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Program Year 3 DCEO Building Operator Certification (BOC) Program Evaluation

Presented to

The Illinois Department of Commerce and Economic Opportunity (DCEO)

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Presented by

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Section E. Executive Summary

E.1 Evaluation Objectives

This report is designed to present Navigant's findings and recommendations from the team's Program Year 3 (PY3) evaluation of the Illinois Department of Commerce and Economic Opportunity's (DCEO's) Building Operator Certification (BOC) training program. These findings and recommendations reflect feedback provided by a sample of participants attending DCEO's BOC trainings during the current evaluation cycle, June 2008 through May 2011, to assure that the participant feedback most accurately represents the training's impact, both process and savings-related, on participants in PY3.

DCEO chose Navigant Consulting to conduct a process and impact evaluation of the BOC program for PY3. The objectives of this evaluation were to: (1) quantify gross and net savings impacts from the program; (2) determine key process-related program strengths and weaknesses to identify ways in which the program can potentially be improved; and (3) calculate the program's benefit: cost ratio.

E.2 Evaluation Methods

Navigant estimated gross savings impacts from the BOC program by analyzing and modeling participant survey data. The survey instrument asked participants about changes they have made to their operations and maintenance (O&M) practices, as well as any equipment retrofits or replacements that have occurred since they participated in the program. The net impacts were estimated based on the level of influence of the program reported by participants, as well as whether projects had already been rebated by other programs.

The methods used for the process evaluation included in-depth interviews with the DCEO program manager, the implementation contractor's (MEEA's) program staff, and with BOC training instructors and coordinators, as well as a participant telephone survey and an analysis of course evaluations completed by students on the last day of classes.

Table E-1 below provides a summary of the principal data sources contributing to the impact and process evaluations of the BOC Training program. For each data element listed the table provides the targeted population, the sample frame, and sample size.

Table E-1. Principal Data Sources Contributing to the PY3 Evaluation

Data Collection Type	Targeted Population	Sample Frame	Sample Design	Sample Size
Final Course Evaluations (Immediate Feedback)	BOC Program Participants	254	All available, consistently formatted and summarized voluntary evaluations by graduating students on last day of class of series	30
In-Depth Telephone Interviews	DCEO Program Staff	2	DCEO Program Managers	2
	MEEA Program Staff	2	Most recent past and present BOC program implementation staff	2
	Instructors (and Coordinators)	10	3 Instructors and 1 Coordinator	4
Telephone Surveys	BOC Program Participants	224	Stratified Random Sample of DCEO BOC Program Participants	43

E.3 Key Findings

The following subsections highlight the key findings from impact and process evaluations.

E.3.1 Key Impact Findings

Table E-2 shows the PY3 and program-cycle-to-date net savings for the BOC program. The program-cycle-to-date period includes course series completed from June 2008 to May 2011 Net savings presented here do not include retrofit projects which have been influenced by the program but also rebated by other energy efficiency (EE) programs. The bottom two lines of Table E-2 show *in italics, for reference,* BOC program net savings levels if such rebated projects were included.

Table E-2. Building Operator Certification Program Net Savings

	MWh	kW	Therms
Per Participant	181	37	557
Per Square Foot	0.374*	0.075*	0.001*
Extrapolated to PY3 Participants	8,880	1,750	30,000
Extrapolated to Full Evaluation Cycle	43,490	8,880	128,000
Note: PY3 Participants, Including Rebated Savings	*19,990*	*3,920*	*31,000*
Note: Evaluation Cycle Participants, Including Rebated Savings	*89,770*	*17,650*	*132,000*

**Per Square foot demand values have units of kWh/ ft² and Watts/ft². Columns may not sum due to rounding.*
Source: Navigant Analysis.

Additional findings are summarized here:

- Savings for the program were high, although net savings are currently 30%, 32%, and 65% of gross energy, demand, and therm savings, respectively. Net savings are based on participant-reported influence scores and whether retrofit and replacement projects were rebated by other energy efficiency programs.
- Net savings per participant and per square foot were generally higher for Level I participants than for Level II participants. However, gross savings per participant and per square foot were similar between the course levels. This could indicate that more Level II participants are taking advantage of other energy efficiency rebates.
- Many retrofit and replacement energy efficiency projects influenced by the BOC program are being rebated by other energy efficiency programs. Participant savings were based on both reported program influence scores and reported information on additional rebates received. It may be possible for the BOC program to "share" some of the savings rebated by other programs in the future if its influence can be demonstrated.
- Compared to similar programs, per participant and per square foot kilowatt-hour and kilowatt savings are high, but therm savings are low. This may be due to regional differences in common fuel types.
- Operations and maintenance (O&M) improvements accounted for33% of net kWh savings, 27% of net kW savings, and 55% of net therm savings.

