

Chapter 1: Introduction

The Uniform Methods Project: Methods for Determining
Energy Efficiency Savings for Specific Measures

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This document provides a set of model protocols for determining energy and demand savings that result from specific energy efficiency measures implemented through state and utility efficiency programs. The methods described here are approaches that are—or are among—the most commonly used in the energy efficiency industry for certain measures or programs. As such, they draw from the existing body of research and best practices for energy efficiency program evaluation, measurement, and verification (EM&V).¹

These protocols were developed as part of the Uniform Methods Project (UMP), funded by the U.S. Department of Energy (DOE). The principal objective for the project was to establish easy-to-follow protocols based on commonly accepted methods for a core set of commonly deployed energy efficiency measures.

About the Protocols

The methods described here represent generally accepted standard practices within the EM&V profession; however, they are not necessarily the *only* manner in which savings can be reliably determined. Still, program administrators and policymakers can adopt these methods with the assurance that: (1) they are consistent with commonly accepted practices and (2) they have been vetted by technical experts in the field of energy program evaluation. If widely adopted, these protocols will help establish a common basis for assessing and comparing the performance and effectiveness of energy efficiency policies and investments across programs, portfolios, and jurisdictions.

These protocols do not provide stipulated values for energy savings; however, their widespread use would provide a common analytic foundation for determining “deemed” values while still allowing for the use of inputs appropriate for a project’s particular circumstances. Nor do these protocols prescribe specific criteria for either statistical confidence or the accuracy of savings estimates. Such thresholds are assumed to be set by the audiences, as determined by their unique objectives and priorities. Instead, the protocols provide a structure for deciding on and applying such criteria consistently and for reporting the uncertainty associated with the indicated savings estimates.

Rationale

Investment in energy efficiency has increased steadily in the United States in recent years. In many jurisdictions, energy efficiency now accounts for a significant share of utilities’ integrated resource portfolios. In several jurisdictions, energy efficiency has been recognized as the “fuel of first choice,” thus amplifying its critical role in electric resource reliability and adequacy.

This trend of increasing investment in energy efficiency will likely continue as utilities strive to meet the energy efficiency resource standards that have been adopted through legislative or regulatory mandates in 26 jurisdictions—and are being considered in several more. In at least

¹ Measurement and verification (M&V) is distinct from evaluation in that it focuses on determining savings for individual measures and projects, while evaluation aims to quantify the impacts of a program.

half of these jurisdictions, the standards are designed to achieve aggressive savings of 10% or more of forecast load by 2020; in six jurisdictions, savings of more than 20% are expected.²

With greater reliance on energy efficiency as a means of meeting future energy resource requirements, there is a growing demand for publicly available information on energy efficiency programs, how their savings are determined, and how the achieved savings are reported. By the sharing and vetting of information among experienced practitioners and those new to the energy efficiency field, this knowledge can reinforce the reliability of the savings. To this end, these protocols offer evaluation methods and techniques for determining energy savings based on generally accepted practices in the energy efficiency industry for certain common measures and programs.

To help reduce the uncertainty associated with determining energy efficiency savings, this material offers guidance for implementing the techniques and interpreting results. It can also provide a basis for comparing the impacts of energy efficiency portfolios and policy initiatives across the country.

DOE envisions the following specific goals for this project:

- Offer guidelines that help strengthen the credibility of energy efficiency program savings calculations.
- Provide clear, accessible, step-by-step protocols to determine savings for the most common energy efficiency measures.
- Support consistency and transparency in how savings are calculated.
- Reduce the development and management costs of EM&V for energy efficiency programs offered by public utility commissions, utilities, and program administrators.
- Allow for comparison of savings across similar efficiency programs and measures in different jurisdictions.
- Increase the acceptance of reported energy savings by financial and regulatory communities.

The Audiences and Objectives

In response to the interest of the State and Local Energy Efficiency Action Network (SEE Action)³ EM&V Working Group and others, DOE commissioned this effort to provide a voluntary set of standard protocols for determining savings resulting from particular energy efficiency measures implemented through state and utility efficiency programs.

