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# Strategic Energy Management Keys to Behavioral and Operational Change

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## ABSTRACT

This paper presents the results of an evaluation of Energy Trust of Oregon's Strategic Energy Management (SEM) initiative. Commercial SEM is designed to deliver comprehensive energy services to large, typically multi-site, customers through behavioral and operational changes, while also identifying potential capital projects. This paper addresses both process findings and an analysis of savings estimation techniques.

The evaluation sought to ensure that the initiative was achieving claimed savings at a reasonable cost and to provide feedback on program design and implementation. This meant both investigating the methods used to calculate savings and understanding how participants had incorporated energy saving policies and practices into their standard operating procedures.

Key operational findings included:

- SEM takes time if organizational changes are to be implemented.
- A cohort approach, using multiple workshops with representatives from 5-10 organizations, appears to be effective in engaging participants and encouraging behavioral and operational change.

Findings relating to the savings methodology included:

- Standardized regression analysis techniques are an acceptable means to determine savings. When regression analyses are used, savings should be calculated using a baseline of the operation immediately preceding program participation, whenever possible.
- Regression analyses should be clearly organized and link operational changes to reduced energy use.
- Linear extrapolation from limited data to project annual savings often induces significant error. Therefore, savings claims should be limited to observed savings to improve accuracy.
- If savings claims must be extrapolated based on limited data, these analyses can be supplemented with heating or cooling models to improve accuracy.

## Introduction

Strategic energy management (SEM) is defined as “taking a holistic approach to managing energy use in order to continuously improve energy performance by achieving persistent energy and cost savings over the long term.”<sup>1</sup> SEM programs, therefore, differ from traditional energy efficiency programs in that they do not focus on specific equipment upgrades or performance enhancements, but instead focus on equipping the customer or the end user to identify opportunities for improvement.

This paper presents the lessons learned from the evaluations of two strategic energy management (SEM) pilot programs for the Energy Trust of Oregon, the Commercial Strategic

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<sup>1</sup> “CEE Strategic Energy Management Minimum Elements.” *Consortium for Energy Efficiency*.  
[http://library.cee1.org/sites/default/files/library/11283/SEM\\_Minimum\\_Elements.pdf](http://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf). Accessed October 1, 2015.

Energy Management (SEM) program and the Strategic Energy Management Introduction (SEMi) pilot.

Commercial SEM is a limited program offering designed to deliver comprehensive energy services to selected large customers focused on behavioral and operational changes as well as capital projects. The program has delivered two approaches to SEM via different contractors: a cohort track and an individual track.

For both approaches, customers receive extensive technical assistance from a Commercial Technical Service Provider (CTSP) and evaluation of their energy savings as well as incentives based on the estimated annual savings. Savings are determined from a top down analysis of behavioral and operations and maintenance changes, which are estimated by analyzing facility energy data at the end of the first and second years of involvement. Monthly energy usage is entered into a monitoring, tracking, and reporting (MT&R) spreadsheet tool so that consumption can be compared to usage during the same time in the prior years, after normalizing for differences in weather conditions or other factors.

The SEMi program is a light-touch, event-based program offering designed to introduce strategic energy management (SEM) to customers who do not meet energy usage or organizational commitment screening criteria for the full commercial SEM engagement. Over the course of 12 weeks, participants participate in a variety of events, including an Opportunity Assessment, Energy Day, and an Organizational Assessment, designed to identify opportunities to save energy. Participants qualify for incentives based on the number of energy saving measures implemented and the priority and level of effort required to complete each measure.

## **SEM Takes Time**

Based on the evaluation for commercial SEM and the SEMi pilots, the first key for success in a SEM program is to allow for enough time for the development of the customers. The goal of SEM is to produce fundamental and organizational changes to the approaches and viewpoints for an organization. The two SEM approaches evaluated had dramatically different activities and timelines. Therefore, they are not directly comparable, but lessons can be learned for the timeframe of each program.

