Features and Performance of Energy Management Programs

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Executive Summary

KEY TAKEAWAYS

- Strategic energy management (SEM) energy efficiency programs provide customers with a structure and methodology for saving energy. Originally focused on industrial customers, these programs are increasingly targeting commercial and institutional facilities. SEM drives energy savings through operations and maintenance (O&M) actions and increased capital project activity. It also increases participation in other utility programs.
- Energy management information systems (EMISs) can increase energy savings by automating data collection; integrating energy and manufacturing processes or building variables; reporting; and analysis.
- We have identified 27 SEM programs serving commercial, industrial, and institutional customers in the United States and Canada. Eleven program administrators offer programs that focus on EMIS systems and 14 more have SEM programs that support EMIS installations. More programs are coming.
- Integrating EMIS into SEM programs can boost the effectiveness of both approaches and maximize energy savings.
- SEM programs are a platform on which utilities can build long-term relationships with their larger customers and through which they can introduce these customers to other programs.
- Once program implementers get customers to make a commitment to continuous improvement, the discussion becomes what to do rather than whether to do something.
- To encourage the growth of SEM, regulators and policymakers should evaluate SEM program performance at the portfolio level and avoid requiring every program component to be cost effective or show positive results every year. Programs should get credit for the increased persistence of the savings they facilitate.

STRATEGIC ENERGY MANAGEMENT PROGRAMS

Strategic energy management (SEM) is a method of managing energy that uses techniques for continual improvement and takes a systematic approach to energy performance. SEM involves at a minimum the following three elements: commitment, energy management planning and implementation, and a system for measuring and reporting performance. We have identified 27 utilities and third-party administrators in the United States and Canada that offer SEM programs to their larger commercial, institutional, and industrial customers. SEM participants establish clear metrics to identify energy-saving opportunities and track reductions in energy use. Energy coaches help customers implement these changes. Many programs also provide incentives for operational improvements and capital investments.

SEM programs across the United States and Canada have reduced both electricity and natural gas usage. They can achieve 6–10% energy savings in the first year of program engagement and more persistent energy savings than many conventional programs offering technical and financial assistance. SEM programs can also yield many nonenergy benefits such as raw material and water savings, and waste and pollution reductions.

Evaluators of SEM programs often use a whole-facility approach to measurement and verification (M&V). In addition to measuring energy savings, they may use such metrics as customer satisfaction, continued program engagement, and participation in subsequent energy efficiency programs. Evaluations indicate that program participants implement more projects than their nonparticipating counterparts do and are more likely to take advantage of financial incentives. Program recruiters may leverage the positive experiences of participants to encourage other organizations to join their programs.

PROGRAMS INCORPORATING AN ENERGY MANAGEMENT INFORMATION SYSTEM

A number of SEM programs support energy management information systems (EMISs). EMIS software and hardware systems help organizations manage their energy use. The software is often provided through a software-as-a-service (SaaS) arrangement. EMISs can integrate advanced sensors, connected devices, networks, data analytics, and predictive modeling to harvest, analyze, and display energy data. EMISs are attractive to managers of large manufacturing concerns because they enable data-driven energy management.

We have identified 11 administrators that offer EMIS-only programs. Fourteen others offer some level of assistance for EMIS installations as part of their SEM offerings. A few EMIS programs target only the commercial sector or the industrial sector, while others welcome participants from both.

As with SEM programs, evaluators of EMIS often use a whole-facility approach. Attribution of energy savings is a key challenge. For example, should the savings an EMIS makes possible through superior control of a heating, ventilating, and air-conditioning (HVAC) system be attributed to the EMIS program or to a financial incentive program that helped cover the cost of purchasing the HVAC?

COMBINED SEM AND EMIS PROGRAMS

A study done by the Consortium for Energy Efficiency (CEE) found that SEM, EMIS, and combined programs saved a total of close to 324 gigawatt-hours and 9 million therms in 2016.[1] Combining SEM and EMIS in one program has the potential to produce greater customer energy savings through the synergies of the two tools while also decreasing administrative costs.

Some programs are already taking this approach. Several SEM programs have integrated technical and financial support of EMIS audits into their services. A couple of EMIS programs are helping customers implement energy management systems such as ISO 50001.

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[1] J. Burgess, *CEE 2017 Strategic Energy Management Program Summary* (Boston: Consortium for Energy Efficiency, 2018). library.cee1.org/system/files/library/13619/CEE_2017SEMProgramSummary.pdf.

Programs are serving: commercial, institutional, and industrial customers. Many use a cohort approach that combines trainees from multiple locations and leverages group learning. Some also engage larger customers one-on-one with tailored services. The trend is to get program participants to start using a systematic approach to energy management and then take them as far along the path to full implementation and certification as they are willing to go, and as far as makes economic sense to them and the program.

Not all customers are prepared to invest and implement technologies like EMIS. Implementing an EMIS takes a level of comfort with technology and a willingness to invest the time and resources to exploit its benefits. For customers prepared to make the commitment, programs can perform EMIS audits to identify available data streams and data needs, and then develop plans and business cases for connecting the two with technology appropriate to the customer's capabilities.

Programs should have staff expertise appropriate to their customer base. Several existing SEM programs (for example, those offered by Energy Trust of Oregon and Bonneville Power Administration) have recruiters and energy coaches with expertise in areas like metal casting, fabrication, and food processing. At a minimum, dedicated teams should be formed to engage commercial and industrial customers.

The potential for SEM programs is considerable. In 2015 ACEEE performed a top-down analysis of the potential energy savings from SEM programs nationally. It found that savings could reach 7 terawatt-hours per year for the commercial sector and 24 terawatt-hours for the industrial sector by 2030. That is equivalent to the all electricity sales in Nebraska in 2017. The current trend in the growth of such programs, both in number and in scope, will achieve less than one-tenth of this volume of savings by 2030. There is ample opportunity for more administrators to offer SEM programs and for existing programs to expand in scope.

RECOMMENDATIONS

- Utilities and third-party energy efficiency program administrators should continue to expand SEM offerings to commercial, industrial, and institutional customers, using them as a platform for customer engagement. They should offer programs that engage customers over longer periods of time or continually.
- Program designers should integrate data management technologies like EMIS into their programs, meeting customers where they are in terms of their familiarity with management systems and their technical expertise.
- Evaluators should assess the energy savings from program participants using whole-facility methodologies. Regulators should consider the performance of SEM programs not in isolation, but as an integral contributor to the performance of their larger portfolio of technical, financial, and market transformation programs targeting the same customers.
- Electric, natural gas, and water utilities should seek opportunities to collaborate in the delivery of SEM programs.
- Policymakers should encourage multi-utility collaboration.

Introduction

Large customers, those with annual energy costs in the hundreds of thousands or millions of dollars, represent some of the biggest cost-effective opportunities for utility-sector energy efficiency programs. However they are often a challenging customer segment to serve. Decision makers may not see energy efficiency as a priority, they may be located outside a program's service territory, and they may have preconceived notions that programs are bureaucratic and unresponsive to their needs. They may also be unfamiliar with the benefits of efficiency programs and therefore reluctant to participate.

Many efficiency programs aimed at industrial, commercial, and institutional customers focus on installing particular energy-saving measures such as efficient lighting; heating, ventilating, and air-conditioning (HVAC); and industrial equipment. Program elements may include technical assistance, financial incentives, and trade ally networks.[2] In recent years, a new kind of program has emerged that takes a systematic approach to saving energy rather than offering individual hardware measures. Called strategic energy management (SEM), these programs help companies map their energy use, establish standard practices for energy management, teach workers to identify and quantify energy-saving opportunities, and set up data review and reporting systems. Most important, they aim to change the company's culture of energy use and to place the responsibility for energy savings not so much on equipment and processes as on all the people in the enterprise. To achieve this, SEM programs require organizational commitment from program participants, engage them in energy management planning and implementation, and help them develop a system for measuring and reporting performance.

Another set of large-customer efficiency programs focus on hardware and software systems that automate the collection and analysis of energy data. These systems include sensors, connected devices, networks, and data analytics. When they are advanced enough to anticipate future conditions and offer optimal energy-saving solutions, they are called "smart" technologies. A familiar example from the residential sector is the learning thermostat. They save energy through observation, analysis, and prediction. In the industrial, commercial, and institutional sectors, some efficiency programs offer a data management and analysis technology called an energy management information system (EMIS), a broad family of hardware and software systems that help organizations manage their energy use. The overarching motivation is that better management of energy data can lead to more energy savings.

This report investigates these two emerging focuses of energy efficiency programs, SEM and EMISs. It is intended to help program stakeholders—utilities, third-party administrators, evaluators, and policymakers—understand SEM and EMIS and the programs that leverage them to save energy. It explores the prevalence, features, and reported savings of SEM and EMIS programs along with the challenges they face, with a view to encouraging stakeholders to facilitate their offering, refine their components, and increase their prevalence. It also considers a third avenue. Both SEM, a workforce development tool, and

[2] Trade allies are vendors and trade associations that help promote programs and deliver services.

EMIS, an automation tool, are promising models, and the two practices are complementary. Some utilities and third-party program administrators have combined them. This report examines the additional benefits these combination programs provide and discusses additional challenges they face.

Methodology and Report Outline

This study attempts to answer several questions:

- Which states and utilities are currently implementing SEM programs? What practices are yielding the greatest success, and what has been their impact to date?
- How common is the use of technologies like EMIS in efficiency programs?
- What does it take to have a successful SEM or EMIS implementation?
- What program activities drive energy savings?
- Which new sectors are programs targeting?
- Which policies encourage program administrators to include SEM and EMIS in their portfolios?
- What results might be possible with greater investments in SEM and EMIS by efficiency programs?

To answer these questions, we conducted a literature review, interviews with program stakeholders, and a survey of experts. Much of the data on SEM program performance comes from research by the Consortium for Energy Efficiency (CEE).[3] It surveyed its members about their SEM programs in 2015 and 2017 and summarized its findings in two subsequent reports (Burgess 2016, 2018). We augmented the CEE data with data from program evaluation reports and information from conference papers and presentations.

We interviewed more than two dozen program stakeholders, including program administrators, implementers, evaluators, and designers. We also talked with other researchers who have studied industrial energy efficiency programs in general and continual improvement programs such as SEM in particular. Many of our interviews were guided by our research questions, though we also talked with interviewees about issues they thought were important to understanding the performance of a program.

Most interviews were done over the phone, but a few participants responded by answering a list of questions in writing. Not all interviewees answered all questions. We shared our initial findings on SEM and EMIS program performance with more than a dozen SEM program experts, presenting them in a questionnaire and asking for their responses. Both the questionnaire and the experts' tabulated responses are presented in Appendix B.

Our analysis of the potential energy savings and the value of saved energy is an update of an analysis we conducted in 2015 as part of our study of emerging program models (York et al. 2015). We used the data we gathered in our literature review and from the responses to

[3] CEE is a US and Canadian consortium of electricity and natural gas energy efficiency program administrators. It focuses on the development and deployment of energy efficiency programs.

our questionnaire to update the assumptions made in the 2015 analysis. Then we repeated the analysis.

This report presents our findings. It begins with an examination of the background and components of SEM-focused energy efficiency programs. This section continues with case studies of four SEM programs, a summary of SEM program results, and a discussion of the challenges and rewards of these programs.

The next section focuses on programs that incorporate EMISs, beginning with a description of typical EMIS features. This section continues with the features of programs that offer EMISs, several case studies, a summary of program results, and a discussion of challenges.

The third part of the report discusses programs that combine SEM and EMIS. After describing a few current offerings, we discuss the challenges and advantages of an integrated approach. Then we address future possibilities for SEM program design; evaluation, measurement, and verification (EM&V); participant recruitment; the policy context; and potential program results. The report concludes with recommendations for energy efficiency program stakeholders.

A note on terminology: An organization can, and many organizations do, implement their own SEM systems without the assistance of an energy efficiency program. These independent initiatives are often called programs. In this report, however, we generally use the term *program* to refer specifically to an energy efficiency initiative sponsored by a utility or third-party administrator.

Strategic Energy Management

Industrial facilities have utilized continual improvement practices for many years as a systematic way to enhance and refine facility operations. Strategic energy management is a subset of continual improvement practices that focuses on energy savings. Some companies implement SEM on their own, while others take advantage of programs offered by utility ratepayer- and taxpayer-funded programs. We begin this section with a discussion of the concepts of SEM. Then we examine energy efficiency programs, offered by utilities and other program administrators across North America, that help companies implement SEM. Figure 1 illustrates these relationships.

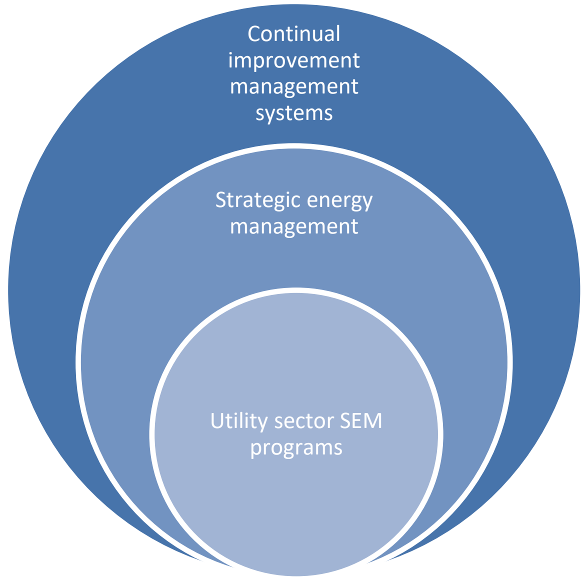

Figure 1. Strategic energy management as a subset of continual improvement

CONTINUAL IMPROVEMENT

Continual improvement is a term for a variety of systematic methods that help manufacturers raise the quality of their products, reduce waste and production costs, and build their long-term sustainability. Continual improvement programs change how problems are solved within a company. Instead of top-down problem solving in which management is expected to understand all aspects of a manufacturing process and how they might be made better, continual improvement charges all workers with identifying and advocating for beneficial changes. Continual improvement involves cultural change. The company trains its employees to look for opportunities to improve their work and gives them a process to bring their ideas to management. It supports them in evaluating a project and developing solutions. Suggestions can be small or large. All are encouraged to contribute and often are rewarded.

Compared with companies using more traditional management systems, the workers at facilities that have fully embraced continual improvement are more productive, work in a safer environment, tend to feel more valued, and are generally more satisfied. Their companies are, on average, more profitable and stable than their more traditional competitors (Soliman 2017).

Popular continual improvement systems include Total Product Quality, Total Quality Management, and Six Sigma. Subaru of America (SOA) operates a manufacturing plant in Lafayette, Indiana, using a system called the Kaizen philosophy, which engages all employees in a continual effort to improve vehicle quality, worker safety, and environmental stewardship. SOA offers cash and other rewards for suggestions resulting in projects that reduce costs and waste. As a result, the plant has cut its waste generation by 60% since 2000 and no longer sends anything to landfills (Guynup 2017).

The most common framework for managing product quality is the ISO 9001 Quality Management Standard, developed by the International Organization for Standards (ISO).

ISO 9001was originally intended for manufacturing, but health-care and hospitality companies now embrace the standard as well. Companies using ISO 9001 have specific procedures for all steps of a manufacturing process, parameters for tracking the quality of components and final products, and processes for identifying and resolving instances when a part or product is out of specification.

The ISO 9001 standard transformed the US manufacturing sector beginning in the 1980s. It was especially important to the major US automobile manufacturers and their suppliers as it enabled them to compete on quality with European and Japanese carmakers after years of lagging behind. The story of their adoption of quality management systems and their subsequent resurgence is well known in the private sector. It is both a reference point and a driver for companies to embrace new management systems when attempting to control costs and risks.

Many companies have also adopted the ISO 14001 environmental management standard. It applies the same methodology to tracking environmental variables and reducing associated risks as the ISO 9001 standard applies to quality. It includes tracking the key performance indicators—such as solid waste, emissions, and energy consumption—that determine a facility's environmental impacts. It also includes establishing standard operating procedures for measuring, documenting, and reporting. The ISO 50001 energy management standard provides a similar framework for managing energy. As we discuss later in this report, many SEM programs are including some or all aspects of the ISO 50001 standard in their engagement.

As explained above, we see SEM as a subset of continual improvement. In this report we use *SEM* as an umbrella term for a range of continual improvement strategy that take a systematic approach to managing energy. Organizations using SEM continually improve energy performance and achieve persistent energy and cost savings over the long term (Burgess 2018). Industrial facilities at hundreds of sites across North America have been applying SEM to their operations for many years to reduce their energy consumption. These programs not only have saved many gigawatt hours and therms but have been successful in changing the way organizations manage their energy. It is against this backdrop that the relatively recent SEM offerings of utility sector energy efficiency programs are perceived favorably.

SEM ENERGY EFFICIENCY PROGRAMS

It is not surprising that over the past 20 years, many federal agencies and energy efficiency program administrators have found continual improvement methods to be useful in engaging the industrial sector. They have come to realize that many companies are already familiar with the concepts and can easily roll energy management into existing management systems. Companies have also been receptive to this type of program because they recognize the methodology and have had positive experiences with continual improvement efforts in the past.

