Promoting Reliability of Industrial SEM Savings Through Multi Year Engagements

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ABSTRACT

Sustained, reliable energy savings is a common goal for both energy efficiency program administrators offering strategic energy management (SEM) programs and industrial participants. Bonneville Power Administration (BPA) has delivered SEM as a component of the Energy Smart Industrial (ESI) Program since 2009. BPA found that engaging participants for a three-to-five year period increases both the magnitude and reliability of energy savings.

The multi-year SEM engagements have two primary benefits:

- Increases the magnitude of energy savings. The magnitude of energy savings continues to grow as participants reach SEM maturity.
- Increases the reliability of energy savings. Ongoing performance tracking raises confidence in reported energy savings.

Even after the initial adoption of SEM practices, the trajectory of participant's energy performance is still unknown. Competing priorities and personnel changes may conspire to prevent SEM practices from maturing. Or, SEM practices may thrive in parts of the organization, but struggle to spread throughout the organization. Ideally, the SEM practices become embedded in the organization and continue to improve energy performance.

This paper describes the multi year engagement model for the ESI Program's SEM component, High Performance Energy Management (HPEM). The results from the first two HPEM cohorts (24 participants) demonstrate the value of longer engagements to both the ESI Program and participants. Case studies further illustrate the benefit of specific support activities.

Introduction – The Energy Smart Industrial (ESI) Program

In 2009, BPA launched the Energy Smart Industrial (ESI) Program, implemented by Cascade Energy, to increase industrial sector energy efficiency acquisition. The ESI Program is a comprehensive energy efficiency program, implementing both capital and behavior-based energy efficiency projects on industrial process and support equipment for industrial facilities of all sizes.

Since 2009, the ESI Program has collaborated with 112 retail utilities to complete more than 800 energy efficiency projects resulting in 750 Million kWh of verified first-year energy savings. Of the 750 Million kWh saved, nearly 50 Million kWh are the result of behavior change and operations and maintenance (O&M) improvements.

The ESI Program design pairs technical account managers with process or project specialists. The Energy Smart Industrial Partner (ESIP) is a technical account manager that works with the local utilities to assist industrial end-users in implementing energy efficiency projects. The ESIP helps identify potential SEM participants, educate potential participants on the benefits of SEM, and provides project support during SEM engagements. SEM coaches are the primary trainers, leading the SEM workshop and on-site SEM events. The ESI Program design is summarized in Figure 1.

