Estimating Savings from Building Operator Certification Training

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ABSTRACT

Behavior-based energy efficiency programs are gaining acceptance among regulators as an important component of utility energy efficiency portfolios in both residential and commercial market segments. Historically, such commercial initiatives have fallen under the auspices of "training" and were therefore not required to quantify the savings. However, as the energy efficiency benefits of these programs are being recognized and more utilities are investing in these programs, there is increasing interest in quantifying these benefits. This paper will outline a detailed approach developed over the course of four evaluation projects to assess the effectiveness and energy efficiency impacts of the Building Operator Certification program. This paper is not intended to present the results of a particular evaluation or to promote a particular training program, but rather to summarize the methodology developed to estimate energy savings from building operator training.

The approach uses self-reported changes in retrofit and operations and maintenance (O&M) practices as well as comparison of these practices between participating and non-participating building operators. Challenges include: (1) knowing what actions to assess from a wide range of building operation certification topics, behaviors, participants, and facilities; (2) collecting the data without a measure tracking system; (3) addressing energy efficiency activities receiving rebates; and (4) considering overlap between various energy efficiency measures. This paper will address questions including: How can one effectively quantify the energy impact of a training program like the Building Operator Certification program? What are sources for credible measure savings data? How can behavior change data be effectively collected from participants and incorporated into the analysis?

Background

Building operators serve the vital role of managing the equipment and responsibilities that make up modern building systems. Building operators often learn their skills in engineering, vocational and trade programs, apprenticeships, or on-the-job training. In recent years the Building Operator Certification (BOC®) program has emerged and expanded greatly to supplement the aforementioned training avenues (TBOC 2012). The program was originally developed in the late 1990s by the Northwest Energy Efficiency Council (NEEC) in consortium with the Northwest Energy Efficiency Alliance (NEEA), the International Building Operators Association (IBOA), and the Washington State Energy Office (Peters, McRae, & Flynn 2001). The BOC program has expanded and several other agencies throughout the U.S. offer training programs using the NEEC curriculum (BOC Training 2012). BOC provides targeted education and training that teaches energy efficient practices to building operators, facilities and maintenance personnel, and others who are responsible for building systems. These programs aim to develop a building operator workforce that deploys the latest practices in energy-efficient building operations. Operators spanning nearly every building type attend BOC training programs and earn a credential that adds value to their trade and improves their potential for professional advancement.

The question of savings

In recent years, regulators, utilities, and BOC administrators have shown a growing interest in evaluating the impacts of these training programs on energy use. Explicitly, interested parties have asked the question of how much energy can be saved through operator education, and in which areas the training is most effective or lacking impact. Evaluation can help training administrators to target specific areas for improvement, and can help training participants to gauge the value of a program. Previous studies have been conducted to assess the energy savings and student feedback from BOC programs (McRae, Mayo 2006).

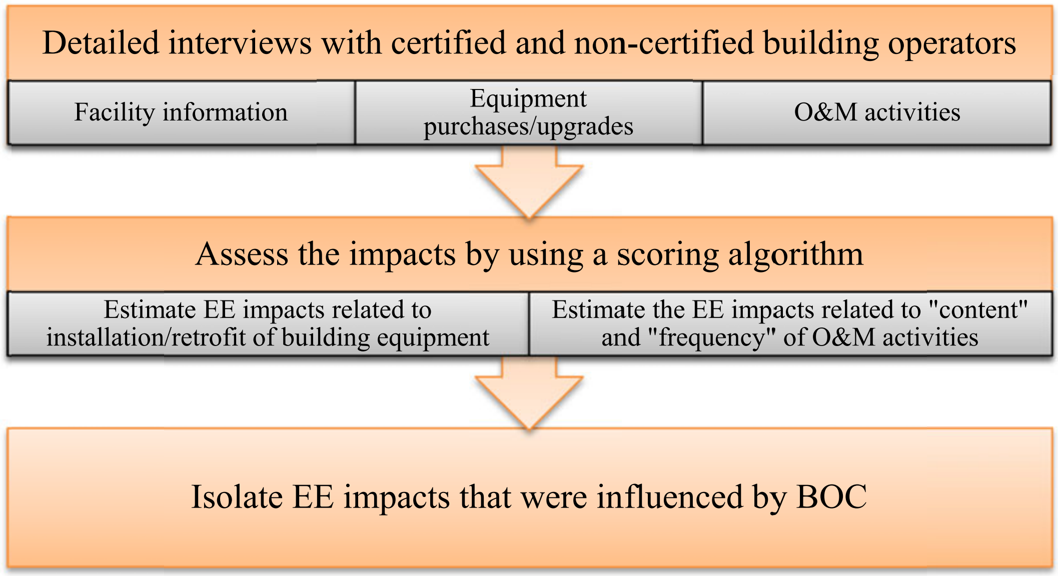
The question of savings is complex to say the least. Building operators' practices can be influenced by a number of factors, ranging from cost and rebates to equipment availability and company goals. Furthermore, building operators learn from a variety of sources ranging from industry publications to equipment vendors and co-workers. It is difficult to isolate the impacts from any one particular source, such as operator training.