E.3.2 Key Process Findings

This section summarizes key findings from the process evaluation with regards to participant satisfaction with the course, course content and approach, course logistics and program administration, and marketing and outreach.

Participant Satisfaction

Overall, both Level I and Level II participant satisfaction with the course was high according to feedback from both the final course evaluations as well as the participant telephone survey. No respondent provided either the lowest rating of "fair" in the final course evaluations or the lowest ratings of "somewhat satisfied" or "not at all satisfied" in the participant telephone survey. Consistent with a high satisfaction rating, 81% of all participants surveyed responded that they had already recommended the BOC training program to colleagues.

Course Content and Approach

While feedback regarding the approach to the course was positive overall, many students and instructors suggested that efforts be made to improve course content and materials, primarily those for Level I courses.

Many Level I students commented that information was not presented in the right amount of detail; i.e., courses were not customized enough to their knowledge levels. For improvements to the course, Level I students suggested that they have more hands-on training. Many of these students also suggested improving in-class workbooks to be more useful and readable. Instructors interviewed agreed that material should be cut down so that there is enough time for hands-on training and all students, with their widely varying backgrounds, can gain additional expertise. Instructors also recommended making workbooks more presentable (in color and more organized) and providing the workbooks at least one week ahead of class so students are better prepared.

Level II students were generally satisfied with the course content in the series and did not provide much explicit feedback on potential improvements. The few that did suggested the course would be better with more hands-on training, more frequent program offerings, and better access to follow-up courses.

Course Logistics and Program Administration

Students surveyed provided mixed feedback on course structure and schedule. The main source of discontent with the course schedule – which was expressed by many of the Level I and Level II students surveyed - was that there was too much time between each class in a course. Students indicated that they would prefer taking classes once a week and/or with on-line training components.

Instructors were positively regarded by Level I and Level II students in general.

Instructors, when asked about facilities, unanimously agreed that community colleges have better facilities and technological resources than the Chicago Center for Green Technology. Most students were satisfied with the course facilities, and any student dissatisfaction stemmed

more from the location than the amenities of the facility itself. Many students indicated that the traffic and time to get to class were negative aspects of the training.

Instructors commented that there had been considerable turnover in MEEA's BOC program administrator, but they nonetheless rated MEAA's program administration very highly.

Marketing and Outreach

Participants almost unanimously stated that they heard about the course through their workplace, where it was mentioned as either recommended training or a mandatory course. The majority of students wanted to improve their skills as building operators or lower energy consumption in their building; others stated job requirements or ComEd's Retro-commissioning program requirements as reasons for deciding to enroll in the course.

Tuition rebates were more important for Level II students than Level I students, possibly because the more advanced students took classes for professional development purposes rather than job mandates. Approximately 50% of Level I participant survey respondents believed that the tuition rebate from DCEO was "very important" or "somewhat important" to their ability to take the course. In contrast, three quarters of Level II respondents stated that the tuition rebate was either "very important" or "somewhat important".

Students stated that the best ways to reach building operators are through word-of-mouth and direct advertising to facilities and employers.

Level I and Level II participants surveyed highlighted program cost and lengthy time period of course schedules as the two major barriers to attending BOC training programs. Proportionately more Level I participants cited these two barriers relative to Level II students.

E.3.3 Key Recommendations

This section highlights both key impact and process recommendations based on the evaluation findings.

Key Impact Recommendations

- The results presented in this report are based on participant responses. Savings estimates could be improved through collection of facility square footage and energy usage data when participants enroll in the program. The impact evaluation is presently constrained to some degree by the participants' relatively limited understanding of their own facilities' energy use and of the potential impact of various measures on that energy use.
- If some of the classes are shorter than the hours allotted to them, there could be potential to add some hands-on real world exercises to the classes either as homework

or as in-class exercises that will benefit both the participants and the evaluators. The results of this homework and in-class exercises would then feed into subsequent impact evaluations. Such activities could include the following:

- Having participants provide the square footage and major processes at the facilities that they are responsible for overseeing
- Having participants report at the end of each session on any changes that they have made at their facilities as a result of the training and any estimated savings
- Having participants report on any changes they would like to make at their facilities and how they plan to go about doing so
- Having participants obtain their annual energy consumption for their facilities and report them confidentially on their evaluation for that course.
- Having course instructors also provide MEEA with the final project report that each of the participants do to receive the final rebate, and get the instructors to ensure that the content of that report includes the cost savings specific to the project.

