SEE Action
STATE & LOCAL ENERGY EFFICIENCY ACTION NETWORK

Utility Manufacturing Workshop Primer 3: Program Evaluation, Measurement, and Verification (EM&V)

Introduction to Utility Energy Efficiency Program Evaluation, Measurement and Verification (EM&V)

Funding for energy efficiency programs throughout the United States has increased significantly in recent years. According to a 2010 study by the Consortium for Energy Efficiency (CEE), U.S. ratepayer-funded energy efficiency program budgets grew more than two and a half times between 2006 and 2010, from $2.6 billion to $6.6 billion.[1] In addition, federal spending on energy efficiency (about $1 billion annually) saw a major boost in 2009, when $25 billion in economic stimulus funding was allocated to energy efficiency initiatives, programs, and projects.[2] With more public funding being dedicated to energy efficiency, there is a growing need to demonstrate that taxpayer and utility ratepayer funding is being used well. When conducted effectively, EM&V can confirm energy savings attributable to energy efficiency programs and verify the cost-effectiveness of energy efficiency programs. EM&V results also can support integrated resource planning and guide future energy efficiency program investments.

EM&V Objectives for Energy Efficiency Programs

EM&V demonstrates the value of energy efficiency programs by providing accurate, transparent, and consistent assessment of methods and performance. A primary objective of EM&V is to determine how much savings to attribute to an energy efficiency program, as opposed to other factors, such as weather.[3] EM&V activities are critical for energy efficiency projects and programs in the industrial sector. EM&V activities provide confirmation of actual energy and cost savings. These data-supported results can present industrial customers with a compelling business case for energy efficiency and convince utilities and regulators of the value of industrial energy efficiency programs. It is important to develop EM&V plans in advance of program implementation rather than attempting to devise a plan after the program has already begun. This helps to ensure that all required data is collected on a regular basis and that baseline measurements can be obtained prior to project or program implementation.

Industrial Energy Efficiency Program EM&V Needs

EM&V is intended to establish the measure or project savings that occurred. A utility may utilize EM&V practices to determine the energy savings attributable to a representative sample of projects in a program and extrapolate from those estimates to determine the overall impacts of the energy efficiency program. This could include determining the impact of various advanced manufacturing technologies offered through energy efficiency programs, such as high-efficiency motors or burners. Although, differences in manufacturing processes and the typical duration of use of these technologies among manufacturers in a utility's territory will affect the reliability of extrapolating EM&V data from a select few projects.

Key Points

- When conducted effectively, EM&V can confirm energy savings attributable to energy efficiency projects and verify the cost-effectiveness of energy efficiency programs.
- It is imperative that utilities work closely with industrial customers to establish data collection practices and information sharing procedures that enable evaluators to obtain needed data within a suitable timeframe.
- Barriers to successful program EM&V include: receipt of consistent, timely data; estimating a program's impact on firm operations and employee behavior; and accurate attribution of savings to a particular efficiency program.
- Program evaluators are encouraged to consider adopting model approaches to EM&V for industrial energy efficiency.

About SEE Action
The State and Local Energy Efficiency Action Network (SEE Action) is a state and local effort facilitated by the federal government that helps states, utilities, and other local stakeholders take energy efficiency to scale and achieve all cost-effective energy efficiency by 2020.

About the Working Group
The working group is comprised of representatives from a diverse set of stakeholders; its members are provided at www.seeaction.energy.gov.

To ensure reliable EM&V, a number of accepted standards are available and commonly used by practitioners, including the International Performance Measurement and Verification Protocol (IPMVP). IPMVP provides a set of protocols and guidelines for EM&V professionals to use when completing an evaluation.[4] Additional standards also exist, such as the energy measurement guidance in the International Organization of Standardization (ISO) Energy Management Standard ISO 50001 and the protocols being developed by the U.S. Department of Energy Superior Energy Performance (SEP) initiative to facilitate accurate EM&V specifically at the industrial plant level.[5]

While some data for an EM&V assessment may be obtained independently by an evaluator, other data will need to be provided by the customer (such as production shifts). The accuracy of energy savings estimates is directly related to the data available to the evaluator. Therefore, it is imperative that utilities work closely with industrial customers to establish data collection practices and information sharing procedures that enable evaluators to obtain needed data within a suitable timeframe.

The following data should be collected by an evaluator to determine the actual impacts of an industrial energy efficiency project:

- Whether the measure or project was actually implemented
- Actual operating efficiency of the improved process or updated manufacturing equipment (as opposed to the claimed or nameplate efficiency)
- If the process or equipment are operating properly
- The number of hours the processes or equipment are used and when those hours occur[6]
- Baseline energy use at the facility of interest—this is the energy consumption that occurred before the project was implemented and is chosen as representative of normal operations
- Reporting period energy use, or the energy consumed after the improved process or advanced equipment was implemented
- Facility/production output before and after implementation (many energy efficiency measures and technologies are installed as part of a total productivity improvement package).

