,219
Lighting	Occupancy sensors, LED exit signs, bi-level stairwell fixtures, LED installations	49	0.016	0
Chiller/chilled water system	VSDs on chiller loops, condensate pumps, and chillers	9	0.002	0
Economizer and ventilation controls	Economizer repair and optimization	3	0.000	0
Water pump optimization	Pump replacements	3	0.000	0
Package/Split-System HVAC Changes	High-efficiency motor switch-outs	1	0.000	0
HVAC equipment scheduling or space temperature	Equipment scheduling, occupancy-based scheduling	0	0.000	808
Domestic hot water	Low-flow faucets	0	0.000	37
Total		**238**	**0.039**	**17,063**

3.2.2 Level II Course

One Level II course participant (N=4) reported in their interview that they made changes to equipment scheduling during the training; this was a new concept for the participant. Three respondents reported they planned to make energy-saving changes in the future based on what they learned in the training. These changes included upgrading/replacing boilers, implementation of preventative maintenance plans, changing equipment scheduling, implementation of a new BMS, and altering operation of air handler units based on weather conditions.

Just one participant that completed an interview also completed the post-course savings survey. As such, the following results should be interpreted accordingly. This respondent reported making several changes to their facilities following the BOC Training, including lighting retrofits, replacement of a water heater, and changes to HVAC scheduling. Based on these changes reported by the one respondent to the survey, as well as the planned changes reported by other participants in the interviews, the evaluation team determined the Level II training successfully resulted in targeted behavior changes (Kirkpatrick's third level).

The participant that completed the post-course savings survey reported the BOC Training was an important influence in their decision to take the energy-saving actions following the training; though, they placed less weight in the training than the Level I course participants. The participant indicated they likely would have moved forward with two of the three energy-saving actions had they not attended the BOC Training. On a scale of 0 to 10, where 0= "definitely would not have taken the action" and 10= "definitely would have taken the action", they reported an average rating of 7.3 out of 10 for the likelihood they would have made the changes in absence of the training. Additionally, the respondent provided an average rating of 1.3 (on a scale of 0 to 10, where 0 equated to "very little importance and 10 equated to "a great deal of importance") when evaluating the importance of the BOC Training on their decision to take the energy-saving actions. Notably, the respondent allocated an average of 30 out of 100 "points of influence" to the BOC Training when considering all influencing factors in their decision to make energy-saving changes. Table 10 includes information on additional factors that influenced the participant's decisions to take the energy-saving actions.

Table 10. Influence of Non-BOC Factors on Decision to Take Energy-Saving Actions

Factor	Post-Course Survey Respondents			
	Total	Influence Score[a]		
		0-3	4-6	7-10
Company commitment to going green	1	0	0	1
Reducing operating costs	1	0	1	0
Rate of return	1	1	0	0
Increased comfort	1	1	0	0
Employee, customer or student complaints	1	1	0	0

[a] Respondents rated the influence of factors other than the BOC Training on a scale from 0 to 10, where 0 was "very little influence" and 10 was "a great deal of influence."

The energy-saving actions the participant took following the training resulted in energy savings (Table 11). As with Level I course participants, the evaluation team removed savings associated with projects the participant completed through other AIC initiatives. The evaluation team deemed the remaining savings attributable to the BOC training as level four results under Kirkpatrick's framework. While the participant reported less influence from the BOC training than Level I course participants, they provided an average of 30 out of 100 points of influence to the training. They also rated all other influencing factors as a 0 or 1 on a 0-10 scale, with the exception of organizational sustainability initiatives (8/10) and desire to cut operating expenses (4/10).

Given these savings are not claimed through other AIC initiatives and the training was a driving factor in making the energy-saving changes, we felt comfortable attributing the savings to BOC.

Table 11. 2019 BOC Level II Course Energy Savings by Enduse

Enduse Category	Descriptions	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Lighting	LED installations	79	0.019	0
HVAC equipment scheduling or space temperature	Equipment scheduling	4	0.006	716
Domestic hot water	Water heater replacement	0	0.000	297
Total		**84**	**0.025**	**1,013**

4. Case Studies

To investigate the connection between Kirkpatrick's four levels on a more granular level, the evaluation team took a deeper look at the data collection results for three participants who represent the majority of the energy savings claimed for the BOC Training. The following sections include the results of this analysis.

