How Best Practices in Documenting Strategic Energy Management Leads to Better Programs and More Savings

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ABSTRACT

As interest grows in Strategic Energy Management (SEM), so does the need for customers and project administrators to understand its true impacts. Effective documentation is essential for multiple aspects of SEM program success, especially to capture the longer-term and continuous improvement aspects of SEM projects. This paper highlights current best practices for SEM documentation that contribute to a better alignment between program funding and support and project-level activities. The best practices are based on evaluation experiences of SEM and other industrial programs that contain a mix of capital and operating measures.

Many SEM programs rely on whole-facility regression analysis to capture both behavior and operational savings, creating a baseline model using energy consumption prior to the program, and applying relevant variables such as weather and production. Program savings are more accurately estimated when projects have clear documentation of baseline consumption and relevant variables are reviewed and selected—starting during the investment decision-making process and continuing all the way through to program evaluation. This documentation is particularly useful to assess the validity of the regression model that is used to establish savings and for assessing program influence over projects as compared to business-as-usual scenarios. Information related to the timing of both program-related energy efficiency actions and the whole range of other actions that might affect energy consumption in a facility serve to inform the regression models, which means that good documentation is critical.

Smart documenting practices support long-term progress. The ability to demonstrate the immediate impact of SEM is the most convincing sales pitch to get customers to do more going forward. In some jurisdictions, poor documentation of industrial and SEM project details by program administrators is a major cause of regulatory savings loss, even when the participant may be satisfied with the project from an internal business perspective. Best practices documentation helps ensure that customers and program administrators remain on the same page regarding planning and tracking, and ultimately accounting for the full range of SEM savings over the long term.

Introduction

In terms of documentation, it is important to define SEM as the continual improvement of energy efficiency in facilities through systematic management of energy. Early SEM stakeholders defined the minimum components of SEM as customer commitment, planning and implementation, and a system of measuring and reporting energy performance (CEE 2014). SEM particularly emphasizes a business's change in behaviors and operations to reduce energy intensity[1] and energy waste. Documentation must capture the essence of management's options and choices for all the SEM components to adequately provide substantiation for program savings.

SEM savings are holistic rather than project based, and while they can include capital projects, they always include savings associated with changes in business practices. In this paper, we use the term "SEM projects" to refer to the participant sites engaged in SEM during the program. To ensure that savings from all activities and actions are captured, whole facility analysis is usually used as the basis for estimates. Typically, this involves developing a whole facility regression model of energy consumption in a baseline period, and using that adjustment model to predict what energy consumption would have been absent the SEM actions. The savings are then estimated as the difference between the modeled and actual consumption in the performance period.

SEM program savings that do not include capital projects are typically between 1% and 8% per year of baseline consumption (Ochsner 2015). These savings at individual facilities are not significant enough to meet the recommended threshold in the International Performance Measurement and Verification Protocol (IPMVP) that savings represent at least 10% of the baseline consumption to use a whole facility regression analysis. Many evaluators and some programs administrators are therefore uncomfortable claiming savings that are less than 10% of baseline consumption.

An alternate approach is to estimate the savings from the most significant individual actions or projects undertaken because of SEM. Accounting for behavior and operational and maintenance (O&M) initiatives requires quantification of many individual items, with some being too small or too difficult to accurately quantify (thus, they are ignored and savings are not tabulated).

As mentioned above, some SEM programs include capital projects as well as operations and behavior actions, though savings from capital projects may also be captured in programs other than SEM. In these cases, it is important to disentangle the capital and operating improvements and account for them separately so they can be appropriately attributed. A further confounding factor arises from the continuous improvement nature of SEM, and the longer-term evolving approach to energy management that it fosters within facilities and organizations. Strictly-defined performance periods may or may not align with the persistence of some SEM program measures, which could range from relatively short term all the way to long-lasting or permanent measures that affect or induce "cultural change."

As SEM has developed, methods to meet statistical requirements needed to demonstrate whole facility savings have evolved (Bonneville Power Authority 2013, Energy Trust of Oregon 2016, Therkelsen 2017, DOE 2012). These statistical methods are in turn bolstered by effective documentation of why the savings occurred, to show that the observed changes in consumption are associated with deliberate (program-related) actions taken to reduce energy consumption and energy intensity.