Due to initial challenges, including changes to implementer staff, the SEMi pilot used a blitz approach, where all of program activities and projects were completed in a 12-week period. The SEM program used both an individual and a cohort approach, both of which had activities occurring for nearly a year, with many people continuing in the program beyond the first year.

Although both approaches were successful in increasing customer awareness of energy efficiency and engaging customers to complete some projects, the overall feedback from both the customers and the program staff was that significant time is required for any lasting change to occur. The 12-week timeframe for the SEMi pilot was considered to be too short to be effective by all the program staff interviewed. As one staff member noted: “If it were 12 weeks from the Energy Day through the last day of implementation and then a few weeks for admin pre and post, that might work, but it can take 2 weeks just to schedule the Energy Day, plus we need a report at the end of 12 weeks, so you’re down to 6 weeks when they can get actual work done – which is hard because it’s not that high a priority for them.”

Even in cases where SEMi participation likely did result in lasting organizational change, this did not always result in energy savings claimed by the program. During the 12-week timeline, only a small percentage of the recommended non-capital opportunities identified were actually implemented. Customers did report that they intended to implement additional measures in future years, and in some cases even incorporated the recommendations into their corporate sustainability plans. However, these potential future savings could not be claimed or attributed to the SEMi pilot at that time.

For the commercial SEM program, the additional time was critical to project success. One of

the key drivers for this program was the free exchange of ideas and plans between facility managers from different organizations or within larger organizations. These discussions occurred naturally and were the result of the ability to meet with people on an ongoing basis over long periods of time.

The time was also critical in overcoming internal organizational barriers. For example, one of the primary initial barriers to success with SEM is the perception that it will require additional work for already over-committed staff. These perceptions are only overcome once the SEM activities become “routine” and not considered additional work. The additional time for the SEM program also facilitated the participation and education of upper and lower level staff, both of which are required for success.

The development of a formal Strategic Energy Plan appeared to lag behind other aspects of SEM implementation, both because of the formal approval process required within each organization and because – in the cohort approach – plan development comes relatively later in the process when participants are already tasked with implementing numerous other changes.

Customer use of the MT&R spreadsheet tool tends to slip over time, in part because of the time required for customers to enter usage and weather data. Additionally, customers did not all understand the statistical foundations of the MT&R spreadsheets, and therefore did not immediately see the value. The longer timeframe of the commercial SEM program allowed program staff the ability to redirect facility staff and reinforce the importance of these tracking tools.

## Cohort Approaches are Effective

Energy Trust’s commercial SEM program used both a combination of a cohort approach and an individual approach. For the cohort approach, cohorts of 8-10 customers are educated through a process of training workshops, opportunity assessments, one-on-one coaching and MT&R to help them incorporate energy management practices into their core business.

The individual approach provides a menu of service options to individual customers, either as a comprehensive package or a custom selection that best meets the organization’s energy objectives. Services include one-on-one opportunity assessment, Energy Information System installation, organizational assessment, strategic planning and implementation support of a strategic action plan.

Based on the evaluations completed, both approaches were effective in achieving the goals for the SEM program of generating energy savings and promoting organizational change. However, based on the overall program costs, the cohort approach was significantly more cost effective at a total program (delivery and incentive) cost than the individual approach.

To compare the cost-effectiveness of the two delivery approaches, we compiled the costs and savings associated with each track, including non-incentive and incentive costs. Because both of the 2012 individual approach participants had significant non-incentive costs in 2012 but only reported incentive costs (as well as additional non-incentive costs) in 2013, results for both approaches were combined for 2012 and 2013. To facilitate a comparison of costs across electric and gas savings, we normalized all savings to MMBTU, and calculated both non-incentive cost and total cost, as shown in the table below.