4.1 School District

4.1.1 Building Description

One of the participants from the Level I course was a Facilities Manager for a local school district. The participant provided information on three of their largest buildings in the baseline O&M survey.[3] The facilities ranged in size from 150,000 to 300,000 square feet and typical occupancy ranged from 900-2,300 people per day. Two of the facilities were in operation 24 hours a day during the school week and 8-12 hours on the weekend. The third facility was in operation for 18 hours a day during the school week and two hours on the weekend. All three buildings utilized natural gas boilers for space heating and chillers for space cooling though one facility was in the process of converting part of the space heating load to a geothermal system.

4.1.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following completion of the BOC Level I course, including a boiler replacement, changes to HVAC scheduling, and installation of LED lighting and occupancy sensors. The participant installed the occupancy sensors as a direct result of what they learned in the BOC Training. The participant was already working with a contractor to convert lighting in a gymnasium and auditorium to LED fixtures. The participant added occupancy sensors to the scope of the lighting projects because faculty and other staff were in the habit of using breaker boxes to turn lights on and off in these spaces manually; a practice that can lead to arc flash. The participant learned about the dangers of arc flash in the BOC training and adjusted the scope of the lighting projects to include occupancy sensors to eliminate the need to turn breakers on and off manually and to avoid the risk of arc flash.

The participant also mentioned they learned useful information about their BMS and how to operate their HVAC system more efficiently. This allowed the participant to have more informed conversations with their

[3] The evaluation team captured energy-saving actions related to additional facilities during onsite verification activities which are included in the impact analysis.

maintenance team and day custodians who handle the day-to-day operations to manage those systems more efficiently. Specifically, the participant mentioned one of the homework assignments prompted them to take a deep look at the heating zones of one of their buildings, the occupancy of those zones, and the schedules for the air handler units in each zone. As Table 12 indicates, the participant applied these learnings and changed the scheduling on air handler units to match building occupancy. This participant received an average score of 98.2 on the course homework assignments and 85 on course exams. It is clear from these results that the participant understood the material well and directly implemented what they learned in their facilities.

Table 12. Post-Series Energy-Saving Actions Reported by Participant

Enduse Category	Action	Related Course
Boiler/hot water/steam system	Replace existing boilers with new high-efficiency boilers	BOC 1001
HVAC equipment scheduling or space temperature	Schedule optimum starts for AHU system	BOC 1001
	Match AHU schedule to space occupancy	
	Schedule fan-powered/VAV boxes	
Lighting	Install occupancy sensors	BOC 1003
	Replace T12, T8, or T5 fluorescents with LED lighting	
	Replace HID fixtures with LED technology	
	Replace incandescent or CFL exit signs with LED exit signs (not in baseline)	

4.1.3 Program Influence

The evaluation team uncovered many of the post-course changes included in Table 12 during the on-site visit rather than the post-course savings survey. Therefore, we did not collect information on how the BOC Training influenced the lighting conversions or boiler replacement. We do have this information for the HVAC scheduling changes, however. Considering all of the factors that influenced their decision to improve their HVAC scheduling, the participant allocated 40 out of a total of 100 influence points to the BOC Training. They indicated they likely would have implemented these changes without attending the training (10 out of 10 - definitely would have taken the action). However, they also rated the importance of the BOC Training as a 10 out of 10 (a great deal of importance). Based on this feedback, it is clear the BOC Training played a large role in the participant executing these changes.

4.1.4 Savings

Table 13 includes a summary of the savings resulting from the post-course changes the participant made.

Table 13. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
227	0.035	16,219

4.2 Religious Organization

4.2.1 Building Description

Another Level I participant was a Facilities Manager for a religious organization. This participant managed a single 77,000 square foot facility that typically operated for 10 hours a day during the week and 4-6 hours a day on the weekends. The average daily occupancy for the space was 25-50 people. The facility utilized natural gas boilers for space heating and chillers for space cooling.

4.2.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following completion of the BOC Level I course, including domestic hot water upgrades, changes to HVAC scheduling, and water pump related adjustments. The participant specifically mentioned in their interview that the training covered new information related to HVAC systems that they were not aware of before the training. The participant felt they extracted the most value from this material. As Table 14 indicates, most of the energy-saving actions the participant took were related to HVAC scheduling. This material was mostly covered in the 1001 and 1006 classes. The 1001 class covered optimization of boiler operations, and the 1006 class covered equipment scheduling and strategies for identifying and reducing simultaneous heating and cooling. As the table shows, the participant took actions directly related to these topics. Additionally, the projects following the 1004 and 1005 classes also related to HVAC equipment scheduling. For the 1004 project, participants were tasked with identifying controls for their HVAC system and assessing the operation of the controlled equipment. For the 1005 project, students developed an occupancy schedule for their facility. The participant scored an 85 and 100 on these projects, respectively, indicating they understood the material well. As a result, it is not surprising they took actions to modify the controls on their system and to match scheduling to building occupancy.

