EM&V for Energy Efficiency Policies and Initiatives

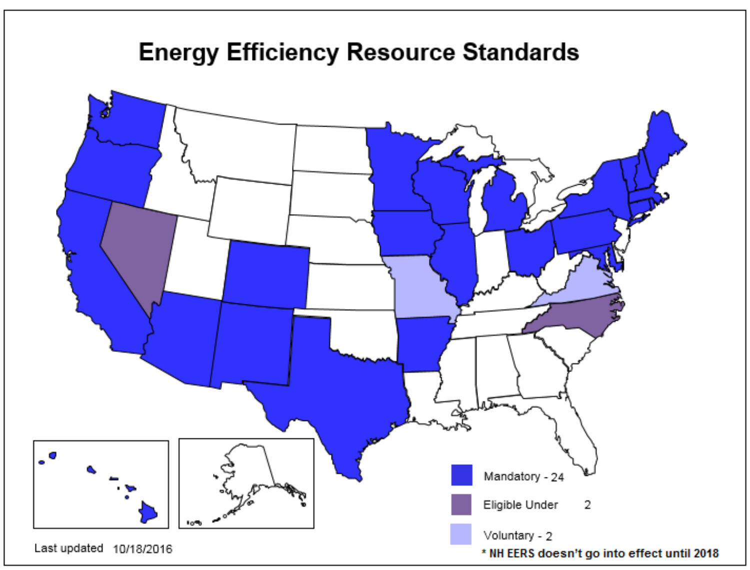
Evaluation, measurement, and verification (EM&V) helps investments in demand-side energy efficiency (EE) achieve intended environmental, energy, and economic goals. This paper briefly describes the status of EE policies and initiatives, identifies the associated objectives, and provides discussion and examples of how EM&V is typically tailored to the objectives for that policy or strategy. The information provided includes an overview of four EE policies and initiatives, a summary of the typical EM&V approaches, and links to applicable EM&V protocols and resources. The policies and initiatives addressed include:

- *Ratepayer-Funded EE Programs*
- *Organization-Led Building EE Initiatives*
- *Forward Capacity Markets*
- *Criteria Air Pollution Reductions in State/Tribal Implementation Plans*

This paper is intended as a primer for representatives of jurisdictions, companies, electricity planning organizations, and other entities that are using or considering using EE to achieve their goals.

Energy Efficiency Policies and Initiatives

State and local governments, companies, and electricity system planners are pursuing a range of EE policies and initiatives that are driving efficiency improvements across the economy. Every U.S. state currently administers some type of demand-side EE program, and half of them have adopted statewide EE policies such as energy efficiency resource standards (EERS) and goals to achieve "all cost-effective EE." These policies and goals are achieved through portfolios of EE programs that are delivered to homeowners, businesses, and other electricity customers. Such programs are typically implemented by the local utility and funded by a surcharge on electricity bills.



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Nationally, ACEEE estimates that customers are saving $90 billion annually on electricity bills from EE programs for a total of nearly $790 billion in cumulative savings since 1990.[1] From a low point in 1998, spending for electricity programs increased more than fourfold by 2010, from approximately $900 million to $3.9 billion. In 2015, total spending for EE programs reached roughly $6.3 billion. Given states' existing and ongoing commitments, growth in spending and savings is likely to continue. The Lawrence Berkeley National Laboratory (LBNL) has identified additional untapped potential for EE programs in every state over the next 5, 10, and 15 years.[2]

In addition, many states and cities have adopted initiatives to promote EE improvements in their own facilities (often via performance contracts with private companies) and may further adopt building energy codes and equipment standards that exceed federal minimum efficiency requirements. In addition, two electricity transmission system operators—ISO New England (ISO-NE) and PJM Interconnection—have established forward capacity markets (FCMs) that compensate EE on par with power plant generation for purposes of meeting regional capacity requirements and ensuring system reliability.