[1] Energy intensity is the energy consumption as a function of the amount of product produced; typically the quantity of energy consumed per quantity of product.

Best Practices for Documentation

SEM programs have many stages and milestones, each of which can be effectively documented. The purpose of this paper is to identify best practices for reasonable levels of documentation that will build credibility for SEM initiatives. Project-level credibility is required by proponents to justify the continuation of their SEM efforts. Credibility is also required by program administrators to justify the project-level attribution of SEM program savings, which ultimately justifies the program expenditures to participants and general rate payers.

SEM programs in North America are typically designed as one or more years of engagement with multiple meetings, workshops, trainings, and facility-specific events. The first phase of a program is usually customer outreach, followed by a customer agreement or memorandum of understanding. In addition, facility/energy managers create documents such as energy plans, energy maps, action plans, project-specific records, general records of energy consumption and production, and reports of achievements. Often, there are energy savings opportunity registers and various energy management assessments. Further, specific measurement and verification reports may be developed.

Each of these program participation phases entails documentation whose quality can affect the overall credibility of the project, and therefore ultimately the program. At the same time, no one wants to create an unreasonable documentation burden that weighs down the program or distracts valuable resources away from actual SEM work. In assessing the usefulness of documentation, the authors assume that it should serve real needs of the project participant and/or the program administrator to address reliability and accuracy of the savings. This includes evidence that the actions taken could drive the magnitude of the savings reported, which if so, allows an opportunity for program influence over changed energy consumption patterns to be demonstrated. And of course, the level of effort of specific documentation practices should be consistent with their value.

The sub-sections following contain information and examples grouped into the typical phases and aspects of a SEM program-sponsored project. The purpose and value of the documentation to both program administrators and project proponents is illustrated by providing examples and recommendations from existing and upcoming programs.

Energy Culture

An often overlooked, but highly recommended element for SEM documentation involves a formal assessment of energy management commitment and practices at the facility and/or organization level. SEM is, by its definition, a continuous improvement process. In addition to checklists and technical details about individual initiatives, their compliance, and measured results, it is also useful to track over time the energy management culture or level of SEM sophistication. These typically evolve as experience is gained and lessons are learned through the continued implementation of measures. DNV GL has a unique energy culture measurement instrument that can be used for this purpose (as seen in Figure 1, below). There are also several other existing systematic outlines of SEM-related elements that proponents could use or adapt. Each element could have metrics attached to it, appropriate to the proponent. For example, using the “Maturity Level” scale seen below, an organization would assign indicators that correspond to the five levels for each element they considered important and relevant. Organizations need meaningful and relatable metrics that can be used initially for action planning and then can be updated and tracked with minimal effort, so that progress over time is clearly visible to all involved.

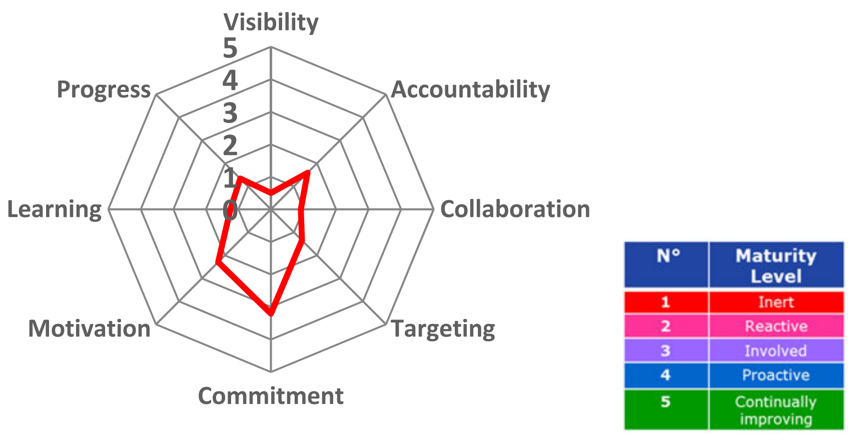

Figure 1. Example of energy culture maturity level

Outreach

Outreach may seem like a phase that occurs before anything relevant to a project, but it is important in terms of establishing credibility related to a program administrator's influence. The timing and nature of outreach relative to what was already happening in the facility or organization is one of the building blocks for attributing program influence. Notations about what was discovered during outreach, if documented, can contribute greatly to the overall assessment of SEM culture or sophistication, which also helps administrators focus and tailor their program assistance to proponents.

