

# EVALUATION, MEASUREMENT, AND VERIFICATION OF ENERGY EFFICIENCY PROGRAMS

## An Overview

Under the requirements of the Energy Conservation and Efficiency Act of 2009 outlined in §1504 and §1506, the Secretary will promulgate regulations for “procedures and standards for defining and measuring electricity savings and natural gas savings targets established under § 1502(a)” from the recommendations of the Energy Efficiency Resource Standards (EERS) Workgroup.

### Definitions

**Evaluation** — The performance of studies and activities aimed at determining the effects of a program.

**Measurement and Verification** — Data collection, monitoring, and analysis associated with the calculation of gross energy and demand savings from individual sites or projects. M&V can be a subset of program evaluation.

**EM&V** - The term “evaluation, measurement, and verification” is a catchall acronym for determining both program and project impacts.

### Goals and Types of EM&V

EM&V encompass a wide range of analyses used to assess energy efficiency programs. The goals of EM&V include:

- Determining whether overall objectives are being achieved
- Identifying any necessary program improvements.
- Assessing program cost-effectiveness.
- Estimating impacts and their persistence over time.
- Capturing energy (kWh) and demand (kW) impacts in energy planning.

Most energy efficiency programs and projects are subject to some type of EM&V.

Three types of EM&V, each with a different purpose, are frequently undertaken to assess program and policy effectiveness.

Evaluation Types	Purpose	Information Derived
Impact Evaluation	Quantifies the direct and indirect benefits of a program or project using measured or deemed savings methods.	Determines the quantity of energy and/or demand saved, the monetary value of these savings; can include the amount of emissions reductions and other non-energy benefits.
Process Evaluation	Indicates how to improve the structure and delivery of a program or project. These evaluations typically survey program stakeholders, analyze their feedback, and use this information to identify opportunities for program improvement.	Determines how well program or project processes are performing and provides recommendations for how these systems they can be improved.
Market Effects Evaluation	Indicates how a program affects the structure or functioning of a market – or the behavior of participants in a market – that result from one or more program efforts.	Determines changes that have occurred in state operations and/or private markets, and evaluates how the marketplace is different as a result of the program.

This overview focuses on impact evaluations.

### Basic Approach to Measuring Impacts

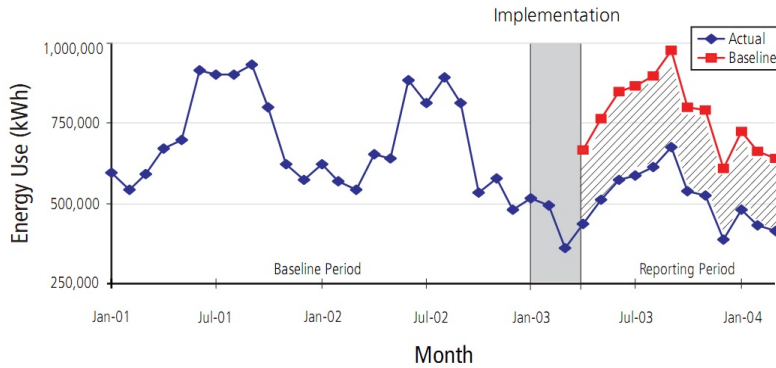
With energy efficiency programs, the key metric of interest is energy savings. For most programs, this quantity cannot be directly measured. Instead, efficiency program impacts are estimated by taking the difference between:

- (a) actual energy consumption after efficiency measures are installed, and
- (b) what energy consumption would have occurred during the same period had the efficiency measures not been installed (i.e., the baseline).

In addition, steps can be taken to adjust the baseline and/or the post-installation energy use to account for factors other than the energy efficient measure or system that affect energy consumption (e.g., weather, building occupancy, operating hours). Energy savings are therefore determined using the equation:

Energy savings = (b) (Baseline energy use) – (a) (Post-installation energy use) ± (c) (Adjustments)

In the graph below, energy savings are represented by the shaded area.



Source: National Action Plan for Energy Efficiency (2007). Model Energy Efficiency Program Impact Evaluation Guide.

## Two Approaches to Energy Efficiency Impact Evaluation

A key step in planning a program impact evaluation is to select an approach to estimating energy and demand savings. The two key options are a deemed savings approach and a measured savings approach.

For programs targeting simpler efficiency measures with well-known and consistent performance characteristics, a deemed savings approach may be appropriate. This method involves multiplying the number of installed measures by an estimated (or deemed) savings per measure, which is derived from historical evaluations. Deemed savings approaches may be complemented by on-site inspections.

For larger and more complex program strategies – including those expected to result in significant savings or those with a high degree of uncertainty – a measured savings approach that follows established protocols may be appropriate. Estimates of energy (and/or demand) savings are calculated using one or more of the following techniques.

Measured Savings Approaches to Impact Evaluation	
Engineering Methods	Standard formulas and assumptions are used to calculate the energy use of the baseline and post-installation energy systems.
Statistical Analyses	Statistical models are used to estimate “before” and “after” scenarios, while taking into consideration changes in weather, facility occupancy, factory operating hours, and other factors that affect energy use.
Computer Simulation of System Performance	Computer models are used to predict the change in energy use after complex, system-wide improvements in energy efficiency are implemented. These models are typically calibrated with actual performance data.
Metering and Monitoring	Baseline and post-installation energy use is directly metered and monitored, while accounting for the non-energy factors that affect energy consumption.
Integrative Methods	Integrative methods combine some or all of the preceding approaches. For example, metering and engineering methods can calibrate computer simulations of baseline and post-installation buildings that receive efficiency retrofits.