The first SEM program, launched in 2005, leveraged many continual improvement concepts and implementation practices (Ochsner et al. 2015). Since then, more than two dozen program administrators have launched SEM programs. However, until CEE published its minimum elements in 2014, there was no standard definition for SEM (Burgess 2014; CEE 2014; Ochsner et al. 2015). Even today, there is not universal agreement on what constitutes a SEM engagement or a SEM energy efficiency program.

Our conversations with professionals in the field indicate that some perceive SEM to be a path rather than a defined set of tasks and actions. They would consider any set of activities that points an organization toward systematic management of energy to be SEM, and any program that guides them on that path to be a SEM program. Others have adopted the CEE definition and its three minimum elements: commitment through policies, goals, and allocation of resources; energy management planning and implementation; and a system for measuring and reporting performance. They would consider any program that has these elements a SEM program. (Of course, a program with more than these three elements would also be a SEM program.) With this definition in mind, we begin our discussion of SEM programs with a list of the essential components and optional additions.

Customer Commitment

The company sets, frames, and communicates energy performance policy and goals. A signed commitment by a member of senior management attests that the organization will set goals and allocate the resources necessary to implement projects to meet those goals (Burgess 2016). A company engaged in a SEM program has one or more energy teams whose members look for energy inefficiency and develop solutions to reduce energy use. Teams are often made up of people from many parts of the organization: engineering, operations, maintenance, purchasing, human resources, etc. They are empowered and expected to implement projects that save energy (Burgess 2014).

Each energy team has a leader, often referred to as the energy champion. If the facility has a dedicated energy manager, that person is usually designated the energy champion. He or she is the primary contact for the program and organizes the team for training. The energy champion also leads the collection and analysis of energy data. This person is usually different from the corporate champion, who is often a c-suite executive who advocates for allocating resources and funding capital projects.

Planning and Implementation

Most SEM programs require participants to conduct treasure hunts in which the energy team and program implementers walk through a plant looking for energy management opportunities.[4] They create a project register of operational and maintenance (O&M) and capital project opportunities. They analyze the costs and benefits of each opportunity and prioritize the list. Registers enable teams to document new opportunities and track existing ones.

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[4] SEM program implementers are subcontractors who ensure that energy management systems are successfully put into place at customer facilities; they also assist with the installation and monitoring of energy-saving measures. Implementers may be state-run organizations, energy efficiency utilities, energy service companies, or others.

Most opportunities identified in a treasure hunt are O&M actions that team members often have the authority to implement directly—and therefore quickly. Other projects require capital and management authorization and therefore take longer to implement.

The planning and implementation element highlights the responsibility of the energy champion or team to understand current energy consumption, to develop goals for future energy consumption, and to implement plans for reaching these goals. In an energy management assessment, a company develops an energy map that captures key energy sources and uses (Therkelson et al. 2013).

Measuring and Reporting

Multiple parties are interested in the energy savings of a program participant. The implementer wants to know if it has effectively engaged the participant; the administrator and utility are interested in how much energy the program has saved and at what cost; the company wants to see whether it is reducing its costs and making progress toward its goals. The respective analyses of energy savings inform future actions by participants and program stakeholders alike.

The implementer works with the customer to develop an energy model to track energy usage and determine energy savings. The model is a regression analysis that takes into consideration energy consumption; weather; and facility operations variables such as production and maintenance activities, changes in behavior, and efficiency measures. A key part of an energy model is the baseline of energy use prior to the implementation of energy-saving measures. The model enables the determination of savings not only for customers but for program reporting as well (NEEP 2017).

The implementer and energy team identify key energy performance indicators (KPIs) that drive a facility's energy use. For each KPI, they establish clear, measurable metrics and goals that they can use to track their progress and report to management. Energy team members continuously monitor energy use and correlate it with production information to track the relationship between the energy they consume and what they produce. This relationship is often called energy productivity and is frequently used as a KPI. A good metric enables one to gauge energy productivity when production at the plant changes.

SEM Program Options

A full-fledged SEM program may involve a number of additional components. Some are program features intended to help participants fulfill the minimum elements. Others are extensions of the minimum elements. Natural progressions from doing the minimum to adopting rigorous practices will increase the likelihood of additional energy savings.

Worker education and skills training. Program workshops teach workers how to identify and quantify opportunities and to develop cost–benefit analyses to justify investments. Some programs engage their customers facility by facility, while others create cohorts made up of representatives from multiple facilities (sometimes in the same industry, sometimes not) who go through training as a unit. This aids learning by encouraging group problem solving and solution sharing. Attendees learn from each other and share non-competitive best practices such as compressed air system optimization.

Energy manager. Several large customer programs co-fund an energy manager, whose job is to drive the implementation of projects and ideally to lead a company's efforts to implement a SEM system. Energy managers often organize the team that helps identify and implement projects (Kolwey 2013; Russell 2013; Burgess 2016). In this report, we do not consider programs that only fund energy managers to be SEM programs. However some utilities offer co-funding of energy managers within their SEM programs or in addition to SEM programs in separate funding streams. Independent Electric System Operator (IESO) of Canada takes a different approach. While it does not have a stand-alone SEM program, the Energy Manager Initiative provides incentives for a full-time energy manager who will help implement SEM components (Russell 2013).

Energy efficiency incentives. It is not always necessary to include financial incentives in SEM programs to make them effective at energy savings. When financial resources are available, however, they can amplify the savings companies achieve. Incentives may be offered through the SEM or through companion programs. Some programs offer annual volumetric ($/kWh) incentives based on energy savings and may offer bonuses when savings goals are met (Ochsner et al. 2015); others are prescriptive, with fixed incentives for prescribed energy measures.

Standard practice. Everything described so far can be specific to a program and its participants. Adherence to standard protocols is not required. However there is value in following a standard protocol for managing energy. Standard practices are easily transferred between participants, programs, and service territories. Outside stakeholders are more likely to accept savings claims when a company uses a standard protocol for managing its energy. In addition, standard practices provide a structure that endures if a champion leaves the company or the membership of an energy team changes. Adherence to standard practice is not dependent upon the will of a single individual, but is instead part of the company's management systems. Companies that adopt SEM require employees to perform certain tasks and to perform them in precise ways. This is different from behavior change, in that these modifications are conditions of employment.

The ISO 50001 Energy Management System Standard is a particular form of continual energy improvement system set forth in an internationally recognized protocol. The standard has requirements for measuring and tracking energy use and consumption; design and procurement practices for equipment, systems, processes, and the personnel that contribute to energy management; and documentation and reporting (ISO 2018). Thousands of companies around the world have implemented energy management systems that follow the ISO 50001 standard and have had their compliance with the protocol certified by independent third parties. Many SEM programs now include technical assistance to help companies adopt the ISO 50001 standard and prepare for certification (Burgess 2014).

The US Department of Energy (DOE) created the 50001 Ready Program to provide organizations a self-guided approach to establishing an energy management system that adheres to ISO 50001. Organizations complete 25 tasks in the 50001 Ready Navigator software tool, measure and document their performance, and self-attest to their completion of the tasks (DOE 2018a). Several SEM programs have integrated the 50001 Ready Program into their offerings.

Finally, some programs are helping companies implement the DOE's Superior Energy Performance (SEP) protocol. It builds on the ISO 50001 framework to provide a more rigorous approach to goal setting and measurement and verification (M&V) of energy savings. It requires third-party audits of energy savings and performance improvement claims (Therkelson et al. 2013). SEP is the most comprehensive approach to energy management and continual improvement.

SEM PROGRAM EXAMPLES

SEM programs initially focused on energy-intensive industrial facilities. It remains true that industrial customers account for a large proportion of energy demand and that programs need to take advantage of this opportunity for large efficiency savings. At the same time, SEM programs are expanding their focus to include large commercial property concerns, hospitals, educational institutions, and water and wastewater treatment facilities. All are energy intensive and have staff appropriate to adopting and implementing the key principles of SEM.

The design of a program and the nature of an implementer's engagement can vary by customer type. Manufacturing companies will generally implement SEM at the facility level, while commercial and institutional operations often implement it at the organizational level. The reason for this is related to how energy expenses are managed and how technical experts are organized. In manufacturing, energy costs are usually managed and paid at the plant level. Engineering and maintenance staff, the people most likely to form the backbone of an energy team, are located at the plant level. For these reasons, programs usually engage manufacturing companies at the plant level.

On the other hand, commercial users, such as retail stores, and institutions, such as hospitals, often have multiple locations within a utility service territory. Utility expenses are often paid at the regional or corporate level. Technical staff may have multiple buildings to maintain and may be spread across multiple locations. To accommodate this reality, programs will often engage institutional and commercial customers at the organizational level.

SEM programs have been well received by commercial and industrial (C&I) customers. Many programs have surveyed participants and received positive reviews. The number of programs has increased every year, and the inclusion of commercial customers has substantially increased the number of potential participants. At the beginning of 2018 we identified 31 program administrators that collectively offer 13 SEM-only, 11 EMIS-only, and 19 SEM-with-EMIS-option programs in North America. Their locations are shown in figure 2. The programs described in the following case studies have different features. This is because each program administrator develops its program to meet the needs of its customer base, and because state regulations affect which features an administrator can and cannot include.

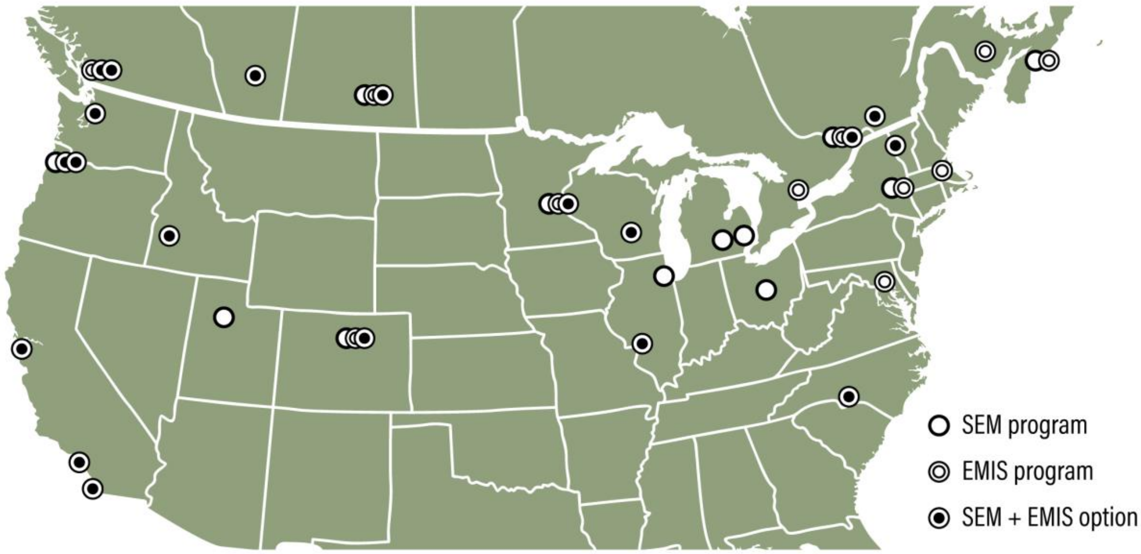

Figure 2. SEM and EMIS programs in North America. Additional detail is provided in Appendix A.

Energy Trust of Oregon

The commercial and industrial SEM programs offered by Energy Trust of Oregon are useful examples of typical SEM offerings. Since 1999 Energy Trust has, at the direction of the Oregon Public Utility Commission, brought energy savings and renewable energy to its constituent investor-owned utilities by providing technical and financial assistance to its customers (ETO 2014). Energy Trust's SEM programs are nested within its Production Efficiency Program and its Existing Buildings Program. The first targets industrial and agricultural companies as well as water treatment facilities and takes a facility-level approach; the second is for commercial and institutional buildings and facilities and works at the organization level (ETO 2018c; Volkman et al. 2014). Energy Trust has two separate teams of implementers to work with companies in the two sectors.

Energy Trust recognized that not all industrial customers are equally prepared to implement continual improvement systems, and therefore it needed to offer customers options. It created two SEM programs for industry, one for companies to test the waters, the other for those willing to make a multiyear commitment. The first of these, titled First Year SEM, began in 2009. The second program, Continuous SEM, was launched in 2016.

Energy Trust designed First Year SEM to engage companies through a series of activities over a 14-month period. The program comprises three stages: implementation, reporting, and report completion. After a site has completed First Year SEM, it is eligible for enrollment in Continuous SEM.

Continuous SEM is a two- to five-year program that is based on a repeated yearlong process similar to First Year SEM. Energy Trust trains participants using either a cohort or individual organization engagement in the First Year SEM program. Continuous SEM training is provided only on an individual-company basis (Burgess 2018). Key activities required of participants include attending training workshops, forming an energy team, appointing an onsite energy champion and energy data manager, and collecting and analyzing production and energy consumption data (ETO 2018b).

The Commercial SEM program is similarly organized. Commercial and institutional customers start with the First Year SEM program and then enroll in Commercial SEM. Energy Trust has engaged more than two dozen property management, retail, health-care, and other institutional organizations so far.

Participating companies do not pay for any of the training. They are, however, required to sign a memorandum of understanding (MOU) that commits them to undertake certain acts such as documenting management commitment, developing an energy plan, having staff attend training, creating an energy team, and reporting energy savings. After completing First Year SEM, companies can earn additional incentives by implementing O&M projects that save energy. Incentives are tied to the volume of electricity (kilowatt-hours) or natural gas (therms) saved as well as for achieving milestone targets (ETO 2018b).

The two programs have been quite successful at helping companies reduce their energy consumption and have served more than 200 customers since 2009. They have saved more than 20 gigawatt-hours (GWh) and 1 million therms throughout the 2015 and 2016 program years. These savings represent a substantial portion of the energy savings achieved by the Production Efficiency and Existing Buildings programs (ETO 2018a).

SEM programs are particularly popular in the Pacific Northwest. In addition to Energy Trust, the Bonneville Power Administration (serving public utilities in the region), BC Hydro, Idaho Power, and Puget Sound Energy also have active programs (Burgess 2018). The Northwest Energy Efficiency Alliance (NEEA) was involved in the development of a continual energy improvement program, which served as the model upon which many of the current programs are based (Kolwey 2013).

ComEd and Nicor Gas

The Premium Commercial and Industrial SEM program jointly run by Commonwealth Edison and Nicor Gas shows how two utilities can work together to simultaneously achieve electricity and natural gas savings. ComEd is a subsidiary of Exelon and the largest electric utility in Illinois, serving customers in and around Chicago. Nicor Gas is the largest natural gas distributor in Illinois, with a service territory that overlaps much of ComEd’s. The partnership of these two utilities means customers deal with only one program instead of two, and program implementers can focus on all types of energy savings projects.

The pilot SEM program in 2014 required annual consumption of 750,000 therms and 10 GW to participate. In its second year the requirement was reduced to annual consumption of 150,000 therms and 5 GW of electricity, enabling hospitals and universities to participate (Baily and Rokke 2018). Customers are required to sign an MOU that expresses their commitment to allocate resources and establish SEM policies or goals (Burgess 2018). The program runs for a year, with the option of a second year. Customers must have an executive sponsor, an energy champion, and an energy team to support the SEM program (Baily and Rokke 2016).

Implementers train participants in how to structure an energy management system, how to create and maintain an energy model, and how to engage employees in energy management. Educational workshops are conducted both in cohorts and individually onsite. This program provides site reviews, technical resources, coaching, and mentoring (Burgess 2018). At the customer's request, support may be provided to help participants pursue certifications such as ISO 50001 and SEP (Burgess 2018).

In addition to technical assistance to help customers identify low-cost and no-cost opportunities, the program provides incentives to encourage project implementation. Incentives are tied to the volume of electricity or natural gas saved. Additional incentives are available for capital projects completed in the first year.

Since its launch, the program has served three rounds of cohorts. The first cohort spanned two years and was composed entirely of industrial facilities; seven of the ten customers in the group continued into the second year. Table 1 summarizes the industrial and nonindustrial facilities engaged between 2014 and 2017. Companies that complete the cohort phase can enter the practitioner phase and receive more individualized attention from the implementer.

Table 1. Facility engagement

Participant group	Customers	Time period
Cohort 1	10 industrial	November 2, 2014–October 31, 2015
Cohort 1	7 industrial	January 2, 2016–December 31, 2016
Cohort 2	2 industrial 3 hospital 4 university	June 1, 2016–May 31, 2017
Practitioner group	7 industrial 3 commercial	Began in August 2017 with rolling enrollment. The practitioner participants' usage will be re-baselined each year with savings calculated on the previous 12-month usage.

Source: Baily and Rokke 2018

Efficiency Nova Scotia

Efficiency Nova Scotia has a SEM program within its industrial portfolio that engages industrial companies on a one-on-one basis with the program implementer. It helps companies implement the energy management structure needed for their energy-intensive operations and improve performance over the long term; it also provides employee training. The program begins with a 12-month engagement during which the contracted implementer helps companies adopt continual improvement practices, set up an energy management structure, and develop energy teams. The implementer works with those teams to create energy maps that identify their facilities' key energy-consuming processes and opportunities to reduce energy consumption. This information is used to develop a regression model that customers can employ to track their energy savings and energy productivity over time.

