Summing it Up: The National Action Plan's New Program Impact Evaluation Guide

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ABSTRACT

A key recommendation under the National Action Plan for Energy Efficiency (Action Plan) is to "Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource." (NAPEE 2006) To support this recommendation – and to address the need for a guidance document that fosters best practices for evaluation and promotes consistent evaluation practices – the Action Plan developed a *Model Energy Efficiency Program Impact Evaluation Guide* (NAPEE 2007). The Guide synthesizes previously disparate information on *program* evaluation into a single resource that builds on existing *project* protocols – such as the IPMVP and FEMP Guidelines – to address *program* evaluation. The resulting document provides an overview of industry-standard approaches for evaluating the energy, demand, and emissions benefits of efficiency.

The primary use for the Guide is to help entities that are getting started with efficiency programs to establish a structure for calculating the savings resulting from their facility (non-transportation) energy efficiency programs. Specific "issues of special interest" are also addressed in the Guide, including: co-benefits, persistence of savings, and uncertainty. Another factor differentiating the Guide is a clear explanation of how emission factors can be calculated and applied to energy savings to determine avoided emissions. Potential consumers of the Guide include program designers and evaluators employed by cities, states, utilities, companies, and other entities positioned to run programs. By describing a set of best practices and consistent procedures and terminology, the Guide can help these entities adopt, assess, and improve their efficiency programs.

Introduction

Evaluation involves real time and/or retrospective assessments of the performance and implementation of a program. There are two key objectives of evaluations:

1. Document and measure the effects of a program in order to determine how well it has met its goals.
2. Understand why those effects occurred and identify ways to improve current and future programs as well as select future programs.

Another objective can be to document compliance with regulatory requirements. Many efficiency evaluations are oriented toward developing retrospective estimates of energy savings attributable to a program, in a manner that is defensible in regulatory proceedings conducted to ensure that public funds are prudently and effectively spent. However, the role of evaluation can go well beyond simply documenting savings to actually improving programs and providing a basis for future savings estimates. If applied concurrently with program implementation, evaluations can provide information in real time to allow for as-needed course correction. Perhaps this was best described by John Kenneth Galbraith and William Edwards Deming: "Things that are measured tend to improve."

The *Model Energy Efficiency Program Impact Evaluation Guide* (the Guide) is provided to assist electric and gas utilities, utility regulators, and other entities in implementing the recommendations of the National Action Plan for Energy Efficiency (Action Plan) and the pursuit of its long-term aspirational goal of achieving all cost-effective energy efficiency by 2025. The Guide describes a structure and several model approaches for calculating energy, demand, and emissions savings resulting from facility-level (non-transportation) energy efficiency programs that are implemented by utilities, states, private sector firms, and others. It also describes best practices and consistent procedures for conducting evaluations, with the objective of improving and documenting the effects of energy efficiency programs.

The primary audience for the Guide is program designers and evaluators employed by cities, states, utilities, companies, and other entities positioned to run programs. By describing a set of best practices and a set of consistent procedures and terminology, the Guide can help these entities adopt, assess, and improve their efficiency programs. It can also be used by regulators and others to understand the principles of evaluation, including how it can be used to establish common approaches to measuring the benefits of emerging policies that treat energy efficiency as a resource. Similarly, the Guide can be referenced by agency staff in their efforts to educate policy-makers about the reliability benefits of efficiency and its role in the regional energy mix.

After reading the Guide, readers with some evaluation experience may be able to prepare a complete plan for conducting a program impact evaluation.

Why a Program Evaluation Guide?