If a utility is calculating demand savings, energy savings data must be collected for the time periods of interest. Annual average demand savings can be determined with annual energy savings information. But, if peak or other demand reduction values are needed, then monthly, hourly, or 15-minute energy savings data (or estimates) may be required. Sources of hourly or 15-minute data include the following:

- Facility interval-metered data
- Time-of-use consumption billing data
- Monthly billing demand data
- Field-measured data.[7]

In order to determine how much of the difference in energy use before and after program implementation can be attributed to the improved process or equipment, adjustments must be made to account for factors that are beyond the control of the program administrator and energy consumer. Much of this data would come from the customer. Common adjustments include corrections for the following:

- Weather variation
- Manufacturing production levels
- Hours of equipment/system/building operation
- Maintenance practices
- Occupancy levels
- Price of energy input (large fluctuations may shift product focus or the process used).

EM&V Barriers to Successful Utility Energy Efficiency Programs

EM&V is an important element of any industrial energy efficiency program. However, a variety of barriers make it difficult for program administrators and industrial customers to conduct effective EM&V activities for energy efficiency programs.

Receipt of consistent, timely data from the customer that identifies any external factors potentially impacting energy savings can present a barrier for data collection. As previously discussed, some key data points cannot be known by the utility and instead must be supplied by industrial customers. It is essential for customers to provide accurate, timely, and comprehensive data so that energy efficiency programs can be properly evaluated. However, it is important for utilities to create a consistent and simple approach to collecting the information so that reporting requirements do not create an unnecessary burden or expense for industrial customers.

Estimating the impact of free riders ("additionality") and spillover is challenging and controversial.

- **Free riders** are program participants that would have implemented the program measure or practice, in the absence of the program, through their own initiative and expenditure.[8] Since these customers would have taken action regardless, the impact of the free rider should not be directly attributed to the energy efficiency program.[9]

- **Spillover** (or "market effects") refers to energy savings resulting from actions taken by (1) customers that did not participate in the program but were influenced by it; and (2) participants that took *additional* actions as a result of the program. To make the issue more complicated, market effects can happen concurrently or after a program ends. Spillover effects may be included in the savings attributable to an energy efficiency program.[10]

Estimating the effects of free riders and spillover is not a straightforward task. In order to determine the contribution of free riders and spillover to program savings, evaluators may use stipulated estimates based on historical studies of similar programs, or they may employ tools such as surveys, sampling, and statistical models to arrive at a calculation.[11] Ultimately, there's no exact science for making these determinations, and the treatment of free riders and spillover is diverse across evaluators.[12]

Estimating a program's impacts on firm operations and employee behavior is challenging and often is not well understood. Many energy efficiency measures can affect the manner in which individuals operate energy-using equipment and how frequently equipment is used.[13] For example, a program may influence employees to reduce the overall time a certain tool needs to be operating and to turn it off when not in use. Alternately, behavior can move in the opposite direction when an energy-saving measure results in greater usage due to increased perceived value per unit used. This is known as the "rebound effect." For example, energy-efficient equipment may be used more often simply because the operator knows that it is more cost-effective than the alternative.[14] The impact of an energy efficiency program on operations and behavior can be complicated and difficult to measure.

Utilities frequently combine commercial and industrial energy efficiency programs and their results, making it difficult to discern which sector's participation resulted in the savings. Differentiating between commercial and industrial savings is important for assessing overall program impacts by sector and potentially comparing results between different programs or regions. While energy sales are reported separately for "commercial" and "industrial" use, many utilities actually divide tariffs by demand or voltage, meaning that small industries get mixed with retail and office usage and large industries get mixed with office tower and university campus loads. These two customer groups represent differing challenges and opportunities in terms of energy savings; it's important for utilities to address those distinctions in energy efficiency program design and reporting.

Attribution is becoming more complex. It has never been easy to attribute savings to a particular program, but recent societal changes are making it even more complicated. Energy efficiency program savings are determined, in part, by comparing a firm's business as usual (BAU) energy use to energy use after project implementation. The recent economic downturn, coupled with volatile energy prices and technological changes, has served to significantly impact the BAU energy consumption scenario across all sectors of the economy. These sudden changes in energy use make it more difficult to distinguish BAU behavior from behavior influenced by energy efficiency programs. Furthermore, the abundance of energy programs and policies means that customers are often affected by multiple programs, so attributing savings to any one program has become a complex undertaking. Finally, some vendors and other external parties may encourage energy savings practices that may or may not be influenced by the local utility.

