The DSM Participant Experience Enhanced—How Energy Management Information Systems Impact Behavior-Based Programs

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ABSTRACT

Behavior-based programs, offered by utility demand-side management (DSM) administrators, encourage utility customers to think beyond a single project, or an occasional operations and maintenance (O&M) event. These programs ask that customers take a multifaceted approach to efficiency. Successful behavior-based approaches such as strategic energy management (SEM) and sub-system technical coaching achieve and maintain energy savings through O&M improvements and tracking savings over time. From a customer perspective, implementing and maintaining behavior-based improvements requires company-wide support and training. Innovative tools such as energy management information systems (EMIS) can enhance the customer's SEM experience and provide significant benefits to program administrators.

Several energy efficiency program administrators in the Northwest and Northeast United States, in partnership with Cascade Energy (an energy program delivery firm for the industrial sector), offer an EMIS in support of SEM. This program experience, grounded in a lessons-learned approach, demonstrates the many EMIS benefits to the customer and the DSM program administrator:

- A timely view of a facility's energy performance
- Visual display of how actions influence results
- Reflection of real-time changes in savings trends that promote learning and drive action
- Reduced burden of data collection and savings tracking
- Stronger connections between facility stakeholders and DSM administrators

This paper draws on the experience of several behavior-based programs that offer SEM with EMIS implementation at more than 50 industrial facilities. It describes successes and failures, and discusses lessons learned. It describes how EMIS is integrated into program design, and illustrates the ways EMIS has been used by participants, coaches, and administrators.

Introduction

Efficiency programs are increasingly improving their energy savings bottom lines with behavior-based programs that promote low- and no-cost energy efficiency improvements at industrial facilities. DSM programs reach beyond the single, capital project. They require executive commitment, efforts to help employees make better choices around energy efficiency, and ongoing analysis of energy savings from a whole-facility perspective. DSM programs take a multifaceted, long-term approach to energy efficiency. This approach demands new and better tools to manage projects and ensure participant success.

Cascade Energy is a program delivery partner for utility DSM programs, including Energy Trust of Oregon, Efficiency Vermont, and Bonneville Power Administration's Energy Smart Industrial (ESI). All of these programs offer behavior-based components for SEM and technical operator coaching—with EMISs playing an important role in driving participant success. In fact, more than 50 industrial facilities have used an EMIS in the course of their participation in one of these programs.

Effective Uses for an EMIS

The Northwest Energy Efficiency Alliance (NEEA) defines EMISs as "enabling tools that support users' efforts to improve the energy efficiency of their facilities by providing better access to energy and system data and by applying analytics to this data." (Heather et al. 2013) The use of the term *enabling tool* is appropriate because an EMIS alone does not save energy. When building owners implement energy-saving action and the savings are then validated by an EMIS, opportunities for increased efficiency can happen.

EMISs are Web-based, typically software-as-a-service applications. Each EMIS offers a method for acquiring interval energy data through data transmission hardware connected to site utility meters, or—increasingly, directly from utilities via secure file transfer protocol (FTP) sites. Effective EMIS tools meet the end user's needs for collecting, storing, analyzing, and reporting energy data. When used in the context of SEM and technical coaching programs, an effective EMIS:

- Displays current and historical energy data through charts and graphs
- Integrates energy driver variables—for example, production and weather data
- Incorporates multi-variable regression models to track predicted energy use from established energy drivers
- Compares energy savings to goals
- Supports action item tracking in an opportunity register

Behavior-based Programs and the Need for Better Tools

The Consortium for Energy Efficiency defines SEM 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" (CEE 2014).

In practice, SEM encourages building commitment, planning, and implementing energy efficiency projects, and measuring energy performance. SEM takes energy-efficient practices and applies them to operations and maintenance approaches throughout an industrial facility. Examples of utility-sponsored SEM programs are Energy Trust of Oregon's Corporate Strategic Energy Management and Efficiency Vermont's Continuous Energy Improvement.