The Action Plan's Leadership Group identified evaluation, measurement, and verification (EM&V) as an area where additional guidance is needed to help parties assess progress towards achieving their public commitments[1] to energy efficiency. Specifically, this Guide supports the Action Plan recommendation to "Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource." A key option to consider under this recommendation is to develop robust measurement and verification procedures. Establishing evaluation, measurement, and verification mechanisms is also included as one of the ten implementation goals in the Action Plan's Vision for 2025.[2]

Further, two recent surveys of the energy efficiency industry indicated a need for guidance documents that foster best practices for evaluation and promote consistent evaluations of energy efficiency programs (Michals, J. and E. Titus. 2006; Schiller 2007a). First, a 2006 survey by the Northeast Energy Efficiency Partnerships (NEEP) found that as investments in energy efficiency increase, states can benefit from establishing common protocols for measuring, verifying, and reporting energy and capacity savings in a consistent and transparent manner. Lacking this, system planners and policy makers will likely find it difficult to incorporate energy efficiency into power system planning or reliably assess the impacts of energy efficiency policies and programs to meet energy, economic, or environmental goals.

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1 A complete listing of all public statements and commitments can be found at: http://www.epa.gov/cleanenergy/energy-programs/napee/commitments.html

2 National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025*: Developing a Framework for Change. <*www.epa.gov/eeactionplan*>

Second, a California-based survey of evaluation professionals noted that there was no model guidance that individual jurisdictions (e.g., states, utilities) can use to establish their own evaluation requirements in a manner that builds from experience in other areas, and that is consistent with national best practices. The survey further identified the need for guidance on the specific mechanisms for calculating energy savings that achieve an acceptable level of rigor, with consideration for the trade-offs between uncertainty, budget, and value of the resulting information. It was determined that addressing these needs is particularly critical for entities with limited or no experience with efficiency programs that are just getting started or ramping up from a low level of funding.

The Guide fills the identified gaps by providing:

- A model impact evaluation process that individual jurisdictions can use to establish their own evaluation requirements.
- Policy-neutral[3] descriptions and guidance for conducting impact evaluations of resource acquisition programs.

The information in the Guide is a summary of definitions, approaches, and best practices for EM&V developed over the last 30 years of energy efficiency program implementation and evaluation. This experience and expertise is documented in numerous guides, protocols, papers, and reports. The key documents that were used in the development of the Guide are:

- 2007 International Performance Measurement and Verification Protocol (IPMVP)
- 2006 California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals
- 2000 FEMP M&V Guidelines.

An important factor differentiating the Guide is that it builds upon existing *project* protocols – such as the IPMVP and FEMP Guidelines – to address *program* evaluation.[4] It describes techniques and approaches for conducting evaluation using a sample (versus a census) of projects, with the results applied to the entire program "population" of projects. Perhaps the resource coming closest to meeting the needs of survey respondents is the *2006 California Energy Efficiency Evaluation Protocols* (CPUC, 2006). Nevertheless, survey results revealed that the California protocols were too detailed and expansive for entities just beginning to administer and evaluate efficiency programs.

Another factor that differentiates the Guide is a clear explanation of how emission factors can be calculated and applied to energy savings to determine avoided emissions. This material was developed in response to survey data suggesting the critical need to effectively aggregate, compare, and communicate emissions reductions, particularly of greenhouse gases (GHG). An

[3] The Guide is "policy-neutral" in that it can be applied to energy efficiency or emission reduction programs irrespective of the programs' policy objectives or constraints.

[4] *Program* is defined as a group of projects with similar technology characteristics that are installed in similar applications. Examples include a utility program to install energy-efficient lighting in commercial buildings, a company's program to install energy management system in all of its stores, or a state program to improve the efficiency of its public buildings. In contrast, a *project* is often a single activity at one location, such as an energy-efficient lighting retrofit in an office building.

additional difference between the Guide and existing evaluation resources is that the Guide includes basic discussions of special issues related to program evaluation (these issues – including co-benefits, persistence, and uncertainty – are discussed in greater detail below). These differences, plus a current bibliography of EM&V resources, define the Guide's niche and "added value" among the guidance and literature on energy efficiency evaluation. For information on the range of existing guidance and protocols, with additional distinctions between the Guide and related reports, see the Consortium for Energy Efficiency's (CEE) "Guide to the Guides."[5]

Topics Covered in the Guide

The Guide provides information and direction to entities seeking to evaluate the impact – i.e., the energy, demand, and emissions savings – of energy efficiency programs implemented in facilities. It describes the key steps and issues to consider when calculating the fuel oil, natural gas, and electricity savings from programs that encourage lighting, space conditioning, process approaches, and similar energy efficiency strategies in residential, commercial, and industrial facilities. The Guide also describes methods and approaches for determining the avoided emissions associated with these energy savings.