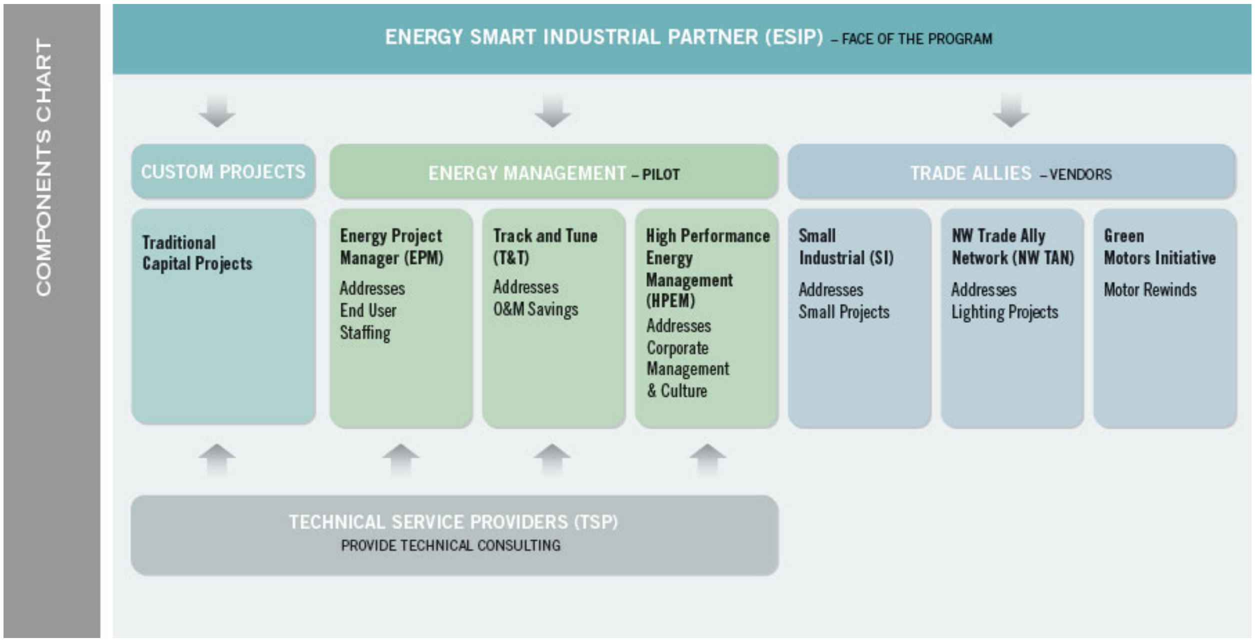


Figure 1. Energy Smart Industrial (ESI) Program Design.

High Performance Energy Management (HPEM)

HPEM is an SEM component of the ESI Program. HPEM assists end users in the development and implementation of an energy management system through a combination of workshops, on-site coaching, project support and energy modeling. The ESI Program primarily delivers HPEM as a cohort of geographically proximate facilities. Figure 2 illustrates the HPEM delivery model.

Since 2009, the ESI Program has delivered five HPEM cohorts reaching 35 industrial facilities with annual energy consumption ranging from 1 to 650 MWh ($50,000 - $30 million of annual electrical energy spend). The first two cohorts provide a rich data set to examine the results of multi-year SEM engagements at multiple sites from multiple industrial sectors (e.g., manufacturing, pulp and paper, food processing, fresh water and waste water). The ESI Program's first two cohorts are summarized in Table 1.