Teams conduct treasure hunts to find low-cost and no-cost opportunities to save energy. They may also do more formal and detailed energy audits that identify potential capital projects. Then they develop project lists and set goals for energy reduction. The implementer sometimes installs submeters to get customers used to harvesting and using data.

If companies have existing management structures such as ISO 14001 for environmental management, they integrate energy management into those structures. Otherwise, implementers get customers started with an ISO 50001-inspired system to help them document and analyze energy use, projects, and performance. If customers are interested, the program can help them progress toward ISO 50001 certification in a subsequent year of SEM that is offered to all participants as a customized plan to assist them in furthering their energy management objectives and achieving greater energy savings.

Each participating company is required to sign an MOU that commits it to a scope of work and a financial contribution of $10,000. At the beginning of each additional year that a company participates in the program, it is required to sign a new MOU that outlines the expected outcomes of the year's engagement. The program has served 15 customers since 2015 and has been successful in helping them reduce their consumption, with a collective energy savings of 6.139 GWh (Econoler 2017; Andrea Henwood, program manager, Efficiency Nova Scotia, pers. comm., November 13, 2018).

New York State Energy Research and Development Authority

While West Coast organizations like the Energy Trust and the Bonneville Power Administration (BPA) have been implementing SEM programs for years, some energy efficiency players, like the New York State Energy Research and Development Authority (NYSERDA), are just getting started. Over the next few years, NYSERDA intends to implement several pilot programs for both its On-Site Energy Manager initiative and its Strategic Energy Management initiative (NYSERDA 2018e). The two new continual energy improvement programs are aimed at increasing energy efficiency and adoption of energy management practices by companies in the industrial sector (NYSERDA 2016).

NYSERDA hopes that data collected from the pilot programs can inform the design of future programs. The Authority also hopes to build the trust of private sector entities. This will lead to greater participation in programs and increased savings through the adoption of continual improvement practices (NYSERDA 2017a).

The first of the Strategic Energy Management industrial cohort pilots involved eight customers and ran through September 2018. Registration for the second cohort closed in June 2018 (NYSERDA 2018a). Industrial SEM participants develop energy maps, participate in treasure hunts, perform onsite energy management assessments, and participate in group workshops, best-practices trainings, and webinars. Training sessions are provided by Energy Coaches.

Though the Strategic Energy Management initiative itself does not provide funding for an energy manager, the separate On-Site Energy Manager initiative is available to interested participants. The purpose of this initiative is to explore the potential for improvements and savings delivered by a full-time energy manager (NYSERDA 2018c).

NYSERDA's Strategic Energy Management program is still in its early stages, and the new SEM program is the organization's first attempt at a market transformation program for the industrial sector. The program structure incorporates many aspects of successful SEM programs, such as identifying an energy champion, developing an energy team, training workers through a cohort approach, and developing regression models. The future of NYSERDA SEM looks promising, with program efforts projected to save an average of $12.9 million per year and reduce carbon emissions in the next 15 years by 1.2 million metric tons (NYSERDA 2016).

SEM PROGRAM RESULTS

SEM programs across North America have reduced both electric and natural gas consumption. SEM success has been documented using several metrics including energy savings, customer satisfaction, continued program engagement and improvement, and participation in subsequent energy efficiency programs. As more programs come online and existing ones mature, we can expect that implementation will become more efficient, the cost of saved energy will decrease, and SEM will be a reliable source of energy savings for many years to come.

SEM programs have evolved and spread across North America. According to the most current CEE summary of SEM programs, by 2016 more than 1,000 industrial sites had implemented SEM programs. The study found that aggregate electric energy and natural gas annual savings for reporting sites in 2016 were upward of 324 GWh and 9 million therms, respectively (Burgess 2018). Of these savings, 78.9 GWh and 3.1 million therms came from O&M projects (Burgess 2018). The balance came from capital projects. Programs calculate energy savings differently; some include savings from capital projects and others do not, so the totals CEE arrived at reflect multiple measuring methodologies. Table 2 captures the cumulative performance of the SEM programs that responded to the 2017 CEE surveys. These programs are identified in Appendix A.

Table 2. CEE members' SEM programs performance, 2016

Savings type	Number of programs reporting	Energy savings	Number of customers	Average savings per customer
Total electricity savings	12	324.2 GWh	372	0.87 GWh
O&M electricity savings	7	78.9 GWh		
Total natural gas savings	6	9.21 million therms	185	0.05 million therms
O&M natural gas savings	3	3.1 million therms		

The CEE survey of 2016 program performance was conducted in 2017 and reported in 2018. Some programs report only O&M savings; some report O&M and capital project savings. *Source:* Burgess 2018.

Total annual savings from existing programs are approximately 0.01% of the C&I electricity and 0.02% of the natural gas consumption in the United States and Canada. So, although existing programs are having success, there is, as we will discuss later, potential for much greater savings from SEM programs.

Trends in SEM Programs

CEE also tracked the number of SEM programs offered by its members since 2002. The number of offerings added each year has varied, but the overall number continues to grow, as shown in figure 3. This is indicative of the popularity of the program model. There are programs offered by utilities that are not CEE members, so figure 3 does not capture all SEM programs.

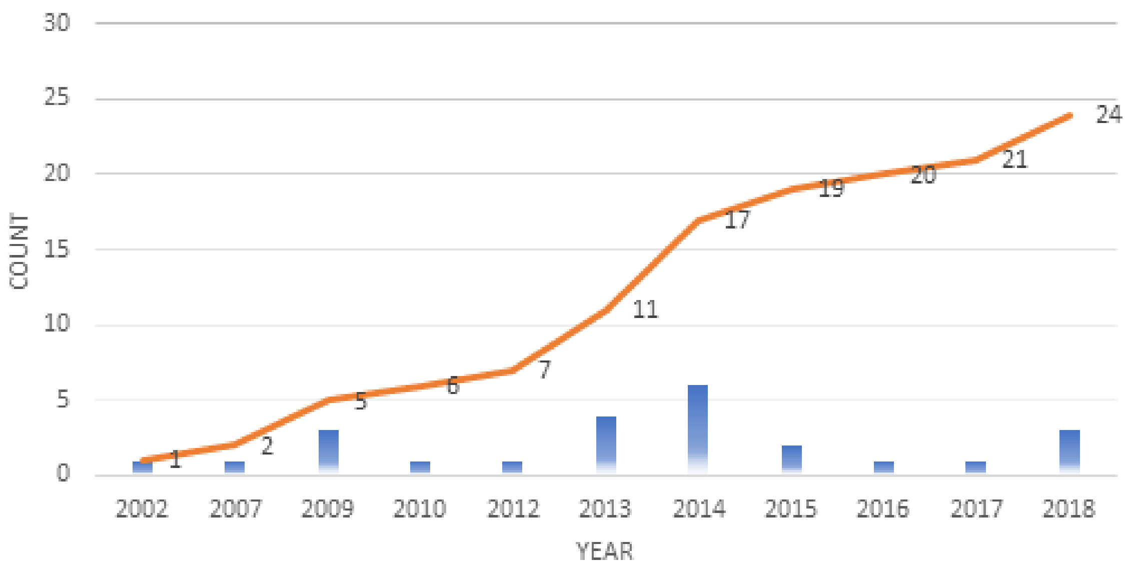

Figure 3. Number of SEM programs added by year and total to date. The blue bars indicate the number of programs launched in that year; the red line represents the total number of programs in place. *Source:* CEE 2014; Burgess 2014, 2016, 2018.

Several new programs were launched in the past year. NYSERDA rolled out its pilot programs, as discussed above. Each of the four investor-owned utilities in California launched a new program as well. Two of them, Southern California Edison and Southern California Gas, are collaborating on a combined program with a single administrator and set of implementers.

With more programs coming online, the number of customers each year increases. CEE members reported 886 customers served prior to 2015, 282 in 2015, and 376 in 2016. More than 1,500 organizations have participated in some type of SEM program in the past decade. The average number of customers engaged by a SEM program increased from 23 in 2015 to 27 in 2016. Participation ranged from 4 to 83 customers, however, so it is unlikely this is indicative of a trend. As SEM programs in more populous states like California and New York come online, we expect to see considerably more customers served and greater overall energy savings.

Persistence of Savings

Energy savings are a function of time, so the persistence of savings from an energy measure is an important variable to program administrators. Persistence is the stream of benefits over time from an energy measure or program. When programs adjust savings claims for persistence, they factor in an energy measure's life, a savings persistence factor, and the initial estimate of savings. Measure life studies identify the median number of years that a measure remains functional. In a project with multiple measures, the measure life is defined as the time until 50% of the installed measures, in terms of predicted savings, are no longer operable or in place (Stewart 2017). Measure life and persistence factors are determined by engineering judgment, field studies, or statistical analysis (Vetromile et al. 2018).

SEM programs were created in part to drive actions that save energy. The cost effectiveness of SEM programs is dependent in part upon the persistence of savings. For capital expenditures (CapEx) this is tied to the length of time the equipment operates as intended. If the equipment is not maintained or operating conditions change, savings may degrade. The persistence of savings for O&M measures is tied to the persistence of the practices. Fixing compressed air leaks saves energy but only so long as a maintenance practice is in place to continue to repair the leaks (Vetromile et al. 2018).

Analyses to date indicate that SEM programs can extend the persistence of energy savings. In 2017, BPA's SEM programs were evaluated by a third party, and savings were found to persist over the engagement period. Specifically, SEM savings from BPA's High Performance Energy Management program were found to persist over three to four years of program engagement and increase during the final year. BPA did find that maintaining focus on SEM savings throughout engagement and the years following is important to prevent backsliding on savings (SBW and Cadmus 2017).

Energy Trust started its First Year SEM program with an estimated three-year average measure life for savings. For participants that go on to the Continuous SEM program, Energy Trust credits a measure life of up to five years. The longer engagement periods are enabling Energy Trust to gather considerable information on the persistence of savings from individual energy measures (B. Crumrine, senior SEM coach and northwest SEM manager, and L. Belmont, SEM specialist, Cascade Energy, pers. comms., May 8 and November 11, 2018). After several years of program activity, Energy Trust worked with its evaluator to conduct a review. They found that three years was a reasonable estimate of measure life and that for some measures, a longer period would be acceptable (Vetromile et al. 2018).

Our interviews and surveys of people involved in SEM program delivery and evaluation indicate that many believe participation in a SEM program can extend the savings of numerous O&M measures (see Appendix B). This is not yet a consensus, however. One concern is backsliding, the degradation of savings over time. Program evaluation reports and interviews indicate that backsliding on savings has occurred with some customers after program engagement periods ended because the customers lost their focus and commitment to systematic energy management. These observations make sense; the more consistently an organization tracks its energy use and reports trends to decision makers, the more likely it is to stay on top of maintenance issues and avoid degradation of savings.

In its most recent survey, CEE found that programs are using many assumptions for persistence of savings in their analyses. Twenty percent are using less than two years, 60% two to six years, and 20% more than six years (Burgess 2018). The determination of the persistence of savings is in its infancy. Methods for determining persistence vary among programs. In summary, the community has not reached consensus on whether SEM programs extend the persistence of savings. More analysis is needed, but early indications are that many SEM programs are seeing and claiming savings that are more persistent.

Increased Project Activity

One motivation of administrators to invest in SEM programs is that they create more activity for other programs, thereby driving greater savings. The people we interviewed and surveyed were almost unanimous on this point. They felt that SEM programs drive more O&M and CapEx projects (see Appendix A).

Recent research has confirmed this impression. An analysis of Energy Trust's industrial SEM program found that average savings for participants came to 4,400 MWh/year, which is 3,100 MWh greater than the average savings of Energy Trust industrial customers participating in other programs. Energy Trust customers were four times more likely to complete a new capital project annually after participating in a SEM program than those that did not participate. Customers saved on average 200 MWh more per year (from capital projects and O&M measures) following SEM engagement than did other customers during the same 2009–2012 time frame (Rubado, Batmale, and Harper 2015).

SEM program participation has also been linked to participation in subsequent energy efficiency programs, increasing the potential for energy savings and efficiency beyond the initial program's prescribed measures. Research on Energy Trust program data compared the rate of participation among SEM customers in other energy efficiency programs at Energy Trust with that of non-SEM customers. SEM participants were found to be more likely to have completed project activities before SEM engagement, reporting an 80% participation rate in previous efficiency programs. The study also found that after SEM, participants were even more likely to participate in at least one subsequent energy efficiency program per year and had a greater rate of change in program participation than the 917-site control group (Rubato, Batmale, and Harper 2015). While it is likely that self-selection bias skews the findings upward, it is true that participants in SEM programs are contributing more to utility goals for programs.

Program Participation

Another indication of success for SEM programs can be found in customer satisfaction. At Energy Trust of Oregon, about 70% of SEM program participants were willing to show support for their programs by helping with SEM marketing, recruitment, or other efforts (Kolwey 2013). This behavior indicates good customer satisfaction among SEM participants, providing another benefit of industrial customer participation.

Conclusions

The key conclusions from these data are that programs are helping customers reduce their energy consumption. The number of SEM programs is increasing, as is the number of companies seeking assistance from the utilities. SEM program participants achieve greater savings and have a much higher rate of project activity than non-SEM participants. Participation in SEM programs is driving capital investments and extending the persistence of energy savings (Kolwey 2013; Rubato, Batmale, and Harper 2015).

CHALLENGES AND REWARDS OF SEM PROGRAMS

This section describes a number of challenges faced by SEM energy efficiency programs, suggests ways forward, and discusses some of the benefits these programs can provide to utilities and program administrators.

SEM systems can address all of a company's energy issues: electricity, natural gas, fuels for vehicles, and any other fuels it uses in production. They can also include other utilities such as water and wastewater as well as raw materials and wastes. However only 7 of the 14 programs responding to the most recent CEE survey took on both electricity and natural gas. Seven were electricity only (Burgess 2018). A piecemeal programmatic approach that has one program for electricity, another for natural gas, and maybe a third for production inputs and outputs is less attractive and likely unworkable for many companies. They need a single point of contact that can help them address all their energy and material management issues.

Some public utility commissions (PUCs) and utilities categorize SEM as a behavior change or market transformation program. Behavior change programs, as the name indicates, attempt to persuade customers to be more thoughtful about their use of energy (Sussman and Chikumbo 2016). Market transformation programs engage market participants like manufacturers, project developers, wholesalers, and retailers to make, recommend, and sell equipment that is more efficient. Interviewees indicated that some PUCs are resistant to behavior change programs because of concerns that savings may not be real or lasting. Some PUCs do not support market transformation programs because of their long-term nature and the need for substantial up-front investments before producing savings (York et al. 2017).

Some utilities worry that their PUCs may not allow them to claim O&M savings. For example, Xcel Energy and Arizona Public Service had to go to their respective PUCs and provide testimony that proved the legitimacy of the O&M savings they claimed (N. Kolwey, senior associate, Southwest Energy Efficiency Project, pers. comm., November 5, 2018). Since many of the savings from SEM programs come from O&M projects, the risk that such savings will not count toward their goals can make utilities reluctant to pursue them.

A challenge brought up in our interviews is whether or not utilities have sufficiently ambitious savings goals to drive them to pursue energy savings from energy management programs. Administering energy management programs requires a set of resources different from those needed by a rebate program. It also requires a long-term approach to customer engagement. The additional costs involved amount to additional risks for utilities. If they can achieve their goals with conventional prescriptive and custom programs, they are less motivated to take on more complicated program models. Bigger goals and financial rewards for exceeding them may be what is necessary to motivate utilities to consider energy management programs.

EM&V

DOE recommends three protocols for estimating energy savings from utility SEM programs. The first is IPMVP Option C, developed by the Efficiency Valuation Organization.[5] It applies to comprehensive energy management programs affecting multiple energy-using systems. It is the most common method for quantifying SEM program participant energy savings (Ochsner et al. 2015). Option C requires analysis of metered energy consumption at the whole-facility or sub-facility level (EVO 2012; Violette 2013). The second protocol is the Superior Energy Performance Measurement and Verification Protocol for Industry (DOE 2018b). It defines procedures for determining compliance with the energy performance requirements of DOE's SEP program. The third protocol, the 50001 Ready Protocol, is based on the SEP M&V protocol.[6] It allows determination of energy savings (and carbon emissions reductions) for single or multiple energy types consumed by a facility. The 50001 Ready program includes a website that DOE hopes will become a platform for SEM programs to develop a framework for their energy savings and emissions reductions (DOE 2018a; Violette 2013).

Many SEM program evaluators use the Option C, whole-facility approach. They start by developing a baseline for the facility using interval energy data and production information. Then they develop a model that ties energy consumption to production (or another set of variables) and perform a regression analysis. Energy savings are determined by checking where post-implementation energy use (ex-post) falls on the regression curve (EVO 2012; Ochsner et al. 2015).