- The BOC program stands to benefit from increased interaction with other EE programs. DCEO could work with other programs to track savings claimed by and rebates paid to BOC participants. If the BOC program is a strong influencer for participation in other programs, it could claim a larger portion of retrofit savings reported by participants.

Key Process Recommendations

Process recommendations focus on program design, administration and resources.

Program Design

- **Increase Student Engagement.** MEEA should consider increasing student engagement and learning in classes by providing workbooks at least a week before class.
- **Enhance Classroom Experience.** DCEO, MEEA, instructors and BOC should consider the potential to implement student and instructor feedback regarding improvements in content (shorter Level I lessons, more hands-on activities) and approach (on-line course components, colored workbooks) provided.
- **Consider An Alternate Schedule.** Many students surveyed commented that the classes in each Level are too spread apart. MEEA should consider holding class sessions for each series more frequently – weekly at best – to keep students engaged and active.
- **Consider An Alternate Chicago Facility.** Multiple participants preferred not to drive into the city during rush hour and drive long distances to get to classes at the Chicago Center for Green Technology. Instructors also commented that the amenities at the Center were not as good as those in the community college classrooms. DCEO should consider providing a facility that may reduce commute and have better amenities in the city of Chicago.

Program Administration

- **Enhance Data Collected in Application.** MEEA should consider asking participants to provide employer and facility type in their application so that marketing efforts can be better channeled to increase participation.
- **Standardize Final Course Evaluations.** Currently, MEEA's final course evaluation for students is not standardized. MEEA should consider standardizing feedback forms so that data from all courses can be aggregated and analyzed to provide a full picture of student opinions. Navigant can work with MEEA to create standardized forms so that immediate feedback can be better mined and Navigant's future process surveys can provide more robust conclusions.

Program Resources

- **Leverage Utilities (ComEd and Ameren).** ComEd's and Ameren's account executives have relationships with many of the companies and facilities managers whose building operators are potential BOC participants. DCEO and MEEA should determine whether these avenues have been fully utilized in marketing the BOC program.
- **Investigate requiring participants in retro-commissioning programs to participate in BOC as a retro-commissioning program requirement.** ComEd currently requires participants in their retro-commissioning program to do so.

E.3.4 Cost-Effectiveness Review

Cost effectiveness is assessed through the use of the Illinois Total Resource Cost (TRC) test. Table E--3summarizes the unique inputs used to calculate the TRC ratio for the Building Operator Certification Program in PY3. Most of the unique inputs come directly from the evaluation results presented in this report. Measure life estimates were based on similar ComEd programs, third party sources including the California Public Utilities Commission (CPUC) developed Database of Energy Efficiency Resources (DEER) and previous Navigant evaluation experience with similar programs. Program costs data came directly from DCEO. Incremental costs were estimated from program, survey data and similar ComEd programs. Avoided cost data came from both ComEd and Ameren and are the same for all programs.

Table E--3. Inputs to TRC Model for Building Operator Certification Program

Item	Value Used
Participants	601
Annual Gross Energy Savings	8,879 MWh
Gross Coincident Peak Savings	1.76 MW
Net-to-Gross Ratio	100%
DCEO Administration and Implementation Costs	$34,989
DCEO Incentive Costs	$43,325
Participant Contribution to Incremental Measure Costs	$2,158,106

Based on these inputs, the Illinois societal TRC for this program is 1.11 and the program passes the Illinois TRC test.

Section 1. Introduction to the Program

This evaluation report assesses both the PY1 to PY3 and PY3 results of the Building Operator Certification (BOC) program, one of DCEO's Public Sector Electric Efficiency incentive programs, based on feedback from participants who participated during the three-year evaluation cycle.

1.1 Program Description

The Illinois Department of Commerce & Economic Opportunity (DCEO) offers the Building Operator Certification (BOC) training program to building operators in Illinois to educate them about maintenance practices that can increase the energy efficiency of building equipment. DCEO outsources program implementation to the Midwest Energy Efficiency Alliance (MEEA), which coordinates, markets, and administers the BOC program in Illinois. BOC is a national training program licensed to MEEA to offer in Midwestern states, including Illinois.