Table 14. Post-Series Energy-Saving Actions Reported by Participant

Enduse Category	Action	Related Course
DHW	Install low-flow faucets	BOC 1002
HVAC System Equipment Scheduling or Space Temperature Changes	Match AHU schedule to space occupancy	BOC 1001
	Schedule boilers	
	Reset supply air temperature	BOC 1006
	Reduce simultaneous heating and cooling	
	Replace failed VAV box	BOC 1001
Water Pump Optimization Changes	Adjust the freeze protection sequence for pumps	BOC 1006
	Replace failed pumps	

4.2.3 Program Influence

This participant reported that the BOC Training was a factor in their decision to take the energy-saving actions included in Table 14, particularly the HVAC scheduling and water pump changes. While they reported they likely would have implemented the changes if they did not complete the BOC Training (7.3 out of 10), they also rated the importance of the BOC Training as an 8 out of 10 (on average) and allocated an average of 63 out of 100 "points of influence" to the BOC Training when considering all influencing factors in their decision

to make these energy-saving changes. Based on this feedback, it is clear the BOC Training played an important role in the participant executing these changes.

4.2.4 Savings

Table 15 includes a summary of the savings resulting from all the post-course changes the participant made.

Table 15. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
3	0.000	844

4.3 University

4.3.1 Building Description

One participant in the Level II course was a Maintenance Mechanic for a local college. The participant provided information on three of the largest buildings on campus, ranging in size from 20,000--60,000 square feet. The participant estimated the typical occupancy for these buildings ranged from 350-750 people per day. All three of the buildings were in operation 24 hours a day, seven days a week. Additionally, all three buildings utilized packaged units for space cooling needs. However, each building employed a different type of heating system; one building used a natural gas heat pump, another had electric room heaters, and the third had a natural gas furnace.

4.3.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following completion of the BOC Level II course, including domestic hot water upgrades, changes to HVAC scheduling, and LED installations. As Table 16 indicates, class 2002 discussed how to optimize operation of HVAC systems through use of controls. The participant received a perfect score on both the exam and project for this course. For the project, students were tasked with writing a sequence of operation for air handlers in one of their buildings, as well as a test procedure for verifying proper operation of the sequence of operation. The participant was able to implement these learnings in their facility and noted in their interview they were working with their BMS to optimize equipment scheduling. In addition to the HVAC control changes, the participant mentioned their organization would likely begin to convert the fluorescent lighting in their facility to LEDs; an action they followed through with. Notably, this participant completed the Level I course prior to taking the Level II course. We do not have information on how the participant performed in that course, but we do know they would have learned about the benefits of converting to efficient lighting, optimizing HVAC equipment scheduling, and low-cost opportunities to improve operational efficiency such as installing efficient showerheads.

Table 16. Post-Series Energy-Saving Actions Reported by Participant[a]

Enduse Category	Action	Related Course
DHW	Install showerheads	BOC 1002
	Direct-fired water heater replacement	N/A
HVAC System Equipment Scheduling or Space Temperature Changes	Schedule boilers	BOC 1001/BOC 2002
	Schedule heaters	
Lighting	Replace T12, T8, or T5 fluorescents with LED lighting	BOC 1003
	Replace HID fixtures with LED technology	
	Replace incandescent or CFL exit signs with LED exit signs	
	Replace incandescent lamps or CFLs with LEDs	

[a] This participant completed the Level I course prior to the Level II. Therefore, we included both Level I and Level II related courses.

[b] N/A means the action is not specifically covered in a BOC class.

4.3.3 Program Influence

This participant reported that the BOC Training was a factor in their decision to take the energy-saving actions included in Table 16, particularly the HVAC scheduling changes. While the participant indicated they likely would have implemented the changes if they did not complete the BOC Training (7.3/10), they also indicated the BOC Training was an important factor in their decision to move forward, allocating an average of 30 out of 100 "points of influence" to the BOC Training when considering all influencing factors in their decision to implement the energy-savings changes. The participant noted in their interview that there are other decision makers in the department that plan larger energy-related projects. Therefore, it makes sense the participant felt the BOC Training did not have much influence on the lighting and hot water changes; but had the most impact on changes to HVAC scheduling. The daily management of the building automation system is likely a day-to-day task of this participant, whereas planning larger projects is the responsibility of other decision-makers.

4.3.4 Savings

Table 17 includes a summary of the savings resulting from the post-course changes the participant made.

Table 17. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
84	0.025	1,013

5. Evaluation Findings and Recommendations

This section includes the evaluation team's key findings and recommendations based on the results of the 2019 process evaluation.