Energy Efficiency Supports Multiple Objectives

EE policies and initiatives have been proven to reduce electricity usage while also supporting important objectives, including:

- Saving homes and businesses money on their electricity bills
- Decreasing stress on the electricity system
- Supporting electricity capacity and reliability mandates
- Stimulating local economic development and new jobs
- Improving public health and the environment by reducing emissions of greenhouse gases (GHGs) and other air pollutants

As the electricity savings from EE policies and initiatives contine to grow, state and local governments, companies, and electricity system planners are increasingly turning to EE to achieve these diverse objectives. For example:

- Utilities are deploying EE to meet the electricity (measured in megawatt-hours, or MWh) needs of a growing customer base, and to fully or partially replace retiring power plants.
- Electricity system planners are using EE as a strategy to achieve their reliability and system capacity (measured in megawatts, or MW) requirements over a multi-state territory.
- State environmental regulators are explicitly including emissions reductions from EE in their plans for improving air quality and public health.

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[1] See: ACEEE. 2016. *The Greatest Energy Story You Haven't Heard: How Investing in Energy Efficiency Changed the US Power Sector and Gave Us a Tool to Tackle Climate Change.* Available at: http://aceee.org/sites/default/files/publications/researchreports/u1604.pdf.

[2] See: Barbose, G.L., Goldman, C.A., Hoffman, I.M., and Billingsley, M. 2013. *The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025.* Available at: https://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf.

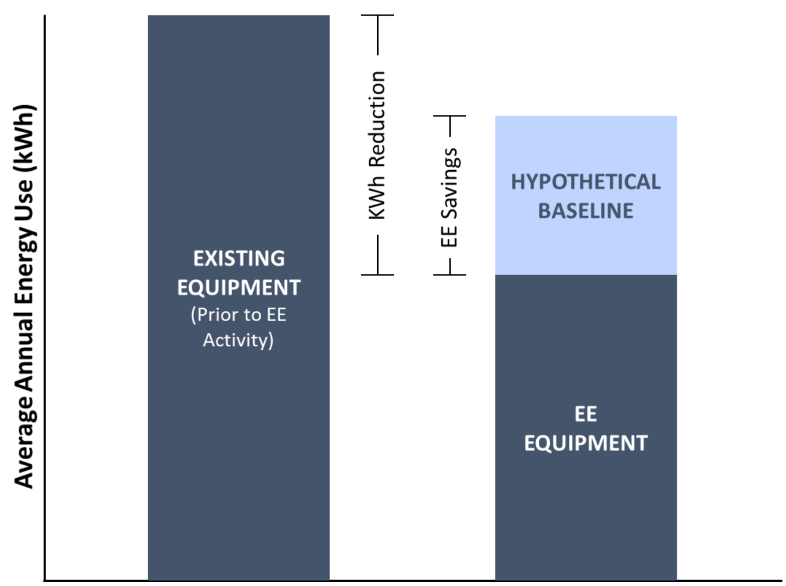
EM&V Basics

The procedures, methods, and analytic approaches used to quantify and verify EE savings is referred to as evaluation, measurement, and verification (EM&V). As practiced today, EM&V generally relies upon a set of well-established methods, procedures, and definitions that are codified in standard protocols and guidelines. These resources are derived in large part from state public utility commission (PUC) oversight of ratepayer-funded EE programs, as well as the DOE's Federal Energy Management Program (FEMP) guidelines for energy performance contracts in federal facilities.[3]

EM&V compares measured electricity usage with an EE project or EE measure in place with the best estimate of the likely energy usage in the absence of the project or measure. MWh of electricity savings are quantified relative to this counterfactual baseline. Specifying the baseline case is a key challenge with EM&V. If the condition prior to the installation of an EE project or EE measure were always the baseline, this determination would be relatively straightforward. However, most EE activity takes place in a context of ongoing changes in markets, technology, policy, and operations. Specifying a baseline requires consideration of this context.

For example, when the EE activity is a new equipment installation that would occur regardless of the efficiency level, the baseline can be defined in terms of the new (less efficient) equipment that would otherwise be installed. When this new EE equipment installation occurs in the context of other EE activities, such as in a market affected by building codes or equipment standards, these other EE activities must be considered in determining the baseline for the new equipment.