There is additional value of outreach data to the program, as it can be mined to look for patterns in success and failure. For example, from which subsectors or North American Industry Classification System (NAICS) codes are prospects most likely to participate? What size facilities are most interested in SEM? When parent companies have multiple facilities in the program jurisdiction, are individual "child" facilities more, or less, likely to engage? Are there other ownership or business characteristics that affect SEM capabilities or eventual program participation?

A database is often used to track the initial outreach, program team, roles and responsibilities, and participation records. Many organizations already have a customer relations management (CRM) system; it could be used to feed a database set up specifically for SEM project and program tracking. As an example of best practices, NEEA developed a database for their 2006- 2013 Industrial Initiative that served as a one-stop shop for the program. In addition to a section that documented customer contacts, it had a separate section to document the program activities and another section that documented specific actions and projects completed. The project section also linked to reports and spreadsheets that described the projects in detail, and provided calculations for energy savings.

Thoughtful design of the initial contact database, and the inclusion of it in the regular program tracking system, allows for easy data review and analysis, including facilitating better quality and faster program evaluation. The NEEA database allowed program administrators to quickly and efficiently assess past projects since the successes and failures inherent in these must inform future participation in the program—both in general and for the specific facilities documented.

Management Commitment

An agreement between the proponent and the program administrator, often in the form of a memorandum of understanding (MOU), specifies the details of the commitment to SEM initiatives from each party. This includes commitment of resources, both staff and financial, and may require staff filling specific roles to participate in SEM meetings, trainings, workshops, and events on- and off-site. Participation in SEM inevitably requires the facility to provide data on energy consumption and the factors that drive it, such as production and schedules. The MOU should establish the requirements the organization must meet to be eligible for technical assistance, incentive payments, or any other program benefits.

The MOU provides useful documentation that could be interpreted for the measure of energy culture mentioned above. It is also useful for its own purpose—to inform and protect both parties related to planned efficiency actions and investments. An example of a best practice is California's upcoming industrial SEM program that proposes to detail requirements for completion of specific actions within a defined timeframe as a prerequisite for the participant to receive incentive payments (Diaz 2017). The first milestone payment is to be paid only if the energy data collection plan is completed and the energy data provided meets the program requirements, and all within the first two months of the program. If carefully crafted, an MOU also outlines risks, *quid pro quo*, justifications, and business logic for the project. This provides a handy reference for those who come along later, including evaluators, of an encapsulation of the business decision-making related to the SEM project and the broader facility context.

Energy Management Practices

SEM requires participants to plan and achieve energy performance improvement. This includes goal setting, taking stock of current energy management practices, establishing metrics and then executing projects or new processes that use energy more efficiently. Monitoring and tracking of the energy use related to proposed savings is often a formal program requirement (or part of ongoing energy management schemes such as ISO 50001). Finally, results are tabulated and reported back to team members so that further action and next steps can be planned.

Each of these steps involves documentation and SEM program designers can help by creating templates. For example, DNV GL created an Energy Management Handbook based on ISO 50001 to support programs delivered to its clients. The handbook is completed by the facility energy team and can be a convenient way to centralize all documentation related to energy management activities and track progress against goals.

Similarly, NEEA developed an internal playbook for their implementation of the Industrial Initiative, one of the first SEM programs. The playbook included a series of detailed templates and useful tools to document progress with SEM.

CEE suggests that there are 13 elements an SEM program needs to address (CEE 2014), which could be codified into various templates for ease of the documentation process. The key issues can be expressed as questions:

- How well does senior management set and communicate long-range energy performance goals? Do they ensure that SEM initiatives are sufficiently resourced and a responsible individual or team designated?
- Does the energy management team in the facility or in the organization:
    - assess current energy management practices using a performance scorecard or facilitated energy management assessment;
    - develop a map of energy use, consumption, and cost;
    - establish measurable metrics and goals for energy performance improvement;
    - maintain registers or record actions to be undertaken to achieve the goals;
    - implement a plan to engage employees in energy performance improvement;
    - implement planned actions;
    - periodically reassess outcomes related to energy performance;
    - regularly collect performance data to improve understanding of energy use;
    - collect and store performance data related to metrics and goals;
    - analyze energy use data, determining relevant variables affecting use compared to a baseline;
    - report regularly to senior management on results?