**Table 1:** SEM Program Cost and Savings

Approach	Non-incentive cost	Incentives	Elec. Savings (MMBTU)	Therms Savings (MMBTU)	Total (MMBTU)	Non-incentive cost per MMBTU	Total cost per MMBTU
Cohort	\$294,340	\$131,375	19,333	12,694	32,028	\$9.38	\$13.49
Individual	\$72,152	\$4,300	346	1,136	1,482	\$54.11	\$57.15

The results clearly show the lower cost of savings when the cohort approach is used. They

also show that delivery service provider costs are several times higher than the amount of the incentives, indicating that the delivery program strategy does have a significant impact on overall cost-effectiveness.

Additionally, based on the participant feedback, the sharing of experience and knowledge appears to be one of the most valuable aspects of the cohort approach, particularly when past participants describe how they implemented SEM. Individuals within one organization can exchange ideas with their peers who hold similar positions in other organizations, thereby increasing the amount of learning beyond what would be possible in a one-on-one expert-participant setting.

Individual approaches can still be effective, however, but are most cost effective when applied to organizations with multiple similar buildings where the training and recommendations can be widely applied.

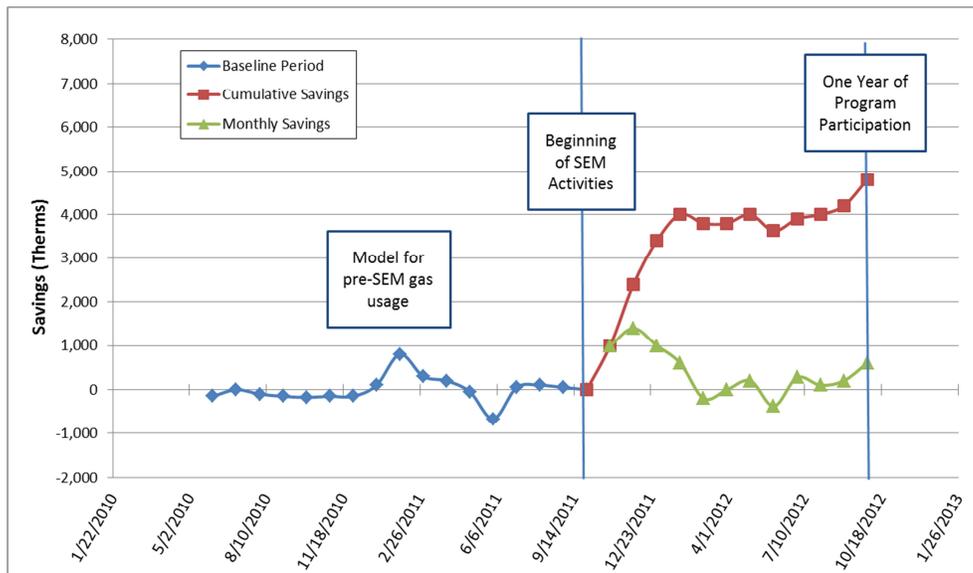
## **Regressions are Appropriate**

There is a solid basis for using regression to estimate savings using billing data, and the technique is called out in International Performance Measurement and Verification Protocol (IPMVP) as Option C: Whole Building Analysis. However, IPMVP notes that for Option C “billing analysis is appropriate when:

- Savings are above noise—that is, the estimated energy savings are greater than at least 10% of the monthly utility bill being analyzed.
- There is a high degree of interaction between multiple measures at a single site.
- The energy conservation measure (ECM) improves or replaces the building energy management or control system.
- The ECM involves improvements to the building shell or other measures that primarily affect the building load (e.g., thermal insulation, low-e windows).
- The measurement of individual component savings is not relevant.
- Other approaches are too expensive.

While SEM meets several of the above criteria, expected savings from SEM fall far below the 10% threshold noted, which suggests that the regression analyses may have some uncertainty for the overall savings estimates. However, the use of regression analysis to establish a relationship between energy use and various “independent” variables is well established, having been employed by EPA on Commercial Building Energy Consumption Survey (CBECS) data, by Georgia Tech University to model industrial energy consumption, and by Energy Trust and NEEA to estimate savings for SEM programs targeted to industrial users.