5.1 Participant Satisfaction

Overall, participants in both the Level I and Level II BOC Trainings reported they were very satisfied with the training. All the students were complementary of the instructors and reported they were knowledgeable, helpful, and delivered the content of the course in an effective manner. In terms of the material, participants were pleased with the technical level of the course and felt the course content included a nice balance of review of important concepts and introduction of new information. Table 18 and Table 19 include results from exit surveys that participants completed at the end of each class to evaluate the instructors and content. The results show the participants were very satisfied with the instructors and content.

Table 18. BOC Level I Course Exit Survey Results

Question	Average Rating for Each Class							
	1001	1002	1003	1004	1005	1006	1007	All Classes
	n=9	n=8	n=9	n=9	n=8	n=7	n=6	
How would you rate the instructor's time management?[a]	4.89	4.13	4.33	4.89	4.63	4.43	4.83	4.59
How would you rate the instructor's organization?[a]	4.67	4.38	4.33	4.89	4.63	4.43	5.00	4.62
How would you rate the instructor's clarity?[a]	4.78	4.25	3.78	4.78	4.88	4.29	5.00	4.53
How would you rate the instructor's in-class exercises?[a]	4.67	4.38	4.00	4.89	4.75	4.43	4.80	4.56
How would you rate the opportunity for questions?[a]	4.89	4.38	4.33	4.89	4.75	4.43	5.00	4.67
In general, how useful was today's BOC class?[b]	4.89	4.13	4.22	4.89	4.63	4.14	4.83	4.53
How much of the information presented was new?[c]	3.67	4.38	4.11	3.78	3.88	4.00	4.67	4.07
How would you rate the technical level of the content presented?[d]	3.11	3.38	3.33	3.11	3.00	3.29	3.50	3.25

[a] Scale of 1 to 5, where 1 = "Needs improvement" and 5 = "Excellent"

[b] Scale of 1 to 5, where 1 = "Not useful", 3 = "Somewhat useful", and 5 = "Useful"

[c] Scale of 1 to 5, where 1 = "None", 3 = "Some", and 5 = "All"

[d] Scale of 1 to 5, where 1 = "Too basic", 3 = "Comprehensive", and 5 = "Too technical"

Table 19. BOC Level II Course Exit Survey Results – Classes 202, 214, and 216

Question	Average Rating for Each Class			
	202	214	216	All Classes
	n=4	n=4	n=4	
How would you rate the instructor's time management?[a]	5.00	4.75	4.75	4.83
How would you rate the instructor's organization?[a]	5.00	4.75	4.75	4.83
How would you rate the instructor's clarity?[a]	5.00	4.75	4.50	4.75
How would you rate the instructor's in-class exercises?[a]	5.00	4.50	4.75	4.75
How would you rate the opportunity for questions?[a]	5.00	4.75	4.75	4.83
In general, how useful was today's BOC class?:[b]	5.00	4.50	3.75	4.42
How much of the information presented was new?[c]	3.50	3.75	3.25	3.50
How would you rate the technical level of the content presented?[d]	3.00	3.00	3.00	3.00

[a] Scale of 1 to 10, where 1 = "Not Useful", 4 = "Somewhat Useful", 7 = "Useful", and 10 = "Very Useful"

[b] Scale of 1 to 10, where 1 = "None" and 10 = "All"

[c] Scale of 1 to 10, where 1 = "Too Basic", 5 = "About Right", and 10 = "Too Technical"

[d] Scale of 1 to 10, where 1 = "No" and 10 = "Yes"

Three Level I participants experienced challenges with the pace of the course. These participants noted the course covers a lot of material in a short amount of time; spreading the course over a longer timeframe would allow students more time to digest the material and complete assignments. Two Level I and one Level II participant mentioned it was difficult to balance the workload from the training with the workload from their job; particularly at the beginning of the course when there are classes on consecutive days and multiple assignments to complete.

5.1.1 Recommendation

Training staff should consider spreading the course over a longer timeframe or altering the schedule of assignments to avoid overburdening students and to provide participants with more time to explore the material.

5.2 Participant Learning

This positive learning experience translated to strong performance on the course assignments. Average exam scores for each of the courses generally fell in the mid-eighties to low-nineties; performance on the projects was even better (Table 20 and Table 21). These results indicate that the participants understood the material presented in each class and successfully applied the material in a practical context.