It is important that no matter which specific metrics are used, the program administrator and the participant have a common understanding of the initial or current energy management culture and where the participant intends to progress. It is particularly important that facilities with more sophisticated energy teams, planning, and a range of projects do not inadvertently or inappropriately get misconstrued as free riders due to their premeditated, but intentional and program-encouraged actions.

Energy Mapping

Facilities practicing SEM need to understand how they consume energy, and which end uses or processes are most significant. Although this is part of the normal energy management documentation described above, it is worth highlighting because of the critical role it can play in communicating energy use and monitoring changes and progress over time. The map is usually developed first in a spreadsheet, highlighting all key end-uses and their associated energy consumption. The value of the energy map is to identify areas of potential savings, and focus attention on the significant energy uses. Facility boundaries need to be clearly defined to allow for appropriate accounting of energy received. Facilities may produce for sale, or conversely import, derived energy sources such as chilled or hot water, steam, or electricity from cogeneration. As the energy map is developed, the facility should document how these sources are transferred across facility boundaries.

The energy map and definition of facility boundaries should be included with the documentation of the energy consumption adjustment model. SEM program rules may impose limitations on which energy sources and uses are eligible for incentives or other program support (e.g., some forms of fuel switching may be ineligible). The best programs and projects develop a Sankey diagram to easily visualize the energy flows and to see changes occurring over time. An example of an energy flow map (Figure 2, below) shows the complexity that can be involved in some industrial facilities and the value of a visual representation of that data and the system. Paths are labelled and include specific quantities whenever possible to facilitate comparisons as the map gets updated in subsequent iterations.

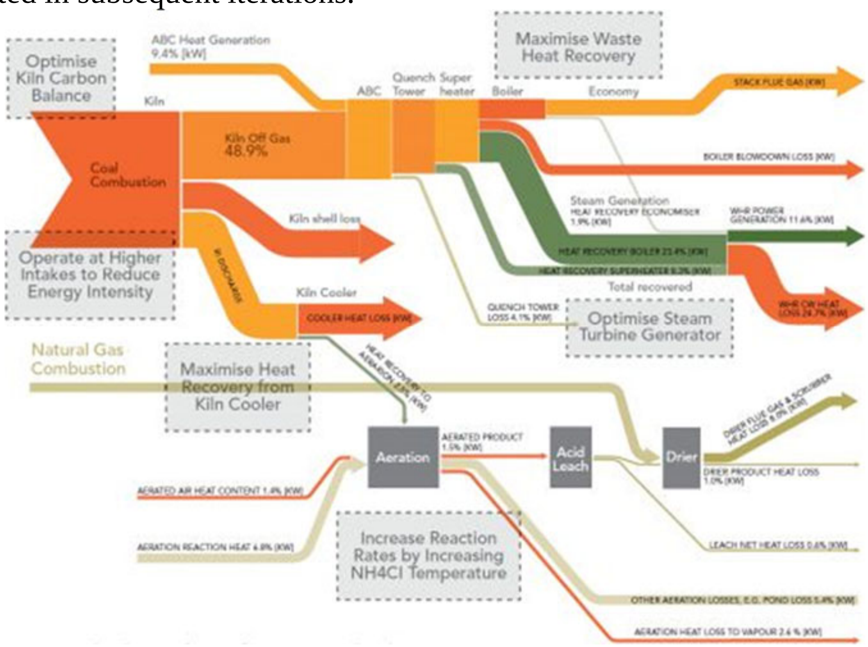

Figure 2. Example Industrial Facility Energy Map

Energy Consumption Adjustment Model

Each facility should develop a plan that is accessible for collecting the data to be used in the adjustment model. In addition to the types of data collected, the planned frequency and the data sources should be identified. Table 1 provides an example of the type of information needed. Note that the plan should identify the conversion factors to calculate energy.