Comparison of Total kWh Reduction vs. EE Savings Using a Hypothetical Baseline for the Installation of New Equipment



[3] Recent advances in data availability and analytics are making it easier to apply these core EM&V approaches, for example through automated and real-time analysis of electricity usage data. These advances are occurring in parallel with ongoing stakeholder efforts to develop a consistent approach to EE protocols that enhances the rigor, consistency, and transparency of EE savings estimates. For example, see the DOE's Uniform Methods Project, the National Efficiency Screening Project, and the NEEP Regional Energy Efficiency Database.

Other key components of a robust EM&V approach for an EE project or EE measure include but are not limited to determining the effective useful life (EUL)[4] of the project or measure, selecting an appropriate EM&V method, verifying that the EE project or EE measure is installed and operating properly, and accounting for interactive effects and independent variables that affect electricity use. In contrast to this EM&V approach for EE, quantifying the electricity output from a generation resource such as a power plant or solar panel is relatively straightforward since it involves using a meter to directly measure electricity output in real time.

Tailoring EM&V to EE Policies and Initiatives

Despite this core set of standardized approaches and resources, EM&V is routinely and appropriately tailored to the EE policy or strategy. This helps ensure that the EM&V metrics and outputs align with intended outcomes for the policy or initiative. Tailoring EM&V to the EE policy or strategy also gives EE providers, oversight entities, and other stakeholders the information they need to plan for and deploy EE in a way that maximizes the intended benefits. It similarly helps implementers identify challenges and barriers to the effectiveness of the EE, make necessary changes in real time, and inform future planning efforts in a manner that is consistent with objectives.

Likewise, tailoring EM&V to the policy or strategy can help ensure that savings are quantified with appropriate accuracy, rigor, and overall cost. For certain EE policies and initiatives, tailoring EM&V to EE objectives can also help stakeholders quantify the full range of EE benefits and costs (which supports comparisons of EE to other electricity options, including both demand- and supply-side resources). Examples of how government agencies, companies, and electricity system planners may tailor their EM&V requirements to policies and initiatives include:

- Selecting EM&V protocols and guidelines that support the intended EE objectives
- Identifying the appropriate EM&V metrics, measurement bounds, baseline, and time period over which savings are quantified
- Determining whether and how to account for "additionality" or "attribution"[5]
- Balancing EM&V rigor and accuracy with the level of effort and cost involved in EM&V

One implication of tailoring EM&V to EE policies and initiatives is that the protocols, metrics, and assumptions that apply in one context may not be appropriate for use in another. For example, the ISO-NE's measurement and verification manual[6] was developed to quantify capacity (MW) savings during a limited number of hours, support EE as a reliability resource, and calculate payments to EE providers.

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[4] EUL is the duration of time an EE project or EE measure is anticipated to remain in place and operable with the potential to save electricity.

[5] Additionality answers the question: would the EE activity have occurred—holding all else constant—if the activity were not sponsored, funded, or promoted by the entity? Or more simply: would the EE activity have happened anyway? If the answer to that is yes, the activity *is not* additional. Attribution analysis seeks to understand whether changes in energy use were caused by a particular EE activity or other influences.

[6] See: ISO New England. 2014. *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources: Manual M-MVDR.* Available at: http://www.iso-ne.com/participate/rules-procedures/manuals.

Therefore the underlying EM&V approaches may not be appropriate, for example, for EE policies and initiatives that focus on achieving energy (MWh) savings in the current year.

The remainder of this paper and the accompanying website provide examples of how certain EM&V considerations and approaches differ by EE policy and strategy. The following electricity-sector policies and initiatives are addressed:

- Ratepayer-Funded EE Programs
- Organization-Led Building EE Initiatives
- Forward Capacity Markets
- Criteria Air Pollution Reductions in State/Tribal Implementation Plans

Ratepayer-Funded EE Programs

What are they?