Energy Trust’s program used a “CUSUM” regression analysis to determine the savings levels. In a CUSUM analysis, a model of energy usage is developed from a baseline period, based on the energy consumption and the heating degree days, cooling degree days, occupancy levels, days in the billing cycle, or other factors. This model is then applied to each month going forward. Any reduction in energy consumption compared to the modeled usage is “savings.” The CUSUM analysis then presents the total savings since the start of SEM program activities, as shown in the figure below. The monthly savings are shown, however, in many cases, the monthly savings are not presented.



**Figure 1:** CUSUM Savings Analysis

The CUSUM analysis has many positive attributes. One of the most significant advantages of it over other regression approaches is that the total savings are immediately apparent to the customer. For example, in the figure above, it is immediately apparent that the total first year savings for this site is nearly 5,000 therms. This clear presentation of savings can be a driving force for customers to push to achieve greater savings levels.

Additionally, the CUSUM analysis can be tailored to the individual customers' levels of technical ability and information available. For example, the starting point for the CUSUM analysis may be simply heating degree days, cooling degree days and days per billing cycle, but customers CUSUM analyses were expanded based on site conditions to include occupancy, "event" days, production levels, or other site factors. These additional variables can add accuracy and encourage customers to examine what factors affect their energy usage.

Despite its value, the CUSUM is not the best approach for all cases. In some cases, the savings are simply too small to be seen in a CUSUM analysis. It is important to recognize these cases and use alternate approaches, such as calculated savings values, so that customers have the feedback for the savings.

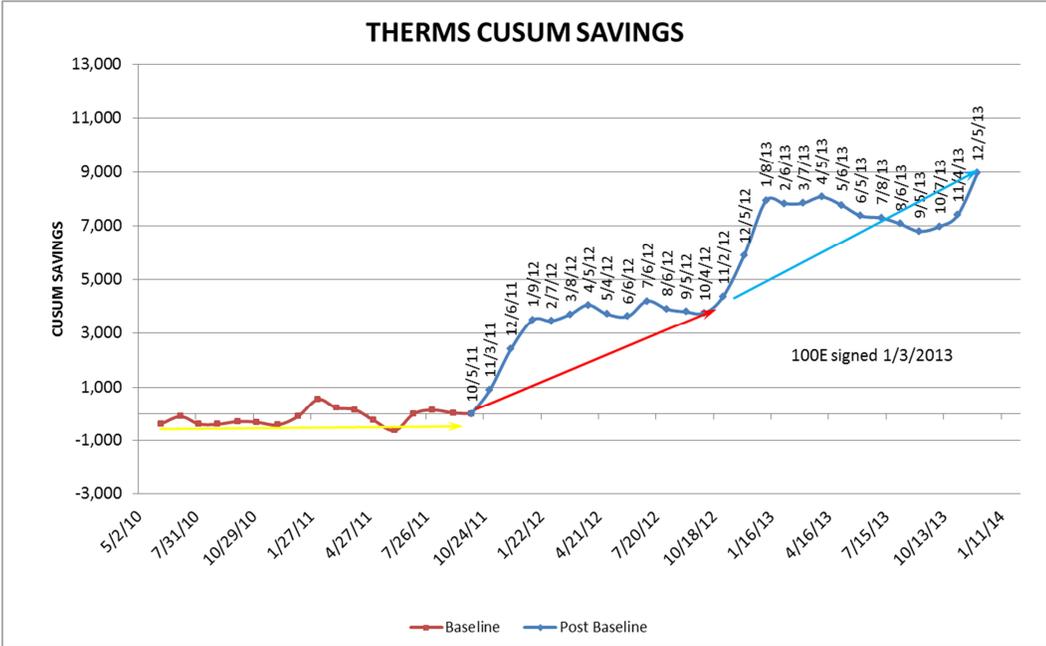
Using CUSUM regression analysis applied to the SEM savings calculations, there is no explicit linkage between individual SEM actions and their associated energy savings. Instead, the savings from SEM typically come from an overall plan that includes numerous small, often incremental changes in occupant behavior as well as potentially more significant changes in facility operations. At least in theory, one would expect to be able to observe some link between the timing of specific actions noted for a participating facility and a resulting drop in usage. The reverse is certainly promoted as one of the benefits of SEM; that is, if a jump in usage is observed, the obvious question to ask is what is causing that.