The BOC program has been offered by DCEO since 2003, with training available at two levels: Level I and Level II. The Level I series offers a series of introductory courses, while the Level II course series takes a deeper look at Level I topics. To date, according to MEEA, 601 participants have completed the trainings. During the three program years from June 2008 through May 2011, 221 students completed Level I and 33 students completed Level II students. Twenty of the 221 students in Level I also completed Level II. . Each course series is typically open to any interested building operator, with Level II students only required to have completed level I. However, over the last seven years, there are two exceptions to open classes: in one series, course attendance was restricted to Wilbur Wright Community College students. In the second instance, only interested parties from Scott Air Force Base were allowed to attend. This evaluation captures feedback from a sample of students who attended courses during PY1 to PY3 (except Wilber Wright community college students who had not completed the course by the end of PY3), and applies those findings to PY3 participation.

Courses are typically full-day sessions spread out over four to six months and are offered throughout the state of Illinois. In Chicago, classes are held at the training center of the Chicago Center for Green Technology. Classes offered outside of Chicago are mostly held in classrooms of community colleges.

During PY3, rebates of $350 (towards a training course cost of $1250) were provided to graduates once they have earned BOC credentials. Credentials are awarded to participants who have attended classes, completed required projects, and passed competency exams. DCEO's objective for the BOC program in PY3, per their revised plan, was to measure and claim savings from the program on a pilot basis.

1.2 *Evaluation Questions*

Navigant Consulting conducted the PY1 to PY3 process and impact evaluation of DCEO's BOC program. The objectives of this evaluation were to: (1) quantify PY1 to PY3 gross and net savings impacts from the program and to apply those impacts to PY3 participation only; (2) determine key process-related program strengths and weaknesses to identify ways in which the program can potentially be improved; and (3) calculate the program's PY3 benefit: cost ratio.

Navigant anticipated answering the following key researchable questions for the impact evaluation:

1. What are the gross impacts from this program?
2. What are the net impacts from this program?
3. Did the program meet its energy and demand goals? If not, why not?
4. What is the program's benefit:cost ratio?

Navigant anticipated answering the following key researchable questions for the process evaluation:

1. Has the program design changed from the previous year? If so, how, why, and was this an advantageous change?
2. Is implementation on track and meeting goals? Has the program been implemented in a manner consistent with program design?
3. Have program design, marketing and processes been effectively implemented?
4. What is the level of customer satisfaction with the program? What are barriers to participation?
5. What market effects among program end-users can be associated with program, such as channeling or spillover to other programs?

Section 2. Evaluation Methods

This section describes the evaluation approach, data sources and data collection methodology, and sampling techniques used to conduct the process and impact evaluations for the BOC program.

The final PY3 evaluation plan called for Navigant to interview DCEO BOC program managers, MEEA implementation staff, instructors, and past participants (via surveys) to provide program process recommendations; estimate energy savings with survey results; and calculate the BOC program benefit:cost ratio.

The sections that follow provide greater detail on the methods deployed.

2.1 Analytical Methods

This section details the evaluation approach for both the impact and process evaluations.

2.1.1 Impact Evaluation Methods

The objective of the impact evaluation is to quantify the energy savings that can be attributed to the program. Navigant used a four-step, quantitative process to estimate the energy savings associated with the BOC program. The first three steps dealt with the evaluation sample of 43 participants who completed telephone interviews for the evaluation. The final step quantified the results from the sample on a per-participant and per-square-foot basis to enable extrapolation to overall program participants.

1. Navigant estimated baseline consumption for the sampled participants based on facility type and square footage. The team used secondary sources to allocate energy use among various end-uses.
2. Navigant then computed gross kWh and therm savings for each end-use at the 43 sites that participated in the telephone interview based on reported measures installed and reported changes to O&M practices.
3. Gross savings were converted into net savings by taking into the account the level of influence of the BOC training on the actions taken and whether other incentives were received for equipment retrofit or replacement measures.
4. Finally, total savings from the sample were calculated on a per-participant and per-square-foot basis to enable extrapolation to all program participants and specifically to PY3 participants.

Data Resources

The impact evaluation, like the process evaluation, was based on the 43 interviews conducted in August to September 2011 with a sample of BOC training participants who took either Level 1 or Level 2 training in the period June 2008 – May 2011. About 35 of the respondents had taken the Level 1 course and eight of them had taken the Level 2 course. During these interviews a series of questions assessed whether the participants had undertaken any energy efficiency activities after the training that could be attributed to the BOC course content. The questions asked about equipment retrofit or replacement measures and operational changes that were a result of the BOC training. Furthermore, the participants rated the influence of the training on their energy efficiency activities and whether other EE incentive programs were used. These factors are used to attribute net savings to the BOC program.