² See *Energy Efficiency Resource Standards: A Progress Report on State Experience*, American Council for an Energy Efficiency Economy (ACEEE), Report Number U112, June 2011.

³ U.S. DOE: www.seeaction.energy.gov

Although these protocols are applicable to a wide range of situations, their initial audience is expected to be stakeholders in states where energy efficiency is relatively new (or is newly expanded) *and* the issues of documenting savings have gained importance. From this general perspective, these protocols primarily serve evaluators working under the direction of regulators and/or program administrators in at least these four ways:

1. Providing a reliable basis for evaluating the effectiveness and viability of energy efficiency, thus offering regulators a basis and the means for both assessing the prudence of rate payer-funded investments in energy efficiency and determining compliance with savings targets.
2. Offering utility resource planners and program administrators greater certainty about program performance and reducing planning and regulatory compliance risks.
3. Supplying independent EM&V contractors with a standard set of tools and techniques that would enhance the credibility of their findings.
4. Providing a resource for educating EM&V practitioners and a basis for the calculation of deemed and algorithm-based savings in technical reference manuals (TRMs) that are being developed or updated in various jurisdictions.

By making the methods for calculation and verification of savings more transparent and uniform, these protocols will increase the reliability of energy efficiency results reported by program administrators and implementation contractors. This will help mitigate the perceived risks of investing in energy efficiency and stimulate greater participation. In order to help achieve the objective of transparency, EM&V contractors should identify where alternate approaches to UMP are used.

Definitions

Various market participants in the energy efficiency industry (such as end-use energy consumers, project designers, contractors, program implementers and administrators, and utility resource planners, as well as independent, third-party evaluators) may define savings resulting from energy efficiency differently. The UMP uses standard industry definitions to differentiate the four ways savings are reported at the design, implementation, and evaluation stages of a program's life cycle:⁴

- **Projected Savings** are values reported by a program implementer or administrator before the efficiency activities are completed.⁵
- **Gross Savings** are changes in energy consumption that result directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated.

⁴ For more complete and detailed descriptions see the State and Local Energy Efficiency Action Network. 2012. *Energy-Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc. www.seeaction.energy.gov

⁵ In certain cases the projected savings may be based on deemed values approved by regulators.

- **Claimed (Gross) Savings** are values reported by a program implementer or administrator after the implementation activities have been completed.⁶
- **Evaluated (Gross) Savings** are values reported by an independent, third-party evaluator after the efficiency activities and impact evaluation have been completed. The designations of “independent” and “third-party” are determined by those entities involved in the use of the evaluations and thus may include evaluators retained by the program administrator or a regulator, for example.
- **Net Savings** are changes in energy use attributable to a particular energy efficiency program. These changes may implicitly or explicitly include the effects of factors such as freeridership, participant and nonparticipant spillover, and induced market effects.

The UMP protocols provided here focus primarily on estimating evaluated gross first-year savings, except where estimates of net savings may be derived as part of the same method. A more comprehensive discussion of the elements of net-to-gross (NTG) adjustments and the methods for measuring them will be described in a separate crosscutting section dedicated to the topic in the second phase of this project. The definition of net savings (for example, whether it includes participant and/or nonparticipant spillover) and the manner in which NTG is applied also vary across jurisdictions as a matter of policy. Therefore, UMP does not offer specific recommendations on how NTG is applied.

Assumptions about baseline conditions form the basis for calculation of savings and should be defined for technology-based, energy efficiency programs depending on whether the efficiency actions involve: early replacement or retrofit of functional equipment still within its expected useful life, replacement of functional equipment beyond its rated useful life, unplanned replacement of failed equipment, or new construction and replacement on burnout. While “as-found” (existing) conditions usually represent an appropriate basis for establishing baselines for early replacement actions, either common practice or the requirements of applicable efficiency codes and standards are usually appropriate for the other categories of efficiency actions.⁷

Project Process

The UMP project is a two-phase undertaking. This report, which presents the results of the first phase, contains protocols for these seven measures, which are primarily applicable to residential and commercial facilities:

- Refrigerator recycling

⁶ In certain cases these savings may have been adjusted by a predetermined net-to-gross (NTG) ratio.

