Evaluating Strategic Energy Management: Guidelines from the Pacific Northwest

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ABSTRACT

Efficiency programs focused on changing behavior and organizational practices are growing in both residential and non-residential energy efficiency programs. Strategic Energy Management (SEM) for industrial customers has been implemented by Energy Trust of Oregon since 2009. Since then, Energy Trust's SEM program has grown tremendously to include over 100 sites.

The first impact evaluation of SEM projects was completed as part of a program impact evaluation covering the 2009-2011 program years (Navigant 2013). This evaluation looked at 18 SEM projects, which achieved a very high realization rate (105%). However, the process of evaluating SEM projects as part of program impact evaluations revealed a number of challenges. The most fundamental challenge was a lack of clarity and consensus around how SEM projects would be evaluated as no SEM evaluation guidelines currently exist.

To address this, Energy Trust's evaluation team held two workshops in August 2014. Each workshop was led by a different evaluation consulting firm with experience evaluating SEM. The goal of the workshops was to discuss issues with evaluating SEM and how best to address them.

The workshops resulted in a list of issues related to evaluating SEM and high-level guidelines for evaluating SEM. In this paper, we first summarize the format of the workshops and goals. Then, we review the challenges associated with evaluating SEM gleaned from past evaluations and as discussed during the workshops. Next, we review the SEM guidelines developed during the workshops. Finally, we conclude with a summary of workshop takeaways and discuss next steps.

Introduction

Over the past six years, Energy Trust of Oregon has piloted and offered numerous Strategic Energy Management (SEM)[1] programs to both industrial and commercial customers. SEM is now a standard offering for Energy Trust's Production Efficiency and Existing Buildings programs.

Energy Trust has been evaluating the energy savings impact of its SEM programs on an ongoing basis. Energy Trust has conducted a number of process evaluations[2], many of which included engineering reviews of the projected energy savings. The engineering reviews have not identified significant issues in how Energy Trust has calculated SEM savings to date.

[1] Energy Trust uses the definition of SEM from the Consortium for Energy Efficiency (CEE) SEM Minimum Elements: http://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf
[2] See the References section for more information.

The impact evaluation for Energy Trust's 2009-2011 Production Efficiency program for industrial customers included 18 SEM projects (Navigant 2013). Evaluators successfully completed the impact evaluation, and estimated a realization rate of 105% for these SEM projects. However, in the process of conducting the evaluation, a number of challenges arose. The most fundamental challenge was that because Energy Trust staff and evaluators had not agreed upon SEM impact evaluation guidelines for industrial sites, they found they lacked clarity and consensus on the best way to proceed.

These challenges, as well as Energy Trust's lengthy and continuing presence in the SEM market, supported the idea of refining and standardizing impact evaluation guidelines for SEM. To support the development of such guidelines, Energy Trust Evaluation staff held two half-day workshops attended by 28 experts with a broad range of experience in SEM, including program design, implementation, and evaluation. These experts brainstormed and discussed key SEM impact evaluation issues, shared their knowledge on best approaches, and laid out next steps and needs related to guideline development. Almost all the discussion focused on industrial SEM; very little was noted about commercial SEM, for which methods are different and not focused on production.

We first summarize the format of the workshops and goals. Then, we review the challenges associated with evaluating SEM gleaned from past evaluations and as discussed during the workshops. Next, we review the SEM guidelines developed during the workshops. Finally, we conclude with a summary of workshop takeaways and discuss next steps.

Workshop Format and Goals

The Energy Trust evaluation team organized two four-hour workshops in August 2014 to discuss and develop SEM evaluation methods and guidelines. Energy Trust invited people with differing perspectives and experience with SEM to bring balance and depth to the discussion.

Two consulting teams with extensive experience in SEM evaluation led each workshop: The Cadmus Group (Cadmus) and TRC/Navigant. Cadmus led the first workshop, and TRC/Navigant led the second workshop. Since many people attended both workshops, notes from the first workshop were provided to the TRC and Navigant team members to ensure that discussion topics at the two workshops were not duplicative. Also, about a third of the second workshop was devoted to transforming the discussion into guidelines and discussing next steps. The discussion was captured and organized into a report by MetaResource Group (2014). That report contains the presentations given by the consulting teams and a high-level summary of the discussion, which included several topics not discussed in this paper.

Energy Trust's goal for the workshops was to develop a set of guidelines for SEM impact evaluation to provide to program implementers and evaluators. In particular, Energy Trust wanted to determine the best approaches to evaluating SEM savings across a whole facility or a process over time, given varying levels of documentation and energy monitoring, and given changing production processes, volumes, and product types. Energy Trust also sought to determine what factors influence the persistence of SEM practices, and how best to isolate the SEM savings from non-SEM related impacts (e.g. capital projects or production changes). These methods may also influence SEM program design and the calculation of initial SEM savings. In addition, Energy Trust hoped these workshops would inform the development of a "research roadmap" outlining many of the remaining evaluation questions and issues for further research.