Calculations used to assess energy impacts were based on both the survey answers and the following secondary sources:

- The 2003 Commercial Building Energy Consumption Survey[1] (CBECS), which provided a breakdown of energy use by end use for types of commercial building represented by program participants.
- ComEd-approved prescriptive savings workpapers, which were used to estimate savings from retrofit and equipment replacement measures as well as operating hours for some measures.[2]
- The Minnesota Deemed Savings Database[3], which was used to estimate savings from retrofit and equipment replacement measures not specified by the ComEd workpapers.
- Program materials for the BOC courses, including secondary sources used during courses such as the Motor Master database.

Gross Savings for Sample

Navigant Consulting undertook a multi-step process to derive gross savings estimates. In the first step, savings were calibrated to typical energy use. To do this Navigant created a Baseline

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[1] US Department of Energy - Energy Information Agency 2003 Commercial Building Energy Consumption Survey http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html

[2] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

[3] Minnesota Deemed Savings Database, MN Department of Commerce. Results from the Zone 3 region were used (primarily for kWh/kW ratios). Zone 3 was chosen since a majority of commercial building stock is in this zone. http://www.state.mn.us/portal/mn/jsp/content.do?subchannel=-536895041&programid=536919090&id=-536893853&agency=Energy&sp2=y

Consumption Model and calculated gross savings based on the actions taken and amount of the facility (or pieces of equipment) affected by those actions. The following two subsections present these processes.

Baseline consumption model

Previous analyses of BOC program savings have been conducted by assuming a universal energy intensity that applies to all building types and is independent of energy end use. One such resource for this approach is the 2009 Northwest Commercial Building Stock Assessment (CBSA)[4], which provides a universal building energy usage intensity of 16.7 kWh/ft^2. This study generated energy intensity estimates by combining utility billing information with respective building square footages, and categorizing the results by building types. Results are presented in categories ranging from building square footage, year of building construction, monthly energy use patterns, and others.

In order to more accurately determine energy savings from the DCEO BOC program, it was necessary to analyze building energy consumption by end use for various building types. This would allow the savings from BOC-influenced procedures, upgrades, and behaviors pertaining to individual end use categories to be targeted and quantified. Navigant used data obtained from the 2003 Commercial Buildings Energy Consumption Survey (CBECS) for this analysis. . The CBECS data is published by the U.S. Energy Information Administration[5].

The 2003 CBECS data for energy intensity by end use are based on monthly consumption data and climate degree-day data. The results for electrical use were determined by data from 1,500 buildings, and the results for natural gas were based on data from 1,000 buildings.

The energy usage numbers were developed using a series of modeling techniques. The models incorporated data regarding the building sizes and equipment types (HVAC, water heating, lighting, office equipment, cooking, refrigeration, other) along with engineering equations from the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), the Illuminating Society of North America (IESNA), and others. A number of technical parameters determine the energy usage model estimates, including the system efficiencies of building equipment, heat losses and gains, ventilation volumes, lighting power densities, and many others.

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[4] *Northwest Commercial Building Stock Assessment, Final Report*, December 21, 2009, report by The Cadmus Group, accessed December 2010 at http://neea.org/research/reports/10-211CBSA.pdf

[5] *2003 Commercial Buildings Energy Consumption Survey*, U.S. Energy Information Administration, accessed December 2010 at http://www.eia.doe.gov/emeu/cbecs/contents.html. The 2007 CBECS report was scheduled for release at the end of 2010; however, at the time of this report it was not available and a release date was not specified.

To determine the DCEO BOC program savings, Navigant used CBECS data to tabulate average energy intensities by end use for various building types. A total of 18 different building types were specified. CBECS reported energy intensities for both electric (in units of kWh/ft²) and gas (in units of thousand Btu/ft²) end use categories. The CBECS data contained ten categories for electric end uses and four categories for gas end uses.

In order to link the DCEO BOC survey results with the CBECS data, it was first necessary to place the results for each survey participant building type into one of the CBECS building type categories. The DCEO BOC survey contained 16 options for building types, plus an additional option to specify any unlisted building type. Several of the types directly corresponded to CBECS categories, whereas some did not. Facilities without direct matching to CBECS were mapped to CBECS categories based on CBECS' description of which types of buildings were included in each of the 18 categories Table 2-1.

Table 2-1: Mapping of Survey Participants to CBECS Facility Type

Facility Type Specified by Survey Participants	Corresponding CBECS Facility Type
School/University	Education
Grocery	Food Sales
Restaurant	Food Service
Hospital/Medical	Health Care
Hotel/Motel	Lodging
Office	Office
Government	
Real estate/property management	
Process Industrial	Other
Other Industrial	
Residential/Apartment Building	
Mixed Use	
Waste water treatment	
Other	
Corrections/Jail	Public Order and Safety
Retail	Retail (non-mall)
Warehouse	Warehouse

End-Use Savings Calculations

Navigant used a variety of resources, combined with engineering analyses, to estimate energy and demand impacts for the various actions taken by the sample sites. Both electric and natural gas savings were included in the analyses, as appropriate.