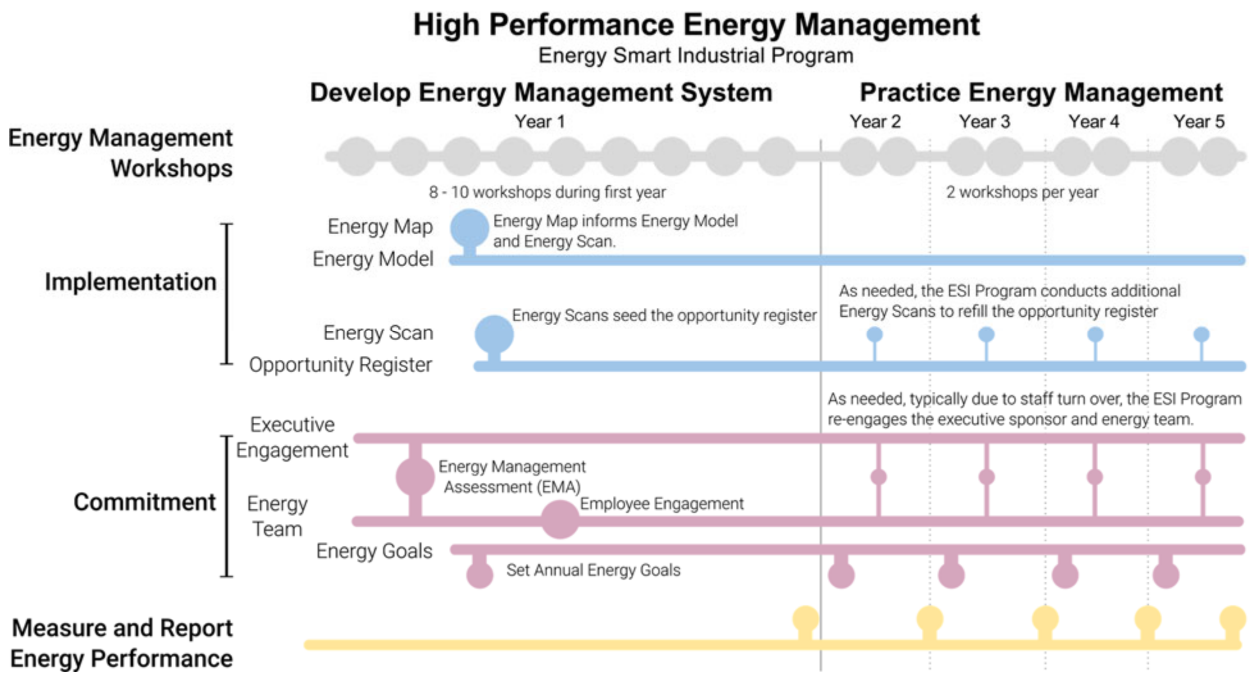


Figure 2. HPEM delivery model

Measuring energy savings

The ESI Program uses gross energy savings to evaluate the benefit of the HPEM component. Regression energy models based on whole-site energy usage (Amundson et al. 2013) measure gross energy savings. Gross energy savings include both energy saved from capital investments in efficient equipment (capital projects) and behavior-changes and O&M improvements (behavior-based). The ESI Program calculates behavior-based energy savings by removing the savings from capital projects calculated by a project specific measurement and verification (M&V) plan from the gross energy savings. The ESI Program tracks the persistence of energy savings and incremental energy efficiency improvements by measuring and reporting energy savings annually throughout the multi-year HPEM engagement.

Table 1. Summary of HPEM Cohort 1 and Cohort 2

Cohort Description				Gross Energy Savings Relative to Pre-HPEM Baseline			
Cohort	Started	# of Sites	Total Load	Year 1	Year 2	Year 3	Year 4
1	6/25/11	13	250 M kWh	3.9%	7.2 %	8.4%	10.2%
2	11/1/11	11	600 M kWh	0.8%	1.1%	3.1%	NA

Motivations for multi-year SEM engagements

BPA's goals for the ESI Program are to (1) acquire industrial energy efficiency to offset future generation requirements and (2) increase customer satisfaction. Industrial end-users participate in HPEM to reduce their operating costs. The ESI Program and participants achieve these goals through energy savings that persist beyond the first year. By implementing HPEM as a multi-year SEM engagement, the ESI Program has been able to increase both the magnitude and the persistence of the energy savings.

Figure 3 year illustrates the annual increases in both capital and behavior-based energy savings the ESI Program and HPEM cohorts have achieved. Both cohort 1 and cohort 2 demonstrate the desired outcome of the HPEM design: year-over-year increases in both capital and behavior-based energy savings over the course of the engagement. While the ratio of custom projects to behavior-based savings vary on a year-by-year basis due to budget cycles and site resource allocation, the long-term trends for both cohorts show a similar rate of improvement in each category.

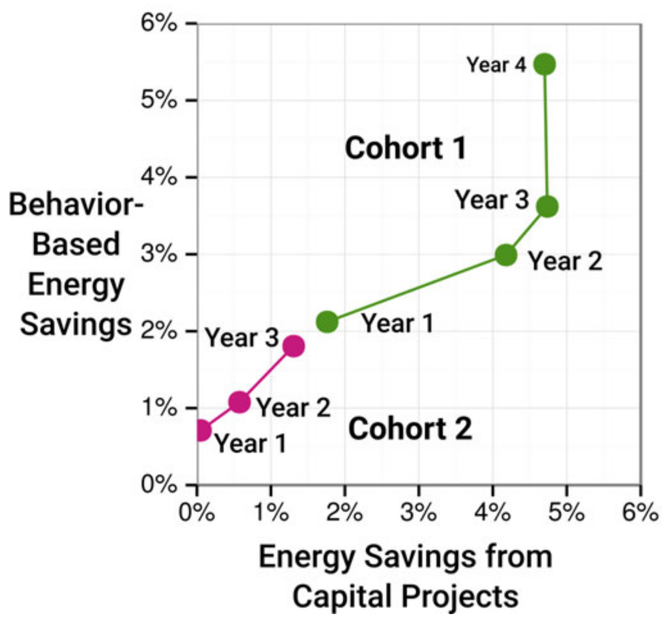


Figure 3. HPEM cohort energy savings by year. The difference between cohorts' energy savings as a percent of total load may be from the decision of Cohort 2's largest participant to focus on a section of their process.