Technical coaching programs, although not as broad in scope as SEM, address building knowledge around a particular sub-system. However, the goal is similar: to identify and implement O&M practices that increase energy efficiency. DSM-sponsored technical coaching programs can be described as "mini" SEM engagements, because they still require commitment and energy performance tracking, even if they are all about a specific sub-system. Examples of technical coaching programs are Energy Trust of Oregon's Refrigeration Operator Coaching (ROC) and ESI's ROC Track and Tune.

EMISs serve both SEM and technical coaching programs in four important ways. First, SEM and technical coaching place a strong emphasis on regularly tracking performance to understand the impact of improvements over time—both while participating in a program and beyond. Monitoring performance requires data on energy use, production, and weather. In a utility-sponsored SEM or technical coaching program, participants must share data with program administrators to develop an energy model and analyze energy performance. Utilities also need to share data analyses regularly with customers. An EMIS makes it possible to quickly, easily, and securely represent and share visual energy information with multiple parties. These might be energy champions, executive sponsors, energy team members, or program staff.

Second, an EMIS provides a central location for documenting and storing information related to a customer's SEM engagement. SEM and technical coaching programs uncover many no- and low-cost energy efficiency opportunities. For example, an industrial site practicing SEM often maintains a list (sometimes referred to as an *opportunity register* or *action item list*), of energy-saving opportunities. A typical list might have 20 to 80 items, and is used as a project management tool to track execution. Each opportunity comes with its own benefits and challenges, so clear communication and effective project management are necessary to ensure smooth and timely implementation.

Third, EMISs help SEM and technical coaching programs connect actions to results. An SEM participant ultimately wants to understand how energy efficiency efforts affect actual energy performance at their facility. A modern EMIS provides both energy performance data and action item data, so that site personnel can access visual representations of energy performance overlaid with information on when O&M actions were completed. This allows site personnel to see the improvements and understand the results of specific actions.

Fourth, an EMIS can be used to increase an entire organization's awareness of energy efficiency and to engage staff and executives in the energy management process. Energy managers can more easily communicate with employees through the EMIS's automated reports that provide relevant visuals of energy performance. This kind of communication promotes transparency, and accountability helps increase executive support. It also deepens interest, understanding, and engagement around energy efficiency—up and down an entire enterprise.

How EMISs can be Integrated into DSM Programs Effectively

Programs such as those in Oregon and Vermont, and the BPA's, use the EMIS in very similar ways. Table 1 summarizes those similarities and differences.

Table 1. Summary of EMIS use by efficiency program

	Energy Trust of Oregon	BPA (Track and Tune)	Efficiency Vermont
Included with DSM program offer	Strategic Energy Management (in some but not all cases), Refrigeration Operator Coaching	Track and Tune	Continuous Energy Improvement

	Energy Trust of Oregon	BPA (Track and Tune)	Efficiency Vermont
Cost	Energy Trust pays for a subscription to EMIS software and for hardware (or data integration); customer is given the hardware; customer pays for utility meter upgrade (where necessary) and hardware installation	Utilities may co-fund performance tracking hardware and software, up to program-defined limits	Efficiency Vermont provides the customer with 75% cost share for all related first-year costs. Hardware, integration, software, installation, all fall under this category
Software subscription terms	Two years; site can continue on their own afterward	Three or five years, depending on SEM engagement period selected by serving utility	One year; site can continue on their own afterward
Energy data transmission	Typically hardware installed on a utility meter to transmit use to EMIS. Uses FTP data transmission with some utilities to replace hardware requirement	Typically hardware installed on a utility meter to transmit use data to EMIS	Typically hardware installed on a utility meter to transmit use data to EMIS. When available, integration with onsite metering systems and databases for sub-meters
Production data transmission	**Standard method:** Participant uploads data to secure FTP site, from which it is automatically pulled into EMIS	**Standard method:** Participant provides production data to ESI to upload. **Preferred method:** Production data are automatically transmitted via FTP	**Standard method:** Participant provides production data to program manager to upload. **Preferred method:** Production data are automatically transmitted via FTP
Users	User accounts given to all relevant ETO representatives. User accounts given to Energy Champion and Executive Sponsor at a	User accounts given to all relevant BPA ESI representatives. User accounts given to Energy Champion and	User accounts given to all Efficiency Vermont representatives. At each customer, Energy Champion and Executive

