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Methodologies and Results of Building Operator Certification (BOC) program Evaluations

CUNY BPLab

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8/17/2012

Acknowledgments

I would like to thank the following people and programs for their contributions to the development of this paper:

Michael Bobker, who was always patient and generously shared his time and knowledge.

Daniella Leiffer, and Honey Berk who were always very supportive and happy to help.

The Smith Praxis Program, without which I would not have had the wonderful opportunity to work at BPL.

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1 Executive Summary

The Building Operator Certification (BOC) is a continuing education training program designed to teach building maintenance and management staff energy conservation methods. The goal of this report was to collect Building Operator Certification (BOC) reports, analyze them, and compare them to find an overall estimate of quantifiable savings attributable to BOC. The first step was to find the reports. Eight reports were found on the BOC website, but extensive Internet searches resulted in only one additional report being found. The final nine reports were then carefully examined.

While many reports pursued similar lines of inquiry, their methods and questions were often different. There were different questions asked in order to determine savings, and different factors taken into account depending on the report, such as building type and rebates. Details such as units and formulas used for calculations were also different and made the results difficult to compare. Of the nine reports, only six presented quantifiable savings. It was then determined, from those six, what information could be abstracted and made comparable.

In order to compare the quantifiable savings certain standards were set. Savings were calculated in (thousand) Mbtu per square foot rather than by kWhs or per number of operators. The average accumulative savings were then calculated against certain assumptions in order to calculate percentages. The first assumption was the average cost of gas and electricity in NYC, and the second was the amount of electricity and gas used per square foot. After collating the results of the reports in a comparable manner it was concluded that the application of BOC techniques resulted in a total of 4.2 to 5 percent cost and energy savings.

2 Introduction

This paper reviews a set of 9 BOC training program evaluation reports. The reports were found primarily on the BOC website. The organizations that sponsored or offered the BOC training hired third party evaluators to analyze and report on the BOC programs. The third party evaluators are agencies with experience in the field of energy conservation. The evaluations used for this report are listed below with the BOC training organization shown first, followed by the date of the report, and then the evaluator. In chronological order of when they were written, these reports are:

1. PG&EC, November 2003, research/into/action
2. NEEA, December 2003, Summit Blue & Stratus
3. NEEP, June 2005, RLW Analytics
4. CAL Nonresidential Sector, 2004-2005, research/into/action
5. KCPL, September 2009, Opinion Dynamics Corporation
6. SCE, May 2010, McLain ID Consulting KVDR Inc.
7. NEEA, June 2011, Navigant Consulting
8. MEEA, March 2011, Navigant Consulting

9. DCEO, May 2012, Navigant Consulting

These reports are all unique. They were sponsored by different organizations, in different locations around the U.S., at different times. No two reports are exactly alike.

3 Different Goals

Each organization had a unique goal in orchestrating the evaluations. I divided those goals into three categories, the collection and assessment of qualitative, quantitative, and marketing data. While the majority of the reports have some information in all three categories, they often focus on one or two of the goals and gather information primarily in that field. Within the three categories there are a range of topics discussed.

3.1 Quantitative Data

The quantitative data is concerned with the quantifiable impacts and savings of buildings as a result of the training. Quantifiable savings can include savings on use of electricity, gas, oil, and water. This was the category with which I was the most concerned. More detailed information on how these saving and how they were calculated is under the section, “Evaluation of Data”. The subcategories of quantitative data are listed below:

- BOC Attributable Energy Savings & Persistence
- BOC Attributable Non-Energy Savings
- Overall Savings Attributable to BOC
- Costs of Program Influenced Initiatives Installed by Participants

3.2 Qualitative Data

The qualitative data is based on surveys and interviews with participants. The data is concerned with participant perceptions and opinions, which are often reported through ratings and percentages. Common topics are participant satisfaction ratings, the value of the program, and potential program improvements. The subcategories of qualitative data are listed below:

- Participant Satisfaction
- Directly Useful Applications of Program/Program Impact & Effectiveness
- Perception of Training &/or Certification as Valuable
- Performance indicators / Student Enrollment & Dropout Rates
- Location Specific Tailoring of Program
- Synergies With Other Utility Programs
- Has the Program Changed?

3.3 Marketing Data

The marketing data is collected to assess the demand for BOC training services as well as to determine the promotional opportunities. The evaluators use several methods, including student surveys and enrollment information, to analyze current and future market activity, issues, and barriers. The evaluation agencies also gather recommendations from participants for future marketing improvement. All marketing information was condensed under the label of Marketing Activity, Issues & Barriers.