Table 20. BOC Level I Course Average Exam and Project Grades

Class	Topic	Average Exam Grade	Average Project Grade
1001A	Energy-Efficient Operation of Building HVAC Systems	88.9	88.6
1001B		85.0	
1002	Measuring and Benchmarking Energy Performance	83.3	87.4
1003	Efficient Lighting Fundamentals	86.1	94.8
1004	HVAC Control Fundamentals	87.8	86.7
1005	Indoor Environmental Quality	95.6	100.0
1006	Common Opportunities for Low-Cost Operational Improvement	81.7	N/A
1007	Facility Electrical Systems	N/A	N/A

[a] N/A indicates the class did not include this assignment.

Table 21. BOC Level II Course Average Exam and Project Grades

Class	Topic	Average Exam Grade	Average Project Grade
2001A	Building Scoping for Operational Improvements	85.0	93.3
2001B		93.8	95.8
2002	Optimizing HVAC Controls for Operational Improvements	91.3	100.0
201	Preventative Maintenance & Troubleshooting Principles	95.0	N/A
202	Advanced Electrical System Diagnostics	96.3	100.0
214	Building Commissioning	91.3	N/A
216	Enhanced Automation and Demand Reduction	90.0	N/A

[a] N/A indicates the class did not include this assignment.

Five Level I participants and one Level II participant mentioned in their interviews that they learned new concepts in the course about how to operate their buildings more effectively. For example, one Level I participant said they learned about the benefits of staggering start times for different components of their HVAC system. They implemented this practice in their facility to limit demand charges. This participant also installed variable speed drives (VSDs) on blowers to assist with limiting run times. The participant said these changes were a direct result of the BOC Training. One Level II participant learned that the BMS utilized at their facility lacked functionality typically included in newer systems; such as the ability to compare current usage to historical usage and develop consumption trends. This participant planned to speak with decision-makers about implementing a new system.

5.2.1 Recommendation

Participants in both the Level I and Level II courses expressed interest in learning more about building infrastructure, occupant education, renewables, and water efficiency.[4] Training staff may want to explore

[4] Water efficiency topics are being added to the BOC Level II training in the Fall of 2020.

opportunities to incorporate these topics into the curriculum if possible. One student in the Level I course suggested the indoor air quality course could likely be combined with another topic.

5.3 Participant Behavior Change and Energy Savings

It is clear from the feedback that participants learned useful information on how to improve the operation of their facilities during the BOC Trainings. More importantly, the participants applied the new information in their facilities. Two Level I participants and one Level II participant reported making energy-saving changes in their facilities during the training, and five participants (four Level I and one Level II) made changes in the year following the training. These energy-saving changes include lighting replacements, alterations to HVAC equipment scheduling, installation of VSDs, and replacement of inefficient equipment (Table 22 and Table 23).

Participants reported the BOC Training was an important driver in making these changes. As is typical for large commercial facilities, decision-makers plan building upgrades well in advance of execution and weigh a range of factors when considering whether to move forward with a major capital improvement. As such, surveyed participants indicated they likely would have moved forward with most of the energy-saving actions they completed had they not attended the BOC Training. However, on average Level I participants allocated 64 out of 100 "points of influence" to the BOC Training when considering all factors that influenced their decision to implement energy-saving changes; one Level II participant allocated an average of 30 points. These energy-saving actions produced energy savings, indicating MEEA and AIC successfully achieved their goal of generating energy savings through educating building operators about efficient building practices (Table 22 and Table 23).

Table 22. 2019 BOC Level I Course Energy Savings by Enduse

Enduse Category	Descriptions	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Cooling tower optimization	VSDs on chiller cooling tower	109	0.021	0
Boiler/hot water/steam system	High efficiency boiler	65	0.000	16,219
Lighting	Occupancy sensors, LED exit signs, bi-level stairwell fixtures, LED installations	49	0.016	0
Chiller/chilled water system	VSDs on chiller loops, condensate pumps, and chillers	9	0.002	0
Economizer and ventilation controls	Economizer repair and optimization	3	0.000	0
Water pump optimization	Pump replacements	3	0.000	0
Package/Split-System HVAC Changes	High efficiency motor switch outs	1	0.000	0
HVAC equipment scheduling or space temperature	Equipment scheduling, occupancy-based scheduling	0	0.000	808
Domestic hot water	Low-flow faucets	0	0.000	37
Total		**238**	**0.039**	**17,063**

Table 23. 2019 BOC Level II Course Energy Savings by Enduse

Enduse Category	Descriptions	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Lighting	LED installations	79	0.019	0
HVAC equipment scheduling or space temperature	Equipment scheduling	4	0.006	716
Domestic hot water	Water heater replacement	0	0.000	297
Total		**84**	**0.025**	**1,013**

5.3.1 Recommendation

AIC should consider ways to increase participation in evaluation activities, particularly the post-course savings survey. AIC could require participation as part of the tuition reimbursement agreement or adjust the incentive structure to provide additional incentives to participants who complete all the activities–either through additional tuition reimbursement or discounting costs of the certification exam. Without robust participation in these activities it is difficult to get a full picture of the effectiveness of the training and identify opportunities for improvement. Further, lack of participation makes it difficult to assess the success of the training to determine whether AIC's investment in the training is producing the results AIC is seeking.