	Energy Trust of Oregon	BPA (Track and Tune)	Efficiency Vermont
	minimum; others, where requested	Executive Sponsor at a minimum; others, where requested	Sponsor at a minimum, others where requested
Energy model integrated	Yes	Yes	Yes
Email reports	Weekly is the default, more frequently at site request	Weekly is the default, more frequently at site request	None provided at this time
Opportunity tracking	Opportunities added and updated by program participants and key staff; selected project files are uploaded to the EMIS and shared through e-mail	Opportunities added and updated by program participants and key staff; project files are uploaded to the EMIS	Opportunities added and updated by customer and program staff. Action items: organizational opportunities identified in the energy management assessment, and technical opportunities identified by program staff and customers
Training	Webinar on using EMIS; integration of EMIS into ROC workshops; illustrates results and offers lessons learned. EMIS reviewed during SEM energy team meetings	Individual training provided via webinar, or in person by ESI Partner	Three-part webinar training: EMIS Intro, Explore Deep Dive, Act Deep Dive

Demand-Side Management: Program Manager Perspectives of EMISs

To understand the impact of EMISs on DSM programs, the authors conducted interviews with program managers representing the three efficiency / DSM programs shown in Table 1. The questions revealed the benefits, challenges, and unexpected results of using an EMIS. Six findings from these interviews further illuminate the benefits and challenges of using an EMIS. SENSEI® was the EMIS used in most of the projects discussed below. However, other EMISs, such as eSight Energy, have also been used in DSM settings.

1. Although energy use information is interesting, the dynamic display of energy model results is the biggest value-add of an EMIS. During each interview it became very apparent that it is difficult to talk about EMISs without talking about the impact of incorporating an energy model. Energy Trust of Oregon cited the greatest value of an EMIS as the ability to show predicted versus actual energy use. Essentially, it is one thing to track energy use, and another to track energy use relative to key production variables or indicators.

EMIS tools provide real-time, or close to real-time, energy data. But given the complexity of many industrial facilities, looking solely at energy use without considering other important energy drivers such as production levels and weather does not always lead to information an energy manager or energy team can act on.

Actionable information is an important part of SEM. Facilities practicing SEM learn to implement energy-saving opportunities and then monitor energy performance to ensure that long-term savings are achieved and maintained. Tools that easily and consistently deliver actionable information to the right people are critical. For example, Energy Trust believes that if someone in management asks, "Are we using more or less energy than we should be?" an energy manager can point to the "predicted vs. actual energy-use model" in an EMIS and say with confidence, "Here's our energy use. And here's what the model says we should be using, given our recent production activity. Even though our bill says energy use is up, you can see that we're actually saving energy."

Administrators at Efficiency Vermont looked for something more dynamic for their customers. Although they periodically send end users Excel files, what they find beneficial about an EMIS is that customers can view a Web-based visual model that is continually updated.

For the display of energy model results, the program administrators interviewed for this paper typically used a "predicted energy vs. actual energy" chart to compare modeled results to actual energy use. This approach can be taken further by mapping the cumulative differences between the predicted and actual energy use over time, via a cumulative sum (CUSUM) chart. The CUSUM shows the amount of energy savings achieved, and how the rate of accumulation changes over time.