Table 1. Examples of energy data

Data	Frequency	Data source	Units	Conversion Factors	Notes
Electricity – from utility	Weekly	Meter #123	kwh	Convert to primary energy using grid factor and kwh/Btu factor	

Data	Frequency	Data source	Units	Conversion Factors	Notes
Natural gas	Monthly	Meter #456	Cubic feet,	Convert to MMBTU	Heating value needed from provider
Electricity – onsite solar	Weekly	Inverters 1 and 2	Kwh	Convert to MMBTU	Check program rules for how onsite renewables are addressed
Propane	Occasional purchases	Tank level inventory and purchasing records	gallons	NA	Source will be omitted; only used for 2 forklifts
Purchased steam	Weekly	Flowmeter, temp and pressure, purchasing records	Lb/hr	Convert to MMBTU – identify calculation in documentation	Explain how used at facility to support inclusion in model

One of the most important and complex tasks for a SEM project is to determine which elements and variables in the facility affect energy use and therefore need to be tracked and included as elements in models that will be used to estimate and attribute savings. These could be in a stand-alone data collection plan or embedded in a report that documents the development of the energy consumption adjustment model, typically a regression model. One location that is often convenient, but problematic to rely upon, is in proprietary software, where the data itself is often not available to program staff, an independent evaluator, or sometimes even to the facility staff. It may only be accessible to the contractor who developed the M&V plans for the project.

Table 2. provides examples and considerations of potential relevant variables that likely affect energy consumption.

Table 2. Examples of relevant variables considered

Variable	Frequency	Data source	Units	Notes (identify why variable selected or rejected for model)
Production	Daily, weekly or monthly available	Product meter as received by shipping department[2]	Lbs/day	Most commonly included variable; production usually drives energy consumption
Product 1	Daily	Product meter	Lbs/day	May be included when energy intensity varies by product type
Product 2	Daily	Product meter	Lbs/day	May be included when energy intensity varies by product type; sometimes only one product drive consumption significantly
Raw material characteristic	Weekly	Daily lab records	Lbs/day	Useful if raw material characteristic drives consumption, such as moisture content
Shifts/days worked	Weekly	Production department records	Shifts or days worked/ week	At some facilities, operating time is a significant driver of energy consumption

[2] It's preferable to get product as completed rather than shipped, as product can be stored for indefinite periods before shipping. Energy consumption is more likely to correlate with the product produced when the data for both reflects the same timeframe.

Variable	Frequency	Data source	Units	Notes (identify why variable selected or rejected for model)
Weather	Hourly, aggregated to daily or weekly	NOAA	Heating degree days, cooling degree days	Weather may affect heating, cooling, refrigeration, air drying and other operations.

Documentation of which variables were selected with corresponding rationale should be provided. Plots of energy use compared to the tested variables are useful to demonstrate the selection process. For example, a series of graphs compared to total production, specific products, weather, and other factors help to identify which factors drive energy consumption. Figure 3 shows an example of five variables selected at a pigment plant. Production of yellow and red pigments, total production, heating degree days (HDD) and cooling degree days (CDD). Both yellow and total production appear to be reasonable correlations. Red production relates somewhat less well to energy consumption, while HDD and CDD do not appear to drive energy consumption.

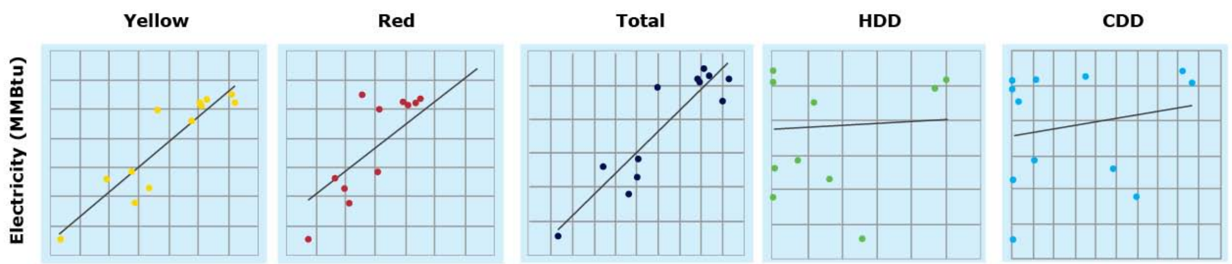

Figure 3. Assessment of Potential Relevant Variables

Thorough and relevant documentation gives visibility into the industrial process and operations. This view is needed to estimate which changes in energy use could be due to actions sponsored by the program versus other factors. More visibility into the operations of a facility also means a higher likelihood of achieving a more precise savings estimate, which is an important factor when the expected savings is below the 10% of total energy use threshold.

