Evaluating Strategic Energy Management – Lessons Learned

Erika Kociolek, Energy Trust of Oregon, Portland, OR

ABSTRACT

Programs focused on changing behavior and organizational practices are growing in both residential and non-residential energy efficiency sectors; strategic energy management (SEM) is one such offering that is rapidly expanding. Several different flavors of SEM for industrial customers have been implemented by Energy Trust of Oregon since 2009. Since then, hundreds of sites have participated in Energy Trust's industrial SEM offering.

While multiple process evaluations of SEM have been conducted to date, fewer impact evaluations have been completed (Navigant Consulting 2013; DNV GL 2016; SBW Consulting and The Cadmus Group 2017). Using evaluation guidelines resulting from two workshops held with 28 program designers, implementers, and evaluators in 2014 (MetaResource Group 2014), Energy Trust undertook an impact evaluation of industrial sites that participated in SEM between 2010 and 2014. The impact evaluation sought to answer the following two key research questions:

1. On average, what are annual energy savings and energy savings rates for SEM and how (if at all) do these change over time?
2. What energy-saving activities are sites implementing?

In this paper, we first briefly summarize the key components of Energy Trust's industrial SEM program and the evaluation guidelines used for the impact evaluation. Then, we discuss the challenges that impacted our ability to answer the key research questions, and summarize the key findings resulting from this project. We end with a brief summary of lessons learned and recommendations for what other SEM programs can do to facilitate evaluation.

SEM Background

Energy Trust's Production Efficiency (PE) program offers strategic energy management (SEM) training and support to industrial customers. The program provides energy management consulting services via a group of SEM coaches that educate and train industrial energy users to: (1) develop and execute an energy planning strategy, and (2) integrate energy management into their business planning. Customers participate for one year, and must have commitment from management to implement the opportunities identified. After the first year, participants can choose to participate in subsequent years. Although Energy Trust has implemented several different flavors of SEM, most have common elements, including:

1. Identification of energy-saving opportunities, which are captured in an **opportunity register**.
2. Tracking of energy savings using a **regression model**, which takes energy consumption, production, and other data (e.g., when facilities are closed, weather, etc.) prior to the start of the SEM engagement to produce an equation that predicts energy consumption in the absence of the SEM engagement. The difference between actual energy consumption and predicted energy consumption is assumed to be energy savings.
3. A final **report** summarizing the *ex ante* energy savings estimated by the SEM coach, along with information about the activities undertaken by the participant.

Given that savings from SEM have accounted for, on average, 15% of annual electric savings for the Production Efficiency program, Energy Trust decided to undertake an impact evaluation of industrial sites that participated in SEM between 2010 and 2014.

SEM Evaluation Methods

As noted previously, Energy Trust's industrial SEM offering (prior to 2014) was a one-year engagement, although participants could choose to participate in subsequent years. To develop estimates of savings, the program gathers energy consumption, production, and other data (e.g., when facilities are closed, weather, etc.) prior to the start of the SEM engagement to produce a model that predicts energy consumption in the absence of the SEM engagement. Programs typically select the twelve months immediately preceding the SEM engagement as the "baseline period". During the SEM engagement, SEM coaches work with participants to update their models to reflect changes in operations or production. They also work with participants to develop an opportunity register, which is a dynamic lists of energy efficiency opportunities identified at the facility. The last three to six months of the SEM engagement period are considered to be the measurement period; the difference between actual energy consumption and predicted energy consumption (using the regression model) is savings, and is extrapolated to a year to obtain an estimate of first-year savings. A final report documenting the estimated savings is generated using data from the model and opportunity register, and is provided to the program. Typically, approximately one year after the SEM engagement, Energy Trust performs an impact evaluation to assess savings, and produce an estimate of *ex post* savings. This is summarized in Figure 1, below.