- Baseline lighting and HVAC load intensities (kWh and Therms/ft²) were primarily based on the Commercial Buildings Energy Consumption Survey (CBECS)[6] and adjusted to match the specifications of individual sites as noted above.
- The ratio of energy savings to demand savings (kWh/kW) for specific end-uses were estimated based on a review of ratios of energy savings to demand savings from the ComEd prescriptive savings workpapers[7] and the Minnesota Deemed Savings Database[8]. Operating hours were estimated based on the approved prescriptive measure savings and operating hours used by ComEd and DCEO.
- Engineering analysis was used directly to estimate energy savings from motor measures.

2.1.2 Process Evaluation Methods

Navigant's approach to the process evaluation comprised the following steps:

1. Navigant held an initial kick-off meeting with DCEO program staff to review Navigant's assignment and discuss the team's proposed work plan approach and timeline.
2. The evaluation team conducted two interviews with MEEA program managers to discuss MEEA's responsibilities, implementation strategies, and lessons learned. MEEA also provided to Navigant the student participation records from classes held during the past three program cycles and summarized results from final course evaluations requested by the coordinator of all participants at the final course in both the Level I and Level II course series.
3. Navigant also reviewed and analyzed the BOC program course listings and training materials.
4. The team interviewed several instructors and coordinators of the BOC program identified by MEEA as some of the more active and knowledgeable of those MEEA employs for the BOC program.
5. Navigant developed a participant sample for a telephone survey based on student graduation year and class location, from data provided by MEEA for PY1 to PY3.
6. Navigant also drafted a telephone survey instrument that was then approved by DCEO and tested by Navigant's market research provider, Opinion Dynamics Corporation (ODC).

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[6] Commercial Buildings Energy Consumption Survey 2003, Public Use Microdata, U.S. Department of Energy, Energy Information Administration. http://www.eia.doe.gov/emeu/cbecs/contents.html

[7] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

[8] Minnesota Deemed Savings Database, MN Department of Commerce. Results from the Zone 3 region were used (primarily for kWh/kW ratios). Zone 3 was chosen since a majority of commercial building stock is in this zone. http://www.state.mn.us/portal/mn/jsp/content.do?subchannel=-536895041&programid=536919090&id=-536893853&agency=Energy&sp2=y

7. DCEO emailed letters to all program participants to notify them of a possible phone call for a 20-30 minute survey.
8. Past BOC program participants were then surveyed by ODC.
9. Results from the final course evaluations, instructor and coordinator interviews, and participant phone surveys were analyzed and summarized in this final report.

Details of data sources are provided in the next section.

2.2 *Data Sources*

Table 2-2 provides a summary of the data collection activities in support of the PY3 evaluation, including the targeted population and source of data.

Table 2-2. Principal Data Sources Contributing to the PY3 Evaluation

Data Collection Type	Targeted Population	Sample Frame	Sample Design	Sample Size
Final Course Evaluations (Immediate Feedback)	BOC Program Participants	254	All available, consistently formatted and summarized voluntary evaluations by graduating students on last day of class of series	30
In-Depth Telephone Interviews	DCEO Program Staff	2	DCEO Program Managers	2
	MEEA Program Staff	2	Most recent past and present BOC program implementation staff	2
	Instructors (and Coordinators)	10	3 Instructors and 1 Coordinator	4
Telephone Surveys	BOC Program Participants	224	Stratified Random Sample of DCEO BOC Program Participants	43

2.2.1 Final Course Evaluations

Navigant received a summary from MEEA of final course evaluations turned in by students on the final day of the BOC course series. Navigant was only able to quantitatively analyze course

feedback from 21 Level I students and 9 Level II students due to inconsistencies in the course evaluation form. Navigant also qualitatively analyzed comments provided by 21 additional Level I students regarding their satisfaction with the BOC course. There were no comments provided by Level II students.

2.2.2 In-Depth Telephone Interviews

Navigant conducted in-depth telephone interviews with three sets of respondents knowledgeable about the DCEO BOC program.