Appendix A. Initiative Description

AIC, in partnership with the Midwest Energy Efficiency Alliance (MEEA), offers the BOC Training to building operators in AIC territory. BOC is a nationally recognized training and certification program that was developed by the Northwest Energy Efficiency Council (NEEC) and focuses on energy-efficient building operations and preventative maintenance procedures. The BOC Training consists of two levels of training. The Level I course consists of seven classes focused on building systems maintenance, and the Level II course consists of six classes focused on equipment troubleshooting and maintenance (Table 24). Both courses include classroom training, project assignments to be completed at the participant's facility, and in-class tests at the end of each day. Successful graduates of the training program earn Training Certificates of Completion. Graduates who elect to take the Certification Exam and pass, earn the BOC Certification and become a Certified Building Operator. Certified Building Operators maintain their certification through annual continuing education and completion of maintenance processes. While participants do not need to be AIC customers to enroll in the course, AIC provides a partial tuition reimbursement upon completion of the course ($500 to put toward the total cost of $1,400) to incentivize participation.

Table 24. List of BOC Training Topics

Topic	Level I Course	Level II Course
1001 - Energy Efficient Operation of Building HVAC Systems	✓	
1002 - Measuring and Benchmarking Energy Performance	✓	
1003 - Efficient Lighting Fundamentals	✓	
1004 - HVAC Control Fundamentals	✓	
1005 - Indoor Environmental Quality	✓	
1006 - Common Opportunities for Low-Cost Operational Improvement	✓	
1007 - Facility Electrical Systems	✓	
2001 - Building Scoping for Operational Improvements		✓
2002 - Optimizing HVAC Controls for Operational Improvements		✓
201 - Preventative Maintenance & Troubleshooting Principles		✓
202 - Advanced Electrical System Diagnostics		✓
214 – Building Commissioning		✓
216 – Enhanced Automation and Demand Reduction		✓

Appendix B. Participant Summary

In 2018, MEEA offered a Level I course in Peoria from October 11 through November 29, 2018, and a Level II course in Bloomington from October 31 through December 13, 2018. Table 25 presents a summary of the 2018 Level I and Level II course participants by certification level, organization, and segment.

Table 25. 2018 BOC Training Participation Summary

Participant ID	BOC Level	Segment
20001	I	Government
20017	I	School/University
20033	I	Church
20049	I	Process Industrial
20081	I	School/University
20097	I	School/University
20113	I	School/University
20129	I	School/University
30001	II	Office
30002	II	Government
30003	II	School/University
30004	II	Office

Appendix C. Expected BOC Outcomes

Table 26 includes a list of common outcomes with high energy savings potential. The table also provides information on the BOC classes that are linked to each outcome. The evaluation team prioritized these outcomes in data collection activities.[5]

Table 26. List of Expected Outcomes from BOC Courses

Outcome	1001	1002	1003	1004	1005	1006	2001	2002	201	202	214	216
Tune-up boiler(s)	✓						✓					
Test and replace faulty steam traps	✓											
Optimize chiller sequencing	✓							✓				
Install thermal storage systems												✓
Measure and optimize chiller performance	✓											
Schedule optimum starts for AHU system	✓							✓				
Match AHU schedule to space occupancy	✓							✓				
Schedule boilers	✓							✓				
Schedule exhaust fans	✓							✓				
Schedule fan-powered boxes	✓							✓				
Schedule fan-powered/VAV boxes	✓							✓				
Schedule heaters	✓							✓				
Schedule pumps	✓							✓				
Schedule return/exhaust fans	✓							✓				
Set back space temperature	✓							✓				
Install demand control ventilation	✓							✓				
Install hot water pump VSD(s)		✓								✓		
Install combustion fan VSD(s)		✓								✓		
Use variable speed condenser fans for capacity control		✓						✓				
Utilize VSDs for fans		✓								✓		
Install VSD(s) for pumps		✓								✓		
Install ECM(s)		✓										
Install VSD(s)		✓								✓		
Install occupancy sensors			✓									
Install daylighting/photocells on interior fixtures (skylights/window walls)			✓									
Install lighting control panels (sweep/timers)			✓									

[5] The evaluation team also asked about outcomes not included in Table 26, including outcomes not directly linked to a specific BOC class such as large capital investments where the BOC Training may have impacted the decision-making process.