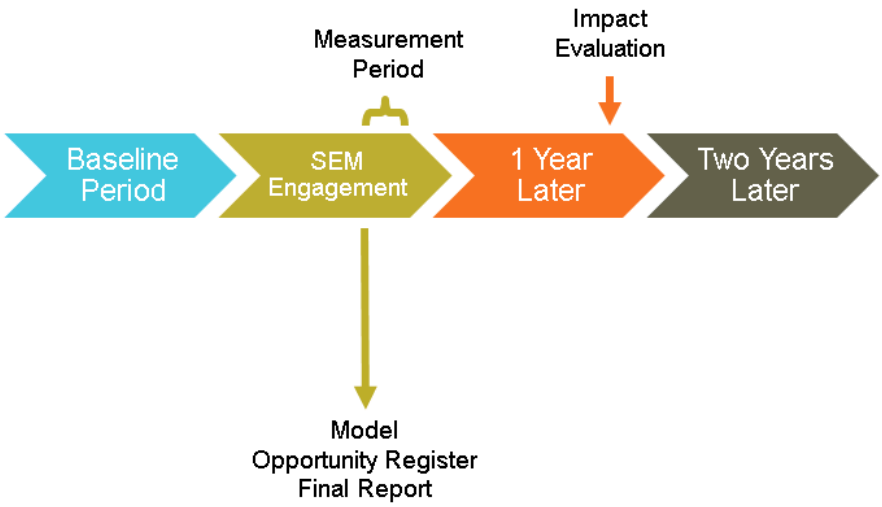

Figure 1. Summary of SEM baseline, engagement, and evaluation periods. *Source:* MetaResource Group 2014.

Two workshops held in 2014 with program designers, implementers, and evaluators led to the development of high-level guidelines for evaluating SEM, which are shown in Figure 2, below (MetaResource Group 2014; Kociolek et al. 2015; Kociolek 2016). Workshop participants agreed that the preferred method for evaluate energy savings from SEM was to review the models developed by the program to estimate *ex ante* savings, and gather the data needed to update the model to check the original *ex ante* savings estimate and estimate the persistence of SEM savings (1 in Figure 2). Workshop participants also agreed that reviewing participants' opportunity registers, interviewing staff, and conducting a site visit would be useful to explain why savings occurred (2 in Figure 2). The final step

would be to account for the savings from any capital projects that had occurred in the baseline, SEM engagement, or performance periods (3 in Figure 2).

Workshop participants felt that if after reviewing the models (4 in Figure 2), updating them was not possible, information from participant's opportunity registers, interviews with staff, and site visits (5 in Figure 2) could be used to produce a bottom-up, engineering estimate of energy savings (6 in Figure 2), and/or a qualitative assessment[1] of savings could be conducted (7 in Figure 2).