⁷ As a general rule, it is recommended that the more efficient of the applicable common practice or code/standard requirement should be used if either might be applicable. Information on establishing baselines is discussed in Section 7.1 of the previously cited *Energy-Efficiency Program Impact Evaluation Guide*. Since the manner in which baseline conditions are defined has a direct bearing on how net savings are defined and calculated, methods for establishing baseline will be discussed in greater detail in the second phase of the project.

- Commercial lighting
- Commercial lighting controls
- Residential lighting
- Residential furnaces and boilers
- Residential and small commercial unitary and split system air conditioning equipment
- Whole-building retrofit.

These measures were selected because they: (1) represent a diverse set of end uses in the residential and commercial sectors; (2) are present in most energy efficiency portfolios across all jurisdictions; and (3) have a significant remaining savings potential.

In the second phase, this list will be expanded, so the final set of measures covered is expected to represent a significant share of the available technical and economic energy efficiency potential in most jurisdictions.

For each energy efficiency measure, the protocol explains the underlying technology, the end uses affected by the measure, the method for calculating the measure's savings, and the data requirements. Also, each protocol attempts to provide sufficient detail without being overly prescriptive, allowing flexibility and room for professional judgment.

The measure-specific protocols are supported and complemented by separate chapters that discuss technical issues and topics common to all measures. These crosscutting topics, which are organized into the following five sections, are referenced in measure-specific protocols, where applicable:

1. Sample design
2. Survey design
3. Metering
4. Calculation of peak impacts
5. Other evaluation topics (including rebound and persistence of savings).

These supplemental, crosscutting discussions help extend the measure-specific method for determination of savings to evaluating whole programs.

Relationship to Other Protocols

The protocols provided here are based on long-standing EM&V practices, and their methods conform to well-established engineering and statistical principles. They draw from and build on a number of previous attempts to develop comprehensive, systematic approaches to estimating the impacts of energy efficiency. Those efforts were conducted by various entities, including Oak

Ridge National Laboratory (ORNL, 1991⁸), the Electric Power Research Institute (EPRI, 1991⁹), U.S. Environmental Protection Agency (EPA, 1995¹⁰), DOE, 1996,¹¹ and DOE, 2008.¹²

Several of these protocols were developed to address specific policy objectives, such as the verification of utility program savings, the determination of savings from special performance contracts, and environmental compliance. In addition, a number of protocols have been developed to address specific EM&V requirements in certain jurisdictions (such as California and the Pacific Northwest).

A valuable companion document to this set of protocols is the *SEE Action Energy Efficiency Program Impact Evaluation Guide*.¹³ It provides both an introduction to and a summary of the practices, planning, and associated issues of documenting energy savings, demand savings, avoided emissions, and other nonenergy benefits resulting from end-use energy efficiency programs.¹⁴

Designed to be consistent with the *SEE Action Energy Efficiency Program Impact Evaluation Guide*, the UMP protocols are more detailed and specific for particular measures and projects. (The preparation of these protocols was closely coordinated with that guide.)

The EM&V methods described here draw on the International Performance Measurement and Verification Protocol (IPMVP).¹⁵ The UMP protocols expand on the IPMVP options by adding detail and describing specific procedures for application to program- and portfolio-level evaluations. To this end, each protocol clearly identifies the IPMVP option with which it is associated. For many technologies, evaluation tools and methods continue to improve, and the industry will continue to benefit from advancements to evaluation methods so that system performance can be estimated more accurately in the future. As such, the evaluation methods will no doubt continue to evolve in response to these changes.

⁸ Oak Ridge National Laboratory, *Handbook of Evaluation of Utility DSM Programs*, ORNL/CON-336, December 1991.

⁹ Electric Power Research Institute. *Impact Evaluation of Demand-Side Management Programs, Vol. 1: A Guide to Current Practice*, EPRI CU-7179, Palo Alto, CA, February, 1991a.

¹⁰ *Conservation Verification Protocols, Version 2*, EPA-430/B-95-012, June 1995.