In studies involving multiple sites, there is often a mixed result. At some sites a good correlation between production and energy use is found, while for others it is not. After testing additional variables, reasonable models can be developed for most, but typically not all sites in a program. Most often, the lack of visibility into the fundamental drivers of energy use in those facilities prevent the development of a model.

Once the right variables are identified and utilized, it is critical to accompany the energy consumption model development process with transparent and adequate documentation. Most programs have a template for this, such as the Monitoring, Tracking and Reporting tool used in the Northwest (BPA 2014, Energy Trust of Oregon 2016) and the DOE Superior Energy Performance Energy Performance indicator tool (DOE 2017). Although documentation may be included in the tool in the form of notes or instructions, the best practice observed uses a report that explains in more detail the decisions made in the development of the model. This is a more accessible document and approach.

Most SEM participants generate separate models for their major energy sources, typically electricity and gas. Each model will need to meet program requirements for statistical parameters and model validity. The valid range for the relevant variables should be documented for each model, along with the statistical parameters. Justification should be provided for removal of data or identification of outliers.

Documentation of Timing

A critical aspect to highlight is the selection of the baseline period. The rationale for the length of the period, as well as the selection of starting date should be documented to demonstrate that this period adequately represents the operations of the facility prior to the implementation of SEM. For example, if a facility has a major change in operations in the middle of the baseline period, such as an addition or significant modification to an existing process or a shutdown of part of the operations, the baseline may not represent normal operations.

Timing of activities also makes a difference in the savings calculations and the credibility of the model. The timing of major changes in energy consumption patterns, e.g., when was the new wing built or when was line #5 shut down permanently, should be identified. Documenting all activities that should affect consumption, whether SEM related or not, allows the calculation of savings to be aligned with facility activities. For instance, if a large capital project goes online at a given date, the changes to energy consumption should then be apparent in the model results for subsequent months. With knowledge of when the change in consumption occurred or is expected, a non-routine adjustment can be made to account for the capital project. Similarly, a shutdown or other significant change in operations should be apparent in the model.

Professional Judgment

The previous sections make clear that documentation should support reasons for model choices made, and provide a rationale of why those choices were appropriate. Engineers and other staff developing the model are required to make choices and judgments, so these choices should be transparent to any reviewers of the model. A reviewer, whether from the facility, the program staff or an independent evaluator, should subsequently be able to comprehend, from reasonably plain language, why the model is appropriate for the facility.

The value of the model to the proponent is also increased when the model makes sense and is able to respond to changes in operations. The model must be credible to confirm savings, and if so may contribute to justify why SEM is worth the effort.

Best practices documentation of the energy consumption model involves at least two phases. First, a baseline or hypothetical model report is developed that describes the specifics of the model developed, the variables, relevant statistics and the reasons that the model is purported to be valid. After several months, the model can be reviewed tested based on its ability to predict real-world energy consumption. Second, an M&V report at the end of the performance period (typically the first year of SEM) retrospectively documents the model, its uncertainty, and the results. As an example, PSE used a series of reports to track specific stages of their O&M program (DNV GL 2017): development of the baseline model, action plan, and M&V report at the end of the program. Each report explained the methods and decisions to support their results.

Opportunity Register

SEM savings occur from a variety of actions taken to improve facility energy performance. A facility audit or treasure hunt event are major sources of opportunities; facility brainstorming and planning sessions are another source. The identified actions should be listed in a format such as a spreadsheet, table, or database that can be updated with results and findings. This "opportunity register" becomes a record of what was identified, considered and then completed and is a valuable source of project documentation.