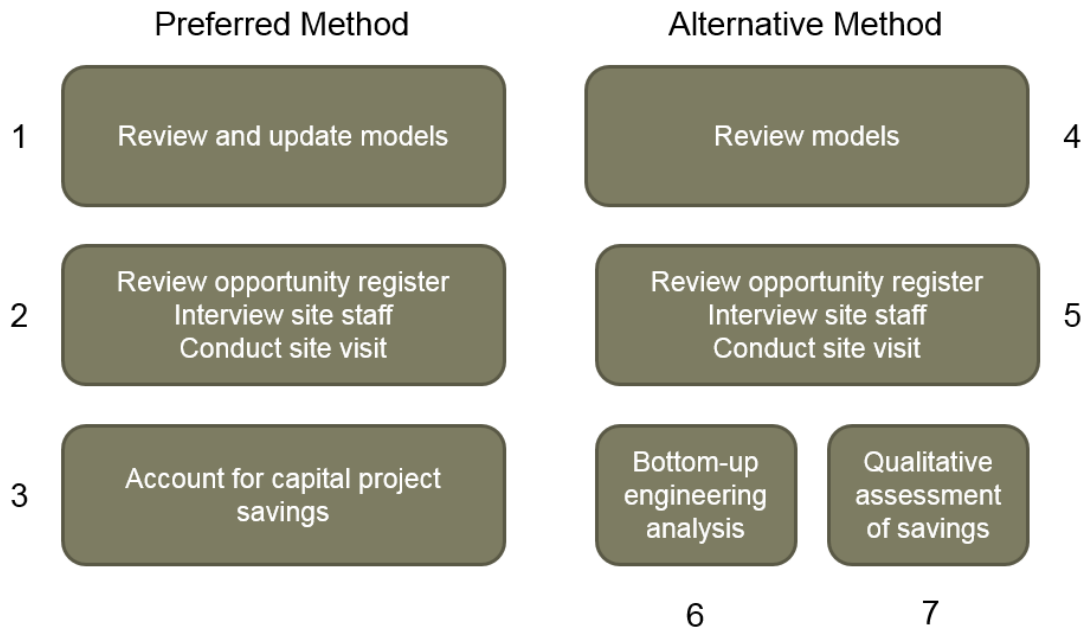

Figure 2. Summary of SEM evaluation methods. *Sources:* MetaResource Group 2014; Kociolek et al. 2015; Kociolek 2016.

With these guidelines in mind, Energy Trust and the evaluator, Cadmus, ("the evaluation team") designed the SEM impact evaluation to include the following activities:

1. Review participants' opportunity registers, models, and final reports, and other relevant documents and data
2. Conduct participant interviews
3. Perform site visits (if necessary)
4. Replicate facility-level regression models used to estimate *ex ante* savings, with a goal of verifying the *ex ante* savings estimated by the program
5. Collect energy consumption, production, and other data to update regression models and determine the persistence of savings over time

[1] A quantitative assessment of savings may involve using data collected by programs and/or by evaluators in engineering calculations and statistical models to derive a realization rate (the ratio of *ex ante* to *ex post* savings). If data to support engineering calculations and statistical models is not available, a qualitative assessment of savings may be used. For example, in the absence of data to feed into a model, the evaluator could review a participant's opportunity register to understand the types of energy-saving projects that were implemented, and ask the participant about the status of those projects, which could provide insight into whether or not the participant is continuing to save energy.

Evaluation Challenges

As the SEM impact evaluation progressed, the evaluation team realized that the preferred method for evaluating SEM would not be possible, for three key reasons.

First, for program years 2009-2014, Energy Trust did not require SEM coaches to provide final versions of the opportunity registers and models - only the final report summarizing the information found in these documents. It was extremely difficult to obtain the final versions of the models and opportunity registers that aligned with the final reports, which meant that the evaluator could not replicate the *ex ante* savings. Starting with the 2016 program year, Energy Trust requires final versions of both the models and opportunity registers to be provided along with the final reports.

Second, a key finding from the interviews was that many participants did not maintain their models after the end of the SEM engagement period (discussed in more detail in the next section), meaning that pulling together the energy consumption, production, and other data needed to update the models was extremely time-consuming. As a result, participants were generally reluctant to provide the evaluator with the data needed to update models. Given this, the evaluator was not able to check the original *ex ante* savings estimate or estimate the persistence of SEM savings, which was one of the key research questions of interest.

Third, the evaluator found a variety of small issues that hindered their ability to check the original *ex ante* savings estimate and estimate the persistence of SEM savings. One issue was that some of the models and the final reports did not clearly define the baseline and measurement periods, which is necessary to replicate the *ex ante* savings estimate and produce estimates of the persistence of SEM savings. Another issue was that the models did not contain all of the data that was needed to verify the *ex ante* savings – for example, a gas model may not have contained production data if the SEM coach found it to be not statistically significant for the equation used in calculating *ex ante* savings. However, that data is needed when verifying the *ex ante* savings estimate. Finally, the evaluator found that some models were missing data because the SEM coach determined that certain datapoints were outliers; again, that data is needed to verify the *ex ante* savings estimate.