¹¹ *The North American Energy M&V Protocols*, U.S. Department of Energy, DOE-GO 10096-248, February 1996.

¹² *Federal Energy Management Program (FEMP) M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0*, U.S. Department of Energy Federal Energy Management Program, April 2008.

¹³ Op. cit.

¹⁴ An ample discussion and initial examination of issues raised by pursuing a broadly applicable approach to EM&V can be found in *National Energy Efficiency Evaluation, Measurement and Verification (EM&V) Standard: Scoping Study of Issues and Implementation Requirements* at http://www1.eere.energy.gov/seeaction/pdfs/emvstandard_scopingstudy.pdf

¹⁵ Energy Valuation Organization, *International Performance Measurement and Verification Protocols, Concepts and Options for Determining Water and Energy Savings, Vol. 1*, January 2012.

About EM&V Budgets

Historically, the costs of determining energy savings are embedded in the larger context of evaluation activities undertaken as part of large-scale programs. The range of those total evaluation costs can be obtained by reviewing those sources. For example:

- DOE’s FEMP Measurement and Verification (M&V) Guidelines for federal-level performance contracting projects estimate the average, all-in cost of M&V as ranging from 3% to 5% of total project costs.¹⁶ The FEMP Guidelines report M&V expenses averaging 3.3% of costs for the typical performance-contracting project.¹⁷
- A report sponsored by the National Association of Energy Service Companies and the U.S. Environmental Protection Agency suggests that each IPMVP Option will cost the client the following percentages of total project costs: from 1% to 5% for verification involving key parameters (IPMVP Option A), and from 3% to 10% for verification involving all parameters (IPMVP Option B).¹⁸
- In several jurisdictions, the evaluation costs for large demand-side management portfolios are available from regulatory filings. Our review revealed portfolio-level EM&V expenditures ranging from 2% of portfolio costs in Indiana to 4% of portfolio costs in California.¹⁹

As a rule, the EM&V effort—and expenditures—should be scaled to both the program being evaluated and the accuracy necessary to inform the decision for which evaluation results matter. The value of the information provided by the EM&V activity is determined by the resource benefits of the program and the particular policy and research questions the EM&V activity aims to address.

These budget figures should be considered as only rough guidance, as they are mostly self-reported, and the definitions of cost categories may vary significantly across states and program administrators. This is particularly true considering how internal verification processes may be different from independent, third-party evaluations.²⁰

Evaluation resource requirements also depend on how often they are conducted. The frequency with which evaluations are performed depends on a number of considerations, including, but not limited to, the type and complexity of the measure and its expected contribution to portfolio savings, the uncertainty about the savings, the life cycle stage of the program in question, and

¹⁶ FEMP M&V Guidelines, op. cit., p. 5-2.

¹⁷ FEMP M&V Guidelines, op. cit., p. 5-9

¹⁸ David Birr and Patricia Donahue, “*Meeting the Challenge – How Energy Performance contracting Can Help Schools Provide Comfortable, Healthy, and Productive Learning Environments*” (The National Association of Energy Services Companies and the US Environmental Protection Agency), pp. 32-33.

¹⁹ Similar estimates are also available for Illinois (3%), Indiana (5%) Michigan (5%) and Pennsylvania (2%-5%), Arkansas (2%-6%).

²⁰ For additional discussion on budgeting see the SEE Action Guide, Section 7.5.2.

regulatory requirements. In light of these considerations, UMP has no specific recommendation about how often programs should be evaluated.

Considering Resource Constraints

The UMP protocols are designed to represent approaches for providing accurate and reliable estimates of energy efficiency savings that draw on best practices without undue cost burdens. However, the UMP protocols do not offer recommendations about the levels of rigor and the specific criteria for accuracy of the savings estimates. Those issues are largely matters of policy, ease and cost of data acquisition, and availability of resources.