There are two challenges for evaluators using regression analysis to quantify savings from SEM programs. The savings must be large enough to be separated out from the normal variability in a facility's energy consumption, and evaluators must be able to account for nonroutine events that alter a facility's operations. The first challenge might be raised by a school that experiences considerable variation in use throughout the year. The second challenge could be presented by a manufacturing facility that changes its product mix or adds a shift (Ochsner et al. 2015).

Another issue is how to treat savings from capital projects that customers identify and implement as a result of their SEM program participation. Evaluators usually credit O&M project savings to the energy management program, but their treatment of savings from capital projects varies.

Capital projects range from simple equipment replacement to redesigns of production processes. In the absence of SEM programs, the former is often addressed by a prescriptive

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[5] IPMVP Option C uses meters (usually the ones used for utility billing) to measure the energy use of an entire building, facility, or a subset of the facility. It compares energy consumption during the reporting and baseline periods, usually using 9 to 12 months of monthly data for each. In addition, evaluators monitor all independent variables that affect energy consumption during the performance period, including weather, occupancy, throughput, and operating schedules. Multivariate regression analysis factors these variables into the savings determination.

[6] The 50001 Ready program is a self-guided approach for facilities to establish an energy management system and self-attest to the structure of ISO 50001 standard. See www.energy.gov/eere/amo/50001-ready-program.

rebates for specific types of equipment such as high-efficiency motors, and the latter is often addressed by custom programs that provide incentives based on the volume of energy savings. However, since many projects are identified as a result of team participation in a SEM program, there is some debate about which program should get the credit for the savings.

While it makes sense to give credit to the program that provided the incentive, it also makes sense to recognize that the project would likely not have been implemented without the SEM program. A common solution has been to determine the total energy savings for a facility using the top-down, whole-facility approach, and then subtract the savings of capital projects using a bottom-up, project-specific approach. The SEM program gets credit for the balance. The downside of this approach is that it does not recognize the contributory impact of the SEM program on the capital projects. There is also the risk that the savings determination for the capital projects may overestimate or underestimate actual savings, thereby hurting or benefiting the savings attributed to the SEM program. This is a significant risk when using deemed savings values derived from industry averages or equipment label data. A solution to this last concern is for programs to collect more field data and update their deemed savings values.

As we discuss in the next section, taking a program portfolio approach to program evaluation addresses many of these concerns.

Another evaluation issue facing SEM programs is the treatment of nonenergy benefits. Continual improvement practices help companies become more competitive, contribute to workforce development, and often reduce waste and environmental impacts. Program administrators should try to assign a monetary value to these gains so they can be included in cost–benefit analyses.

The decisions made regarding the treatment of cost savings from SEM programs affect the cost effectiveness analysis of these programs and, by extension, how they are perceived by regulators and other stakeholders.

Cost Effectiveness

Some policymakers see SEM as a type of market transformation (MT) program. The protracted participant engagement and lagging impacts of SEM are typical of MT programs. The up-front costs of MT can be substantial, while the benefits are often diffuse and take several years to materialize. Consequently, MT programs in general, and some SEM programs in particular, have had difficulty passing commonly used cost-effectiveness tests (York et al. 2017).

This issue can be addressed in part by taking a different approach to assessing cost effectiveness. Some of the more significant barriers to widespread deployment of market transformation programs like SEM stem from utility regulation such as restrictive cost-effectiveness screening focused on single-year results and short funding periods (three years or less). Extending the period over which SEM programs are evaluated would do much to address this issue.

As previously discussed, SEM programs were created to drive energy performance improvement largely through O&M projects. Therefore the cost effectiveness of SEM programs is dependent in part on the persistence of O&M improvements. Research to date and the responses to our interviews and surveys indicate that SEM programs generate O&M projects that produce energy savings for multiple years. Programs should get credit for the persistence of the savings they facilitate. They should track savings and update models as more information is gathered.

Low-cost, high-impact O&M actions can be a stepping-stone for larger capital projects. The issue here is how to treat savings from capital projects. Whether or not savings from capital projects initiated by SEM program activity are attributed to a SEM program is often dictated by program structure rather than set policy. As long as a utility's entire portfolio of C&I programs can be evaluated as a unit, attribution at the program level is not problematic. However, if there is no visibility by policymakers of these relationships and if there is not recognition in program evaluation that SEM programs drive other activities, SEM is at risk of not being properly valued. Assessing cost effectiveness based on year-by-year savings, such as is common with resource acquisition programs, is akin to using a yardstick where a tape measure is more appropriate.

Another issue, although one that may not affect many programs for some time to come, is that the long-term viability of any program requires a continuous pipeline of energy savings opportunities. Within any given utility service territory, there is a finite number of viable candidates for a given type of program, and there is a limited number of organizations with sufficiently large energy usage to warrant participation in an energy management program. This creates a twofold challenge: If a program offering SEM uses the conventional approach of a limited customer engagement, it could over time exhaust its best opportunities. One interviewee expressed an additional concern: A SEM program must engage a sufficiently diverse set of customers every year so that it can consistently meet its energy savings goals. The interviewee observed that a new SEM program might sign up all the companies with the greatest potential to save energy in its first year. This could result in a successful first cohort (with performance periods typically in years 2 and 3 in addition to part of year 1) with great cost-of-saved-energy numbers, but it might be impossible to sustain that performance with subsequent cohorts when the pool of available candidates has less opportunity. As customers recruited for the SEM program get smaller in size, the cost effectiveness of the program will tend to drop. At some point, the viability of the program may be questioned and it will be at risk of being discontinued.

Program implementers can avoid this issue by seeking a mix of program participants in each program cycle so that the potential for savings is consistent year after year. They can also address the issue by reducing training and other soft costs associated with delivering program services. Extending the engagement period or turning the program into a platform for long-term customer engagement increases the likelihood of a continuous supply of projects from participants. Part of an extended engagement philosophy is encouraging capital projects. They will increase overall savings for the program, which will have a positive effect on the cost of saved energy.

The issue of cost effectiveness and the issue of savings attribution have a common basis and a common solution. The needs of customers and the benefits from the services of a utility and its efficiency programs are all considered in isolation rather than as parts of a business-to-business relationship. Examples of a holistic approach do exist. Many municipal utilities and rural electric co-ops do not think in terms of cost-effective savings but in terms of cost-effective customer service. To the degree that they measure impacts, all benefits—energy and nonenergy—are valuable to them in the name of effective customer service. This cost effectiveness model is similar to practices in the private sector where companies grow their businesses through expanded service offerings and relationship building.

Customer Recruitment

Utilities often find it challenging to engage industrial customers and recruit them into energy efficiency programs. It is often difficult to get the attention of decision makers, many of whom are located outside the utility's service territory. Program recruiters must overcome any perception customers have that programs are bureaucratic and unresponsive to their needs. A related concern is that many customers are unfamiliar with how public sector programs work. They are more familiar with and thus more comfortable with private sector vendors, and they are accustomed to service providers that tailor offerings to meet their schedules and their unique needs. By contrast, public sector programs are constrained by fixed budgets, funding cycles, and requirements to offer uniform services. Not only do these structures inhibit recruiting customers, they also inhibit establishing long-term relationships with them.

SEM programs can address some of these challenges and help utilities engage their larger customers. Many companies and institutions are familiar with continual improvement systems, so they understand the value of a management system and of hiring a vendor to help them implement one. They also have management systems in place that can accommodate the additional metrics and standard practices of a SEM program; participation in a program adds value to these systems. Most companies are interested in developing their workforces, another key feature of SEM programs. Many understand the value of data-driven decision making, and the regression models that implementers develop are a compelling benefit to many plant managers. A SEM program functions in a manner similar to a conventional vendor providing a consultative service, so the MOU required by a program is a familiar framework for working together. All of these features make SEM programs responsive to many organizations' needs. As a result, their value is understandable to executive-level decision makers.

A number of tactics for marketing SEM programs have proved successful. Publicity and outreach approaches include websites, emailing, promotional videos, and solicitation. NYSERDA collaborates with several utilities that have their own promotional activities. Other success strategies include BPA's collaboration with its distribution utility customers and BC Hydro's use of customer experiences in its promotional materials. The common themes among these marketing and recruitment efforts is that they attempt to convey the value of SEM program participation and they target companies that are likely to sign up, participate fully, and realize energy savings.

In terms of first-time customer recruitment, the more established programs like Wisconsin's Focus on Energy and BPA's Energy Smart Industrial (ESI) program have found pursuing multiple avenues to attract customers to be the most successful approach. Energy Trust uses program delivery contractors to cultivate relationships with companies in specific territories. ESI uses its analogous Energy Smart Industrial Partners (ESIPs) to achieve the same thing. NYSERDA and Focus on Energy also use contractors.

A common practice of mature programs is to leverage the relationships program representatives have established with customers through past activities. Reps seek out companies with existing energy teams, energy champions, and leadership-level champions. All of these are predictors of successful participation in a SEM program. Program staff can also leverage their own relationships with account managers and customers for targeted recruitment efforts. The easiest way to ensure customers are aware of all opportunities is to have account representatives who are familiar with all program offerings. Having knowledgeable staff with responsibility for connecting customers to all program resources simplifies the customer experience and enhances the service provided by a program. Energy Trust attributes much of its success to experienced account managers, energy coaches, and delivery contractors, as well as an initial assessment of customer goals and rolling program enrollment.

SEM programs provide a platform for introducing other programs. Once a company starts a project register, it can start identifying projects that are eligible for any prescriptive and custom rebate programs the utility has to offer. The forecasting aspect of energy management is also useful to utilities. They can learn of customers' plans for future investment and determine how these plans will increase or decrease their energy demand. The programs also create a reason for routine interaction between a utility and its largest customers. Large-customer representatives have a framework for engaging their clients. The discussion changes from one of providing a commodity to one about offering customer service, delivering solutions, and driving customer satisfaction.

Energy Management Information Systems

Whereas companies look to management systems like SEM to organize their human activities in their efforts to manage energy, they also often look to computer systems to organize their energy data gathering and analysis. Sometimes pursued separately, sometimes in a coordinated way, both types of systems are helping companies manage their energy usage, and efficiency program administrators are accelerating the adoption of both.

SMART TECHNOLOGIES

Recent advances in information and communication technologies are adding a new dimension to what programs offer and how companies can save energy. In commercial, institutional, and industrial facilities, smart technologies are enabling entirely new levels of system and process control at the facility level and throughout enterprises. Building automation systems (BASs) are capable of accomplishing in large buildings what learning thermostats do in homes. The most advanced BASs track outside weather conditions, space occupancy, and indoor air quality, and they correlate these with the energy use of building systems to optimize energy consumption and building performance (ACEEE 2018).

The integration of data collection and analysis systems with production control systems in the industrial sector is often referred to as smart manufacturing. Smart manufacturing can help companies reduce costs by enabling people throughout an organization to access the information they need, when they need it, where they need it, and in a context that aids their decision making (Rogers 2014). Workers operate their equipment more efficiently, supervisors manage their processes more effectively, and executives utilize their resources more dynamically. Productivity is increased. Waste and defective parts decrease. All of this saves energy.

Smart manufacturing has garnered interest from both the DOE and the National Institute of Standards and Technology (NIST). These federal agencies are funding projects and partnerships in smart manufacturing that focus on advanced sensors, controls, platforms, and modeling across value and supply chain enterprises and are addressing operational interoperability, interconnected system cybersecurity, and more (Rogers 2018; NIST 2018a, 2018b). The Clean Energy Smart Manufacturing Innovation Institute (CESMII), under the auspices of the Manufacturing USA project, is working toward broader acceptance and implementation of smart manufacturing business practices, technologies, and shared infrastructure.[7,8] It focuses on development of a workforce skilled and trained in using advanced data technologies to optimize manufacturing operations. CESMII's research is examining how data and information from devices, when combined with advanced controls, a smart manufacturing software platform, and process simulation models, can lead to reduced energy consumption (CESMII 2018).

In 2008 the European Commission launched an initiative to create a single digital market for all of Europe to address IT and communications issues affecting all businesses. Within the Single Digital Market initiative are programs to accelerate smart manufacturing, also known in Europe as Industrie 4.0, virtual design, and artificial intelligence (Rogers 2017).[9] Smart manufacturing and Industrie 4.0 (originally Smart Factory in Germany) are similar in that they focus on data connectivity, contextualization, and modeling to drive energy and materials usage as economic business opportunities.

Companies can also use data analytics to identify optimal operating conditions that maximize productivity and reduce waste. The first step is to create a mathematical model of the building or facility, sometimes referred to as a digital twin. The software runs multiple operating scenarios on this model and then compares them. Smart manufacturing can also include a feedback loop that continuously compares current operating conditions with historical operating data. Such a system can achieve levels of efficiency that have never been possible before. The Smart Manufacturing Leadership Coalition, the organization that

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[7] CESMII serves the manufacturing sector by providing technical capacity and capability to members to help them accelerate their adoption of advanced process sensing, control, and modeling. See www.cesmii.org.

[8] Manufacturing USA brings together private sector companies, academia, and federal resources in a network of advanced manufacturing institutes. Its research and development projects innovate new technologies and practices that increase the competitiveness of US manufacturers. See www.manufacturingusa.com.

[9] Industrie 4.0 is a strategic initiative to establish Germany as a lead market and provider of advanced manufacturing solutions. See www.gtai.de/GTAI/Navigation/EN/Invest/industrie-4-0.html.

created CESMII, estimates that additional energy savings of 10–25% are possible (Davis 2017).

EMIS FEATURES

Energy management information systems (EMISs) are software and hardware systems that help organizations manage their energy use. The software is often provided through a software-as-a-service (SaaS) arrangement, but not always. Hardware can include additional sensors, meters, and computers. These systems, which allow users to view the performance of their facilities online, are commercially available from such companies as ABB, Cascade Energy, Emerson, Energent, Siemens, and Schneider Electric. The features of EMISs vary by intended user: Commercial building EMISs are different from those designed for industrial facilities. EMISs are distinct from building and industrial systems that control facility equipment. An EMIS may monitor and display equipment parameters that affect energy use, but it does not control those systems. Rather, it uses sophisticated analytics to enable data-driven energy management and process control decision making (Crowe, Kramer, and Effinger 2014; ACEEE 2018).

An EMIS for a commercial facility can stand on its own or be an application within a BAS. In an industrial facility, an EMIS can be part of a larger smart manufacturing platform that leverages existing data management systems. Existing systems can include sensors and meters that collect data, process data management systems that analyze production data, historians that store production data, and dashboards that provide operators contextualized information about operations. In the future, we are likely to see integration of these data management and analysis components and the manufacturing process control systems (ACEEE 2018).

NEEA's taxonomy for commercial EMISs divides the software tools into two categories: building-level EMISs and system-level EMISs. Building-level EMISs focus on whole-building M&V, while system-level EMISs focus on optimization of specific systems such as a building's HVAC system (Kramer et al. 2013). The parallel for an industrial EMIS is whole-facility level and process level.

EMISs take a variety of data inputs and simplify them for easy decision making by operators, supervisors, engineers, and management. They include dashboards that provide a visual representation of a facility's energy consumption and display this information in contexts that facilitate easier and more informed decision making and energy management actions. When operating conditions are outside of established parameters, the EMIS may directly display that information visually or may send alerts to operators, either through a visual cue on the dashboard or through email or text messages. Operators then respond by making adjustments, taking into consideration information provided by the EMIS and their own knowledge of the facility. Connecting to EMIS data via mobile devices is becoming more common and expanding how operators communicate with and receive communications from EMIS.

A key EMIS function is measuring energy savings. An advanced EMIS can support development of predictive energy savings models using building simulation software to create a computer model that captures energy flows through a building and building performance. Skilled users can determine energy savings by simulating the performance of the building or facility with and without an energy measure. The simulation involves an energy-consumption multivariate regression analysis that typically includes the weather, day and time, and any other relevant variables such as building occupancy or production schedule. Operators can also use an EMIS to predict the impact that changes in building equipment or production might have on energy consumption. By modeling those changes within a simulation, operators can understand the implications and act accordingly (Kramer et al. 2013).

Advanced EMISs may also:

- Use utility meter or equipment-level data to track energy consumption on a daily or more frequent basis
- Disaggregate loads by analyzing energy data
- Develop benchmarks against which future performance can be compared
- Analyze monthly utility bills
- Enable the set-up of key performance indexes (KPIs)
- Perform energy savings cost analysis
- Automatically quantify savings from projects
- Include data security and data quality assurance
- Include integrated M&V
- Include a platform for organizing the implementation of projects

The most advanced of these systems include a continuous commissioning feature that routinely reassesses operating set points for building mechanical systems operations and suggests new ones. Such systems continuously collect and store energy consumption data in data historians, use data analytics to analyze current activities, and compare the two to provide operators with insights that can guide their efforts to improve performance (DOE 2015; Crowe, Kramer, and Effinger 2014; Kramer et al. 2013; Rogers 2014).

Some EMISs allow users to document projects in time-series charts to indicate times of actions taken so that energy managers can track associated changes in energy consumption. Advanced project-tracking features can also be used to document actions so that savings can be attributed to program-related efforts. Such features are very popular with program implementers and evaluators.