Energy management maturity increases energy savings and reliability

SEM adoption can be segmented into three levels (1) Develop Energy Management System, (2) Practice Energy Management, and (3) Energy Management Maturity. The phases of

SEM adoption are summarized in Table 3. The ESI Program designed the HPEM Delivery Model (Figure 2) to support participants from the development of their energy management system to energy management maturity.

Table 3. Levels of SEM adoption

Attributes	Level 1. Develop Energy Management System	Level 2. Practice Energy Management	Level 3. Energy Management Maturity
Description	Develop the foundation to manage energy consumption	Systematically improves ability to management energy consumption	Resilient energy management system embedded in business
Program Involvement	High	Variable	Light
SEM Curriculum	Sequenced	Targeted	None
Energy Savings Measures	Focus on near-term 'wins' and simple measures	Increased level of complexity and implementation ownership	Larger number of process-oriented measures requiring organizational buy-in
Savings Persistence	Fragile	Durable	Resilient

During the first year, HPEM assists participants in the development of their energy management system. After completing the first year of an HPEM engagement, participants typically have established an energy team, set an energy goal, committed resources to achieving that goal, and engaged employees in saving energy. However, the time and effort required to develop an energy management system varies and the level of SEM adoption at the end of the first year varies amongst HPEM participants.

Some participants quickly develop an energy management system and transition to energy management practice. Others, typically larger participants, are still working on energy management development at the end of the first HPEM year. HPEM engagements longer than one year allow the ESI Program to provide support to help complete the development of any incomplete energy management systems.

Even after the first HPEM year, the trajectory of participant's energy performance is still unknown. Competing priorities and personnel changes may conspire to prevent energy management practices from maturing. Or, energy management practices may thrive in parts of the organization, but struggle to spread throughout the organization. Ideally, the energy management practices become embedded in the organization and continue to improve energy performance.

While the ESI Program's cohort-level results show steady annual increases in energy savings, the participants-level results are highly variable in (1) the pace of SEM adoption, (2) the depth of energy savings, (3) the interaction between capital and behavior-based energy savings, and (4) persistence of behavior-based savings. Figure 4 illustrates the variability in energy savings by participant.

The variability in participant-level results inhibits the ability for SEM program administrators to forecast energy savings. Only measured, not forecasted, energy savings are likely to be viewed as a reliable resource to offset future generation requirements.