4 Overall Distribution of Outcomes

The 12 subcategories into which the goals were divided and the reports that pursued those goals were placed on a table, provided below:

	1. Participant Satisfaction	2. Program Impact & Effectiveness	3. Perception of Training/Certification Value	4. Marketing Activity, Issues & Barriers	5. Energy Savings & Persistence	6. Non-Energy Savings	7. Overall Savings Attributable to BOC	8. Costs of Program Influenced Initiatives	9. Performance Indicators	10. Location Specific Tailoring of Program	11. Synergies With Other Utility Programs	12. Has the Program Changed?
1. PG&EC	X	X	X	X						X	X	
2. NEEA			X	X		X						
3. NEEP			X	X	X	X		X	X			
4. CAL	X	X	X	X						X		
5. KCPL	X	X	X	X	X	X	X					
6. SCE	X	X	X	X								
7. NEEA				X	X	X	X					
8. MEEA	X			X	X	X						
9. DCEO	X			X	X	X					X	X

It is evident that all the programs were interested in marketing to some degree and some form of qualitative information, but only six groups were interested or were able to collect quantifiable data.

5 Means of Data Collection

There is no standard method of data collection for BOC evaluation reports. The resources used are surveys, interviews, databases, and BOC materials.

5.1 Surveys

Because there is no standard report or method for collecting data, there is no standard survey. As the organizations often have different goals, the survey questions can vary dramatically. For example, one of the ways that the SCE 2010 report assessed program impact was by testing participant recall and recognition of courses, which no other reports did. There are numerous examples of evaluators following lines of inquiry which no other agency pursued. Additionally, there are cases where the evaluators are seeking the same information, but have minimal but significant differences in the questions asked, making the resulting data incompatible. The KCPL survey asked students if they had or would save energy or reduce demand at their facility, while the Cal residential survey asked if participant's actions had saved energy. Both groups were hoping to assess energy savings as a result of BOC, but one question is more general, while the other is specific and takes into account future savings. This difference in wording makes the results incomparable. The ratings and percentage systems are different as well. The KCPL report has students rate the answers to their questions on a scale from 1-10 then only count ratings 8-10 as significant. The SCE report just had students answer their questions with a yes or no, and then showed the percentage of students that answered yes. Other groups had students rate their answers from 1-4 or 1-5, and either showed the percentage of each rating or, like KCPL, grouped together their top ratings and depicted those as significant.

5.2 Interviews

Interviews are done with an assortment of different people with different positions. They are students, instructors, supervisors, and more. The range of people questioned is wider, but there is a lack of uniformity in the interviews that is also present in the surveys.

5.3 Review of BOC materials

Evaluators often review the BOC curriculum, teacher's notes, course literature, and other BOC materials to get a better understanding of the program and as a tool for analysis.

5.4 Databases and Other Secondary Sources

Some of the evaluations looked at past evaluations, and energy and appliance databases. The databases used were Commercial Building Energy Consumption Survey (CBECS), ComEd-approved prescriptive savings work papers, Database for Energy Efficient Recourses (DEER), California Commercial End-Use Survey (CEUS), and The Minnesota Deemed Savings Database (MDSB). These were used to calculate savings. Different databases were used as a baseline for calculating savings by different evaluators.

6 Evaluation of Data

There were six, of the nine reports, that worked with quantifiable data. These were:

- NEEA, December 2003, Summit Blue & Stratus
- NEEP, June 2005, RLW Analytics
- KCPL, September 2009, Opinon Dymamics Corporation
- NEEA, June 2011, Summit Blue & Stratus
- MEEA, March 2011, Navigant Consulting
- DCEO, May 2012, Navigant Consulting

The data was collected through surveys and then analyzed. Just as the survey and general data collection is different, so too were the means of analyzing that data. There were several notable key differences in how different companies calculated savings and what they did or did not take into account or make easily available in their reports.

6.1 Units

6.1.1 Mbtu, therms & kWh

An issue that arose from the use of Mbtu was that some reports specified that Mbtu stood for a thousand btu, while other reports failed to clarify this. There therefore may be some doubt as to whether the unit was meant to signify a thousand btu or a million btu.

Gas was measured in either Mbtu or Therms depending on the report. In order to compare the gas, those numbers set to therms were converted to (thousand) Mbtu. Electricity, typically measured in kWh, was also converted to Mbtu so as to compare gas and electricity savings.

6.1.2 aMW

NEEA was the only group to calculate aMW and as such those calculations were not included in the data comparison charts.

6.1.3 Per participant, per ft², participant/ft²

Energy savings were calculated with several different units. They were calculated per facility, per operator, per ft², and per ft² per operator. The most commonly used metric was per ft² per operator.