2. An EMIS connects actions to results. Another benefit of using an EMIS is the ability to draw a correlation between energy results and energy-saving actions. Efficiency Vermont and other program providers must track customer actions and attribute them to energy savings indicated in the energy model. The EMIS brings actions and results together on a participant's energy-performance chart. Seeing these results on the same chart has been critical to influencing change at an end-user's site. For example, a site practicing SEM might use a chart similar to the one presented in Figure 1. It shows the CUSUM line (or energy savings line) in pink, increasing as energy-saving actions are implemented (indicated by red and yellow-numbered blocks) over time.

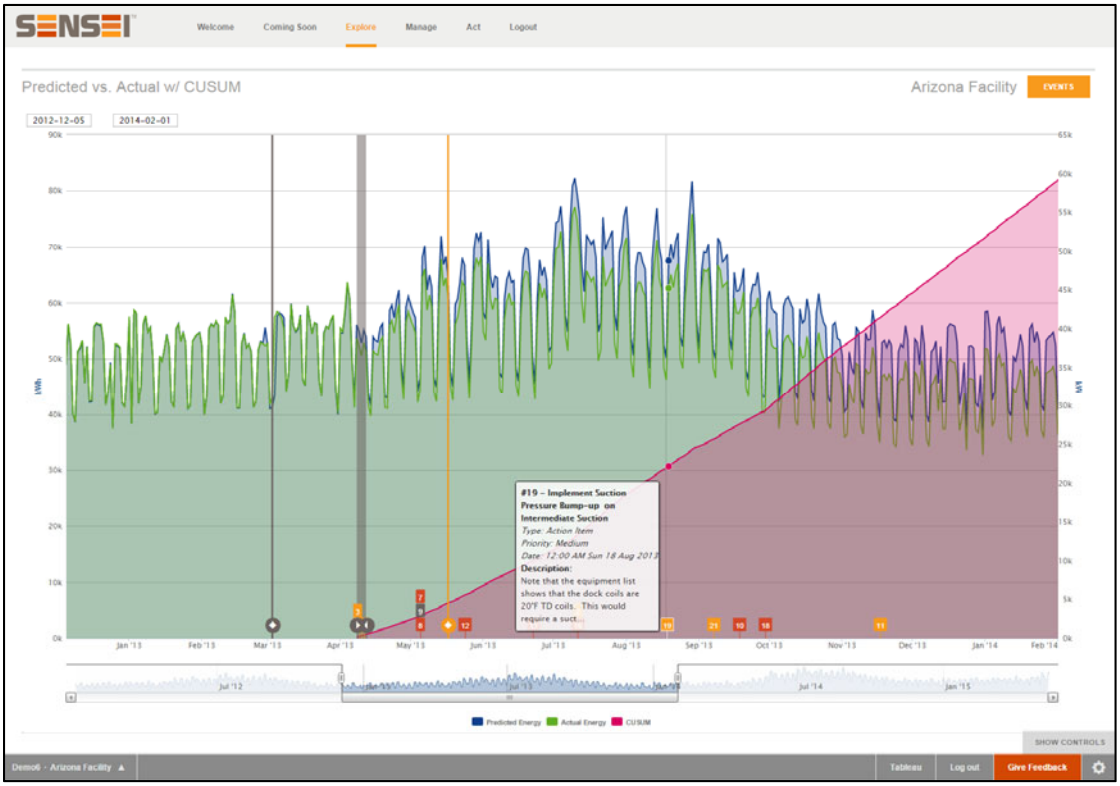

Figure 1. Sample EMIS chart showing energy model results overlaid with completed action items.

3. EMISs offer a secure method of receiving, storing, and sharing data. DSM program components that use facility-level data analysis typically require a significant amount of data sharing. This involves sharing data and results between an end user and efficiency program administrators. End users are frequently asked to share sensitive data, such as daily production totals, or other data that provide insight into their operations. Not surprisingly, data security is an important topic. Bonneville Power Administration's ESI Program is concerned with data security. ESI finds that using an EMIS's secured system with authorized users, and different levels of permissions for different types of users, is a more secure solution than e-mailing Excel files.