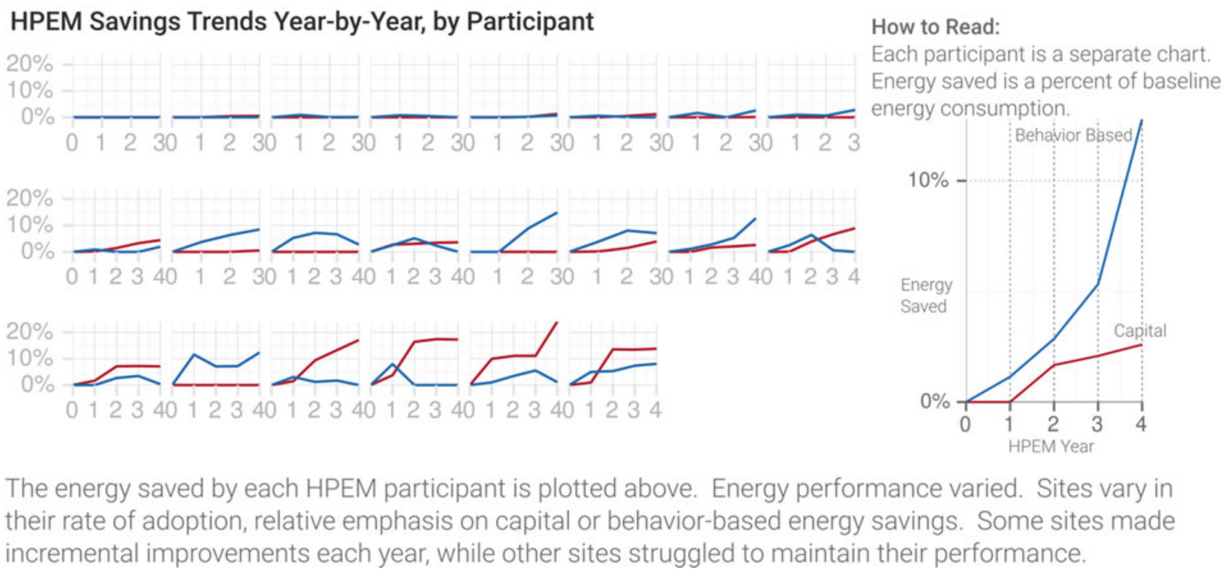


Figure 4. HPEM Savings Trends Year-by-Year, by Participant

HPEM Support Activities and Case Studies

At the conclusion of each annual reporting cycle, the ESI Program carefully plans the next year's proactive HPEM support, aimed at increasing the level of SEM adoption. Some HPEM support resources are reserved for reactive support to prevent energy savings backsliding. Typically, the budget for each of the following years is approximately 15% of the first year budget. The ESI Program is able to maximize the benefit of resources committed to continuing HPEM support by:

- *Lightening the touch.* Maturing energy management systems need less support than developing the energy management systems.
- *Tailoring the support.* Unlike during the first year, when all participants receive similar support, support during the energy management practice phase is tailored to the participant.

The following sections describe four key support activities provided by the ESI Program to HPEM participants: (1) workshops, (2) energy scans, (3) organization re-engagement, and (4) measuring and reporting energy performance. Case studies are used to demonstrate the value of the HPEM support activities.

HPEM Support Activity: Workshops

The ESI Program uses workshops to help develop participants' energy management system and to engage participants practicing energy management. HPEM workshops are summarized in Table 4.

Energy management development workshops - first year

During the first year, workshops are the most effective method of teaching energy management fundamentals to the participants. Workshops during the first year are typically a half-day (four hours) and feature a structured overview of core SEM concepts.. The order of the workshops matter, the topics are sequential and combine to form a curriculum.

Energy Management practice workshop – years 2-5

During the energy management practice phase, workshops serve to routinely engage energy champions. Compared to first-year workshops, much less content is presented. The workshops are shorter and more focused on peer-to-peer interaction. Workshop topics are requested by participants or chosen to address specific needs.

Table 4. HPEM workshop summary

Focus	Energy management development	Energy management practice
Year	First year	Year 2-5
Number of Workshops	8-10	2 per year
Length	4 hours	2 hours
Workshop Topics	HPEM kickoff Building an energy management foundation Monitoring, Targeting, and Reporting Identifying opportunities Efficiency opportunities in common Industrial systems Engaging employees in saving energy Celebration	Revitalizing your energy management foundation Strategies for maintaining the vitality of your Energy Team Overcoming barriers to change Energy wastes –applications for advanced energy teams Barriers in mature SEM organizations Energy efficiency communication
Agenda	Coaching – 50% Facilitated peer-to-peer sharing - 30% Program Administration – 20%	Facilitated peer-to-peer sharing – 60% Coaching – 30% Program Administration – 10%

The case study in Figure 5 demonstrates that sites with mature energy management systems are able to continue to build energy savings even with a light program touch. Continuing HPEM support encourages participants to take incremental steps towards significant energy savings that could not be accomplished within a single year. Participants are more likely to make adjustments to complex processes or sensitive equipment (pulp refiners in Figure 5) after validating the energy management process on small or less sensitive projects first.