To provide maximum flexibility, each protocol contains recommendations for alternative, lower cost means of deploying the protocol, such as relying on secondary sources of data for certain parameters and identifying guidelines for selecting appropriate sources of such data. Practitioners should document when they have used these alternative means. The costs of deploying the UMP protocols will vary, depending on the features of the energy efficiency program being evaluated, the participant characteristics, and the desired levels of rigor and accuracy. Thus, cost estimates for implementing the protocols are not provided. Instead, the utilities and program administrators adopting the protocols should consider benchmarking their programs and gauging their EM&V budgets against those of other entities with experience in conducting EM&V for similar programs.

Options for Small Program Administrators

UMP recognizes that even the lower cost options provided in the UMP protocols may be impractical where resources are constrained or programs are small (such as those offered by small utilities).²¹ In these circumstances, program administrators may consider using deemed savings values from:

- TRMs created by regional or state entities
- Evaluations of similar programs performed by other regional utilities. (These can serve as the basis for determining energy efficiency savings, provided that the installation and proper operation of the energy efficiency measure or device has been verified.)

Deemed savings may be adjusted to allow for climate or other factors (regional or economic/demographic) that differ from one jurisdiction to another. Given the differences in how TRMs determine savings for identical measures, program administrators choosing this path should use deemed savings values based on calculations and stipulated values derived using the UMP protocols when possible. Those using this approach should update their deemed savings values periodically to incorporate changes in appliance and building codes and the results of new

²¹ According to the Small Business Administration, small utilities are currently defined as electric load serving entities with annual sales of less than 4 million megawatt-hours. Additional information on the costs and benefits of different measurement and verification approaches for small utilities can be found in the *Analysis of Proposed Department of Energy Evaluation, Measurement and Verification Protocols*, sponsored by the National Rural Electric Cooperative Association available at: <http://www.nreca.coop/issues/ElectricIndustryIssues/Documents/EMVReportAugust2012.pdf>

EM&V studies (such as the primary protocols developed under the UMP or other secondary sources).

Alternatively, where possible, program administrators may consider other cost-saving measures, such as pooling EM&V resources and jointly conducting evaluations of similar programs through local associations. (This has been done successfully in small utilities in California, Michigan, and the Pacific Northwest.)

Small utilities may also consider either coordinating with regional larger utilities or adopting the results of evaluations of similar programs implemented by larger utilities.

Project Management and Oversight

This project was funded by DOE and managed by the National Renewable Energy Laboratory. The Cadmus Group, Inc., was engaged to manage the protocol development and provide technical oversight. The project was designed to be inclusive of a broad set of stakeholders so as to ensure technical excellence. To facilitate the final appeal and acceptance of the work products, the following steps were taken.

Project Oversight by Variety of Stakeholders

The National Renewable Energy Laboratory formed a project steering committee to provide general direction and guidance. The steering committee consisted of regulators, utility managers, energy planners and policymakers, and representatives of industry associations.

Authorship by Experts

Nationally recognized experts on specific energy efficiency measures and technologies drafted each protocol.

Review by Technical Advisory Groups

Two technical advisory groups—one focusing on the validity of the protocols and the other on applicability — reviewed draft protocols. Each member provided comments on one or more protocols. These advisory groups included experts from major consulting firms engaging in EM&V throughout North America.

Review by Stakeholders

The protocols were subject to a review process that enabled stakeholders to provide feedback about the draft protocols before they were released in their final form.

Protocol Organization

The material in measure-specific protocols is organized in a similar structure to provide consistency. Each protocol provides the following information:

1. Measure Description—a brief description of the measure or measures covered by the protocol
2. Application Conditions of Protocol—details on what types of delivery channels or program structure are or are not covered by the protocol

3. Savings Calculations—the prevailing algorithm(s) needed to estimate energy savings with explanation of parameters included
4. M&V Plan—the recommended approach, including the IPMVP option, for determining values for the parameters required in the savings calculation
5. Sample Design—overview of considerations on how to segment the population to provide a representative sample for evaluation; in some protocols, this is discussed in conjunction with the M&V Plan
6. Other Evaluation Issues—any additional information deemed pertinent by the author and/or reviewers, including brief discussions of persistence or NTG considerations; often this information is supplemented by the crosscutting protocols.

As each measure is unique, some protocols have additional sections to provide more details on specific areas of interest or consideration.