SEM Evaluation Challenges

One of the first topics of discussion at the workshops was when evaluation typically occurs. As shown in Figure 1 below, the baseline period is typically the two years before the program "intervention" (implementation). The program intervention typically lasts between 12 and 15 months. The implementation contractors, with input from the customer and Energy Trust, develop a statistical model, also known as the "baseline model," using data on energy use and variables, such as production, from the baseline period. The 12- to 15-month program intervention then begins. During the last two to three months of that intervention period – typically the point at which the customer has implemented some changes and is tracking their activities – implementation contractors collect new data on the customer's usage (see "Measurement Period" in the figure). The implementation contractors enter these new data into the implementation M&TR model, and use the model to project this new usage out one year as an estimate of energy savings from the program. After the first year of the program intervention, evaluators conduct an impact evaluation ("Year 1 Impact Evaluation" in the figure below) to determine if they can verify the savings projections of the implementation contractors.

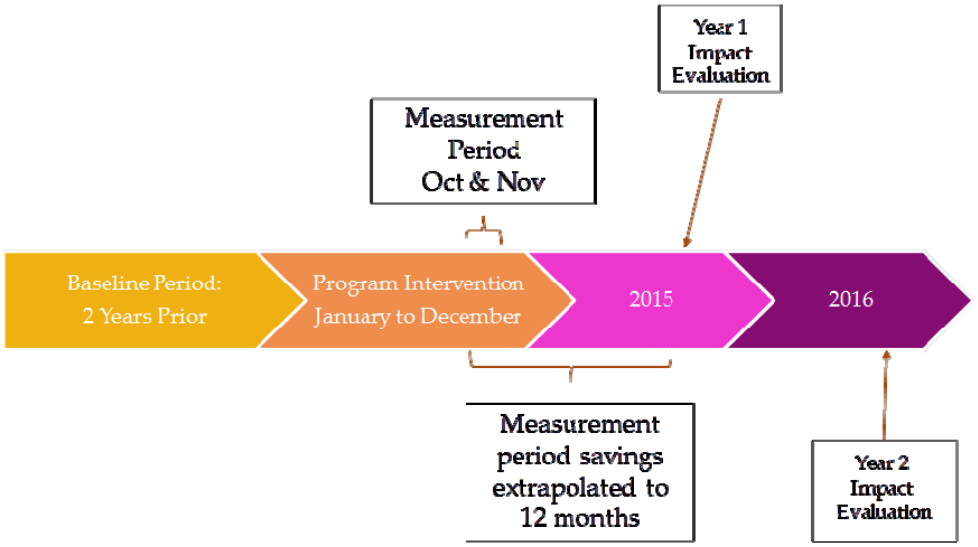

Figure 1. Timeline of Energy Trust SEM intervention and evaluation

Energy Trust's SEM interventions utilize Monitoring, Targeting, and Reporting (MT&R) models to help customers track their energy use and estimate energy savings. Evaluators also leverage the MT&R models to conduct regression analysis to verify savings estimates. A key to effective use of MT&R models is the availability of data at adequate and consistent levels of granularity. However, these data are seldom available at the optimal levels ideally preferred by evaluators; evaluators have to be flexible, skilled, and creative in working with what they can obtain. Much of the discussion at the workshops focused on issues related to MT&R models, which are relevant not only for evaluation, but for program implementation. Below is a summary of some key issues with MT&R models:

Interval Data. Interval data can be informative for both customers, implementers, and evaluators, providing implementers and customers a near-real-time look at facility energy use, and allowing implementers and evaluators with enough data to obtain precise estimates of energy

use. Most gas companies only record consumption data on a monthly basis and do not provide interval data. Also, while electric data are usually available at 15-minute intervals, it still can be expensive to obtain, especially if there are many meters at a facility.

Production Data. A key challenge is identifying production data that are actually driving energy consumption, are easily collected by the customer, are historically available (to develop a baseline), are sufficiently granular to provide meaningful correlation to energy use, and are meaningful to both evaluators and customers (for example, number of shipments may be easy for a customer to understand, but shipments may not correlate to energy consumption).

Time Lags & Alignment. There can be lags between the reading of the meter, the customer receiving the bill, and the customer entering data into their MT&R model. Additionally, there may be a time lag between when a production process actually uses energy and when the customer records the production data. For example, a customer may use energy when firing a batch of bricks in a kiln, but they may not record that batch as a "unit of production" until it is shipped. Finally, aligning different time periods for energy billing, production, and weather data can be complex and time-consuming.

Model Maintenance. Customers may not maintain the MT&R model in the post-engagement period consistently and with the same granularity of data. Evaluators may be able to repopulate the model if the data are available, but sometimes must create a new model.