Programs like Efficiency Nova Scotia’s EMIS and NYSERDA’s Real-Time Energy Management (RTEM) programs will perform a needs assessment or audit that results in a custom EMIS plan and business case for each facility and organization. This gap analysis includes examining existing energy data streams, assessing how to harvest other needed energy data, and determining which EMIS hardware and software resources are required to properly manage a facility’s energy use. Then program implementers think through the details of the EMIS analysis and come up with an implementation plan.

Participants have found these to be important preliminary steps. The use of simulations enables pre-implementation estimates of EMIS operational energy savings in order to support the business case for the required expenditure. Program participants can use the

EMIS business case to obtain management approval for funding and resource commitments (Henwood and Bassett 2015).

Some EMIS products are suitable for both industrial and commercial applications; however most of them are intended for only one sector. The EMIS products for industrial facilities tend to be more complex than those for commercial buildings. They must be able to incorporate more variables into regression analyses, accept a greater diversity of inputs from production systems, and contend with greater variability in operations (Crowe, Kramer, and Effinger 2014).

In a commercial building, the number of people with responsibility for maintaining mechanical systems and optimizing energy consumption can be less than one. It is not uncommon for a property management firm to have dozens of buildings in a city. The firm may centralize the monitoring of its buildings and dispatch maintenance staff as needed. In such instances, the technology is the primary tool for managing energy. In contrast, a manufacturing facility is likely to have onsite engineering and maintenance staff to implement projects as well as accounting and finance professionals interacting with the utilities.

EMIS IN ENERGY EFFICIENCY PROGRAMS

The key benefit of EMIS programs to manufacturing companies is improving the use of data to drive process control. Most manufacturing companies are accustomed to using time-series data to identify production trends, correlations among production variables, and cost-saving opportunities. Therefore additional information in a similar format from EMIS is something that many customers can immediately relate to and use. Setting up a system to collect and analyze production and energy data is one of the early steps in implementing smart manufacturing or creating a smart building.

Recognizing this opportunity, many utilities are incorporating EMISs into their program portfolios. By offering an EMIS program, the administrator is encouraging companies to use data to save energy through improved control over energy use in day-to-day operations. Programs are seeking system-level savings that they believe is not obtainable without customers routinely analyzing their energy data. In many cases, this is a reasonable assumption. Energy management may not be a priority for a company that is not aware of its opportunities to save energy. In addition, not all customers are convinced that smart technologies are worth their costs or that they have the capacity to install them. An incentive from an efficiency program may be enough to encourage customers to install an energy management system and to use it.

Several types of programs encourage customers to invest in sensors, networks, and automation so they can better control their energy use. The use of EMIS in industrial programs is emerging. One reason that programs are interested in including EMISs in their industry offerings is that interval meter and device-level data can increase everyone's confidence in savings claims and reduce evaluation costs (Crowe, Kramer, and Effinger 2014). Even though the tracking of energy savings is a key activity of all types of industrial programs, few companies take advantage of the newer technologies that are available. Monthly utility bills and Excel spreadsheets are still what is typically used to track savings.

In the commercial space, existing building commissioning and retrocommissioning programs often include financial assistance for building automation systems that have EMIS applications. Some programs incentivize only investments in building automation software that can collect and analyze information about energy use in buildings. Others have a broader focus that includes hardware and software for manufacturing process data collection, analysis, and display (ACEEE 2018).

Programs may fund all or part of an EMIS audit, all or part of an EMIS system, EMIS infrastructure installations, service provider training and support, and some fraction of EMIS software subscription fees.[10] An example of the last option is the NYSERDA RTEM program described below. In some instances, the focus of a program is retrofitting existing commercial and institutional buildings. In addition to upgrading the building's shell and mechanical components, such programs can include installing advanced building management systems to provide operators superior control of energy consumption. Some programs cover worker training because of how important it is to the success of an EMIS implementation.

A customer could include an EMIS in a project receiving incentives from a custom program. The difference between leveraging a custom program to pay for an EMIS and an EMIS-focused program is that custom programs provide incentives tied to the volume of energy savings and tend to be less concerned with the specifics of equipment installed by customers. They give customers greater flexibility in designing systems but can require extensive engineering analysis of energy savings. Within such a program, a company can include all types of sensors, connected devices, networks, and energy data analysis equipment. Technology is part of a bigger project and not singled out. For example, a project to upgrade a production line might include dozens of motors, drives, fans, pumps, and conveyors. It will very likely also include some new sensors, add to an existing communication network, and incorporate new or improved controls.

It is likely that more than a few projects funded by custom energy efficiency programs have included the installation of an EMIS or other data management and analysis technologies. But since little to no data exist on the types or volumes of technologies custom programs have funded, we did not include such programs in our analysis. We mention it here to alert program stakeholders that custom programs are a viable programmatic tool to drive customers' investments in energy-saving EMIS-like technologies.

EM&V

The evaluation of EMIS programs often involves determining the savings from O&M projects that are attributable to the EMIS, and savings from capital investment projects that are attributable to other programs. As with SEM programs, the evaluators of EMIS often follow the IPMVP Option C, whole-facility approach to M&V. A few EMISs support IPMVP Option D, which includes a calibrated whole-facility simulation informed by meter data.

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[10] EMIS software is often provided in a subscription format, also known as software as a service (SaaS), in which the customer has access to continually updated software but does not own it.

The more granular the data, the better the simulation. Analysis of large capital projects is done using a bottom-up analysis method (IPMVP Options A or B) on the savings from each of the capital investment projects and subtracting these savings from those of the top-down analysis.[11] The balance of savings is attributed to the EMIS.

A common approach to M&V is to gather 12 months of post-implementation data. When an EMIS has access to higher-resolution data, such as from an interval meter taking measurements every 15 minutes, it can detect savings that normally would be missed because they are small; this can also decrease the amount of time needed to develop an annualized savings estimate (Kramer et al. 2013; Crowe, Kramer, and Effinger 2014).

Examples of EMIS Programs

We have identified 10 energy efficiency programs that include EMISs among their offerings (see Appendix A). As the following case studies illustrate, some of these programs focus on industrial facilities, some on commercial, and some include both. Though EMIS-focused programs are relatively new, a few are already showing results.

Efficiency Nova Scotia

Efficiency Nova Scotia's EMIS program provides financial assistance to companies to purchase hardware and software capable of collecting, analyzing, and displaying information on energy consumption and its relationship to production. The program also trains workers and engineers in how to operate the system and teaches management how to use it to improve their facilities' energy performance. Implementers help company technicians set up the EMIS, put in place data collection and reporting processes, and establish operating parameters. They also set up dashboards that simplify monitoring, aid operators' decision making, and alert technicians when equipment is not functioning properly.

The bulk of the EMIS program is executed in four key steps, with funding provided at each: audit, implementation planning, implementation, and ongoing operations. The EMIS audit is an exercise in scoping and seeks to outline budget constraints, identify current energy usage and costs, and determine training needs (Econoler 2017; Henwood and Bassett 2015). During the implementation planning stage, final cost estimates, schedules, information and technology training plans, and communication channels are established (Henwood and Bassett 2015). Once the EMIS is set up and workers are trained, companies can use energy data to set targets for production and downtime modes and develop KPIs that operators can use to make process control decisions.

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[11] IPMVP Option A and Option B use engineering models to calculate energy consumption for a project end use, like a lighting system or a ventilation system, and estimate savings by changing the model parameters that are affected by an energy efficiency program. Parameters include operating characteristics of the systems or facilities where the measures are installed and equipment operating hours and loads. Option A requires the direct measurement of only one of the key parameters during the baseline and reporting periods; the others are stipulated on the basis of assumptions or analysis of historical data. In Option B, all the parameters affecting energy savings are measured rather than stipulated. Both options involve short-term or continuous measurement of both baseline and reporting-period energy use.

After training and engagement are completed, the implementer will continue to provide technical assistance related to the EMIS for one year. The program collects performance information throughout the engagement and monitoring period. During this time, efforts are focused on progress in reporting, O&M, and energy management culture. Post-implementation, the program continues to support its customers for one to five years (Henwood and Bassett 2015).

New York State Energy Research and Development Authority

NYSERDA's RTEM program claims customers can achieve energy savings of 15–30% per year (NYSERDA 2017b). Though EMIS programs often involve only software, RTEM supports up to 30% of all software, hardware, Internet connectivity, and cloud-based metering costs. Many of the systems funded by RTEM have fault detection diagnostic capabilities, and some enable facilities to participate in automated demand response programs (NYSERDA 2017b, 2018f). RTEM systems analyze site performance data and make adjustments in order to provide more responsive, comfortable, and energy-efficient environments (NYSERDA 2018b).

RTEM systems work with customer BASs and over time amass more and more data. Data collected from program participants' buildings, useful for benchmarking the performance of various building types, are stored in the cloud and can be accessed from anywhere. This enables program participants and their vendors to troubleshoot any problems remotely. NYSERDA covers the cost of maintaining the cloud-based infrastructure as part of the RTEM program (NYSERDA 2018d, 2018f).

Xcel Energy Colorado

Xcel Energy Colorado offers an energy efficiency program called Energy Information Systems (EIS) that aims to achieve greater savings in commercial and industrial buildings by allowing customers to harness the benefits of intelligent building controls such as EMISs. The EIS program is offered as a standalone but also can be an additional module within Xcel's Process Efficiency program. The EIS dashboards enable operators to visualize building performance, and this helps them identify low- or no-cost behavioral measures they can take to reduce their energy usage (Xcel 2015, 2016). Xcel offers coaching and consultative services to help customers select the EIS solution, identify energy-saving opportunities, and verify savings. The program provides a 30% incentive for qualifying installation costs and an additional incentive of $0.02/kWh on O&M savings (Burgess 2018).

FortisBC

The EnerTracker Program offered by FortisBC in partnership with BC Hydro provided customers access to an EMIS. It was a subset of FortisBC's Continuous Optimization program targeting commercial building owners. FortisBC designed this program to give customers unable or unwilling to participate in the full Continuous Optimization program insights into their natural gas usage and to identify gas conservation measures. The software provided fault detection in near real time, avoiding wasted gas consumption. The program covered the cost of the annual EMIS subscription and saved an average of 2% of annual natural gas consumption. However FortisBC deemed the program ineffective and discontinued it after 2016 (Fortis 2017).

EMIS PROGRAM RESULTS

Most of the EMIS programs listed in Appendix A are relatively new and have yet to demonstrate a history of energy savings. We do not have a sufficiently large data set to calculate any averages or trends. In lieu of data analysis, we cite the performance of specific programs with the thought that their results could be representative.

The Efficiency Nova Scotia EMIS program splits implementation costs with the customer. A portion of the implementation incentive is awarded after customers complete quarterly reporting requirements. In 2015, when the program was launched, the average cost of program participation per customer was $142,600 (US), and Efficiency Nova Scotia provided an average of $102,500. The utility also provides incentives to program participants at milestones along the way (Henwood and Bassett 2015). In 2016, participating customers saved 2.02 GWh, and net program cumulative savings reached 4.66 GWh (Econoler 2017). As of 2018, a total of seven participants have benefited from the program (P. Bassett, president, Energy Performance Services, pers. comm., January 18, 2018).

Xcel Energy Colorado reports that the EMIS program has typically come close to or met its energy savings goals and has been cost effective. In 2016 the program achieved 100% of its electric energy savings target and 170% of its natural gas savings target and came in under budget. Participation in the program has increased in recent years, allowing the utility to achieve even greater savings. Xcel cites the following benefits beyond energy savings (Xcel 2017):

- Integrated equipment monitoring and control
- Centralized building system operations
- Enhanced tenant comfort and increased customer satisfaction
- Reduced nuisance calls
- Reduced energy waste and operating expenses

As indicated by Xcel's claims, EMIS programs produce many benefits in addition to reducing customers' energy consumption. NEEA's 2014 survey of industrial EMIS found that the ability of many EMISs to track project performance is a valuable feature. Some project tracking applications include project management features, which can also be valuable to some businesses. The most important feature is perhaps the ability to quantify energy savings automatically. In order to do this, the EMIS must be able to incorporate production data into the energy regression analysis, so the ability to connect to third-party devices and networks is critical. Evaluation of energy savings from an energy efficiency project requires the ability to track energy data at daily or more frequent resolution.

Fault detection and alerts reduce downtime and support product quality efforts. Team leaders are able to use outputs to drive discussions and task assignments in routine meetings. Managers with more than one facility can keep track of the progress of multiple projects at multiple facilities (Crowe, Kramer, and Effinger 2014).

EMIS PROGRAM CHALLENGES

A challenge that many companies have with any advanced technology is getting the full value out of it. For example, Energy Performance Services, Inc. (EPS), the implementer for several programs across Canada, has routinely found EMISs in place but not in use, or not used to their full potential. Often only one person knows how to use the software. This discovery caused EPS to shift its delivery model. It started working with companies to integrate their EMIS into the rest of the company's business systems. This involved worker engagement and training, management commitment, and building energy performance metrics into the production reports that management used (P. Bassett, EPS, pers. comm., January 11, 2018).

Utilities were initially reluctant to include EMIS in their programs. The proprietary software programs were essentially black boxes; there was no visibility into the embedded analytics and therefore no way to validate the energy savings claims. Vendors realized this was a problem and started providing their model equations and specifications, which users can now download and view. Many EMISs now report precision and accuracy statistics such as R^2 and the coefficient of variation of the root mean square error. This type of statistical reporting gives programs the opportunity to assess the EMIS M&V algorithms.

A key step in developing a regression analysis is characterizing the facility's energy consumption relative to variables such as occupancy or product mix and volume. For manufacturing facilities, it can take up to six months and require multiple facility visits for a program to develop a baseline energy regression model. This type of analysis requires a considerable amount of manual input, filtering of data, and experimenting with different sets of variables.

A barrier to authorization in some states has been regulators' perception that EMIS programs are market transformation or behavior programs. Some regulators have a bias toward resource acquisition programs that provide incentives for the purchase of physical assets. Some EMISs are SaaS products that companies purchase on a subscription basis. The annual subscription fees can represent more than half of the cost of implementing an EMIS. There is no physical asset that could be repossessed or transferred to another facility if the company went out of business.

Illinois recently saw resistance to allowing utilities to recover costs on SaaS. The Attorney General's Office did not agree with a proposal by state regulators to let utilities get cost recovery on their cloud computing investments. The Office argued that a rule change was not necessary because outlays for cloud computing are operational costs, not capital investments (Stark 2018). Though this issue was related to direct investment by utilities, the same thinking can transfer to the items for which efficiency programs provide incentives. Regulators or policymakers may be resistant to programs providing funds to purchase SaaS subscriptions they perceive to be operating costs.

A challenge with SaaS investments is how to measure and verify energy savings. Program evaluators must verify that the SaaS was purchased and installed and is being used, a much more challenging task than verifying the installation of a piece of production equipment. Including subscription fees in a program and requiring multiyear reporting both address this issue. Some programs, like NYSERDA's RTEM, cover subscription fees for a few years to make sure the company uses the software and develops a habit of making decisions based on the analysis provided. This also ensures that the program will continue to receive performance updates.

Some of the experts we talked with thought that the costs of EMISs might be a barrier for some companies. Software for a commercial building can run to tens of thousands of dollars. For a manufacturing facility, an EMIS can cost $100,000 to $200,000. This is a barrier for companies that need a quick return on investment and for utility programs concerned with cost effectiveness.

Others stated that compared with other capital projects, EMIS costs are on the low end. Their EMIS audits gather the information needed to develop cost-effective energy savings strategies and convincing business cases.

Programs Combining SEM and EMIS

What is apparent in analyzing existing programs and listening to stakeholders is that SEM and EMIS programs do not exist in isolation. Whether it is a SEM program offering an EMIS audit or an EMIS program integrating the ISO 50001 standard into its engagement, these two sets of energy management tools are organically merging. They may have been conceived separately, but many implementers are finding success by bringing them together.

In this section, we examine programs that combine the workforce development and organizational culture change benefits of SEM with EMIS programs that provide more automated data management and system-level savings from superior control. Referring back to our earlier definition of SEM, such programs, whether they be SEM plus EMIS or EMIS plus SEM, fall within the broader set of what are considered SEM programs.

After looking at existing examples, we contemplate what programs could look like in the future. Our discussion examines how these two important energy management tools, when combined in one program offering, might affect program features, benefits, barriers, participants, structures, and results. We also consider any trade-offs that programs might face. Program developers can use this information to guide them in their creation of new SEM programs.

EXISTING PROGRAMS

SEM Plus EMIS

Our conversations with people involved in SEM and EMIS programs indicate that in most cases, it makes sense to start with SEM and then integrate EMIS. The former creates the structure and the culture to get the most out of the latter. One implementer thought it easier to convince some customers, those with an existing focus on automation and data-driven process control, of the value of an EMIS than of a SEM program. The consensus was that regardless of where you start, in the end it makes sense for most customers to have both.

More than half of the existing SEM programs provide some sort of EMIS assistance (see Appendix A). The range of assistance for EMIS is not binary: It extends from just providing a list of EMIS vendors to technical and financial assistance to determine EMIS needs followed by installation and setup. Typically, programs will include some sort of cost-sharing or co-funding option. This may mean providing funding for all or part of an EMIS audit, for all or part of an EMIS system, or for SaaS subscription fees.