EMISs typically use rigorous security protocols, often as strong as those used in the banking industry. An EMIS also provides a central location from which approved users can access relevant program data. For example, Cascade Energy's SENSEI EMIS allows program managers to view data from multiple sites, whereas end users see only their respective sites' data. Energy data transmitted directly to an EMIS minimizes the potential security risks that arise when e-mail is used as a file transfer protocol.

4. An EMIS fosters better and closer relationships with end users. There are strong indications that the presence of an EMIS can help build closer relationships with end users. Both program managers and delivery contractors can view a site's energy performance remotely, via the Web, with little to no effort on the part of the facility. In the absence of an EMIS, an end user typically needs to send energy use data manually to program administrators. Efficiency Vermont has discovered the benefit of being able to view a customer's model before calling the customer to have an informed conversation about energy performance. Efficiency Vermont has discovered

that their EMIS has offered them more, valid reasons to contact customers and to have deeper, more meaningful, conversations about energy improvements in customer facilities.

The ready availability of EMIS data also engages an end user in the SEM process more deeply. In BPA's experience, an EMIS makes obtaining data a value-add for the end user. Now the end user can do something with the data, instead of merely shipping it off to their program provider and receiving a model in return. From an end user perspective, managing energy data can become a valuable part of the process, rather than just a chore. End users can easily access the data, use the data, and draw conclusions from them.

5. Making energy data flow into an EMIS can be hard, but it is becoming easier. Although technology has made the flow of data from an industrial site into an EMIS easier, the process can still be difficult. One of the challenges BPA has encountered with EMIS data involves obtaining high-quality data and entering those data into an EMIS. It is easy to underestimate the hardware that needs to be installed to produce meaningful data at the site level. This was an initial surprise for BPA—that an EMIS doesn't resolve all data acquisition problems.

For the three cited DSM programs, the most common method of entering energy data into an EMIS is through data transmission hardware connected to a utility meter. The hardware transmits the metered data over the cellular network to secure EMIS servers. The technical questions that need to be answered: Which utility meters should be included? Are the utility meters capable of the correct output signals? If not, who is responsible for upgrading the meter(s)? Further, in most cases, a certain threshold of technical expertise is necessary to install the required hardware.

Some end users have the technical capability to transmit energy data automatically through secure FTP or other Internet protocols, via an existing on-site data collection system. Although this approach alleviates the need for hardware installation, it does require specialized expertise to program and maintain the data link.

Another option is to feed energy use data directly from a utility to a third-party EMIS, via secure FTP, or other Internet protocols. This approach requires setting up only a secure data transmission between the utility and the EMIS, with no additional hardware needed. This option benefits the end user by minimizing both effort and cost—but at the expense of a slower data refresh rate.

The effort and cost of getting data into an EMIS varies according to the number of metering points, hardware requirements, and skills required of the personnel implementing the solution. This cost is coming down with the introduction of newer, less expensive hardware, and a more streamlined onboarding process.

Determining the best approach and then executing it can take time, especially if it is not managed well. Efficiency Vermont sometimes considers the potential impact a delay has on customer engagement. One of Efficiency Vermont's tallest barriers is getting the implementation to happen quickly. Staff do not want to risk losing their customers' focus and attention because of a delay in implementation. Those delays are often exacerbated by a customer's internal struggle with identifying the best method for obtaining data from their facility.

Program representatives should have a clear understanding of an end user's situation, needs, and level of expertise. They must communicate a path forward, by identifying critical decision points and resources required to transmit energy data into the EMIS.

6. Transmitting production data into an EMIS is critical, and often challenging. With the energy model critical to the value of the EMIS, it is only as good as the production, or other energy driver, data fed into it. For example, an SEM participant's energy model might contain total daily production, by product type. Regularly using the model to manage energy performance requires that total daily production, by product type, is routinely sourced and transferred to the EMIS. Therefore, it is important to clearly define and implement a process for loading energy driver data into the EMIS.