- **DCEO Staff:** The team's discussion with DCEO program managers set the foundation for what was expected in the process and impact evaluations and also provided necessary program background and objectives.
- **MEEA Staff:** An interview with MEEA program managers was conducted to discuss MEEA's responsibilities, implementation strategies, and lessons learned.
- **Instructors and program coordinators:** Navigant conducted phone interviews with three instructors who taught segments of the BOC training program in Illinois. Navigant also interviewed one instructor who was also a coordinator for an Illinois training series. Coordinators are essential to the program because they attend every class in a course and set up facilities, correct homework, and coordinate feedback and evaluations. The coordinator and instructors' suggestions and comments are reflected in the process evaluation analysis.

2.2.3 Telephone Surveys

The evaluation team's primary data collection approach was the telephone survey administered to a subset of Level I and Level II graduates. Navigant evaluation team member Opinion Dynamics Corporation (ODC) conducted the telephone surveys for this project, as is the case with all DCEO program evaluations. The survey included questions about program satisfaction and barriers to attending the trainings, as well as actions completed with regard to energy efficient equipment installation and operations and maintenance (O&M) practices. The survey is attached as a PDF in Appendix A.

Of the 221 enrolled students who completed the BOC Level I training series in program years June 2008 through May 2011, Navigant targeted 50 students stratified based on the year and location of the class they attended. Navigant also targeted surveying all 33 students who completed the BOC Level II training series in the same program years. After two weeks of survey outreach, 35 Level I and eight Level II students provided complete phone interviews.

2.3 *Sampling*

In July and August, 2011, MEEA provided the Navigant team a list of all participants in the BOC training program from June 2008 through May 2011 with each participant's company, contact information, course level, and location of the course.

MEEA ran twelve Level I course series and two Level II course series in PY1 through PY3. A total of 221 Level I students and 33 Level II students completed those courses.

Navigant created a stratified sample of all Level I participants based on year and location of class. The Level I population, after removing 10 bad phone numbers and 20 students who also took Level II training, yielded a total of 191 students. The target for complete surveys was set at 50 Level I students, stratified by year and location of class, based on participant proportion of the total population. Table 2-3 below details the targeted completes by stratified year/location code.

Since there were only two Level II courses offered during that program cycle, Navigant chose to attempt a census of all 33 graduates, recognizing that all would not agree to respond to the survey.

Table 2-3. Phone Survey Targets for Level I Participants

Code	Target Completes
2008Chicago	13
2008Edwardsville	4
2008Normal	5
2009Carterville	4
2009Chicago	4
2009Scott Air Force Base	4
2010Aurora	2
2010Bloomington	4
2010Chicago	7
2011Chicago	3
TOTAL STRATIFIED SAMPLE	**50**

ODC conducted interviews over the period of August to September 2011. In order to reach as many participants as possible, ODC implemented different strategies, including calling over extended work hours and relaxing the qualitative strata. In that time period, 43 surveys were completed with 35 Level I students and eight Level II students.

Section 3. Program Level Results

This section presents the PY1 to PY3 Building Operator Certification (BOC) program impact and process evaluation results, as well as the PY3 program impact results.

3.1 *Impact Analysis*

The impact analysis for the BOC Program utilized survey data from 43 program participants. Due to the nature of the program, typical document review and M&V protocols were not feasible. Navigant has presented savings results at three levels: gross savings, BOC-attributable savings, and net savings. Gross savings represent all measures taken by participants, regardless of program influence or other EErebates. BOC-attributable savings account for how much influence the program had on participant actions, but includes measures rebated by other programs. In the net savings values, these rebated savings have been removed to eliminate any "double-counting" of savings. In the future, the DCEO may be able to work with other programs to claim a portion of these savings.

3.1.1 Gross Program Impact Parameter Estimates

The following subsections describe the savings estimation approach for each of the ten retrofit/replacement measures and seven operational system improvement categories identified in the follow-up interviews.

Installed Lighting Controls

Lighting controls reduce the hours of operation of a lighting system. Navigant estimates that controls reduce hours of operation for the lighting end use by approximately 27%.[9] The analysis covered occupancy sensors, daylighting, photocells, and timeclocks.

Gross Energy Savings = End-Use Intensity (kWh/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

Savings ratio: Navigant estimate based on survey responses and secondary research

Affected Area: Based on survey responses

[9] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

Installed Energy Efficient Lighting

Lighting technology upgrades are typified by T8 or T5 replacements for T12 systems, CFL replacement of incandescent lights or fluorescent high-bay replacement of HID lighting. Navigant estimates lighting equipment saves about 32% of the lighting end-use.[10]

Gross Energy Savings = End-Use Intensity (kWh/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

Savings ratio: Navigant estimate based on survey responses and secondary research

Affected Area: Based on survey responses

Installed High Efficiency Motors

Premium efficiency motors have higher efficiency compared to like-style standard motors of 1% to 2.7% depending on the size of the motor.