- Organized efforts, typically overseen by a state public utility commission (PUC) and delivered by a utility, to promote the adoption of EE projects or EE measures in homes and businesses
- Approaches include providing financial incentives (e.g., rebates and loans), technical services (e.g., audits, direct installation, training and assistance for architects, engineers, and building owners), information intended to change customer behavior (e.g., feedback on electricity usage), and educational campaigns about the benefits of EE improvements

What are the goals for EE?

- Lower customer energy bills, reduce pollution, create local jobs and avoid the need for new power plants
- Serve as an "electricity system resource"—on par with power plant generation—that states, utilities, and system planners can use to:
  - Deliver annual EE savings equal to a specified percentage of total electricity sales
  - Meet forecasted electricity demand over a defined geographic area (i.e., a utility service territory) within a specified timeframe

What are typical EM&V objectives?

- Help ensure that public spending on EE is prudent and cost-effective
- Quantify costs and benefits, including electricity savings (MWh), demand savings (MW), and non-energy benefits (e.g., avoided emissions, job creation)
- Improve EE programs for customers and guide future investment decisions
- Determine whether utilities receive performance-related incentives or penalties

Select resources

- **General Information:**
  - U.S. EPA Energy and Environment Guide to Action
  - U.S. DOE Ratepayer-Funded Energy Efficiency Website
  - State and Local Energy Efficiency Action Network (SEE Action) Website
- **EM&V Related:**
  - M&V Guidelines: Measurement & Verification for Performance-Based Contracts, Version 4.0, U.S. DOE Federal Energy Management Program (FEMP)
  - DOE Uniform Methods Project (UMP)

- SEE Action Energy Efficiency Program Impact Evaluation Guide
- International Performance Measurement and Verification Protocol (IPMVP), Efficiency Valuation Organization (EVO)
- California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals

Organization-Led Building EE Initiatives

What are they?

- Actions that organizations take to improve efficiency and reduce energy costs in a single building or a portfolio of buildings[7]
- Typically includes adopting an energy management program[8] that involves setting goals for energy performance, creating a plan to achieve them, and taking action[9]
- Many organizations partner with energy service companies (ESCOs) to help them achieve their energy performance goals
  - "Performance-based contracts" commit ESCOs to installing new EE equipment and reducing customer energy usage by an agreed-upon percentage

What are the goals for EE?

- Reduce energy waste (a typical commercial building in the United States wastes 30% of its overall energy use)[10]
- Capture opportunities to significantly improve the efficiency of buildings and save on energy bills
- Benchmark energy use to help prioritize cost-effective EE investments within and across buildings
  - Custom databases or publicly available tools such as the EPA's ENERGY STAR Portfolio Manager are typically used

What are typical EM&V objectives?

- Support organizational goals for energy management and financial savings
- For ESCOs, bolster performance-based contracts and reconcile differences between actual and guaranteed savings

Select resources

- **General information:**

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[7] Any organization regardless of size, function, sector, or mission can apply these strategies for improving efficiency and reducing energy costs in their buildings.
[8] The EPA's ENERGY STAR *Guidelines for Energy Management* offers a comprehensive approach to improving building efficiency. Available at: https://www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/guidelines
[9] Such actions may include investing in operations and maintenance (O&M), encouraging building occupants to implement energy-saving behaviors, and replacing old lighting systems and office equipment.
[10] See U.S. EPA. 2017. *Improve energy use in commercial buildings*. Available at: https://www.energystar.gov/buildings/about-us/how-can-we-help-you/improve-building-and-plant-performance/improve-energy-use-commercial

- U.S. EPA ENERGY STAR
    - ENERGY STAR Guidelines for Energy Management
    - U.S. DOE Energy Service Companies Website
    - ENERGY STAR Portfolio Manager
- **EM&V related:**
    - M&V Guidelines: Measurement & Verification for Performance-Based Contracts, Version 4.0, U.S. DOE Federal Energy Management Program (FEMP)
    - International Performance Measurement and Verification Protocol (IPMVP), Efficiency Valuation Organization (EVO)

Forward Capacity Markets

What are they?