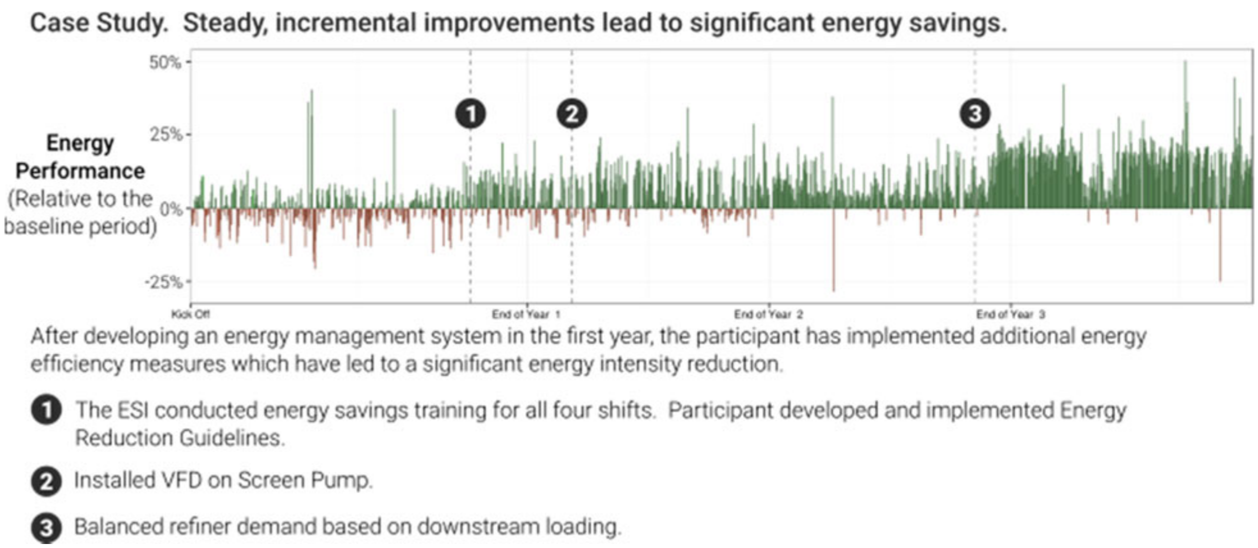


Figure 5. Case Study. Steady, incremental improvements lead to significant energy savings.

HPEM Support Activity: Energy Scans.

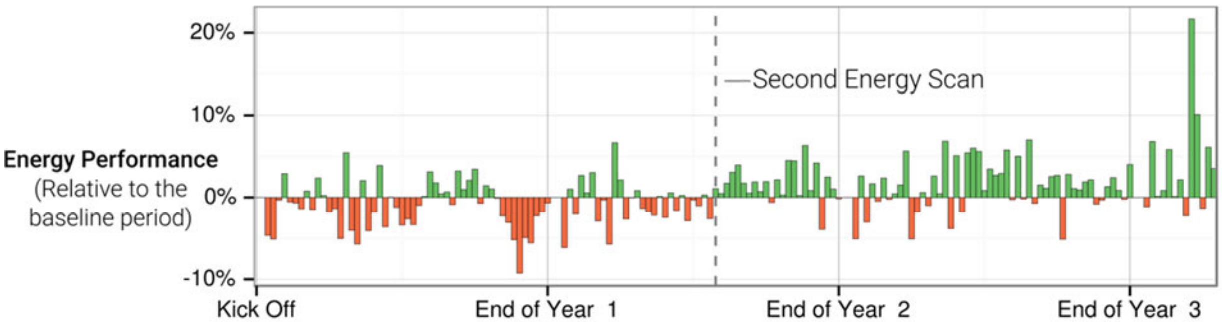
Energy scans are an extremely flexible tool for energy efficiency programs to help promote savings with their SEM participants. While energy scans are typically technically focused, the ESI Program uses energy scans to both develop energy efficiency measures and coach energy champions.

Potential outcomes of an energy scan include:

- Identify and prioritize energy efficiency measures, both capital and behavior-based
- Install sub-metering to identify opportunities, support decision-making, as well as provide a bottom-up sanity check of a measure’s energy performance
- Review previously implemented energy efficiency measures for backsliding
- Provide participant with a report for referencing throughout the SEM engagement
- Increase the Energy Champion’s ability to identify and prioritize energy efficiency measures.