Gross Energy Savings = Nameplate HP x Conversion Factor x Hours of Operation x Loading x Gross Savings Ratio.

Where:

Nameplate HP: Survey data

Conversion factor: 0.746 kW/HP

Hours of operation: 4,067 hours, based on average installed HP of 22.9[11]

Loading: Navigant estimate 70%

Gross Savings Ratio: Navigant estimate 1.5%

Installed Variable Frequency Drives (VFDs)

VFDs drive motors serve centrifugal loads with far less power at lower loads and speeds. Various load profiles estimate power energy reduction between 10% and 60% depending on use.

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[10] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.
[11] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

Gross Energy Savings = Nameplate HP x Conversion Factor x Hours of Operation x Loading x Savings Ratio.

Where:

Nameplate HP: Survey data

Conversion Factor: 0.746 kW/HP

Hours of Operation: 4,067 hours, based on average installed HP of 33.1[12]

Loading: Navigant estimate 70%

Gross Savings Ratio: Navigant estimate 30%

Installed Energy Efficient Heating

The heating end-use measures include condensing boilers and furnaces, retrofit heat recovery and retrofit combustion controls.

Gross Energy Savings = End-Use Intensity (Therms/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

Gross Savings Ratio: Navigant estimate based on survey responses and deemed savings databases, 4%.

Affected Area: Based on survey responses

Installed Energy Efficient Cooling

The cooling end-use measures include new chillers or high-efficiency direct expansion cooling, cooling towers and cooling coils.

Gross Energy Savings = End-Use Intensity (kWh/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

[12] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

Gross Savings Ratio: Navigant estimate based on survey responses and secondary sources, 14%.[13]

Affected Area: survey response

Installed Energy Efficient Domestic Hot Water

Condensing and instant water heaters, insulation and heat recovery are measures for the hot water end-use category.

Gross Energy Savings = End-Use Intensity (Therms/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

Gross Savings Ratio: Navigant estimate based on survey responses and deemed savings databases, 5%

Affected Area: Based on survey responses

Installed Energy Management System

This end-use is an overlay to heating cooling and ventilation end-uses and includes basic stop-start control all the way up to optimization of heating, cooling and ventilation systems.

Gross Energy Savings = End-Use Intensity (kWh/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS heating (Therms/ft²), cooling and ventilation energy use.

Gross Savings Ratio: Navigant estimate based on survey responses, 10%

Affected Area: Based on survey responses

[13] "ComEd Workpapers 6-1-10.doc," used with permission from ComEd.

Installed Economizer

This end-use is a subset of the cooling end-use and it reflects installation of new equipment to reduce hours of mechanical cooling operation.

Gross Energy Savings = End-Use Intensity (kWh/ft²) x Gross Savings Ratio x Affected Area (ft²).

Where:

Energy Use Intensity: Based on CBECS data

Gross Savings Ratio: Navigant estimate based on survey responses, 5%

Affected Area: Based on survey responses

Operations and Maintenance (O&M) Activities

The participant survey also asked about operations and maintenance improvements. Navigant grouped O&M activities by end-use. Savings calculations are similar to those for equipment installation measures except for two universal differences – O&M savings ratios are generally lower than those for equipment upgrade measures, and the thoroughness and frequency of O&M activities are key to realizing savings. Table 3-1 shows the estimated maximum savings ratio from rigorous O&M practices for end-uses investigated in this study.

Table 3-1: O&M Savings Ratios by End-Use

End-Use	Maximum O&M Savings Ratio
General Energy Management	1%
Building Shell	2%
Cooling[14]	5%
Heating[7]	5%
Motors[15]	1%
Ventilation[7]	5%
Electrical PM[7]	0.5%

[14] Navigant Consulting Estimate based on survey responses and conservative estimates based on Piper, J., "HVAC Maintenance and Energy Savings", Building Operating Management, March 2009, http://www.facilitiesnet.com/hvac/article/HVAC-Maintenance-and-Energy-Savings--10680 . The paper notes "Facilities in which proper HVAC maintenance is completed will use at least 15 to 20 percent less energy than those where systems are allowed to deteriorate." Navigant chose conservative estimates of HVAC maintenance savings, not knowing the existing state of facility maintenance.

[15] Drivepower Technology Atlas (Volume IV), eSOURCE. This reference indicates that optimal operations and maintenance practices can save 3 to 10% of all drive power, compared to very poor maintenance practices. Navigant assumes a conservative 1% improvement over existing practices