Since evaluating savings via the models was not an option for the reasons described above, the evaluation team turned to the opportunity registers, which document energy-saving opportunities, to assess the feasibility of performing a bottom-up analysis as a check on *ex ante* savings claims. We found that these opportunity registers tended to contain relatively high-level descriptions of opportunities, many of which lacked estimated energy savings or key details (e.g., compressed air system horsepower, RTU capacity, etc.) that would be needed to perform a bottom-up analysis and inform site visits.

The evaluator was able to conduct interviews with 36 of the 46 sites included in the evaluation (78%). Although the information provided via interviews did not provide answers to the first key research question, it did provide insight into the second key research question – the energy-saving activities occurring at sites that participated in SEM – and these interviews provided useful information to program staff looking to refine the industrial SEM offering.

Key Findings from SEM Participant Interviews

Interviews with SEM participants covered a wide range of topics, and lasted approximately 40 minutes. Key topics covered during these interviews included:

1. Energy policies and goals, resources for energy management, and management support for SEM
2. Use of energy management tools
3. Persistence of energy management activities
4. Impact of SEM on future energy management activities

Key findings related to these four topic areas are summarized in the following sub-sections, and are summarized visually in Figure 3.

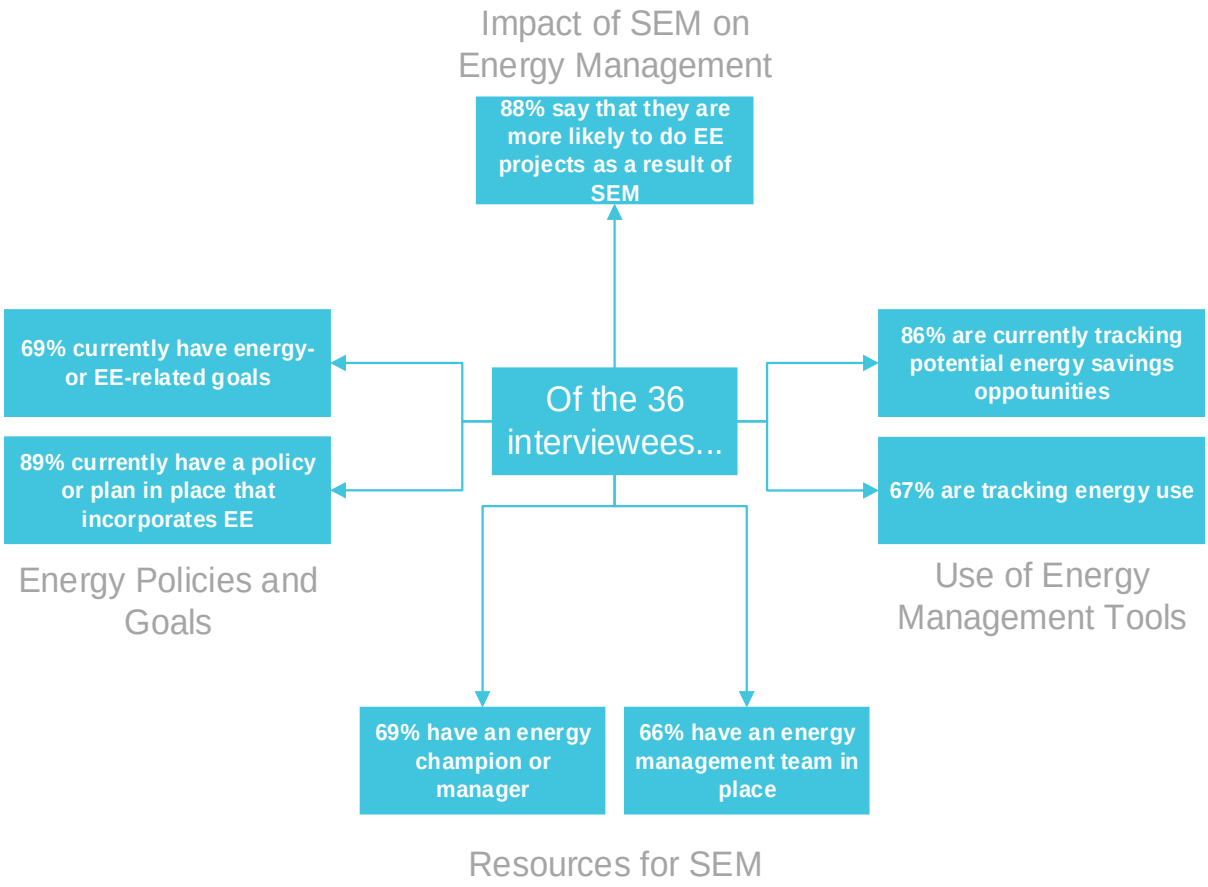

Figure 3. Visual summary of key findings from SEM participant interviews

Energy Policies and Goals, Resources for Energy Management, and Management Support for SEM

Of the 36 interviewed participants, 89% said that their organization currently has a policy or plan in place that incorporates energy efficiency; fewer (69%) participants said that their organization currently has goals in place related to energy or energy efficiency. Of the participants that indicated their organization currently has goals in place related to energy or energy efficiency, 88% indicated that the goals had been communicated to staff. Just over a third of participants (36%) that indicated that their organization currently has goals in place related to energy or energy efficiency said that they have met or will meet 100% of their goal, 20% expect to meet at least 75% of their goal, 20% expect to meet less than 75% of their goal, and just under a quarter (24%) did not know if their organization will meet their goal.