The case study in Figure 6 demonstrates how, after a slow start, a second energy scan can refocus an energy management program by identifying immediately actionable, high impact energy efficiency opportunities.

Case Study - Second energy scan helps refocus energy management program after slow start.



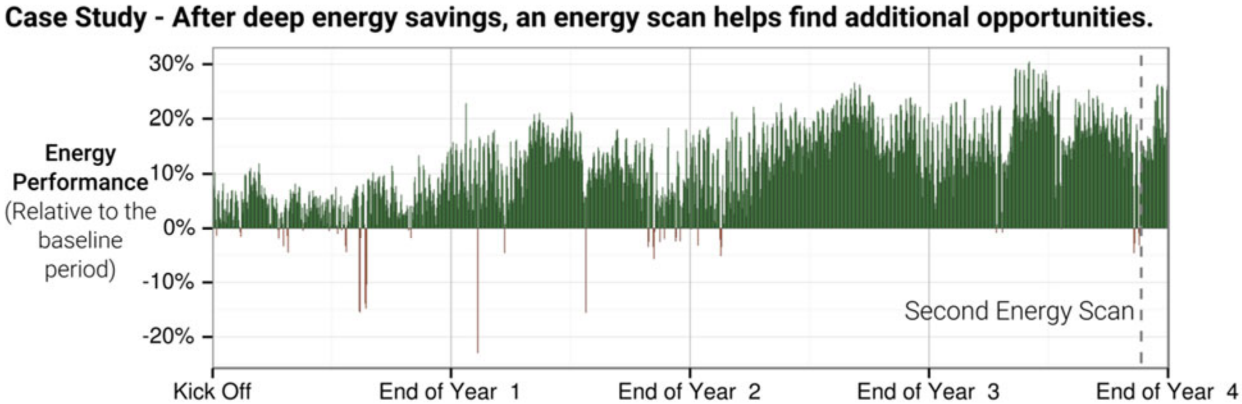
Size and complexity lead to slow start.
During the first year and a half a large pulp and paper mill in Cohort #2 struggled to reduce energy intensity despite establishing an energy team and committing to a savings goal. The size and complexity of the process overwhelmed the energy teams efforts to identify a focal area for O&M improvement.
The ESI Program met with the energy team and decided that the large horsepower pumps in the old corrugated cardboard (OCC) process represented a viable O&M opportunity.

Refocused.
The ESIP identified a pump O&M specialist, and together they facilitated a full-day Energy Scan in the OCC process. The group characterized impeller trim opportunities on 16 pumps. Eight high-potential opportunities were identified during the scan, and two impellers were subsequently trimmed.
The mill's energy model proved that trimming the impeller resulted in improved energy performance.

Figure 6. Case Study. Second energy scan helps refocus energy management program after slow start.

HPEM Support Activity: Organizational Re-Engagement

SEM is a people and systems-based approach to energy efficiency and, at the early stages, is often dependent on a key individual or small team.
When staff turnover or a changing business climate divert attention from the energy management program, the ESI Program has found SEM momentum can be regained through an on-site engagement designed to refocus the participant. Depending on the need, the ESI Program may engage the executive sponsor, energy champion, or energy team. The case study in Figure 7 explains how the ESI Program used a second energy scan to re-engage an energy team that felt they had run out of energy saving opportunities.



Successful energy management program

Even mature energy management programs benefit from occasional program support. A waste water treatment participant from Cohort #1 achieved consistent savings through the first four years of HPEM. By the end of Year 4, the participant had reduced their energy intensity by 17% through O&M and capital projects.

Outside perspective helps find additional opportunities

At the beginning of Year 5, the participant felt they had exhausted their ideas and requested ESI Program assistance to develop new savings ideas. The SEM coach along with ESI Program's waste water specialist facilitated a full-day energy scan. The group identified 19 energy savings ideas including high-potential, high-impact ideas related to O&M improvement of the scrubber fan, room air-change optimization, and improvements to solids inventory management.