- Markets established and overseen by an independent system operator (ISO) or regional transmission operator (RTO) to ensure long-term grid reliability by procuring electricity capacity resources sufficient to meet forecasted demand during peak periods and in the case of a grid emergency
- Market mechanism is an auction that:
    - Sets prices at levels that help ensure supply and demand-side capacity resources will be available when needed on a "forward" (future) basis
    - Signals that investors will be adequately compensated for investments in construction, permitting, and maintenance of capacity resources

What are the goals for EE?

- Compete directly with traditional electric power suppliers, demand response (DR) providers, transmission companies, and other entities to provide capacity
- Provide unique value to the grid compared to other capacity resources. EE can be:
    - Implemented without extended siting, environmental, and regulatory analyses
    - Targeted to locations where needed
    - A source of significant peak load reductions (e.g., efficient air conditioners in summer peaking regions)

What are typical EM&V objectives?

- Quantify the portion of total savings from an EE policy or initiative that occurs during the relevant peak hours
- Determine associated capacity payments to EE providers
- Establish consistent, minimum requirements for quantifying savings across EE activities (e.g., ratepayer-funded EE programs and organization-led building EE initiatives) and jurisdictions

Select resources

- **General information:**
    - ISO New England Forward Capacity Market Website
    - PJM Learning Center Capacity Market Website
- **EM&V related:**

- [SEE Action Energy Efficiency Program Impact Evaluation Guide]
  - ISO New England Measurement and Verification of Demand Reduction Value from Demand Resources Manual
  - PJM Manual 18B: Energy Efficiency Measurement & Verification

Criteria Air Pollution Reductions in State/Tribal Implementation Plans

What are they?

- State or tribal implementation plans (SIPs) describe the emission control strategies, technical documentation, and agreements that demonstrate how the National Ambient Air Quality Standards (NAAQS) for six common "criteria" air pollutants will be attained
- EPA guidance describes an overall approach and set of acceptable quantification options that states and tribes can use to include EE policies and programs in SIPs
  - *Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures*
  - *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans (EE/RE SIP Roadmap*)
- States have found that strong partnerships between air and energy officials are critical for success
  - Such collaborations help all parties understand EE policy and program details, forecast electricity savings over time, and quantify the magnitude of expected emission reductions

What is the role for EE?

- Reduce power plant emissions, improve air quality, and contribute to meeting the NAAQS
  - EE policies and programs have the advantage of addressing multiple air pollutants simultaneously, whereas most pollution control devices are designed to address only one pollutant
- Provide an alternative emission reduction option that states and tribes can use for including EE in SIPs

What are typical EM&V objectives?

- Confirm, on a retrospective basis over the NAAQS planning horizon, that emission reductions resulting from EE are quantifiable, permanent, enforceable, and surplus[11]
- Establish consistent, minimum requirements for quantifying savings across EE policies and programs (e.g., ratepayer-funded EE programs and organization-led building EE initiatives) and jurisdictions

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[11] Surplus means that reductions from EE are "additional" or "incremental" to the baseline identified in the SIP. For example, a state using the "baseline emissions projection pathway" must document assumptions about which EE policies are already included—and which are incremental to—the electricity use forecast submitted as part of the SIP. Given that electricity load forecasting may occur at a single- or multi-state level, coordination between agencies, EE providers, and entities conducting EM&V can help identify which EE savings are included in the baseline forecast and which are not.

- Help ensure that jurisdictions apply equivalent EM&V approaches for determining the amount of SIP credit they may claim[12]

Select resources

- **General information:**
  - Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans (EE/RE SIP Roadmap)
  - U.S. EPA Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures
- **EM&V related:**
  - Avoided Emissions and Generation Tool (AVERT)
  - Emissions & Generation Resource Integrated Database (eGRID)
  - Annual Energy Outlook (AEO), U.S. Energy Information Administration (EIA)
  - Northeast Energy Efficiency Partnerships' Regional Energy Efficiency Database (REED)
  - Utility integrated resource plans (IRPs)
  - EE potential studies
  - EM&V reports

Appendix: Additional Detail on EM&V Approaches

The following table provides additional detail on EM&V approaches by EE policy and strategy. It is illustrative and does not represent how EM&V is planned and implemented in all cases. See the sections above for more information about each policy and strategy.