The information provided is primarily intended to assist in the evaluation of programs for which energy and demand savings are the primary objectives (commonly referred to as "resource acquisition" programs). The Guide also offers a brief description of evaluation approaches for market transformation, codes and standards, and education programs. Process, market, and cost-effectiveness evaluations are defined and references are provided.

It is likewise necessary to indicate what the Guide does *not* cover. First, the Guide is not sufficiently detailed to be the only resource for planning or conducting evaluations of specific programs. Rather, it can offer high-level guidance, identify issues, and direct users to resources for defining policy- and program-specific requirements and details. For example, it does not describe specific data collection and analysis options, although it does list documents where this information can be found for various program types and technologies. Second, the Guide is not intended for use in assessing the savings and benefits from a *future* energy efficiency program, but rather to inform on what has been, is being, or is projected to be accomplished with an existing program. While demand response (DR) programs are not specifically addressed, the basic evaluation approaches and planning process explained in the Guide can be applied to DR. One example is a case study describing how the M&V manual for the ISO-New England Forward Capacity Market (FCM) addresses DR. Other sample applications of DR applications are also provided.

Table 1 provides a basic outline of the Guide, including the contents of each chapter and intended audience.

Table 1. Overview of Model Energy Efficiency Program Impact Evaluation Guide

Document Element	Chapter Title	Contents and Intended Audiences
Part 1	**Executive Summary**	Summarized importance and types of evaluations, the impact evaluation process, key issues, and evaluation planning.

[5] See: http://www.cee1.org/eval/eval-res.php3

		Intended for all readers.
Part 2	**Chapter One:** *Introduction* **Chapter Two:** *Energy Efficiency Program Evaluation* **Chapter Three:** *Impact Evaluation Basics*	Provides basics of energy efficiency evaluation. ***Chapters 2 and 3 are intended for readers who want an overview of evaluation and the key aspects of impact evaluation.***
Part 3	**Chapter Four:** *Calculating Gross Energy and Demand Savings* **Chapter Five:** *Calculating Net Energy and Demand Savings* **Chapter Six:** *Calculating Avoided Air Emissions*	Provides details on the process and approaches for quantifying energy and demand savings, and avoided emission, from energy efficiency programs. ***Intended for readers whose programs are to be evaluated, evaluators, and mangers/regulators of evaluation activities.***
Part 4	**Chapter Seven:** *Planning an Impact Evaluation*	This chapter "brings it all together" and describes how the information described in earlier chapters can be utilized to plan an evaluation effort. ***Also intended for readers whose programs are to be evaluated, evaluators, and managers/regulators of evaluations. Some readers with background in evaluation may want to go directly to this chapter.***
Part 5	**Appendix A:** *Action Plan Leadership Group* **Appendix B:** *Glossary* **Appendix C:** *Other Evaluation Types* **Appendix D:** *Uncertainty of Savings Estimates* **Appendix E:** *Resources* **Appendix F:** *M&V for Renewables and Combined Heat and Power*	These appendices provide resources and further background on evaluation issues. ***Intended for readers interested in specialty subjects or reference materials. Appendix B, the glossary, and Appendix C may be of interest to policy-makers. Appendix C summaries the various types of efficiency programs and the ways these programs can be evaluated.***
The Guide also includes roughly 40 "sidebars" of examples/clarifications and 25 figures and tables		

Three Steps for Calculating Energy, Demand, and Emissions Savings

The Guide describes an overall approach to determining energy/demand savings and avoided emissions, based on the fundamental concept of comparing energy use and demand before and after a program is implemented. The approach can be characterized in three basic steps:

- **Step #1:** Determine gross program energy and demand savings
- **Step #2:** Convert gross program savings to net energy and demand savings using a range of possible adjustments (e.g., free rider and spillover corrections)
- **Step #3:** Calculate avoided emissions on the basis of net energy savings

These steps are described in more detail in the following sub-sections.