6.1.4 Demand calculations

NEEA 2003, MEEA 2011, and DCEO 2012 were the only reports that calculated demand savings. The units used were either Watts or kilowatts.

6.2 Calculations

6.2.1 Baseline

Three of the six reports used existing databases to calculate savings. These were KCPL, MEEA, and DCEO. In order to do this they had to assign building types specified by participants into corresponding CBECS (or CEUS) building types. They then developed formulas, into which they submit the appropriate information.

6.2.2 Net & gross (BOC attributable) / BOC influence on savings

The KCPL, MEEA, and DCEO reports differentiated between gross and net results. Gross savings are all of the savings from actions taken by participants after training. Net, or BOC attributable savings are the gross savings multiplied by the influence of BOC training on those participant's actions. The resulting savings are then a direct result of BOC training.

6.2.3 Rebates

The NEEP, MEEA, and DCEO reports took into consideration rebate incentives rather than, or in addition to, BOC influence. Actions that were taken in order to receive rebates were not considered to have been influenced by BOC training.

6.2.4 Type of facility

NEEP separated their savings into two facility types, school and non-school, due to the high-level of school activity.

6.3 Assumptions, Savings, and Percentages:

Taking all of the above factors into account, any comparable quantifiable savings were extrapolated from their reports and entered onto this table:

	Square Footage per operator (sf/op)	Sample Size	Electricity Saved Annually Mbtu/sf	Gas Saved Annually Mbtu/sf	Oil Saved Annually Mbtu/sf/op	Water saved Annually gallons/sf/op	Total savings Mbtu/sf	Demand Savings W/sf	Cumulative Savings aMW
2. NEEA, December 2003, Sun	142,424	N/A	4.09	N/A	N/A	N/A	4.09	N/A	24 (1997-2002)
3. NEEP, June 2005, RLW Ana	616,045	94	1.19*	0.34*	0.4	0.14	*	N/A	N/A
5. KCPL, September 2009, Op	780,000	22	2.15	0.474	N/A	N/A	2.62	0.097	N/A
7. NEEA, June 2011, Summit E	286,000	N/A	1.43	N/A	N/A	N/A	1.43	N/A	5.9 (1997-2010)
8. MEEA, March 2011, Naviga	194,500	50	2.47	1.8	N/A	N/A	4.27	0.167	N/A
9. DCEO, May 2012, Navigant	508,100	43	2.71	0.1	N/A	N/A	2.81	0.156	
Average:	421,178		2.57	0.79	0.40	0.14	3.04	0.14	

* these numbers are divided by number of operators in addition to sq. ft.

This information was used to estimate percent savings in costs and square footage using estimates for energy cost and usage in NYC.

It is assumed, from the BOMA database, that energy in NYC costs \$3.00 per square foot. Electricity was assumed to cost \$ 0.18 per kWh/sf, and gas was \$ 1.75 therms/sf. These assumptions were used to calculate costs savings percentages. The equation used was:

$$S = EC/A$$

Where:

S = Percentage saved

E = Energy saved per square foot, kWh/sf or therm/sf

C = Cost of energy type, dollars per square foot, \$/kWh /sf or \$/therm /sf

A = Average NYC total energy cost, \$/sf

Assumptions	
NYC energy cost per sf	\$ 3.00
avg cost per kwh	\$ 0.18
avg cost per therm	\$ 1.75

	Square Footage per operator (sf/op)	Sample Size	Electricity Saved Annually kWh/sf	Electricity Savings \$/sf	% of Electricity Costs Saved	Gas Saved Annually therms/sf	Gas Savings \$/sf	% of Gas Costs Saved	Total Savings \$/sf	% Total
2. NEEA, December 2003	142,424	N/A	1.20	\$ 0.22	7.2%	N/A	N/A	N/A	\$ 0.22	7.2%
3. NEEP, June 2005	616,045	94	.35*	*	*	0.0034*	*	*	*	*
5. KCPL, September 2009	780,000	22	0.64	\$ 0.11	3.8%	0.0047	\$ 0.0083	0.3%	\$ 0.12	4.1%
7. NEEA, June 2011	286,000	N/A	0.42	\$ 0.08	2.5%	N/A	N/A	N/A	\$ 0.08	2.5%
8. MEEA, March 2011	194,500	50	0.72	\$ 0.13	4.3%	0.018	\$ 0.0315	1.1%	\$ 0.16	5.4%
9. DCEO, May 2012	508,100	43	0.79	\$ 0.14	4.8%	0.001	\$ 0.0018	0.1%	\$ 0.14	4.8%
Average:	421,178		0.75	\$ 0.14	4.5%	0.0079	\$ 0.0138	0.5%	\$ 0.15	5.0%

* The NEEP results were calculated per square foot per operator

Savings percentages were also calculated according to square footage. In this case the assumption was that the average NYC building uses 80 Mbtu per square foot. The percentages were calculated by dividing the energy saved per sf by the average amount of energy used per sf (80 Mbtu).