Changes That Affect the MT&R Model. Participants noted that one of the most challenging issues related to evaluating SEM is when an MT&R model is no longer considered valid – that is, it cannot be used to accurately predict energy use because circumstances at the facility being analyzed have changed so substantially that even if these changes could be incorporated into the model, it would no longer apply to either the baseline period or the post-participation period. Major causes for the MT&R model to become invalid could include:

- Major additions at the sites such as production lines and/or entire buildings
- New process equipment
- Changes in schedule/production
- A new product quality management protocol that impacts production methods and/or production levels
- Major economic changes leading to changes in production hours

Participants acknowledged that changes to the baseline in the implementation MT&R model do occur and need to be carefully documented. However, there is also a need to create some standards or common understanding of what needs to be adjusted in the baseline, and at what point, or what amount of error in the model, constitutes an invalid model. Another workshop participant did point out, however, that as dire as it sounds to abandon the MT&R model, the model used by evaluators for an impact evaluation does not have to be the same as the model originally developed to estimate savings. Evaluators can and should leverage the implementation MT&R model as a "springboard," and decide if it is still valid. But if it is not, it can potentially be used as the basis for a new model.

SEM Evaluation Guidelines

Out of this discussion of issues with evaluating SEM, participants worked to articulate high-level guidelines for evaluating SEM. First, all participants agreed that methodologically sound regression analysis underlies the evaluation of savings from SEM in industrial facilities.[3] Effective regression analysis depends on including the right explanatory variables and not omitting any key variables, as the latter will result in a biased estimate.

Review MT&R model. Participants agreed that evaluators' first step should be to carefully assess whether the implementation (baseline) MT&R model accounted for all the variables driving energy use. They should analyze the model using baseline data only, and try to replicate the results described in the implementers' final report. If the replication is successful, the evaluators should then predict what energy use would be in the post-period if SEM had not been implemented. Then they should add updated data gathered from participants into the implementation MT&R model and look at the actual post-period energy use to determine the energy savings. If the model is no longer valid due to major changes at the facility, evaluators can:

- Attempt to update the model by accounting for any changes
- Create a new model
- Update the baseline period
- If there are a few dominant measures in terms of savings, conduct a bottom-up, measure-level analysis as a broad check of the magnitude of savings
- Interview the customer to learn about any changes made to the facility and whether they are continuing to implement any energy efficiency practices; the evaluator can then use this information to conduct a more qualitative analysis of savings

Review opportunity register and interview site staff. Given varying levels and types of SEM activities at sites, participants agreed that evaluators should review the site's opportunity register and interview site staff to help identify any major changes that could invalidate the MT&R model, and potentially help to explain why savings did or did not occur.

- *Review the opportunity register.* Evaluators should review a site's opportunity register, which typically lists operations and maintenance-based actions that directly save energy; indirect actions that may enable energy savings, such as employee awareness/action campaigns; and potential projects. The goal of reviewing the opportunity register is to identify a site's SEM activities (and other projects), and evaluators can confirm the status of those activities and projects when they interview site staff. This information can be used for qualitative savings analysis (if applicable) and may help explain why savings did or did not occur.
- *Interview the Energy Champion, Energy Team, or other site staff members*. Specifically, the interviews should focus on SEM activities; any changes made to plants, processes, and product lines that may be affecting the validity of the baseline MT&R model; and changes to company support for SEM and how the Energy Champion and Energy Team

[3] International Performance Measurement and Verification Protocol (IPMVP), Option C.

have evolved over time (e.g. roles, responsibilities, focus). This information can be used for the regression model analysis, qualitative savings analysis (if applicable), and may help explain why savings did or did not occur.

Account for capital project savings. Evaluating and subtracting out savings from any capital projects ensures that SEM savings are isolated and savings are not double-counted. Two possible approaches for doing this are described below:

- Evaluators can use the capital project realization rates for the program or for a specific end-use to adjust working savings for capital projects, which evaluators would then back out of the estimated SEM savings.
- Evaluators can perform site visits to evaluate capital project savings, calculate a realization rate, and back those savings out of the estimated SEM savings.

Conclusions and Next Steps

The goal of the SEM workshops was to help Energy Trust articulate and document key issues with evaluating SEM and develop high-level guidelines for performing SEM impact evaluation. Many of the key issues identified relate to the production and energy data feeding into the MT&R models, the need to update the models, and facility changes that affect the validity of the MT&R models. These issues directly informed the high-level guidelines developed, which are:

- Review MT&R model
- Review opportunity register and interview site staff
- Account for capital project savings

Energy Trust is currently conducting an SEM impact evaluation that is using these guidelines and testing how they work in practice. The evaluation includes 45 industrial sites that participated in SEM between 2009 and 2013. In addition to comparing *ex ante* and *ex post* savings estimates, a key goal of the evaluation is to assess the savings of SEM over time (i.e., one, two, and three years after the SEM engagement). In addition, the hope is to develop interview guides and more detailed procedures for reviewing the MT&R models and opportunity registers that can be used by evaluators (and other programs) to allow for comparison of results.

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