Of all interviewed participants, 69% said that their organization currently had an energy champion or manager, and of those, 88% said that the energy champion or manager has a back-up. Sixty-six percent of all respondents indicated that their organization currently had an energy management team in place, and of those, 75% indicated that the team was comprised of multiple people and 62% indicated that the energy management continue to meet on a regular basis. Notably, 79% of participants that said that their organization currently had an energy management team in place also said that the composition of the energy management team had changed since their SEM engagement.

Two-thirds of respondents (67%) indicated that management is supportive of SEM, and the majority of respondents felt that cost savings are the most important factor influencing management engagement in SEM.

Use of Energy Management Tools

As noted previously, opportunity registers were used during SEM engagements to document energy-saving opportunities. Two-thirds (67%) of respondents said that the opportunity register was useful in helping them to prioritize and implement projects. Just over half (53%) of respondents indicated that they are no longer using the opportunity register; of these, 74% said that they are tracking potential opportunities. In total, 86% of respondents are currently tracking potential energy saving opportunities, either using the opportunity registers or a different method. Two-thirds of respondents had added opportunities to their list of potential opportunities since participating in SEM.

Two-thirds (67%) of respondents tracked energy use, and of those, half use their model, a quarter use other spreadsheet-based tools, 21% use energy management systems, and 13% use other tools. The remaining respondents (33%) that do not track energy at all; reasons given included time constraints, difficulty maintaining models due to changes, and not finding a model that works for them.

Persistence of Energy Management Activities

Because the list of activities in the opportunity registers were extensive for most participants, including discussion of all of them in the interviews was not feasible due to time constraints. Additionally, participants were engaged in SEM two to six years earlier, raising concerns about whether interview respondents would remember the SEM activities. Therefore, the evaluation team selected activities to ask about in the interviews, focusing on those that participants would be most likely recall, such as those with large savings or ongoing behavioral activities that could have been continued since participation. The evaluation team did not select activities that would be covered in other parts of the interview (such as establishing an energy team) and excluded one-time events that happened several years ago, including various employee awareness campaigns. Of the 77 activities the 36 interviewed participants were asked about, 70 remained in place or were continued (91%), 2 had been discontinued, and 2 had not been completed but were still planned.