States that apply measured savings approaches typically adopt an evaluation protocol to guide their efforts, increase transparency, and identify the appropriate level of rigor. For these reasons, such a protocol can be particularly important when impact evaluation results are used as the basis for decision making. Regardless of the approach selected, a key goal for impact evaluation is to minimize uncertainty while balancing evaluation costs with the value of the information received.

## Gross and Net Energy Savings

The applicability of using gross or net energy savings in EM&V activities is dependent upon on a number of factors including the goals of an efficiency program. In general, net energy savings are applicable for process evaluations and cost-effectiveness calculations.

- **Gross energy** (or demand) savings are the change in energy consumption or demand that results directly from program-promoted actions (e.g., installing energy-efficient lighting) taken by program participants regardless of the extent or nature of program influence on their actions.
- **Net energy** or demand savings refer to the portion of gross savings that is attributable to the program. This involves separating out the impacts that are a result of other influences, such as consumer self-motivation or free ridership. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular program) or another can be quite complex.

## Evaluation Protocols

Protocols are documents with varying level of detail that define how the EM&V is to be conducted with a particular jurisdiction. Contents might include:

- Which approaches to use
- Rigor requirements (e.g., sample size, confidence levels)
- Evaluation timing
- Reporting requirements

## Technical Reference Manuals

In the simplest form, 'TRMs' are databases of deemed savings values with applicability conditions. Example of a TRM database contents:

- kWh, kW, therm savings values
- Measure effective lifetimes
- Net to gross ratios
- Measure cost information
- Work papers that document basis for values

## RESOURCES

### M&V Guidelines/Protocols

- International Performance Measurement and Verification Protocol (IPMVP) is the leading international energy efficiency M&V protocol: [www.evo-world.org](http://www.evo-world.org)
- National Action Plan for Energy Efficiency: [www.epa.gov/eeactionplan](http://www.epa.gov/eeactionplan)
- 2008 Federal Energy Management Program M&V Guidelines and related documents: <http://ateam.lbl.gov/mv/>
- 2002 ASHRAE Guideline 14 Measurement of Energy and Demand Savings: [www.ashrae.org](http://www.ashrae.org)
- The PJM Manual for Energy Efficiency Measurement & Verification: <http://www.pjm.com/committees-and-groups/task-forces/eetf.aspx>
- Northeast Energy Efficiency Partnerships (NEEP), Regional (EM&V Forum): [www.neep.org](http://www.neep.org)

## OVERVIEW OF THE NORTHEAST ENERGY EFFICIENCY PARTNERSHIPS (NEEP)

Regional Evaluation, Measurement and Verification Forum's (EM&V Forum)

### Launched in 2008, Forum's Goals Are:

1. Increase credibility of energy and demand savings by providing:
  - a. Greater consistency of savings values for similar measures and programs;
  - b. Increase transparency and accessibility of EM&V protocols and inputs; and
  - c. A direct link between energy and air regulator estimates of savings, cost and emission impacts.
2. Reduce evaluation and other research costs by leveraging funds across a range of interested parties through collaborative research and analysis.

3. Increase the participation in DSM by having one set of regionally accepted protocols across the Northeast and mid-Atlantic region to measure, verify, track and report impacts.
4. Improve state, regional and local demand resource and energy planning, implementation and evaluation by having readily available and consistent inputs, protocols and reporting format and tools.
5. Inform the development of any national EM&V protocols for energy efficiency and other demand resource.

#### **Protocol Development Projects**

- ***Common EM&V Methods and Survey Savings Assumptions Project***  
This project's purpose is to develop EM&V methods guidelines for calculating electric and gas energy efficiency savings across the region.
- ***Develop Common Energy Efficiency Reporting Guidelines***  
This project is intended to address a growing need for consistent reporting of electric and natural gas energy efficiency savings and costs across states in the region.
- ***M&V Standards in Wholesale Capacity Markets***  
Ensure that protocols/standards are sufficiently rigorous and reasonable, based on best practice in the evaluation industry for the participation of energy efficiency in ISO New England and PJM capacity markets.
- ***Develop Common Savings Assumptions (Mid-Atlantic States)***  
This project will develop a technical reference manual or equivalent for the mid-Atlantic states with common savings assumptions, input parameters, and algorithms for priority end-use measures.

#### **Research & Evaluation Projects**

- **Loadshape Study Project**  
The scope of this project is to determine the impact of electric energy efficiency programs in reducing energy use, and associated emissions, during specific, identified hours of the year.
- **C&I Lighting Measure Life and Persistence**  
The scope of this project is to provide estimates of multi-year measure persistence based on on-site inspections and surveys of a sample of lighting measures installed by commercial and industrial lighting programs in the region.
- **White Paper on Net Savings (Issues, Challenges, and Recommended Future Directions in Measurement of Net Savings)**

#### **EM&V Forum 2010 Project Scopes**

- #PD1: Establish Guidelines and Common Approaches to Calculate/Address Net Savings
- #PD2: Develop Common EM&V Approaches/Methods for Emerging Technologies/Programs
- #PD3: Develop Guidelines for Incorporating EE into System Planning
- #PD4: NAESB M&V Standards Development for Energy Efficiency
- #PD5: Develop Common Savings Assumptions/Algorithms (Part 2) – Mid Atlantic
- #RE1: Develop Common Incremental Cost Assumptions
- #RE2: Loadshape Study Project Phase 2 Cont/Expanded from 2009
- #RE3: Estimate EE Impact on Advancing Energy Building Codes
- #RE4: Measure Persistence Study - Phase 2
- #RE5: Natural Gas EE Research & Evaluation

For more information, see [www.ncep.org](http://www.ncep.org).