Step #1: Calculate *Gross* Energy and Demand Savings

Gross savings are the change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated. The Guide states that depending on program objectives, it may only be necessary to calculate gross savings (i.e., an estimate of savings for each project participating in a program). An example is a performance contract to install energy efficiency measures in facilities where the only goal is energy savings. Another example is when a predetermined net-to-gross ratio is applied to the results by an overseeing body (such as a regulatory commission) or if producing reliable net savings estimates is overly expensive or complex. The Guide describes the following approaches to calculating gross impacts:

- **Measurement and verification (M&V).** A representative sample of projects in the program is selected and the savings from those selected projects are determined and applied to the entire population of projects, i.e. the program. The individual project savings are determined using one or more of the four M&V options defined in the IPMVP. This is the most common approach used for programs involving non-residential facilities, retrofit or new construction, and when individual facility savings values are desired.
- **Deemed savings.** Deemed savings are the per-unit energy savings values that can be claimed from installing specific measures under specific operating situations. Savings are based on stipulated values, which come from research of historical savings values from typical projects. Examples include agreed-upon savings per fixture for lighting retrofits in office buildings, with specific values for lights in private offices, common areas, hallways, etc. Applying deemed savings values is only appropriate for projects operating under fixed and well-known conditions (e.g., energy-efficient appliances such as washing machines, computer equipment and refrigerators, lighting retrofit projects with well understood operating hours). As with the M&V approach, the savings determined for a sample of projects are applied to all the projects in the program. However, with the use of deemed savings there are no or very limited measurement activities. In certain cases, the installation and operation of measures is verified.
- **Large-scale data analysis.** Statistical analyses are conducted on the energy usage data (typically collected from the meter data reported on utility bills) for all or most of the participants and possibly non-participants in the program. This approach is primarily used for residential programs with relatively homogenous participants and measures, when project-specific analyses are not required or practical.

Step #2: Calculate *Net* Energy and Demand Savings

The Guide defines *net savings* as the total change in load attributable to an efficiency program, which may include the effects of free drivers, free riders, spillover, and other causes of changes to energy consumption or demand. It recommends calculating net energy savings when it is of interest to know a program's influence on participants and non-participants. This is usually the case when the public or ratepayers fund the energy efficiency program or when actual (i.e., additional) avoided emission estimates are desired. The Guide discusses four of the factors usually addressed when differentiating net and gross savings: free ridership, spillover effects, rebound effects, and electricity transmission and distribution losses. It then provides a detailed description of several approaches for determining net savings, including self-reporting surveys, econometric models, and stipulated net-to-gross ratios. A brief discussion of the criteria for selecting an appropriate net savings evaluation approach is also provided, along with a description of the difference between net and gross savings and the following four approaches for determining a net-to-gross ratio (NTGR) :

- **Self-reporting surveys.** Information is reported by participants and non-participants, without independent verification or review.
- **Enhanced self-reporting surveys.** The self-reporting surveys are combined with interviews and independent documentation review and analysis. They may also include analysis of market-based sales data.
- **Econometric methods.** Econometrics is the application of statistical tools and techniques to economic issues and economic data. In the context of calculating net energy savings, statistical models are used to compare participant and non-participant energy and demand patterns, or simply "pre" and "post" *participant* data. These models often include survey inputs and other non-program-related factors such as weather and energy costs (rates).
- **Deemed net-to-gross ratios.** A NTGR is estimated using information available from evaluation of similar programs. This approach is sometimes used by regulatory authorities.

The Guide acknowledges that it is not unusual for combinations of these approaches to be used. For example, rigorous econometric methods may be used every three years with self-reported or deemed NTGRs used for the other program years. If a previous econometric study is considered more reliable, its results may be used as the deemed value. Another option is to calibrate self-reported calculations to align with the previous study's results.