Evaluation Methodology

There is clearly a market niche for reliable evaluation efforts related to BOC programs. A number of evaluation approaches have been undertaken by various market participants (BOC Reports 2012). This evaluation team has contributed to these efforts by developing a new methodology to estimate the energy savings impact realized by programs that educate building operators to employ energy-efficient practices. The methodology relies on a systematic approach that combines the self-reported behavior of building operators with engineering estimates of the associated energy savings. Ideally (but not obligatorily), results are compared to subsequent interviews with non-certified building operators to further isolate the impacts that are linked to BOC training alone.

A detailed interview guide and scoring algorithm provide the avenue by which building operator practices are combined with engineering analysis to produce savings estimates. Figure 1 presents a break-down of the methodology used to evaluate the BOC energy impacts.

Figure 1. Methodology for evaluating the impacts of Building Operator Certification on energy savings



Source: Navigant analysis

Relying on self-reported changes in behavior to estimate savings has its shortcomings. Ultimately, the results depend on the responses of individual participants and their perceptions of their own actions and decision-making. As such, this methodology contains several steps aimed at reducing the uncertainties involved. The first step is to generate a participant sample that is representative of the population of building operators and large enough to reduce uncertainty. The sample can be constructed randomly or from a number of strata, including: facility type, facility square footage, geographic location, etc.

Additionally, the use of a non-participant sample as a type of "control group" can isolate the influence of the building operator training versus other sources. At least one evaluation has shown that interview results with non-participants can provide an estimate for the baseline used to calculate energy savings, despite that fact that it is very difficult to find a group of building operators that is identical to the BOC training participant group.[1]

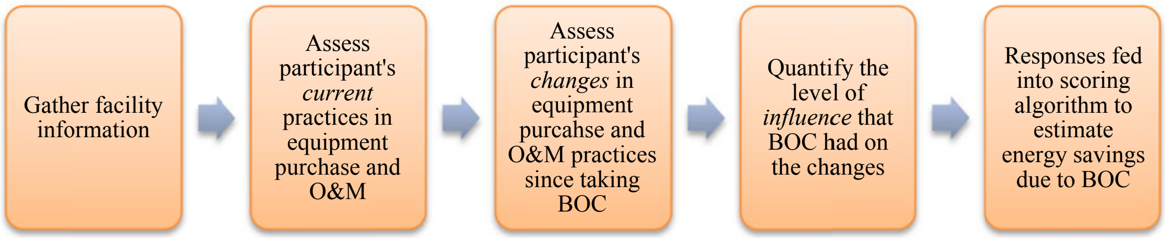
Methodology steps

Interview Guide

Effective collection of participant behavior change relies on a robust interview structure covering the central topics of BOC training and building systems. The interview guide was developed by a team of building systems and evaluation experts, along with instrumental input from several project engagements. Interviews with certified building operators ranged from about 30 minutes to an hour. The interview guide follows the basic structure shown in **Error! Reference source not found.** 2, which feeds in to the scoring algorithm used to estimate energy savings.

[1] A public version of this study is expected soon after this paper was written.

Figure 2. Basic structure of interview guide for certified building operators



Source: Navigant analysis

Gather facility information

Estimates of energy impacts are often dependent upon the type and size of facility for which an interview participant is responsible. Estimation becomes increasingly complex if a certified building operator oversees multiple buildings or there are multiple building operators at a single site. The interview guide seeks to isolate the number of square feet for which each certified building operator is responsible. Furthermore, since energy use varies by building type and energy sources, the interview confirms the building type(s) the operators manage and whether their facility is heated and cooled by electricity or fossil fuels.

Assess current practices

Building operators who have completed BOC training are asked an extensive series of questions regarding the equipment purchases and upgrades implemented at their facilities in the recent past. The interview also asks what types of operations and maintenance (O&M) activities the respondent currently performs. The interviews include eleven equipment upgrade categories corresponding to major end-uses such as lighting and cooling, and eight categories for O&M. Each of the upgrade and O&M categories includes several measure-specific sub-topics that cover the main areas of building operations. Examples include: adjusting schedule to building's occupied hours, entrance air sealing, combustion testing on heating equipment, etc.

The building system categories and topics reflect actual BOC curriculum as well as standards of the building operations industry. At this stage, the interview prompts the respondents by providing the list of possible topics in each category. For example, the interview may ask something such as: "Do you perform service on your facility's cooling towers, and if so, how often?" And the respondent may answer: "Yes, semi-annually."

Assess changes since BOC

Once the current building operation practices are noted, the interview re-visits each category by asking the respondent what changes they have made in that area since starting the BOC training. At this stage, the interview does not prompt respondents by listing the topics, but instead requires the respondent to think back to the changes.

While assessing the changes in O&M since beginning the BOC training, the interview focuses on changes in the "content" of O&M practices, as well as changes in the "frequency"

with which these changes are performed. For example, a respondent may indicate that he or she performs an O&M activity differently since completing the training (a change in content), or simply more frequently (a change in frequency).