## Standardized Regressions Must be Clear

As noted above, one of the primary benefits of the of the CUSUM regression analyses is the ability to clearly present the savings estimates. Initially, the SEM program used a variation of the standard CUSUM analysis to predict the savings. First, a "baseline" model was developed based on a year of operation prior to the start of SEM participation. This period was selected based on the 12 month or longer period that resulted in the "best fit" model, which indicated stable building operation. In Figure 2 below, this period is from June of 2010 to October of 2011, and is indicated by the red "savings" line and the yellow arrow.

Two CUSUM analyses were then completed to determine the savings due to participation in the SEM engagement. First, one CUSUM analysis was performed comparing the “Baseline” period to the period from the end of the baseline period to the start of participation in the program (October 2011 through October 2012 in the figure below, indicated by the red arrow). This was labeled the “Pre” period. Using this model, a “Savings per day” for the pre period was developed, which was equal to the average slope of the CUSUM line. However, it is important to note that the “savings” for this period are not program savings, but instead indicate a change in operation from the baseline period.

A model was then also developed for a period after the start of program activities. This period was labeled the “Post” period. In the figure below, this is the period starting November 2012, indicated by the blue arrow. A “Savings per day” value was calculated for this period as well. Again, the savings for this period are not the program savings either. Instead, the expected savings due to the program was calculated using the difference in the savings per day values (slopes of the lines) for the pre period and the post period.



**Figure 2:** Modified CUSUM Analysis

Because many of the projects completed have less than one full year of operation in the pre period and/or the post period, the savings are linearly extrapolated for the remainder of the year. For example, as shown in the table below, the baseline period for the figure above has a “savings” of 11.1 therms per day. The post period has a projected savings of 11.5 therms per day. Therefore, the savings due to the program is the difference between those two values (0.4 therms per day). Based on 365 days per year, the resulting savings are 160 therms.

Although, this approach is not necessarily any less accurate than a conventional CUSUM analysis, this approach does not clearly present the savings and led to confusion and difficulty for customers to “see” the program savings.