Of the 14 SEM programs examined in the 2018 CEE report, 10 include some support of EMIS (Burgess 2018). They may not require installation of an EMIS, but if the customer is interested and capable of integrating one into its operations, programs will support the installation. Some programs provide assistance on an ad hoc, as-needed basis. Others provide all or nearly all funding for EMIS (Burgess 2018). A review of a few existing programs that combine some or all aspects of SEM and EMIS implementation can provide insights into what future SEM programs might look like.

BONNEVILLE POWER ADMINISTRATION

BPA has offered a SEM program to its customer base in the Pacific Northwest since 2009. It falls within BPA's Energy Smart Industrial program (ESI), which also includes its Energy Project Managers program. ESI implementers often encourage use of EMIS and provide up to 100% of funding for EMIS systems. Additional incentives are available for other performance tracking and energy savings technologies (BPA 2017).

CALIFORNIA INVESTOR-OWNED UTILITIES

California's investor-owned utilities (IOUs) are investing $4 million to provide SEM programs that started in 2018 (Tufts 2017).[12] They are all participating in a standardized program that follows the features recommended by a program design guide and an M&V guide developed for the California Energy Commission (Therkelson and Dias 2017). The California SEM program pulls key elements from CEE's minimum elements, the ISO 50001 standard, and existing SEM programs (Tufts 2017; Dias 2017)

Under the standardized program, industrial participants attend a number of workshops and site-specific activities throughout the two-year engagement period. Over the first year, utilities and participants collect the information needed to develop a baseline and produce a regression model. Cohorts share an implementation contractor or coach responsible for communicating program progress between sites and utilities. Some cohorts are composed of organizations from many industries, while others may be specific to a particular industry, such as food processing.

In the second year, program participants focus on M&V and companies are eligible to request help implementing an EMIS. The program provides incentives at several milestones to drive continued participation and energy savings (Dias 2017).

FOCUS ON ENERGY (WISCONSIN)

Focus on Energy, the statewide efficiency utility for the state of Wisconsin, has a SEM program that serves industrial facilities and other large customers like hospitals and universities. The program can provide comprehensive services to larger customers with the capacity to seek ISO 50001 certification or introductory services to get companies started on

[12] California's IOUs include Pacific Gas and Electric, San Diego Gas and Electric, Southern California Edison, and Southern California Gas.

energy management. The utility is implementing the 50001 Ready tool to guide customers along their energy management journey.

Focus on Energy provides most of the training on an individual basis, although about one-tenth is done through cohorts. If a customer has an EMIS or other system such as enterprise resource planning (ERP) in place, the utility helps customers use it to analyze and report energy data.[13] It has found that many manufacturers already have an ERP in place that can give them enough information to satisfy the needs of the SEM engagement activities. Using customers' existing hardware and software also avoids additional investments that can negatively affect cost effectiveness (N. Altfeather, program design engineer, J. Nicol, energy program director, T. Dantoin, engineering manager, and M. Stover, program operations manager, Leidos, pers. comms., May 25, 2018).

EMIS Plus SEM

XCEL ENERGY

Xcel Energy, which focused on technology in its EIS program, will launch a new program in 2019, offering two tracks, the EIS path and the Process path. The EIS track consists of EMIS and SEM components. The Process track has only SEM components, but customers will be able to switch or combine tracks. Throughout participation, the program will provide companies with a SEM consultant (SEMC) to help identify capital equipment improvements, system-level operational changes, and opportunities for cultural change (Xcel 2018).

There are three main phases within the program. The first is a standardized energy management assessment followed by the scoping of an EMIS solution. In the second phase, the SEMC will help the customer identify opportunities for energy savings and employee engagement, create and document a project register, and determine submetering and data logging needs. The third phase consists of an analysis of energy savings achieved and the awarding of incentives. The project register and implementation plan will be reviewed and reprioritized annually (Xcel 2018).

EFFICIENCY NOVA SCOTIA

Efficiency Nova Scotia's EMIS program implementer found that to get the most out of an EMIS, companies needed a structure for using energy data and deploying their workers in energy management. This drove Efficiency Nova Scotia to offer assistance to help companies implement systems such as ISO 50001.

This is unusual for an EMIS program as they most often focus on technology and leave workforce development and management systems to SEM programs. Efficiency Nova Scotia also has a SEM program, so there is some potential for overlap of services. Both programs focus on O&M savings. Neither program gets credit for savings from capital projects identified by energy teams; these are attributed to separate incentive programs.

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[13] ERP systems integrate business processes through information technologies. They are tools to share common processes and data models across multiple business operations.

Initially, the EMIS and SEM programs did not coordinate their engagement activities and did not share clients. Recognizing the opportunity to realize program delivery efficiencies and achieve greater results, the programs started coordinating and are now managed by the same implementer. Efficiency Nova Scotia also offers a program that co-funds an onsite energy manager. Eligible customers have the option to utilize one, two, or all three programs.

As Efficiency Nova Scotia plans for the future of its industrial programs, it is now considering an even more coordinated effort. It is also looking at a longer (three-year) engagement period, with SEM in the first year, EMIS in the second, and ISO 50001 in the third. With a more coordinated approach, ENS can combine the organizational development and energy management structure that comes from SEM and the data gathering and analysis automation that is possible with EMIS. As companies become increasingly dependent on data analysis to identify cost-saving opportunities, this combination will help companies maximize their energy performance.

Bringing several programs under one umbrella also addresses energy savings attribution issues. Savings from a customer participating in multiple programs are evaluated at the program portfolio level rather than for each program, where attribution is not always clear-cut. Such an approach has the potential to reduce administrative and evaluation costs.

Challenges Facing Combined Programs

Energy management programs have unique challenges to overcome. Not all customers are ideally suited to adopting new technologies while also attempting to incorporate new practices.

Policy challenges for both types of programs can become amplified when they are combined. Regulatory policies and jurisdictional issues often make it difficult to offer incentives for workforce development and technology implementation—and, by extension, make it difficult to help companies implement continual improvement systems.

If providing an EMIS to customers as an additional SEM program feature does not result in greater energy savings, the additional expense could negatively impact the SEM program's cost effectiveness. Some of the program implementers we interviewed felt that getting data from a customer's existing hardware is often enough to make a SEM program successful. Others felt that cost effectiveness will not be affected if a program uses EMISs to drive additional energy savings through data-driven process control. They said that additional energy savings will balance the cost of the additional investment.

Advantages of Combining SEM and EMIS

There are two mechanisms for detecting a change in energy consumption: people and technology, both directed by standard procedures and continual improvement. If properly implemented, neither is dependent on one individual; instead, both are innate to the company so that even if there are shifts in personnel, changes in energy consumption—indicative of a change in savings—will be identified and addressed.

Through SEM, customers continually improve their EMIS platform so they can identify new opportunities to save energy. They start with energy management training and embedding a culture of continual improvement. After some quick wins, they evaluate more opportunities and invest in more projects, such as an EMIS. Those investments generate more savings and the cycle continues. The integration of smart technologies like EMIS into continual improvement programs like SEM has an intuitive appeal. A common barrier for companies to implement SEM is the time it takes to collect, analyze, and report energy data. EMISs are useful tools for accomplishing this task. But by themselves, they may not be enough to ingrain proper energy management practices within an organization. A technician's use of a tool is only as good as his or her understanding of its capabilities and operation. When paired with a management system, the full value of an EMIS can be realized.

An integrated program model appears to be the direction in which many administrators are heading. A number of combined programs are already in operation. Efficiency Nova Scotia will offer a single program in the future. The new California SEM programs include EMIS implementation options. And Xcel Energy is combining its EIS and Process Efficiency offerings into a new SEM program that features two tracks for participants to pursue.

Combining SEM and EMIS in one program could produce greater customer energy savings while eliminating any overlapping administration functions. An integrated program approach may maximize short-term and long-term energy savings, increase savings persistence, and optimize energy productivity. Customers may realize additional nonenergy benefits including workforce development, waste reduction, pollution prevention, and improved competitiveness.

What does EMIS add to SEM? SEM gives companies standard practices and approaches to improve their operations. These cover a broad range of tasks such as preventive maintenance, documenting consumption of energy and raw materials, and routine analysis of operating conditions. An EMIS provides the data, often automatically, to track many variables. Adding energy management technology to a conventional SEM program allows operators to use data to make adjustments to operating practices to achieve more energy savings. In addition, the EMIS simplifies data gathering, analysis, and use. EMISs automate these activities and provide contextualized energy data that aid decision making by operators, supervisors, and engineers. The likely result is less degradation of savings over time.

What does SEM add to EMIS? An EMIS can collect and report all kinds of information. SEM tells a company what information it really needs and directs the use of this information to positive effect. Frameworks like ISO 50001 can provide a system for identifying and prioritizing projects and KPIs. And by knowing its energy data analysis needs, the company is more likely to invest in hardware and software appropriate to those needs. Once an EMIS is in place, the SEM program can help the company set up standard practices to get the most out of its system.

Adding SEM to EMIS programs may also result in more sustainable programs and longer-term energy savings. If a program adopts SEM as a customer engagement platform and anticipates routine engagement with its customers indefinitely, the number of O&M and

CapEx projects should increase. With more projects comes a greater need to collect and analyze data. This activity increases the value of the EMIS to the customer and program evaluators.

Providing customers with a robust and timely analysis of their energy performance can also produce a positive feedback loop that ultimately benefits all program activity. For example, multiple interviewees reported that their customers found great value in the regression analysis programs developed to model their energy use. In addition to helping them understand their energy use, regression analysis shed light on some of their production issues. Account representatives, realizing that these analyses were a key feature of SEM programs, started including them in their marketing targeting small and medium-size companies. That helped them recruit more companies into their SEM programs, producing more savings and yielding more success.

Evolving SEM Program Design

Programs that are comprehensive in scope and integrated in design can help industrial, commercial, and institutional organizations manage their energy with energy management systems and data-driven decision making. We anticipate that many more SEM programs in the future will be able to address the needs of organizations in all sectors. Programs may have dedicated teams to focus on specific sectors like commercial, institutional, wastewater treatment, and food processing. The Energy Trust experience indicates a need to address commercial customers at the corporate level and industrial programs at the facility level. This supports the need for two implementation teams at a minimum.

Some institutional and government facilities, such as wastewater treatment plants, have the same training and technology needs as industrial facilities. Others, like government office buildings, have more in common with property management firms. Program administrators like Energy Trust and Focus on Energy have already adapted their programs to account for this reality. We anticipate many more will in the future.

Many programs are taking a tiered approach to how they engage customers, using a light touch (such as with 50001 Ready) for small customers, a cohort approach for medium-size companies, and individual engagement for the largest. Some customers may want to start with the simplest program and then progress to more complex programs. It is probably better to start some companies with something simple, like conducting a treasure hunt and developing a project register. After some initial success, they can progress to a more comprehensive SEM program that leads to implementation of an ISO 50001–compliant energy management system.

Another early and valuable step is helping program participants develop a regression model so they can understand the drivers of their energy usage. As participants identify major energy-consuming systems and the metrics they will use for KPI, implementers help them assess what additional sensors, meters, and technologies might aid their energy information gathering and support their data analysis needs.

Several implementers observed that it is important for them to meet clients where they are along the curve of technology adoption if they are to maximize results. If clients are tech-savvy, then there is an opportunity for implementers to help them get the most out of their existing technology and then help them advance to more integrated and powerful systems. If customers are not tech-savvy, implementers can still help them use what they have and, if appropriate, help them evaluate options for additional sensor, network, and control investments.

An EMIS audit builds the business case for EMIS with both the scope and costs for the system as well as the strategy for using it to generate energy savings and an estimate of target energy savings. EMIS audits outline budget constraints, identify current energy usage and costs, and formulate an energy management and training plan.

Selection of EMIS and other smart technologies can be a complex and time-consuming processes as decision makers need to educate themselves before they can start to evaluate multiple solutions. The aid of a neutral third party to help them understand the pros and cons of various technologies can accelerate the process and give decision makers more confidence in their choices. The third-party model is familiar to most larger organizations' leadership, who use it when approaching complex technology decisions.

Programs will continue to utilize coaches to help companies implement. They have found them very effective with customers of all sizes. For very large customers, programs may offer onsite energy managers who lead SEM implementation, as BC Hydro and BPA programs do. Implementers engage customers one-on-one or in a cohort. The former is well suited for larger customers that can dedicate multiple staff members to training and engagement activities, while the latter is more appropriate for companies that cannot.

Companies that have participated in cohorts and other workshops may want any new staff they hire to receive the same training. We are not aware of any programs currently offering this, but allowing participating organizations to send new hires to workshops will accelerate their learning and ability to contribute to the team. It will also expose them to the experiences of people from other companies. It may make sense for past cohort and workshop participants to go to trainings and act as mentors. The presence of veteran program participants could improve the training by contributing to the sharing of experiences and best practices.

DESIGN CONSIDERATIONS

What if, rather than engagements of limited duration, programs engaged their customers on an ongoing basis, with the purpose of continually improving their energy performance and moving them toward the goal of systematic energy management? We are already seeing several programs extend the length of their engagement periods. What if programs stayed continually engaged with their most energy-intensive customers?

We suggest that programs consider engaging their key accounts for a minimum of two years, anticipate more limited engagement for twice that, and monitor for an additional two years. In such a scenario, that monitoring is essentially a matter of checking in with customers to see what they have accomplish, what they are planning on doing, and if the program can help. Otherwise, programs are likely to miss energy resource acquisition opportunities and customers may not get the full benefit of program resources.

The monitoring will also involve continued coaching and access to workshops. Key account managers and energy coaches will stay in touch with clients, keeping them aware of financial assistance and training opportunities and helping them stay on track with their energy management activities. This continued engagement should address the risk of backsliding and result in greater persistence of savings as well as more projects implemented.

In a continual engagement scenario, the level of engagement by each customer will ebb and flow as customer needs change. Should a company expand, it may want to take advantage of a cohort to train its new employees. Once a company has a SEM system in place, it may seek out program experts to help with internal M&V. The advantage to the program of continued engagement is the ability to claim savings year after year. While it would be appropriate to incorporate an attrition factor to such savings, the contributions of multiple customers will add up each year.

Extended SEM program engagements can start with commitment by participant leadership and an understanding that they are entering into a business relationship. Several existing SEM programs, such as those offered by Energy Trust and Efficiency Nova Scotia, require companies to sign contracts or MOUs that lay out in detail the obligations of the company and the services that the program will provide. Interviewees indicated that this is an important step because it ensures management awareness of the engagement and reinforces commitment to the process. The number one feature programs seek in a potential participant is the willingness to commit resources to the training and implementation activities. The other key feature is long-term commitment to the process. Energy management is a journey, not a destination.

Program implementers can integrate the 50001 Ready protocol using internal resources or direct customers to third parties that can help them achieve SEP certification. The 50001 Ready tool has the advantages of availability across service territories as well as technical support and endorsement by DOE. It also allows companies to be consistent with an established standard.

All sectors can benefit from a standardization of practice.[14] Aligning practice with the standard will benefit all program participants as they interact with people outside the program service territory. Using established and universally recognized protocols will help companies replicate activities across multiple facilities that may also be in multiple program service territories. It will avoid the potential risk of confusion caused by inconsistent documentation and M&V practices. ISO standards include procedures for documentation. Proper documentation leads to greater credibility of savings estimates within an organization and among external program stakeholders (Vetromile and Collins 2017).

[14] We recommend leveraging the 50001 Ready tool and ISO 50001 standard. Whereas the ISO standard is not appropriate for every customer, the 50001 Ready tool is designed to accommodate a broad range of customer types and sizes.

A move from a program model of limited engagement to one of continual engagement will require additional consideration by administrators and regulators on how energy savings are measured and how program performance is evaluated.

EM&V CONSIDERATIONS

The long-term viability of a program is tied to its cost effectiveness. Program administrators have many options for how to achieve energy savings, so SEM programs compete with many other program types for limited financial and staffing resources. The type of analysis an evaluator uses to assess the efficacy of a SEM program, and the variables allowed in the analysis, have a direct bearing on how it stacks up against other programs and other energy resources a utility might invest in.

One approach is to consider SEM programs to be components of a large-customer engagement portfolio and to perform the benefit–cost analysis at the portfolio level. Intuitively, we understand that administrators and implementers are likely to achieve greater results when programs coordinate their activities. If we treat SEM as a platform for all programmatic engagement, it becomes less important where the savings from individual projects come from. Although it is possible to separate out the savings of capital projects from O&M projects, doing so does not tell a more accurate story of the impact of SEM engagement. Workforce development, culture change, O&M improvements, and capital projects are all part of a larger effort to continually improve the use of labor, capital, and raw materials to make products or deliver services. Utilities are allowed to operate as monopolies in exchange for serving the common good. We should be careful not to let accounting issues prevent them from fulfilling that mission.