The guide further notes that gross energy savings may be determined and reported on a project-by-project or program-wide basis. It describes how net savings can likewise be determined on either basis, but are almost always reported on a program-wide basis. This program-wide reporting is done in terms of the NTGR. For example, a NTGR of 90 percent would indicate that, on average, 90 percent of the indicated gross savings are attributed to the influences of the program.

One additional observation in the Guide is that net savings approaches may work best in regions with new program efforts. It is noted that in regions with a long history of efficiency programming, such approaches may understate a program's current effects because of the program's long-term influences and the difficulty of separating out program influences from other influences. Nevertheless, it can still be important to assess net savings for these regions, as indications of high free-ridership from the current program year can provide evidence that it is time for the program to exit the market, or at least redefine its target technology or participation criteria.

Step #3: Calculate Avoided Emissions

A growing number of state and federal policymakers and utility regulators are broadening the scope of evaluation by integrating efficiency programs focused on technologies that help to mitigate pollution, including greenhouse gas emissions. Because the avoided emissions benefits of energy efficiency are of particular interest, the Guide provides a brief overview, which is summarized in this paper, of efficiency-induced avoided emissions and discusses some specific issues related to avoided emissions calculations: additionality, boundary area definitions, and aspects of cap and trade programs. The Guide describes two general approaches for determining avoided air emissions. It then presents several methods for calculating both direct onsite avoided emissions and reductions from grid-connected electric generating units.

Energy Efficiency and Avoided Emissions

Energy efficiency can reduce emissions associated with the production of electricity and thermal energy from fossil fuels. There is growing interest in quantifying these benefits, both for "criteria pollutants" such as sulfur dioxide (SO_2), nitrogen oxides (NO_X), mercury (Hg), and particulates (PM) as well as for greenhouse gases (GHGs)—primarily carbon dioxide (CO_2) — from fossil fuel combustion. Energy efficiency is particularly important for reducing GHGs because there are few post-combustion "controls" for reducing CO_2 emissions once they are formed, and because of its low cost compared to other options for reducing GHG emissions.

For any type of energy efficiency program, the avoided air emissions are determined by comparing the emissions occurring after the program is implemented to an estimate of what the emissions would have been in the absence of the program—that is, emissions under a baseline scenario. Conceptually, avoided emissions are calculated using the net energy savings calculated for a program and one of two different approaches:

- **Emission factor approach:** Multiplying the program's net energy savings by emission factors (e.g., pounds of CO_2 per MWh) representing the characteristics of displaced emission sources to compute hourly, monthly, or annual avoided emission values (e.g., tons of NO_X or CO_2). The basic equation for this approach is:
  avoided emissionst = (net energy savings)t × (emission factor)t,
  where t = time period of analysis

- **Scenario analysis approach:** Calculating a base case of sources' (e.g., power plants connected to the grid) emissions without the efficiency program and comparing that with the emissions of the sources operating with the reduced energy consumption associated with the efficiency program. This is done with sophisticated computer simulation approaches known as "dispatch models". The basic equation for this approach is:
  avoided emissions = (base case emissions) – (reporting period emissions)

One important consideration for both of these approaches is that the net energy savings calculated for the purposes of an energy resource program may be different from the net savings that need to be calculated to meet the requirements of an avoided emissions program. Three potential causes of the difference are: (1) Different definitions of *additionality*, (2) Different definitions of *boundary areas*, and (3) The characteristics of *emissions control policies or regulations* that may be in place, particularly for cap and trade programs.

Additionality

'Additionality' is the term used in the emission mitigation industry for addressing the key question of whether a project will produce reductions in emissions that are in addition to reductions that would have occurred in the absence of the program activity. The Guide makes the connection between this concept and the efficiency evaluation issue of defining proper baseline conditions and free ridership.

While the basic concept of additionality may be easy to understand, it is observed that there is no common agreement on the procedures for defining whether individual projects or whole programs are truly additional (i.e., different than a baseline scenario). As such, there is no technically correct level of stringency for additionality rules. The Guide suggests that parties need to decide, based on policy objectives, what tests and level of scrutiny should be applied in additionality testing. For example, program objectives that focus on obtaining avoided emissions credits as part of a regulatory program may necessitate stringent additionality rules. On the other hand, programs primarily concerned with maximizing energy efficiency – for which avoided emissions are documented only as a co-benefit – will likely be satisfied with approximate emissions estimates and thus moderately stringent rules.