Organizational and technical capabilities for transferring production data are developing quickly. In Cascade Energy's experience, this process has evolved from the basic approach of e-mailing spreadsheets to implementing a manual, secure FTP data transfer from a client site. In some cases data are pulled manually from an FTP site and fed into the EMIS, and in others, the data are automatically transferred. Either way, the end user must still provide production data manually. The consistency and regularity with which that task takes place can vary. This is heavily influenced by the site's preference for data review and the guidance it receives from SEM program delivery personnel. In Cascade's experience, site managers providing production data manually, and which then are uploaded to an EMIS generally do so once per month.

Many Energy Trust customers find the Excel .csv file conversion to an acceptable format—and the FTP upload process rather daunting. The barrier is not just a technical one, but also process-oriented and behavioral. Program delivery staff must train someone to feel comfortable with regularly preparing a data file in exactly the right format, to confirm it doesn't overwrite legacy data, and to verify that the data showed up correctly in the EMIS. This is a tall order for some participants. In situations where a manual step is required, there is clear value for the EMIS tools that greatly simplify the process of entering data. Data conversion tools are currently being piloted to address this inconvenience.

Automating the production data delivery process can open up plenty of opportunities. Although it is still a rare procedure, a handful of participants in Energy Trust and BPA ESI programs have "wired" their production data directly to an EMIS. For BPA, the more automatic the delivery of model results and the shorter the time between deliveries, the more meaningful the model is to a program participant. However, data integration **is** a challenge. BPA has only three sites that have production data fully wired to their EMIS.

Production data that are transferred automatically require a relatively high level of technical expertise on the part of the end user. These engagements have typically used an automated production data export from an end user's data historian or inventory management system, via a secure FTP transfer directly to the EMIS. This approach requires the end user's underlying data capability and programming ability to build and maintain the data transfer.

Transmitting production data into the EMIS often results in a strong engagement with the energy model. A food processing facility conducting a BPA ESI Track and Tune project incorporated a daily review of energy model results during their regular morning management meeting. The automated feed of production data enabled the team to easily review energy data each day. Furthermore, this particular site reviewed performance with an automated e-mail report sent directly from the EMIS. The site rarely logged into the EMIS, preferring instead to rely on the automated e-mail reports showing up in their inbox.

A recent Energy Trust customer also implemented an automated production data transfer. In this case, the site was very committed to reviewing their model results. Toward the end of their SEM engagement, the site manager looked at its energy model each day, and noticed a decline in energy performance, despite recent energy efficiency improvements. Because their

key model data were transferred automatically, the energy team could focus on what to do about their declining performance.

7. Existing information systems (or models) affect the extent to which end users adopt EMIS. The adoption of EMISs by program participants is a complex topic. The general goal is for the customer is to use the EMIS regularly to manage and record SEM efforts, including tracking energy performance and documenting energy-saving activities. How successful an efficiency program is in encouraging this adoption appears to be influenced by the systems and metrics already in place at a site.

Efficiency Vermont found that sites with no energy metrics and no EMIS quickly embraced the EMIS's ability to allow them to view their energy use patterns relative to internal energy drivers. However, in cases in which customers already had well-developed systems, program delivery staff had to work harder to demonstrate the benefits of an EMIS. Efficiency Vermont encountered difficulty in convincing customers with existing systems that the EMIS offered additional benefits. In some cases, end users might first need to be convinced of the value of an energy model before they understand the value of an EMIS. In such cases, the customers might agree to use another tool, in addition to what they already have, to track results.

BPA ESI has had a similar experience. One customer had an existing model for costing energy use against production. It took time to help the customer understand that while the model might have been good enough for accounting, it wasn't enough for utility resource acquisition. Thus, it has been easier to "sell" a great model to customers who don't have one than it has been to explain the limitations of an in-house model and tell them why they need a better one.