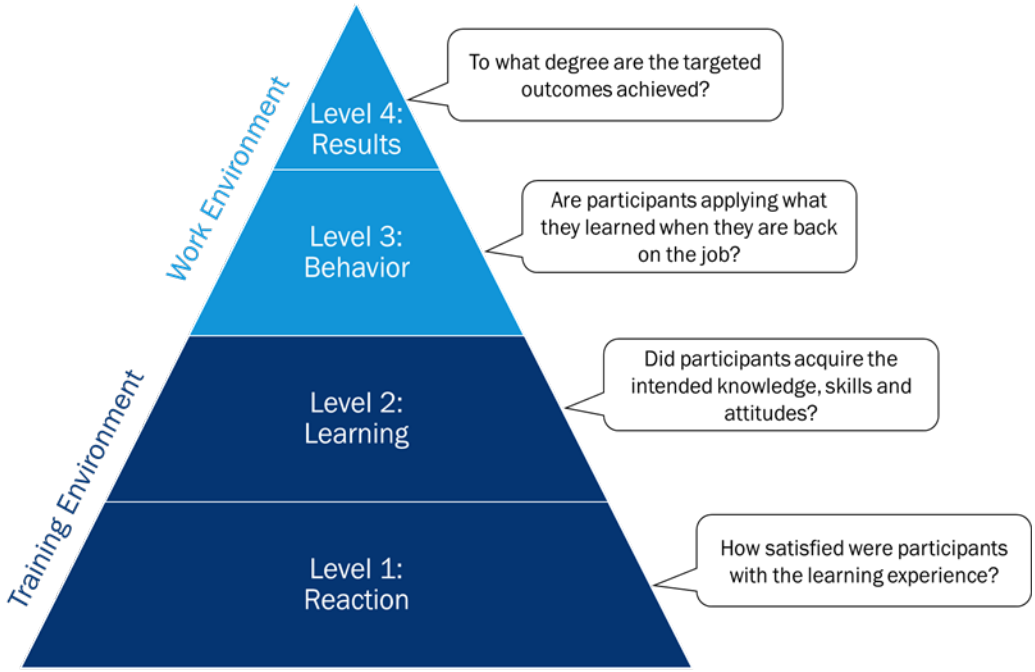
Outcome	1001	1002	1003	1004	1005	1006	2001	2002	201	202	214	216
Replace incandescent, CFL, HID, or fluorescent fixtures with LED lighting			✓									
Replace incandescent or CFL exit signs with LED exit signs			✓									
Replace stairwell lights with bi-level fixtures with sensors			✓									
Install CO-based ventilation control					✓			✓				
Install CO2-based demand control ventilation					✓			✓				
Use economizer and outdoor air control					✓			✓				
Optimize condenser water temperature						✓		✓				
Schedule heaters						✓		✓				
Use natural ventilation instead of cooling						✓		✓				
Install building pressurization control								✓				
Perform night purge cycle for pre-cooling						✓						
Perform economizer commissioning						✓					✓	
Reset supply air temperature						✓		✓				
Balance airside supply						✓		✓				
Reduce simultaneous heating and cooling						✓		✓				
Reduce outside air ventilation						✓		✓				
Commission air systems						✓					✓	

Appendix D. Evaluation Methodology

The evaluation team sought to measure the energy savings attributable to the 2018 BOC Training by leveraging an evaluation approach based on Kirkpatrick's framework of adult training evaluation. The approach is designed to collect information on each of the four levels included in Kirkpatrick's framework (Figure 1):

- **Level 1 - Reaction**: measures how participants feel about the learning experience. The value of Level 1 is that a good training experience improves knowledge transfer.
- **Level 2 - Learning**: measures the degree to which participants change attitudes, increase knowledge, or enhance skills as a result of the learning experience. The value of Level 2 is to demonstrate that learning occurs as a result of the training.
- **Level 3 - Behavior**: measures the degree to which participants apply what they have learned outside of the learning environment. This level seeks to demonstrate whether trainees take the information they learn and apply it.
- **Level 4 - Results**: the degree targeted outcomes are achieved system-wide. In this study, we measured the training's results in terms of energy savings. The value of measuring Level 4 is to inform the return on training investment realized from the training endeavor.