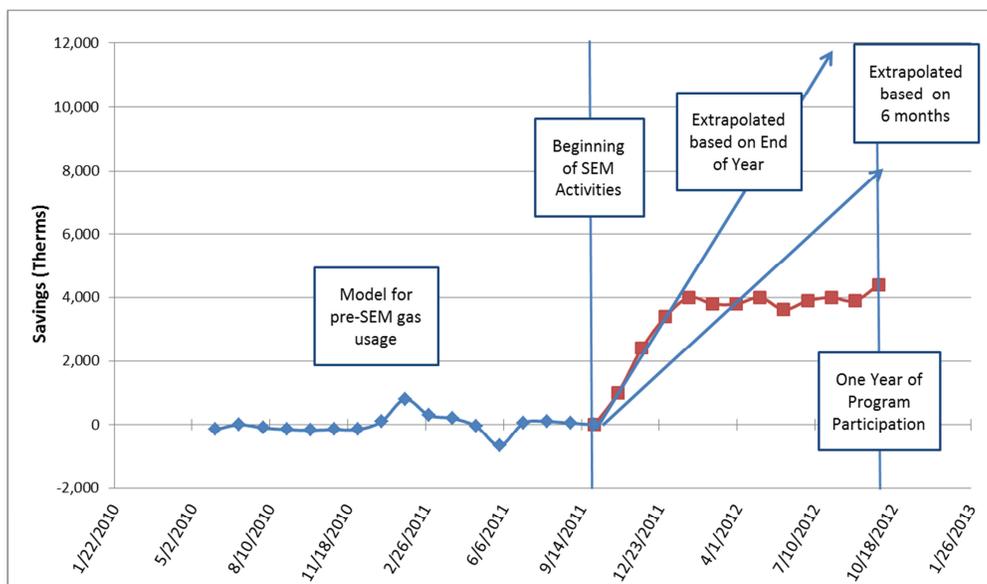
**Extrapolation Leads to Error**

Due to the timing of the program cycles, the savings for many of the projects are based on less than one full year of post period data. For the SEM programs evaluated, to determine the annual savings, the savings were linearly extrapolated based on the savings to date using the formula:

$$kWh_{Annual} = kWh_{day\ i} * \left(\frac{365}{i}\right)$$

This linear extrapolation technique was found to potentially impart significant inaccuracy to the saving estimates, since it does not account for the expected annual usage characteristics for the equipment or the measures completed. For example, when the winter months are used to develop the savings for a heating efficiency improvement that is expected to save natural gas, those gas savings will be projected to the summer months even though no heating is expected.

This can clearly be seen in Figure 3 below. For this example, the overall savings for the first year of SEM activities are approximately 4,200 therms, based on the full year of data. However, if the savings were extrapolated based on the data available at the end of the year (3 months of participation), the projected savings would be over 12,000 therms per year, nearly three times the achieved savings level. Even if the period for extrapolation was increased to six months, the projected savings are still nearly 8,000 therms per year, nearly double the achieved savings.



**Figure 3:** CUSUM Savings Extrapolation

In addition to adding the potential for inaccuracy, savings extrapolation was described by the program staff as one of the most challenging and expensive aspects of the program. The analysts do their best to adjust the limited savings data to reflect non-cooling months by extrapolating using typical meteorological year (TMY) data and professional judgment, but there is clearly no way to accurately predict heating season usage based on cooling usage data. In addition, to avoid the dramatic changes illustrated above, projects were often “trued up” based on additional data after the close of the program year. The implementer staff described this whole process as a very time-consuming activity that contributed a significant portion of the cost of the program delivery.

Based on these findings, we recommended a dramatic shift in the program design. Specifically, we recommended that the extrapolation be abandoned. Instead, the first year savings could be limited to the savings to date at the end of the program year. The remaining savings for the project could then be claimed in the second year of participation. Alternatively, the savings could be claimed only after a full 12-month period had elapsed. This approach simplified the reporting, but required the costs and the savings to be “decoupled” since they would occur in different program years. Both of these approaches eliminated any extrapolation of savings and the uncertainty associated with current annual savings estimates.

In cases where savings must be extrapolated, due to program cost-effectiveness requirements or other factors,, we recommended that the savings not be linearly extrapolated, but instead be extrapolated based on the expected “savings profile.” For example, if the savings are expected to affect the heating energy, the savings could be related to heating degree days.

## **Conclusion**

Commercial SEM programs are fundamentally different than conventional energy efficiency programs. They are designed to assist customers by educating them on their energy usage with the goal of producing ongoing organizational changes. SEM programs must be designed with customer timelines and feedback mechanisms in mind.

Cohort approaches were a successful and cost-effective way to assist participants in generating energy savings and promoting organizational change. One the most important aspect of the cohort approach was the ability for participants to discuss successes and challenges with other participants. An ongoing relationship with participants was also important, as it allowed time to overcome both schedule-related and organizational barriers to success.

Regression analyses are an acceptable approach to identifying energy savings associated with SEM participation. Regression analyses should be designed to clearly present savings, and relate the savings to operational changes. Additionally, extrapolation of savings should be avoided to minimize the potential for error or uncertainty in the savings estimates.