What's Next for EMISs?

Each efficiency program administrator shared their thoughts about using EMISs in behavior-based programs:

Use EMISs to Engage All Employees

In the context of efficiency programming, an EMIS typically can engage a relatively small group of individuals at industrial sites. However, it makes sense to find ways to engage a wider audience. According to Efficiency Vermont, an EMIS engages the facility manager, energy team, and maybe the operations manager. That program administrator hopes to use the EMIS to engage a customer's entire employee base by displaying EMIS data to an entire facility. This approach is expected to help a workforce understand what their company is spending on energy. This would particularly be the case if this information were to be communicated in relevant terms such as energy use sufficient to power X number of homes. One aspect of future development for an EMIS would be to build features and tools that make it easy for an energy team to reach out facility-wide and communicate resonant energy information in an interesting and easy-to-understand way.

Move Beyond Facility-wide Performance to Sub-system Performance

An important element of an SEM program requires that participants more fully understand the performance of major energy-using sub-systems, to optimize their efficiency.

Sub-system optimization is currently the primary feature of technical coaching programs. Collecting and analyzing critical sub-system data in an EMIS environment might result in discovering more opportunities to drive increased efficiency and yield higher energy savings.

BPA's ESI program is testing this idea in its ROC program. One ROC participant "wired" control system data from its industrial refrigeration system directly to their EMIS. Program delivery staff were able to directly monitor refrigeration system performance, which really improved the conversations about possible efficiency ideas. Efficiency Vermont has recognized the EMIS potential as well, and is planning to implement EMISs with a SEM cohort of companies targeting industrial refrigeration systems.

Integrate EMIS Further in SEM Curricula

Utility efficiency programs use SEM teaching curricula to help customers establish SEM programs. An important part of teaching SEM is helping utility customers become more proficient at visualizing and interpreting energy performance data. Therefore, EMIS is a tool that should be further integrated into the curricula used to teach SEM. For example, EMIS can be used in a workshop setting to quickly and easily show different visualizations that emphasize SEM concepts.

Evolve EMIS Modeling Capabilities

The energy model is clearly the most attractive feature of an EMIS. Continuing to evolve how EMISs support energy modeling will enhance DSM program delivery.

Energy Trust envisions attempts to create very simple standardized models that are built in to an EMIS, such as a simple analysis of key performance indicators. End users could run the analysis and check out the results to see if they are useful or make sense. This approach would quickly put information back into the hands of end users, potentially easing the task load of program delivery staff.

Further, EMISs can be improved so that interval energy data might be captured. Such data provide a detailed view of how energy use varies from hour to hour (or more frequently), and does not rely on a model or the entry of production data. The variation seen in interval use data often facilitates valuable conversations between energy team members, executive leadership, consultants, and others. For example, a facility might operate five days a week, but interval data would reveal periods of abnormal high use during weekends when energy use is expected to be low. EMISs can evolve to provide visual tools that reflect on historical energy use and help energy teams identify anomalies and potential energy efficiency opportunities.

Use the EMIS as a Customer Relationship Management Tool

As utilities and end users become more involved in generating and storing data and saving and managing energy, the EMIS could become a key part of integrating and coordinating services around those processes. Energy Trust sees an emerging need for this functionality. The EMIS is part of a culture change that takes place in SEM and which allows other energy services to evolve (with demand response, for example). Energy Trust sees the EMIS, at the end-user level, as a whole new central nervous system around energy services that utilities will provide.

Conclusion

The nature of SEM and technical coaching projects delivered by DSM programs foster a need for tools that help track energy performance and activities related to efficiency. Energy Trust of Oregon, BPA ESI, and Efficiency Vermont, in partnership with Cascade Energy, have integrated the EMIS into their delivery of behavior-based programs. Though not without challenges, these efforts have been successful overall, and much has been learned about improving the integration of EMISs for the future.

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