In the interest of minimizing the reporting requirements imposed on customers, we suggest that SEM programs take a whole-facility approach to M&V, following IPMVP Option C, to track performance for program reporting purposes. Taking a top-down, whole-facility approach to M&V captures the full impact of program activity while also being the least intrusive. It provides program stakeholders the information they need to assess program effectiveness. Program participants may want more granular information, but if they do, that is a burden they place on themselves, not one that is placed on them.

If customers are interested in more exacting M&V, they may want to consider the Superior Energy Performance (SEP) M&V protocol, which also uses top-down modeling. The approach is more rigorous, but it provides methods and options for unusual situations. It also requires documentation for bottom-up savings. It is a useful resource for developing regression models that can model energy consumption, as several methods are provided. SEP certification is a separate option for customers who want to fully incorporate ISO 50001 and demonstrate their energy performance improvement in a rigorous way.

It is also important to be patient with energy management programs. The benefits develop over time, and programs should keep this in mind in measuring results. One of the fundamental reasons for using ratepayer funds to secure future energy efficiency resources is that utilities have more patient money (that is, they can accept a lower rate of return) than private companies. Given this foundational concept, it makes sense to evaluate energy savings over longer periods. If the goal is to transform a company and make it more sustainable, then the M&V practices should reflect that.

Finally, a key output of data management tools such as EMISs is the determination of energy savings. M&V is an important activity of efficiency programs and one that program administrators think SEM and EMIS programs can simplify. Program administrators and evaluators should seek out new ways to leverage information and communications technologies to track participant energy savings and simplify their reporting requirements.

PROGRAM MARKETING AND PARTICIPANT RECRUITMENT

Conveying the value of a SEM program to customers can be challenging if they are not already familiar with continual improvement practices. However many businesses are used to employing operations data to drive their decision making. Hotel operators collect occupancy data and identify weekly, monthly, and annual trends to help them schedule their workers. Manufacturers collect all kinds of production data to drive their process control. An EMIS provides energy data in a similar format, so some customers may recognize the benefits of data management and analysis more readily than others.

The inclusion of technical and financial support for EMIS could be a key selling point for a SEM program. Some customers will already have EMISs or other IT systems in place but may not be getting the full value out of them. In such instances, program representatives can focus on the implementers' ability to train workers in how to set up and use the systems as well as implement a management system that connects energy data with operational decision making.

Another feature for representatives to highlight is that the combination of SEM structure and EMIS data management enables companies to document in a systematic way the history of company actions and associated results. This is useful for retaining institutional knowledge over the long term, but more important, in the short term, is that it improves the evaluation, measurement, and verification of energy savings.

Programs administrators may find it valuable to use implementers with existing connections to target market segments. For example, SEM programs on the West Coast are using this approach to engage hospitals, food processors, and metal fabricators. Potential participants will likely find a program featuring experts in their field more attractive. This addresses a concern we have heard in prior analysis that many programs targeting the industrial sector lack the sector-specific expertise that is needed (Chittum 2011).

POLICY AND REGULATORY CONSIDERATIONS

The role of utilities in many parts of the country is changing from a provider of a commodity to a platform for providing a variety of energy services. In this new paradigm, energy efficiency programs can be useful platforms themselves for engaging large customers. Energy management programs are well suited to frame the conversations between utilities and their most energy-intensive customers. For this to be possible, however, regulators and policymakers may need to remove barriers and provide incentives.

SEM programs generate many benefits, not all of which are germane to the mission of energy utilities or their regulators, though they are important to the economy. Workforce development, worker safety, and pollution prevention are a few examples. The challenge is that a single utility may not have the regulatory obligation, let alone the resources, to maximize the value of its SEM program to customers. It may not get credit for all the benefits of a SEM program and therefore be less inclined to pursue one.

One type of organization that can treat energy efficiency as a form of economic development is the efficiency utility, exemplified by Energy Trust of Oregon, Efficiency Vermont, and Wisconsin's Focus on Energy. Such organizations can pursue goals related to energy, environment, or the economy.

Another type of organization that can do this is municipal government. City and county governments are interested in growing their workforces, improving the environment, increasing the competitiveness of their businesses, and growing their economies. Municipal governments are also interested in improving the effectiveness and value to residents of all the utilities they own.

In the absence of a statewide organization, utilities can collaborate to operate a program together and help customers save electricity, natural gas, water, and other expenses as needed. For example, Commonwealth Edison and Nicor Gas in Chicago collaborate on program implementation to help their customers participate in both electricity and natural gas savings projects. Southern California Edison and Southern California Gas are collaborating on implementation of a new SEM program in Southern California.

Regulators and policymakers should identify and remove policy barriers to such collaborations. They may also want to encourage collaboration between utilities, as the California Public Utilities Commission did when it authorized the state's investor-owned utilities to launch SEM programs (Dias 2017). Authorizing analysis of the issue and inviting public comments and suggestions could be first steps toward removing barriers and advancing progress on this issue.

Generally, utilities track and report program savings annually to satisfy regulatory requirements. It would be better to go for longer periods because it can take time for the savings from some energy measures to materialize. Allowing for fewer and less frequent analyses will lower evaluation costs.

The claiming of O&M and CapEx savings that result from SEM programs is something that regulators and administrators need to resolve. Programs should be able to claim the savings from O&M improvements and get recognition for their ability to catalyze and accelerate the implementation of CapEx projects. One solution would be for regulators to allow program administrators to take a portfolio approach to program evaluation. If a utility can consider its SEM program to be a platform for all of its large-customer engagement, that eliminates the need for each component of its portfolio of programs—prescriptive rebate, custom incentive, SEM, EMIS, and others—to stand on its own. It can engage each of its customers with the resources that will help each achieve the greatest results. This argues for a top-down, whole-facility approach to evaluation across an entire program portfolio. Customer savings are measured not at the project level but at the facility level. Program performance is evaluated at the portfolio level.

There are two main barriers to utilities adopting this approach: inconsistent incentive rates and measure lives between programs. Integration of programs will require harmonization of these. Utilities will be concerned about cost recovery for a program that treats SEM as a customer engagement platform. If SEM programs are services that they provide their larger customers, then they will likely ask to recover those costs and earn a rate of return. Such a position aligns with the concept of energy efficiency as a resource, and so it may be a viable policy approach in some states.

Existing SEM programs provide training and coaching for defined periods. Turning a program from a model predicated on generating savings through limited engagements into a platform for continual customer engagement could involve additional resources and drive up costs. In such a model, the SEM program is performing multiple functions for the utility: resource acquisition, technical assistance, and customer service. The administrative and regulatory question is this: Could any additional costs be allocated respectively to those other cost centers? Also, since SEM programs include considerable worker skill-building, would state workforce development agencies be interested in supporting them? If so, such collaborations could reduce implementation costs to utilities.

Some utilities have a policy of reporting zero savings from SEM programs when non-programmatic events—such as economic downturns or requirements for new pollution-control equipment—impact a facility, increasing the facility's energy intensity and perhaps invalidating the baseline energy model in the reporting period (SBW and Cadmus 2017). While energy intensity is an important performance metric, it should not be the only one used to determine savings from program participation. It is more appropriate to evaluate the performance of implementers using variables that are within their control.

Businesses and institutions routinely seek out vendors that can address multiple issues simultaneously rather than through piecemeal requisitions, thereby lowering acquisition costs and enabling integrated solutions. This often applies to companies' interest in energy management. If a utility program cannot meet all of their needs, they are likely to prefer to use their own vendor. If this is not allowed, they may consider the programs unresponsive to their needs and object to paying into a public benefit fund (PBF) that supports the programs.

One way to address this is through MOUs specifying energy savings targets and reporting requirements. MOUs may be suitable vehicles for companies that pay into a PBF but do not want to be limited to existing program features and those that do not pay PBF fees. The former arrangement is often referred to as self-direct and the latter as opt-out. Two New England utilities, Eversource and National Grid, have had success with self-direct programs built around MOUs that commit their largest customers to continually improving their use of energy resources.

Self-direct programs, such as the ones run by Eversource and National Grid, allow customers to take most of the public benefit charges they would pay and instead allocate them to projects of their own design. These customers are then required to provide performance information so that the utilities can adjust their projections accordingly. One challenge of this approach has been determining how self-direct customers should determine and report their savings. How can utilities trust the values provided by self-direct customers?

The legislatures of several states have passed bills requiring PUCs and regulated utilities to allow larger customers to opt out of paying into PBFs and participating in programs supported by these funds. The motivations for such legislation and the ramifications are covered in other ACEEE reports (Chittum 2011, 2012) and so will not be revisited here. It is, however, important to note that when large energy users opt out of utility programs, in the absence of energy savings and demand reduction information on projects implemented by those large customers, the utilities are still on the hook to ensure sufficient capacity is available to meet future customer needs. Therefore it is important to require companies not participating directly in programs to report their energy savings. Requiring companies not participating in programs to sign MOUs that include reporting requirements is a way to address this issue.

The ISO 50001 standard is a solution to the reporting challenge of self-direct and opt-out. Because of its standardized and internationally accepted framework, and because of the requirement for third-party auditing of a company's implementation, a utility could trust the savings values that an ISO 50001-certified facility provides it. States with or contemplating self-direct programs could ensure proper accounting of energy savings by requiring that any company requesting to self-direct be ISO 50001 certified or possess government acknowledgement of conformance to the ISO 50001 standard, which is what the 50001 Ready tool provides. The same should be required of companies that opt out of participation in programs. Only then can utilities accurately forecast future resource needs. The advantage of this approach is that companies can seek out service delivery providers of their own choosing while also contributing to utility resource acquisition efforts.

POSSIBLE RESULTS

Proving that a systematic approach to energy management will save more energy than a non-systematic approach is challenging. Seldom is there an opportunity to have a control group for comparison. It is therefore doubly challenging to determine if including an EMIS in a SEM program will increase program energy savings. To answer this question, we asked people associated with SEM programs and looked at a couple of case studies. We also revisited a market potential analysis ACEEE conducted in 2015 (York et al. 2015) and examined how the combined benefits of SEM and EMIS might change that analysis.

More Energy Projects

Our survey of program stakeholders, although limited in scope, indicates a consensus that having both tools at a customer's disposal will increase the number of O&M and capital projects, decrease backsliding, and lengthen the persistence of energy savings (Appendix B). The analysis by Energy Trust of its SEM programs, covered earlier, indicates that participation in a SEM program leads to implementing more projects and greater participation in other Energy Trust programs (Rubado, Batmale, and Harper 2015).

A recent analysis by Johnson Controls, Inc. (JCI) addressed this issue in part. JCI has 13 plants in the United States and 13 plants in Europe that manufacture or recycle batteries. The plants in Europe have implemented ISO 50001 and have some type of EMIS in place. In its analysis, JCI set up a matrix that compared the US plants with those in Europe and the plants that had implemented two or more projects with those that had implemented fewer than two. They found that the number of projects drove energy savings, which is what one might expect. They also found the savings of plants with ISO 50001 and EMIS were 4% greater than those without. The ultimate finding was that the plants that saved the most energy were the ones that were ISO 50001 certified, had an EMIS in place, and implemented two or more projects. The plants with the least energy savings were the ones that had none of these attributes (C. Nesler, vice president of global sustainability and industrial initiatives, Johnson Controls, Inc., pers. comm., September 18, 2018). The JCI case study does not conclusively answer the question of whether a SEM program that includes EMIS implementation will produce more savings than SEM alone, but it is indicative of the greater results possible when management structure and energy data analysis technology are combined.

Persistence of Savings

The management structure and data analysis afforded by an integrated implementation of an energy management system and data management technology should also extend the persistence of savings. As SEM programs like those offered by Energy Trust and BPA collected more information, they extended the persistence of savings claimed in their program evaluations. EMIS programs like NYSERDA's RTEM require customers to report savings for several years after initial engagement. They do this to ensure customers will continue to use data provided by their EMIS, and they anticipate that this will positively affect the persistence of savings from O&M types of projects (Katie Dooley, assistant project manager, NYSERDA, pers. comm., May 21, 2018). Management commitment, worker training, and automated notifications and alarms all contribute to creating within participant facilities a culture of continual monitoring, analyzing, and acting that will result in less degradation of savings over time. Survey respondents agreed, suggesting that savings might be extended more than two years longer (Appendix B, question 13a).

Market Trends

At the beginning of 2018, we can identify 31 program administrators that offer 13 SEM-only, 11 EMIS-only, and 19 SEM-with-EMIS-option programs in North America. These programs are administered by utilities and state and provincial organizations that cover 20–25% of the commercial, institutional, and industrial load of the United States and Canada (EIA 2018b; ISED Canada 2018). Collectively, they served about 400 customers in 2018, which means there is potential for many more programs to serve many more customers.

CEE has tracked the growth of SEM programs among its members, and the trend that is apparent from their data, captured in figure 3, is that the number of programs increases at a rate of one or two per year. If the trend continues, there will be around 30 programs in 2020 and 40 in 2025. There are about 200 large utilities in the United States and Canada serving about three-fourths of the total electric load of the two countries (Statista 2018). These are the most likely candidates for SEM program administration.

Although there is growth in the number of organizations participating in SEM programs, there is considerable potential for programs to serve more facilities. CEE members reported 886 customers served prior to 2015, 282 in 2015, and 376 in 2016. More than 1,500 organizations have participated in some type of SEM program in the past decade.

There are around 350,000 manufacturing facilities in the United States and Canada (Census, 2012; ISED Canada 2018). Facilities with more than 100 employees represent 8% of that total but over half of all industrial sector energy use (Census Bureau 2016; ISED Canada 2018; Trombley 2014). These 27,500 plants are the most likely candidates for SEM program engagement. This is considerably more companies than can be served by existing programs.

Program administrators are likely interested in knowing how much of this opportunity they can realistically address. To answer that question, we can look to recent trends and do a bottom-up calculation to determine how many companies programs might engage and how much energy those companies might save.

On average, SEM programs engage around two dozen companies per year. At 24 participants per program, a conservative prediction based on recent history of two or three new programs per year yields 30 active programs in 2020 engaging 720 participants. Projecting further, 40 programs will engage 960 organizations in 2025, and 50 programs will serve 1,200 in 2030 (table 3).

We can also imagine a more rapid increase in the number of programs. Table 3 captures the potential impacts of more accelerated growth rates: Our moderate scenario assumes an early-on growth rate of five programs per year tapering to three per year; our aggressive prediction assumes a very rapid increase in the number of programs before slowing to a growth rate of four programs per year. Beyond 2030 the number of programs and associated number of participants plateaus in all scenarios. The scenarios range from covering one-fourth to more than half of all major utilities, and half to three-fourths of C&I loads in the United States and Canada.

Table 3. Future program activity

	Program growth	2020	2025	2030
Number of programs	Conservative	30	40	50
	Moderate	35	50	65
	Aggressive	45	70	90
Number of participants	Conservative	720	960	1,200
	Moderate	840	1,200	1,560
	Aggressive	1,080	1,680	2,160

Future Performance

The past performance of existing programs can give us an idea of what their performance might be in the future. It can also help us estimate what might be possible when SEM programs are treated as a platform for all large customer engagement. In 2015, ACEEE analyzed the performance of several emerging program types and projected future energy savings. One of those program types was SEM. The analysis used Energy Information

Administration (EIA) *Annual Energy Outlook* projection data and determined national energy reduction potential by making assumptions for the ratio of load covered by programs, participation rates in programs, and average savings rates (York et al. 2015).

The 2015 study was a top-down analysis using macro EIA data. With the data gathered for this report, we can perform a bottom-up analysis based on average energy savings per customer and average customers per program. Some assumptions will remain the same between the analyses.

Total electricity savings by a program vary from 600 MWh for Idaho Power's program to 46,000 MWh for Bonneville Power's ESI program portfolio. Likewise, the energy savings per customer have a wide range: Some programs have realized savings as high as 1,200 MWh per customer, while for others the per-customer savings are only 400 MWh. Similar variability is observed of natural gas savings. Commercial facilities are not as energy intensive as industrial facilities, and so the mix of commercial and industrial facilities served will affect the values for average savings per customer.

In the 2015 analysis of SEM programs, potential energy savings per customer were projected to be 500 MWh/year for commercial customers and 1,600 MWh/year for industrial customers. The CEE survey of 2015 SEM program performance (Burgess 2016) provided much of the data for our 2015 analysis. The more recent CEE survey results as well as other reports and our survey results indicate that many of the underlying assumptions of our 2015 analysis are still valid. Therefore we continue to use the 500 MWh and 1,600 MWh values in this report.

The 2015 analysis also assumed that 20% of the commercial load and 50% of the industrial load could be addressed in SEM programs. There was no consensus among our survey respondents regarding the percentage of customers or load that their programs might address. Nor was there agreement on the fraction of eligible customers that might participate. It is likely that these metrics depend on the details of a particular program's customer base. The assumptions used in 2015 for participation rates were 23–50% for commercial and 38–75% for industrial by 2030. We do not assume a participation rate in our bottom-up analysis; rather, we use the capacity of the programs—the number of organizations that could participate in a given year.