Figure 7. Case Study. After deep energy savings, an energy scan helps find additional opportunities..

HPEM Support Activity: Measure and Report Energy Performance

While measuring and reporting energy performance throughout the HPEM engagement requires maintaining energy models, it also creates an opportunity to incent for incremental energy savings and persistence.

Energy Model Maintenance

Ideally, energy models would remain valid for the lifetime of the facility. In practice, energy models must make assumptions about products and production levels. However, in practice, new products and new production levels render models developed on the pre-SEM baseline unable to predict the current energy consumption. Without the revised energy models, program administrators would not be able to accurately measure energy performance and participants would no longer receive accurate feedback on their energy performance. The longer the SEM engagement, the more likely the model will need to be revised

Energy models may also be improved during a multi-year SEM engagement. As energy champions become more familiar with energy models, they may provide new and valuable insights on how to model energy performance or understand the value of additional data sets. The improved energy models reduce the uncertainty in reported energy savings.

Nine of 24 of the participant in HPEM cohort 1 and cohort 2 required revisions to their energy model after the first year. Several participants required multiple energy model revisions. Table 5 summarizes the HPEM energy model revisions.

Table 5. HPEM Energy Model Revisions

Reason for energy model revision	Process change or expansion	Improved model
Percent of participants requiring revision	30%	20%
Improvements made	Inclusion of new variable(s) New baseline to account for expansion	Model form improvement Reduced model interval Added variable Extended baseline

Incentives in a multi-year SEM engagement

Incentives serve a different purpose for behavior-based energy savings than they do for capital energy efficiency projects. Incentives offered for capital projects are designed to influence the purchasing decision. Incentives for capital projects help reduce payback periods by transferring some of the benefit of reducing the marginal cost of energy to customers paying a bulk retail rate.

While many behavior changes and O&M improvements are cost effective to SEM participants without incentives, financial incentives paid by the utility still help the adoption of energy management practices. The HPEM design of providing continuing support and reporting energy performance annually for three to five years creates the opportunity to reinforce the behavior change through incentives. Table 6 summarizes the benefits of incentives in a multi-year SEM engagement.

Table 6. Benefits of HPEM Incentives

Benefit	Description
Recruiting	Offering an incentive helps the ESI Program recruit participants. The potential incentive helps energy management compete with other priorities.
Visibility	Annual incentives increase visibility for the effort and promoting accountability for annual goal setting and reporting.
Persistence	Annual incentives encourage persistence. Backsliding results in a reduced incentive payment.
Incremental Savings	The possibility to increase incentives year-to-year helps motivate participants to continue improving their energy performance.

BPA is able to provide annual incentives for behavior-based energy savings and maintain resource costs below the resource cost of capital projects by offering an annual behavior-based incentive that averages one-sixth of the capital project incentive per kWh.

Options in engagement length

Since launching HPEM in 2009 with two fixed engagement lengths, BPA has realized the need for greater flexibility in engagement length. The 2009 HPEM design required utilities and participants to select either a five-year or three-year engagement prior to starting HPEM. Requiring a decision prior to the engagement and limiting the options prevented the ESI Program from accommodating the full spectrum of scenarios.

At the end of a three or five year engagement, some participants may still have a list of energy efficiency projects while other participants may not benefit from further engagement. In addition, participants undergoing significant expansion may be best served by an earlier "off-ramp" with the possibility for later re-engagement.

To accommodate the full spectrum of scenarios, starting October 1, 2015, BPA will replace the three-to-five year options with consecutive two-year performance periods. Participants' energy performance will be re-baselined each performance period.

Conclusions

HPEM engagements longer than one year benefit both participants and the ESI Program by increasing the magnitude and reliability of energy savings. The ESI Program has combined an intensive, standardized first year curriculum with a lighter, targeted approach in following years to maximum the investment of program and participant staff. Longer HPEM engagements increase program delivery costs, but the investment is worthwhile, especially if the reliability of energy savings is compared to the lesser reliability of energy savings measured over shorter engagements.

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References

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