Quantify the level of influence the BOC had on the changes

The fundamental information necessary to estimate energy savings is contained in the self-reported behavior changes given by the participant. However, an effective evaluation should attempt to separate the changes that were made as a result of BOC training from the changes that were influenced by other sources. To accomplish this analysis, the evaluator then asks the interview participants to rate, on a scale of 0 to 10, the influence that BOC had on each equipment upgrade or O&M activity that the participant indicated having changed since beginning the BOC training. For example, the respondent may indicate that a new method of performing a particular O&M activity was a direct result of the BOC training, or was completely independent. The methodology simply converts the numeric rating to a percent influence of the program on the activity. For example a rating of six is interpreted as "the program contributed 60% of the influence for the upgrade or O&M activity." Ratings below a three are considered insignificant, and do not contribute to savings. Interview participants are also asked to specify the other sources that influenced their behavior.

Estimate Energy Savings with Scoring Algorithm

The evaluator uses a detailed scoring algorithm to translate interview responses to energy savings estimates. The algorithm uses an assortment of techniques to estimate energy savings that result from each type of equipment upgrade or improvement in O&M. These techniques include but are not limited to: literature surveys, public reports, government databases, internal evaluations (e.g. engineering analysis, energy modeling, on-site metering), expert analysis, and others. The evaluator combines research and industry experience to ensure that sources of measure savings data are credible for each category, and are relevant for each evaluation. The maximum savings for each category is a combination of the percent possible savings from the equipment upgrade or O&M activity (from baseline), multiplied by the energy use of the building system. Savings estimates will vary with facility type and climate region.

Equations one through three (shown below) outline the scoring process. An estimate of "maximum possible energy savings" is assigned to each category of equipment upgrade or O&M activity based on the techniques described above. The content and frequency factors are used to estimate the achieved amount of savings for each category (Equation 1). The content factor is an assigned variable between 0 and 0.7 that depends on the number new O&M activities performed for each end-use as a result of the BOC training. The frequency factor is a variable ranging from 0 to 0.3 that depends on whether a participant reported increased O&M frequency for the end-use as result of BOC training. The content and frequency factors combine to equal one if the participant indicates sufficient activity to merit full savings credit for each category.[2] The self-reported level of influence is used to estimate the amount of energy savings that is linked to BOC training (Equation 2). The total energy savings for each interview participant is the sum of the savings from each category (Equation 3).

[2] As defined by completing roughly 50%-80% of the activities covered in the BOC training curriculum.

Equation term:

- E_{max} = maximum *possible* energy savings value for each building systems category
- E_{cat} = energy savings *credited* to participant for each category
- E_{BOC} = energy savings due to BOC training for each category
- E_{part} = total BOC-related energy savings for each participant
- C_f = content factor (a variable ranging from 0 to 0.7 that depends on the number of new O&M activities performed for each end-use as a result of BOC training)
- F_f = frequency factor (a variable ranging from 0 to 0.3 that depends on whether a participant reported increased O&M frequency for the end-use as result of BOC training)
- I = self-reported level of influence from BOC for each category

$$\boldsymbol{E_{cat} = E_{max} \times \left(C_f + F_f\right)} \qquad \textbf{Equation 1}$$

$$\boldsymbol{E_{BOC} = E_{cat} \times I} \qquad \textbf{Equation 2}$$

$$\boldsymbol{E_{part} = \sum E_{BOC}} \qquad \textbf{Equation 3}$$

Finally, the savings estimates for non-participants are estimated by using a similar approach. The approach is based on calculation of energy savings from current O&M practices and recent equipment upgrades, and is not based on any changes in these practices. The interview guide is easily adapted to non-certified operator applications. The savings estimates for non-participants can be used as a baseline against which to compare savings from participants.[3] The end result is an estimate of BOC-related energy savings per participant, or per facility square foot for which the participant is responsible.

Results

This methodology has been used for several evaluations to estimate the BOC-related energy savings on a square footage basis for the interview sample participants (Navigant 2011).[4] Depending on the sample size of interview participants, savings values can be rolled up across the population of BOC participants based on square footage alone, or by facility type. Results have shown regional differences in energy savings estimates (as expected), and the sources of uncertainty appear to stem from significant variation in reported square footage for which the participants have responsibility for.

Conclusions

A reasonable estimate of energy savings due to Building Operator Certification can be achieved by using a combination of engineering analysis and self-reported changes in energy-related building operations practices by the individuals who achieve certification. These

[3] The alternative is to assume a baseline of zero savings, which relies on the assumption that baseline effects are sufficiently captured by the BOC participants' self-reported *changes* in equipment and O&M practices.

[4] Two additional evaluation reports are expected to be made public shortly after this paper was written.

estimates are not without uncertainty, but several steps can be taken to effectively isolate the impacts of BOC on energy savings. This paper was not intended to present the results of a particular evaluation, or to promote a particular training program. The methodology presented in this paper provides a summary of the detailed process as an example approach to evaluate the effectiveness of a training program. This methodology's effectiveness is expected to grow alongside the increasing demand for BOC credentials by facilities and maintenance personnel. More accurate results can be achieved by taking advantage of larger interview sample sizes along with a focus on tracking facility information from BOC participants.

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