Figure 1. Kirkpatrick Model



To measure the four levels of learning, we conducted several research activities targeted at specific stages of the training process (see Table 27), including:

- **Baseline operations and maintenance (O&M) and energy efficiency equipment survey**: Participants completed this survey as their first homework assignment. Through the survey, our team established baseline O&M conditions and collected information on the energy-related equipment in place prior to the training intervention.

- **Review of course materials**: We reviewed the results of several in-class activities, including a baseline knowledge assessment, exam scores, homework scores, and exit surveys for each class in which participants assessed the effectiveness of the class and instructor.
- **Participant interviews**: Directly following the course, we interviewed participants to: (1) solicit feedback regarding their satisfaction with the course; (2) understand what they learned; (3) document any changes they made to their facilities during the training; (4) record any future plans for energy-saving changes to building operations; and, (5) identify the role the BOC Training played in these future plans. We provided a $50 incentive as a thank you for participating in the interviews.
- **Post-course savings survey**: We surveyed participants a year after they completed the BOC Training to understand the actions (if any) they took as a result of what they learned, including energy efficiency projects and modifications to building or equipment operations. Following the survey, we asked participants for the opportunity to schedule an on-site audit. We provided a $100 incentive as a thank you for participating in the survey.
- **Engineering desk reviews**: Our engineers reviewed the data collected in the post-course savings survey, set up savings calculations, and identified additional data required to calculate impacts.
- **On-site audit**: Our engineers (1) verified the energy-saving actions indicated in the post-course savings survey, (2) ensured participants took these actions following the BOC Training, and (3) gathered additional information to support impact calculations. We provided a $500 incentive as a thank you for participating in the audit.

Table 27 illustrates how each of the research activities contributed to the assessment of Kirkpatrick's four levels. Through these activities, we gathered information about the energy-saving actions that participants took, and how the BOC Training may have motivated participants to take these actions.

Table 27. Summary of Research Activities and the Associated Kirkpatrick Levels

Research Activity	Level 1	Level 2	Level 3	Level 4
Review of course materials	✓	✓		
Participant interviews	✓	✓	✓	
Baseline O&M and EE equipment survey			✓	
Post-course savings survey			✓	✓
Engineering desk reviews				✓
On-site audit				✓

As the BOC Training *indirectly* influences participants to take energy-saving actions, program administrators do not track detailed information to estimate ex ante energy and demand savings. As such, we estimated savings for those that participated in the data collection activities described above. Table 28 presents participation in the evaluation activities by each participant. Notably, five participants completed the post-course savings survey, and one agreed to an on-site audit.

Table 28. Summary of Participation in Evaluation Activities

Participant ID	Baseline Survey	Post-course Interview	Post-course Savings Survey	On-site Audit
20001	✓	✓		
20017	✓	✓	✓	✓
20033	✓	✓	✓	
20049	✓	✓	✓	
20081	✓	[b]	[b]	
20097	✓	✓	✓	
20113	✓	[b]	[b]	
20129	✓	✓		
30001	✓	✓		
30002	✓	✓		
30003	✓	✓	✓	
30004	[a]	✓		

[a] Participant 30004 did not complete a baseline survey because their role is supplemental to the role of participant 30001.

[b] Participants 20081, 20097, and 20113 held similar roles and worked together at the same organization. We only completed the post-course interview and post-course savings survey with participant 20097.

Savings resulting from training programs are akin to spillover in that they are follow-on actions taken by participants as a result of information received from program administrators. Based on guidance provided in the Illinois Technical Reference Manual (IL-TRM), the evaluation team treated these savings as participant spillover, which informed our methodology for determining program influence as well as the timing of this evaluation.

By their nature, follow-on actions such as these require time to be completed after the intervention (training) occurs. Because the 2018 BOC trainings occurred in Q4 of 2018 (ending in November and December, respectively), the evaluation team felt strongly that follow-on actions from the 2018 trainings would not be completed and able to be observed as part of the 2018 evaluation year. We, therefore, chose to evaluate follow-on savings resulting from the trainings during 2019 as part of the 2019 evaluations. Similarly, because these savings are evaluated in the manner of spillover, we do not apply a NTGR to evaluated savings – all savings claimed are already determined to have been influenced by BOC.

The evaluation team calculated energy savings using a combination of data collected through the post-course savings survey and assumptions from version 7.0 of the IL-TRM. Originally, we expected to collect detailed information during on-site verification visits to inform impact calculations; however, just one participant agreed to an on-site visit. In cases where participants applied for incentives through other Ameren Illinois initiatives, we pulled the information from that initiative's tracking database and removed those savings from our BOC impact analysis. Finally, we filled in gaps with TRM baseline assumptions when needed.

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