Persistence of Energy Management Activities

Eighty-eight percent of respondents said that they were more likely to conduct energy-efficiency projects following their SEM engagement, while 11% said that SEM made no difference, supporting research presented at the 2015 ACEEE Summer Study on Energy Efficiency in Industry (Rubado et al. 2015). A majority of respondents indicated that participating in SEM made identifying potential energy efficiency projects easier, and 50% indicated that participating in SEM made implementing potential energy efficiency projects easier. Respondents noted that the SEM engagements made identifying potential energy efficiency projects easier because it increased their awareness, generated new ideas, provided information and case studies, provided tools for measuring energy usage, and made it easier to understand how to save energy. Most respondents (40%) indicated that the opportunity register was the element of SEM that most contributed toward additional energy-efficiency projects, followed by the energy scans (27%), and energy teams (27%).

Lessons Learned

While the impact evaluation's two key research questions could ultimately not be answered, the project yielded a number of interesting findings, which have implications for future program design and evaluation, and may serve as a point of comparison for other SEM programs. In addition, these lessons learned may enable others to learn from our experience and challenges. The key lesson learned from this study was the need for evaluators to work with programs to consider the data required for evaluation upfront, and design programs with evaluation in mind. Below are three specific recommendations for SEM programs intended to facilitate evaluation.

Enhance documentation requirements to facilitate evaluation. As noted previously, it was difficult to verify the *ex ante* savings estimates in the absence of models that aligned with the information contained in the final reports. Programs should require implementers to provide final versions of the models and opportunity registers, and have implementers verify that the final versions of the models and opportunity registers align with the savings reported in any final reports or tracking systems. Also, opportunity registers tended to contain relatively high-level descriptions of opportunities, many of which lacked estimated energy savings or key details (e.g., compressed air system horsepower, RTU capacity, etc.) that would be needed to perform a bottom-up analysis and/or inform site visits. Programs should consider including more detail in opportunity registers, with an eye towards making these documents understandable to more than just the implementer and customer.

Enhance documentation requirements to facilitate evaluation. Programs should require that models have the baseline and measurement periods clearly defined, which is essential for evaluation. Also, programs should request that implementers not remove datafields (e.g., production data for a gas model) or datapoints (e.g., outliers) that ended up not being included in the final equation used in calculating *ex ante* savings, since this data is needed for evaluation.

Incentivize and facilitate providing data to evaluators. If examining the persistence of savings post-program is desired, programs should consider offering a small incentive to participants to provide data to evaluators and/or update their models, and plan to have program staff re-engage participants as part of the evaluation and provide support to participants to update their models.

References

DNV GL. 2016. *Impact Evaluation of Commercial Strategic Energy Management*. Prepared for Energy Trust of Oregon. Link.

Kociolek, E. 2016. *Evaluating Persistence – Lessons Learned from SEM*. Presentation at 2016 ACEEE MT Symposium, Baltimore, MD. Link.

Kociolek, E., Degens, P., Crossman, K., Cropp, J., Huckett, J., Ochsner, H., and J. Barnes. 2015. *Evaluating Strategic Energy Management: Guidelines from the Pacific Northwest*. Paper presented at the 2015 ACEEE Summer Study on Energy Efficiency in Industry, Buffalo, NY. Link.

MetaResource Group. 2014. *2014 Energy Trust Workshops on Strategic Energy Management Impact Evaluation: Report on Key Outcomes*. Prepared for Energy Trust of Oregon. Link.

Navigant Consulting. 2013. *Impact Evaluation of Energy Trust of Oregon's 2009-2011 Production Efficiency Program*. Prepared for Energy Trust of Oregon. Link.

Rubado, D., Batmale, J.P., and K. Harper. 2015. *The Impact of SEM Programs on Customer Participation*. Paper for 2015 ACEEE Summer Study on Energy Efficiency in Industry , Buffalo, NY. Link.

SBW Consulting and The Cadmus Group. 2017. *Industrial Strategic Energy Management (SEM) Impact Evaluation Report*. Prepared for Bonneville Power Administration. Link.