The opportunity register serves as a reasonableness check for savings claimed. If the only energy savings action identified in the facility was to close the door at the loading dock on weekends, little savings would be expected. If the opportunity register lists lots of ideas and plans, but lacks corresponding information on what was completed, sufficient evidence to support the modeled savings may be lacking. Another problem involves a lack of specificity, which also leads to incomplete evidence. Another potential issue involves multi-facility projects. For example, a campus may plan to implement the same actions at multiple locations. If the opportunity register is for the campus but the models are developed for each building, the data may not be sufficient to tell what was done at each location.

The opportunity register also serves as a convenient link to calculations for individual actions, especially in larger retrofits and capital projects. A best practices opportunity register includes documentation of the actions identified, their status of completion, the rationale for whether action was taken, or not, and links to source calculations of project savings.

Reporting

Many SEM programs require the development of a report for each participant facility that provides results following completion of a "period of SEM," typically one year or more. These usually site-specific reports provide a detailed understanding of the energy consumption adjustment model, including the data collection plan, documentation of the model, and energy savings calculations, results, and conclusions relevant to various decisions that were taken throughout the project. This report is designed to serve the participant, the utility, and the program evaluator. For the participant, the report documents their plans, energy management system achievements, actions, projects completed, and savings achieved. The utility and evaluator use the reports to identify accomplishments, understand achievements, and assess program influence.

One of the most important uses of a site-specific report is to provide transparent documentation for future use and action by the customer and the utility. People move and change jobs; the site report establishes a sufficient record for either party to carry-on in the absence of personnel who were involved in the original project. When combined with the assessment of energy management culture, it can help both the utility and the customer justify investments in higher risk projects, corresponding to the gains in sophistication and ratcheting-up of goals that come with more SEM experience.

Meta-Reporting

Data management and documentation have moved beyond paper files and file cabinets to databases, apps, and cloud platforms. As SEM becomes more common, online methods for documenting the multiple planning and reporting phases may soon become the norm. Consider the value of aggregated meta-level data for the program or the population: currently most of the documentation for each SEM participant is in a unique file. Future programs may choose to store data in a manner (i.e., “in the cloud”) that program-level analysis is feasible across sites for energy, relevant variables, capital projects, and opportunity registers.

For example, DNV GL combined all baseline and program period data from multiple sites and developed batch analysis regression models for a SEM evaluation (DNV GL 2016). This combined dataset allowed the comparison of two types of weather sensitivity modeling in a manner that would be prohibitive if only standard site-specific files were utilized. Another example is the combining of opportunity register data. For one program, DNV GL combined all the action items identified. This allowed for an in-depth analysis that provided feedback to the program about what types of actions were most frequently completed or dropped (DNV GL 2017).

Conclusions and Next Steps

Smart documenting practices support the essence of SEM, which is continuous improvement and long-term, sustainable progress for efficiency in the affected facility. Playbooks, templates, and databases are all tools to support effective documentation and therefore the management of SEM projects. Best practices documentation helps ensure that customers and program administrators are on the same page regarding planning, tracking, and achieving savings that can be documented as a resource. Proper documentation leads to improved credibility of savings estimates, which in turn improves credibility with SEM customers and supports their efforts to strive and achieve more going forward. If stored in clever electronic form, it leverages economies of scale for site-level analysis and evaluation and also reveals a program’s attributes at a meta-level. This contributes to a greater understanding of what is working best across the segments and sectors of a program, over time, so administrators can better operate and tailor their programs to the characteristics of their customers.

As SEM programs develop and grow, documentation methods and user-friendly data collection tools should continue to be developed to facilitate improved program performance. Increasingly, documentation will include data and reports from readily manageable controls and Internet-of-things (IoT) devices that may themselves form integral parts of SEM plans and initiatives. The SEM community can promote knowledge sharing and best practices. One excellent example is NEEA’s (2016) Internet portal, semhub.com, which is a resource library of tools, guides, and courses. The site includes documents from regional and utility program providers, implementers, and evaluators, as well as DOE, EPA, non-profits, and facility sources. Teams seeking to develop new SEM programs can use the site to quickly gain from the experience of similar programs, including related to documentation success stories.

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