Assumptions	
	80 Mbtu/sf

	Square Footage per operator (sf/op)	Sample Size	Electricity Saved Annually Mbtu/sf	% of Electricity Saved	Gas Saved Annually Mbtu/sf	% of Gas Saved	Total Saved Mbtu/sf	% Total
2. NEEA, December 2003	142,424	N/A	4.09	5.1%	N/A	N/A	4.09	5.1%
3. NEEP, June 2005	616,045	94	1.19*	*	0.34*	*	*	*
5. KCPL, September 2009	780,000	22	2.15	2.7%	0.47	0.6%	2.62	3.3%
7. NEEA, June 2011	286,000	N/A	1.43	1.8%	N/A	N/A	1.43	1.8%
8. MEEA, March 2011	194,500	50	2.47	3.1%	1.80	2.3%	4.27	5.3%
9. DCEO, May 2012,	508,100	43	2.71	3.4%	0.10	0.1%	2.81	3.5%
Average:	421,178		2.57	3.2%	0.79	1.0%	3.36	4.2%

* The NEEP results were calculated per square foot per operator

The differences between energy savings in dollars and square footage between the two tables (costs and square footages) are minimal. Electricity and gas savings ratios remain consistent, but the electricity percentages show a small decrease while gas savings increase.

The savings extrapolated from the reports are fairly inconsistent, particularly in gas, which has a dramatic range of savings. Additionally, the gas savings are small enough to be considered insignificant and the small sample size (due to lack of reports available) decreases the reliability of the results. These small numbers are unreliable because they could be due to other variables, such as changes in their environment. The savings from electricity, however, are a little more uniform, have a slightly larger sample size, and are significant numbers, and therefore more reliable. The total savings show significant savings as a result of the BOC training program.

7 Problems/Recommendations

	% elec saved	% gas saved	% Total
Average \$	4.5%	0.5%	5.0%
Average sf	3.2%	1.0%	4.2%

7.1 Standard surveys

The lack of one uniform format for the collection of data in these reports makes compiling and comparing information unnecessarily difficult. This could be alleviated by a standard exit survey and feedback forms.

7.2 Databases

There were multiple databases used for the same calculations. The lack of a standard baseline increases the likelihood of error when comparing savings measurements between reports.

7.3 Collect energy consumption data

The energy savings calculations are based on participant responses. Navigant stated that “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.” The following actions, recommended by Navigant, would increase the accuracy of savings estimates:

Having participant 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.

8 BOC Program Evaluation Reports Reviewed to date

Research/into/action. *Evaluation of the 2002 Statewide Building Operator Certification and Training Program*. Prepared for Pacific Gas and Electric Company. November 2003. PDF

Summit Blue Consulting, LLC, and Stratus. *Findings and Report Retrospective Assessment of the Northwest Energy Efficiency Alliance*. Prepared for Northwest Energy Efficiency Alliance. December 2003. PDF

RLW Analytics. *Impact and Process Evaluation Building Operator Training and Certification (BOC) Program*. Prepared for Northeast Energy Efficiency Partnerships. June 2005. PDF

Research/into/action. *California Evaluation Study Brief: Nonresidential Sector*. Prepared for the Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, and San Diego Gas and Electric Company. 2007. PDF

Opinion Dynamics Corporation. *Evaluations of Kansas City Power and Light's Building Operator Certification Program*. Prepared for Kansas City of Power and Light. September 2009. PDF.

McLain ID Consulting KVDR Inc. *PY 2006–08 ETO Process Evaluation*. Prepared for Southern California Edison. May 2010. PDF.

Navigant Consulting, Inc. *Long-Term Monitoring and Tracking Report on 2010 Activities*. Prepared for Northwest Energy Efficiency Alliance. June 2011. PDF

Navigant Consulting, Inc. *Evaluation of MN BOC Training*. Prepared for Midwest Energy Efficiency Alliance and Minnesota Office of Energy Security. March 2011. PDF.

Navigant Consulting, Inc. *Program Year 3 DCEO Building Operator Certification (BOC)*
Program Evaluation. Prepared for The Illinois Department of Commerce and
Economic Opportunity (DCEO). May 2012. PDF