[12] Regarding agency roles, air regulators are not typically responsible for conducting EM&V or applying the results to forecast EE savings. State experience has been that energy agencies partner with their air counterparts to identify the types of data that are useful, where to find these data, and how they should be interpreted.

Appendix: Additional Detail on EM&V Approaches

	Key Considerations and Metrics	Bounds for EM&V[13]	EM&V Frequency and Time Period	Attribution and Additionality	Typical Baseline
Ratepayer-Funded EE Programs	• Metric is typically incremental energy (MWh) savings from current-year EE activities • Continuing savings in current year from EE implemented in a prior year may be reported • Cost-effectiveness, including avoided energy costs, is a priority • EM&V is conducted by a third-party evaluator	• Program and sector portfolio • Often conducted on a statistical sample that represents the entire population of EE projects or EE measures	• EM&V for a given EE program typically occurs every 3 years • EM&V is sometimes used to assess savings by season and time of day • Net present value (NPV) may be calculated using expected EE savings over the EUL • EM&V results may be used prospectively to support electricity forecasting and system planning	• Attribution is typically assessed using net-to-gross savings analysis[14]	• Federal/state equipment standards is a typical baseline for new or replace-on-failure EE activities • Pre-existing efficiency levels or a "dual baseline" is a typical baseline for EE retrofit activities
Organization-Led Building EE Initiatives	• Metric is typically annual energy (MWh) savings • Energy use intensity may also be assessed • Established EM&V protocols are typically used (e.g., FEMP, IPMVP) • For performance contracts, the ESCO conducts EM&V	• Project, facility, or organization	• EM&V is typically conducted for the 12-month period after savings occur • For ESCO projects, savings are typically quantified each year of the EUL	• Not accounted for	• Prior equipment and consumption, adjusted for changes unrelated to the EE, is a typical baseline for ESPC projects • Analysis of whole-premise metered electricity consumption is common
Forward Capacity Markets (FCMs)	• Metric is capacity (MW) not energy (MWh) • Timing and location of savings is a key consideration, coincident with ISO/RTO peak periods • For participating utility EE programs, existing EM&V is typically leveraged (subject to adjustments)	• Individual bidding asset (may be individual customer account or aggregate capacity resource) within multi-state ISO/RTO territory	• Peak hours • Sometimes assessed separately by summer/winter seasons	• Not accounted for • Emphasis on setting rigorous baselines for all EE activities; not on motivation or driver for EE implementation	• Defined in an ISO/RTO EM&V protocol or manual • Savings typically quantified using a business-as-usual baseline (e.g., federal/state requirements or market practices) • FCMs seek to establish a uniform baseline for all eligible EE activities
Criteria Air Pollution Reduction in SIPs/TIPs	• Consistent EM&V requirements across EE activities and jurisdictions is critical • For utility EE programs seeking SIP/TIP credit, EM&V conducted for PUCs can typically be leveraged (subject to adjustments)	• Consistent with scope of EE activities submitted in the SIP/TIP	• May be seasonal • Depends on specific criteria air pollutant • Approach documented in SIP/TIP • Approach applied retrospectively over the SIP implementation period	• EM&V must demonstrate that emissions reductions from EE savings are surplus (additional)	• Requirement is that savings exceed levels in baseline electricity demand forecast

[13] EM&V bounds refers to the applicable scope of quantification and verification, which may be defined on a geographic, sector, system (e.g., piece of equipment, whole building, multiple buildings), or other basis.

[14] Gross savings represent the changes in energy use and demand that result from EE program activities, regardless of what motivated the participant in the program to take the EE actions. Net savings are determined by adjusting gross savings to account for what would have happened without the program.