The timeline for incentive eligibility and associated savings reporting requirements for industrial energy efficiency projects can be problematic. It can take months or even years for industrial energy efficiency projects to be completed and for substantial energy use data to be collected. If a utility is required to report on an energy efficiency program's performance before all industrial project data is collected, this timeline discrepancy can hinder accurate energy savings calculations and reporting.

Industrial Energy Efficiency Program Data Uses[15]

Most EM&V activities have arisen from regulators' need to assess the success of energy efficiency programs funded by utility customers. However, additional stakeholders also may be interested in EM&V findings, including load forecasters, Regional Transmission Organizations (RTOs) / Independent System Operators (ISOs), state and federal governments, utility customers, and others. Timely and accurate data is significant in assessing the success of programs, and the SEE Action Industrial Energy Efficiency and CHP Working Group has begun pursuing a number of avenues to work toward enhanced data collection. These efforts include working with the Consortium for Energy Efficiency to update its annual program administrator survey to focus more specifically on industrial customer data, as well as working with other SEE Action working groups to engage the U.S. Energy Information Administration in enhanced industrial data collection. The following highlights the importance of enhanced data collection by summarizing how each stakeholder could use reliable industrial EM&V data.

Program administrators use EM&V data to demonstrate that programs achieve expected savings targets and deliver a cost-benefit. The data also enables administrators to make comparisons across their programs and make improvements to their energy services portfolios in order to achieve desired results.

Industrial customers need feedback about actual energy savings from efficiency projects to justify participation in energy efficiency programs. Customers can benefit from individualized results from EM&V activities. Beyond establishing accurate energy and cost savings, EM&V data can also verify the environmental benefits of program participation. This is an important benefit for firms that are focused on reducing greenhouse gas (GHG) emissions or otherwise shrinking a company's environmental footprint.

State and federal governments use EM&V data to measure and verify savings to determine that policy targets are met and ratepayers benefit. Data allows them to compare results across programs and improve overall funding impacts by promoting best practices. EM&V methods may also inform efforts to determine environmental benefits from efficiency investments at industrial facilities.

Public utility/regulatory commissions use EM&V data to prove that energy efficiency programs are cost effective and positively impacting the energy resource portfolio. This encourages planning authorities to incorporate energy efficiency into load forecasts and integrated resource planning. Data can also help determine attribution and appropriate incentive payments. Plus, it enables the comparison of different programs to determine which ones are most effective.

Electric transmission system operators and planners need data that is accurate and complete enough to determine the impacts of energy efficiency on resource planning and system operation, including avoided line losses.[16] Comprehensive EM&V data can prove that energy efficiency is a viable resource.

Model Approaches to Utility Energy Efficiency Program EM&V

A large portion of EM&V practitioners follow the guidelines outlined by the National Action Plan for Energy Efficiency in its Model Energy Efficiency Program Impact Evaluation Guide (November 2007). Many states are further establishing their own EM&V policies and requirements. On a regional basis, the Mid-Atlantic/Northeast EM&V Forum is developing standard reporting forms and EM&V protocols.[17] The Pacific Northwest Regional Technical Forum has also developed EM&V tools and databases.[18]

The following list of working approaches to energy efficiency program EM&V should be considered by energy service providers:

- Establish a data collection frequency that meets the reporting needs of energy efficiency program administrators without over-burdening program participants that will need to provide data on a regular basis.
- Automate data collection from program participants wherever possible to reduce and/or eliminate individual customer reporting requirements and ease overall program data synthesis and analysis.
- Institute EM&V evaluation practices that also measure the operational and behavioral change benefits that may result from participation in an industrial energy efficiency program. Attribution of behavioral change is challenging, and the ability to correlate the change to energy efficiency efforts will depend on the granularity of available observational and qualitative data. The Northwest Energy Efficiency Alliance has done some interesting work in this area.[19]
- Institute EM&V evaluation practices that account for the effects of free riders and spillover in a consistent, transparent manner. If there is a larger program budget for EM&V, then an evaluator may administer surveys to program participants and non-participants to gauge the influence of free ridership and spillover. Programs with smaller EM&V budgets may opt for stipulated estimates of these factors based on historical studies of similar programs. In whatever way these effects are estimated, evaluation reports should explicitly state the methodology used.
- Work toward the goal of standardization in EM&V reporting across programs, utilities, and regions. Differences in how program savings are estimated and defined make any sort of cross-comparisons or roll-up statistics very discordant.[20]

Endnotes

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