The 2015 analysis did not make any projections for natural gas savings, so in this analysis we look to the more recent work of CEE. The average per customer from the six programs reporting savings to CEE in 2017 was nearly 9,500 decatherms (Dth) in 2016. The median energy savings was 2,558 Dth. That most programs do not report natural gas savings is not surprising. There are not as many natural gas utilities involved in SEM programs as electric utilities because not as many are subject to energy savings performance targets; moreover, many large users purchase their natural gas on the wholesale market and require only transmission services from their local utility.

We use values of 9,500 and 2,500 Dth as placeholders for the gas savings from industrial and commercial facilities, respectively, and we assume in our analysis that one-fourth of SEM programs capture natural gas savings. These assumptions feed into the analysis reflected in table 4.

On the basis of current program offerings and participation rates, we assume that one-third of SEM program participants are commercial and the remaining two-thirds industrial.[15] We use the number of customers to calculate potential energy savings for a program serving two dozen customers (table 4). Larger programs and programs serving larger customers are likely to see greater savings than smaller programs or those focused on smaller customers.

Table 4. Possible future SEM program performance, conservative scenario

	Commercial (8)	Industrial (16)	Typical program savings (est. 24 customers)
Electricity savings per customer (MWh/year)	500	1,600	29,600
Natural gas savings per customer (Dth/year)	2,500	9,500	172,000

By multiplying the number of programs in table 3 with the average savings per program in table 4, we extrapolate the potential electricity and natural gas savings for future years. Conservative, moderate, and aggressive estimates are listed in tables 5 and 6.

Table 5. Potential electricity savings (MWh) from SEM programs in United States and Canada

Scenario	2020	2025	2030
Conservative	888,000	1,184,000	1,480,000
Moderate	1,036,000	1,480,000	1,924,000
Aggressive	1,332,000	2,072,000	2,664,000

Table 6. Potential natural gas savings (Dth) from SEM programs in United States and Canada

Scenario	2020	2025	2030
Conservative	12,600,000	16,800,000	21,000,000
Moderate	14,700,000	21,000,000	27,300,000
Aggressive	18,900,000	29,400,000	37,800,000

In our 2015 top-down analysis, we estimated that SEM programs would save an additional 2–3% by initiating new capital investments. We modeled low-, mid-, and high-range scenarios. The low-range scenario counted O&M projects only and assumed a 5% energy reduction per facility. The midrange included some capital projects and assumed an 8%

[15] It is likely that the ratio of industrial to commercial participants will change as the number of programs targeting commercial facilities increases. For simplicity's sake, we did not factor this likely change into our analysis.

energy reduction. The high-range scenario included more CapEx measures, greater persistence of savings, and a 10% savings per facility. Conceivably, a SEM program that functions as a platform for all programmatic engagement and that gets credit for all O&M and capital project savings could achieve this level of savings.

On a national level, the midrange scenario of the 2015 analysis estimated that strategic energy management programs would reduce 2030 electricity consumption in the commercial sector by 7 million MWh, or 0.2% of projected electricity consumption. The savings projection for the industrial sector was 24 million MWh, or 0.6% of projected consumption. 31 million MWh equals the total electricity sales in Nebraska in 2017 (EIA 2018a).

The midrange projections of the top-down 2015 analysis are substantially higher than those of the bottom-up analysis of table 6. Even the low-range scenario projections, which were half of the midrange, are higher than the 2.7 million MWh reduction for both sectors of the bottom-up analysis. The reason for this difference is the assumptions about participation rates. The top-down analysis assumed 30% of all commercial and 50% of all industrial facilities would participate in SEM programs, while in the new analysis, as mentioned above, we use program capacity. Even the high-range program scenario in the bottom-up analysis does not provide sufficient capacity to achieve such participation rates.

Nevertheless, we can conclude from these two analyses that there is ample opportunity for growth in the number of programs, the size of individual programs, and the potential for savings. There is also sufficient opportunity for programs covering large service territories to increase the number of customers engaged each year and for the introduction of new programs in regions of the country that do not already have them.

The 2015 analysis also estimated the current cost of saved energy to be $0.059/kWh for commercial and $0.018/kWh for industrial SEM programs. We projected those costs to decrease to $0.014/kWh and $0.044/kWh, respectively, as programs became more effective. Analysis of the most recent program data indicates that the cost of program delivery has not noticeably changed, and so we are comfortable sticking with these numbers. As more programs come online and more data become available in the next two years, this issue will be ready for additional research.

Recommendations

Utilities, regulators, and third-party energy efficiency program administrators should embrace SEM programs for large customers. SEM programs have a proven ability to lengthen the persistence of energy savings, increase the number of O&M and CapEx projects, and boost participation in other program offerings. All of these features lead to greater energy savings per customer during and after program participation.

Where possible, utilities and third-party administrators should offer programs that engage customers over longer periods of time or continually. Programs can become trusted partners in a company's energy management journey. This changes the discussion from whether or not to implement projects to which projects to implement.

Utilities and third-party administrators should continue to expand SEM offerings to commercial and institutional customers. There is considerable unmet need for energy management training and technical assistance in these sectors, as well as continuing opportunities with industrial customers. It will likely be necessary to have multiple delivery teams in order to address the differences in how organizations in each sector manage energy.

Program designers should create programs that can meet customers where they are in terms of familiarity with management systems and their technical expertise with data management. The program design should be flexible to accommodate customers of different sizes and structures, different types of projects, and different types of energy resources. The staff of such programs should have sufficient expertise to take participants from creating regression analyses to implementing standard practices to preparing for ISO 50001 certification.

Program administrators should leverage SEM programs to forge long-term relationships with their customers. They should use SEM programs as a platform from which to manage other programmatic engagements. In certain jurisdictions, this may require treating SEM programs as technical assistance rather than resource acquisition.

Program recruiters should be familiar with the organizations in their territories, understand their prospects' likely energy savings opportunities, and know all the programs available to those prospects. This will enable them to identify the best candidates for SEM programs and then work with them to leverage other program offerings.

Evaluators should assess the energy savings from program participants using whole-building methodologies. The evaluation of an engagement should take into consideration performance over multiple years. This approach will capture the ability of SEM programs to produce sustained energy savings and avoid misleading cost-effectiveness values that may result from narrower evaluation periods.

Program regulators should consider the performance of SEM programs a piece of the portfolio of technical, financial, and market transformation programs offered by a program administrator. While it is appropriate to analyze the performance of individual programs, it is equally important to see how the performance of each program contributes to the performance of the entire portfolio.

Electric, natural gas, and water utilities should seek opportunities to collaborate in the delivery of SEM programs. A coordinated approach to program delivery can lead to greater savings per customer and lower administrative costs per program.

Policymakers should encourage multi-utility collaboration. They should also encourage other organizations such as economic development agencies to work with utilities to reach more organizations and realize all the benefits of SEM programs.

Continual improvement programs like SEM should also undergo continual improvement. Administrators should work with all stakeholders to evaluate what is working within their programs and in the programs of other utilities. Implementers can share information on training practices that have and have not worked. Evaluators can continue to refine models for predicting future energy savings and tracking the persistence of savings.

We close with a call for more research on the cost effectiveness of SEM programs, the persistence of energy savings for O&M improvements, and the cost of saved energy.

Conclusion

Industrial, commercial, and institutional customers represent many of the biggest opportunities for utility sector energy efficiency programs to meet their goals for energy savings and cost effectiveness. However securing savings from these customers year after year is challenging. Programs that reduce energy use through discrete measures will find it increasingly difficult to meet their goals as those savings are subsumed in standards for equipment such as lighting, motors, pumps, and fans. That is why programs that secure system-level energy savings are becoming all the more important. At the same time, such projects are often complex and expensive, and they can require dedication of program resources for extended periods.

SEM programs are effective at addressing these challenges. The best of them combine the features of resource acquisition, market transformation, workforce development, behavior change, and economic development. They help workers and company decision makers understand complex issues and technologies, evaluate options, and integrate new practices. They teach managers to treat energy costs like all other variable costs and manage them on a continual basis. They can also change the culture of an organization by helping leadership realize that the responsibility for energy management lies with its people and not its equipment; improving the use of energy is everyone's responsibility. SEM gives organizations the tools to identify opportunities, implement solutions, and track results, all of which improve their competitiveness.

Many utilities have found their relationship with smaller customers interrupted by third parties that provide smart devices and energy management services. Some third parties are working to become the retail face the customer sees and a broker of customer data analysis back to the utilities. SEM programs are a mechanism for utilities to reassert themselves as a primary source of energy services with their larger customers. The more services a utility can provide its customers, the more valuable the utility will be to them.

A key step is getting customers to agree that continual improvement is the goal, so that discussions each year can focus on what to do rather than whether to do something. This will keep the conversation going between utility and customer year after year. The conversation should take customers along a path toward comprehensive energy management that combines SEM with smart technologies like EMIS.

At the same time, as we heard from many program implementers, smart technologies are not appropriate for all customers. It is important to meet customers where they are in terms of technology adoption. Some will see the value and have the ability to implement smart technologies. Others will not yet have the vision or the capacity. In many cases, simple is better. In continual improvement system thinking, an organization should avoid adding costs that customers will not value. In data management and analysis, the corollary is that tools should work for the operator; the operator should not be working to satisfy the needs of a tool.

However, while not all companies will want to go the distance, and for some it may not make economic sense to do so, programs should have the ability to help customers progress from project-based energy efficiency to systematic energy management supported by smart technology. For companies that are ready, the integration of SEM and EMIS in a comprehensive SEM program will fulfill most or all of their energy management needs while continuing to engage them year after year.

SEM programs may ultimately become a platform for all larger-customer engagement. Should this happen, it will represent a fundamental change in how utilities interact with these customers and the structure of C&I programs. In the future we may see a shift from a passive offering of incentives to a proactive engagement predicated on providing customers with comprehensive energy management solutions. Such a change would be certain to decrease the energy intensity of thousands of facilities across North America and reduce their collective demand for energy.

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Appendix A. List of SEM and EMIS Programs

Table A1. Program offerings, types, and locations

Program administrator	SEM program	EMIS program	SEM with EMIS option	City	State/Province
Ameren Illinois			✓	Collinsville	Illinois
Baltimore Gas & Electric (Exelon)		✓		Baltimore	Maryland
BC Hydro			✓	Vancouver	British Columbia
Bonneville Power Administration			✓	Portland	Oregon
Commonwealth Edison & Nicor Gas (Exelon)	✓			Chicago	Illinois
Consumers Energy Co.	✓			Jackson	Michigan
DTE Energy	✓			Detroit	Michigan
Duke Energy—Carolinas			✓	Charlotte	North Carolina
Efficiency Nova Scotia	✓	✓		Dartmouth	Nova Scotia
Efficiency Vermont			✓	Burlington	Vermont
Enbridge Gas			✓	Calgary	Alberta
Energy Trust of Oregon			✓	Portland	Oregon
Focus on Energy Wisconsin			✓	Madison	Wisconsin
Fortis BC		✓	✓	Vancouver	British Columbia
Hydro Quebec			✓	Montreal	Quebec
Idaho Power			✓	Boise	Idaho
IESO		✓		Toronto	Ontario
National Grid		✓		Waltham	Massachusetts
New Brunswick Power		✓		Fredericton	New Brunswick
New York State Energy Research Development Authority (NYSERDA)	✓	✓		Albany	New York
Northern States Power Co.—Minnesota (Xcel Energy)	✓	✓	✓	Minneapolis	Minnesota
Natural Resources Canada	✓	✓	✓	Ottawa	Ontario
Ohio Power Co (AEP)	✓			Columbus	Ohio
Pacific Gas & Electric Company			✓	San Francisco	California
PacifiCorp—Pacific Power (Berkshire Hathaway Energy)	✓			Portland	Oregon
PacifiCorp—Rocky Mountain Power (Berkshire Hathaway Energy)	✓			Salt Lake City	Utah

Program administrator	SEM program	EMIS program	SEM with EMIS option	City	State/Province
Public Service Company of Colorado (Xcel Energy)	✓	✓	✓	Denver	Colorado
Puget Sound Energy	✓		✓	Bellevue	Washington
San Diego Gas & Electric Company (Sempra)			✓	San Diego	California
SaskPower	✓	✓	✓	Regina	Saskatchewan
Southern California Edison & Southern California Gas Company			✓	Los Angeles	California
Totals	13	11	19		

Appendix B. Questionnaire

Table B1. Questionnaire responses

Question	Responses (n=11)	Summary of results
1. Our research has shown that SEM programs on average can help companies reduce their energy consumption in the first year of program engagement by 6 to 10%. Based on your experience, would you expect to see similar results, or would you expect the values to be lower or higher?	a. <3% (3) b. 3–5% (3) c. 6–10% (5) d. 11–20% (0) e. >20% (0)	Respondents tended to agree with our research findings that SEM programs could save 6–10% in their first year, but all respondents agreed that first-year savings would be expected to save no more than10%.
2. Our research has shown that EMIS programs on average can help companies reduce their energy consumption in the first year of program engagement by 6 to 10%. Based on your experience, would you expect to see similar results, or would you expect the values to be lower or higher?	a. <3% (3) b. 3–5% (2) c. 6–10% (2) d. 11–20% (1) e. >20% (0)	Most indicated that savings would be no more than 5%. This could be due in part to EMIS programs lacking the needed organizational structure to capitalize on the opportunities that it helps identify.
3. Our review of vendor publications and case studies indicates that closed-loop control can yield an additional 10–15% energy savings. In your experience, is this a reasonable expectation?	a. <10% (2) b. 10–15% (3) c. >15% (0)	Respondents agreed that a closed-loop system would not generate more than 15% energy savings. It was suggested by one respondent that vendors might overestimate the savings generated from these controls.
4. In your experience, would you expect a facility that participates in a SEM or an EMIS program to implement more O&M projects than one that does not?	a. Yes, more O&M projects (11) b. No, same number of O&M projects (0)	100% of our respondents expected SEM or EMIS programs to lead to the implementation of more O&M projects.
5. Would you expect that company to implement more capital expense projects?	a. Yes, more CapEx projects (8) b. No, same number of CapEx projects (2)	The majority of respondents expected SEM or EMIS programs to lead to the implementation of more CapEx projects.
6. What values are you using in your analysis of energy savings persistence from O&M projects implemented as part of SEM program participation?	a. Same as for other programs (2) b. 1 year longer than for other programs (1) c. 2 years longer (0) d. 3 or more years longer (4)	While some respondents indicated that they use the same O&M savings persistence for SEM projects as for other programs (typically 1 year), many have increased the savings persistence to 3 or more years.
7. What values are you using in determining O&M project savings for EMIS programs?	a. Same as for other programs (4) b. 1 year longer than for other programs (0)	Conversely, all respondents indicated that for EMIS projects, they used the same O&M savings persistence as other programs. It

Question	Responses (n=11)	Summary of results
	c. 2 years longer (0) d. 3 or more years longer (0)	should be noted that there were few responses to this question.
8. What share of <u>customers</u> do you anticipate would be receptive to SEM?	a. <10% (4) b. 10–20% (2) c. >20% (2)	The responses show no clear consensus on the share of customers that would be receptive to SEM programs.*
9. What share of your <u>load</u> do you anticipate would be receptive to SEM?	a. <10% (4) b. 10–20% c. >20% (2)	The responses show no clear consensus on the share of load that would be receptive to SEM programs.*
10. What share of <u>customers</u> do you anticipate would be receptive to EMIS?	a. <10% (5) b. 10–20% (3) c. >20% (0)	Respondents expect no more than 20% of their customers to be receptive to EMIS.
11. What share of your <u>load</u> do you anticipate would be receptive to EMIS?	a. <10% (4) b. 10–20% (0) c. >20% (2)	The responses show no clear consensus on the share of load that would be receptive to EMIS programs.*
12. Would you recommend that a company start with SEM first and then add energy data management technologies like EMIS, or start with the technology first and then add the management structure second?	a. SEM first (10) b. EMIS first (1)	10 of 11 respondents recommended that a SEM program should be implemented first and followed by an EMIS rather than the other way around. Most respondents indicated they believed the culture change and organizational foundation of the SEM program was imperative for an effective EMIS program. One respondent suggested implementation of an EMIS first because it could establish the business case for implementing a SEM program.

Question	Responses (n=11)	Summary of results
13. We are interested in answering the question, Will the combination of SEM and EMIS produce greater savings than just SEM or EMIS? To answer this question, we ask that you imagine a company that already has one (an energy management system in place or an EMIS in place) and plans to add the other.		
a. Would you anticipate energy savings from O&M projects to persist even longer? If so, how much longer?	a. No change (1) b. Savings last <1 year longer (0) c. Savings last 1–2 years longer (4) d. Savings last more than 2 years longer (3)	Most respondents anticipated that the combination of a SEM and EMIS program would produce greater savings persistence from O&M projects than either program individually.
b. Would you expect the company to implement more O&M and/or CapEx projects?	a. No, same number of projects (1) b. Yes, likely to implement more projects (7)	Respondents tended to agree that a combination of SEM and EMIS programs would result in more O&M and/or CapEx projects.

* A few factors may have contributed to the disparity of responses to these questions. Possible explanations include regional differences (e.g., weather, types of industry, customer base) and the expansion of programs from commercial to industrial or vice versa. The responses may indicate markets where the respondents are active; it may be inappropriate to assume an average level of penetration of customer base and load.