Assessment Boundary Issues: Primary/Secondary Effects & Direct/Indirect Emissions

The Guide defines "emissions assessment boundary" as the demarcation within which all the effects associated with a program are evaluated. This concept is used to define and encompass all the energy uses and emission sources affected by activities in a program.[6] For avoided air emissions, the assessment boundary can be much larger than the boundary for calculating energy and demand savings, including changes to emissions beyond efficiency project sites.

Direct and indirect emissions are two categories the Guide calls out for consideration when setting an emissions assessment boundary. Direct emissions are changes in emissions at the site (controlled by the project sponsor or owner). For efficiency projects affecting onsite fossil fuel use—for example high-efficiency gas water heaters or boilers, the avoided emissions are direct. Indirect emissions are changes in emissions that occur at a source away from the project site (e.g., an electric power plant). Indirect emissions are the primary source of avoided emissions for electrical efficiency programs.

When defining the assessment boundary, the Guide indicates that it is also important to consider intended and unintended consequences, also called primary and secondary effects. A primary effect is the intended change in emissions caused by a program. Efficiency programs generally have only one primary effect—energy savings at facilities that consume energy, translating into avoided emissions. A secondary effect is an unintended change in emissions caused by a program. Secondary effects are sometimes called "leakage." The Guide notes that leakage and interactive effects are similar concepts, although leakage is a more "global" issue whereas interactive effects tend to be considered within the facility where a project takes place.

[6] The "assessment boundary" and "primary/secondary" terminology is drawn from: WRI and WBCSD, 2005.

Emission Control Policies

There are numerous mechanisms for controlling pollutants such as greenhouse gas emissions, and "cap and trade" is just one of them. The Guide explains that, under a cap and trade program, an overall emission tonnage cap is set for an affected sector or set of plants. Allowances are created that represent the temporary right to emit one unit (e.g., one ton) of the regulated pollutant under the cap. Emissions may not exceed the cap, and they are also unlikely to be below the cap over any substantial time period. The reason for this is that a unit that emits fewer allowances than it has available may sell those allowances to another unit, which will then use them to pollute. Plants may also "bank" unused allowances to use in a future year. Thus, the regulated sector as a whole will always emit approximately at the capped level.

The fact that capped emissions tend to remain at the cap is very relevant to the effect of energy efficiency. When emissions are not capped, energy efficiency reduces the output of electricity generators and thus reduces emissions. However, this is not necessarily true for emissions from sources subject to caps (e.g., large boilers, power plants). Reductions in these capped-source emissions make extra allowances available and thus lower the price. The Guide points out that those "efficiency" allowances can be sold in the market and used elsewhere or banked for use in a later year, and thus if the "efficiency" allowances are used, the total emissions will remain roughly equal to the cap.

Thus, the Guide acknowledges that within a capped sector under a cap and trade program, an efficiency program may not be able to claim avoided emissions unless either (a) the "efficiency" allowances are retired (removed from the market) or (b) policies are put in place to ensure that the emissions trading cap and the amount of allowances allocated are reduced commensurate with the amount of energy efficiency. Since the goal of the trading program is typically not to go below the capped level of emissions but to achieve the cap at the lowest possible cost to society, by helping to minimize the compliance cost, energy efficiency contributes to the primary goal of the cap and trade program. And, of course, efficiency programs may reduce emissions from non-capped emission sources and directly claim avoided emissions if properly calculated.

Issues of Special Interest to Efficiency Evaluation

The Guide presents several issues of special interest for conducting impact evaluations, including calculating co-benefits and demand savings, determining persistence of savings, characterizing uncertainty, and defining appropriate applications of impact evaluations. Some of these are discussed below.

Co-Benefits

Co-benefits are defined simply as the impacts of an energy efficiency program other than energy and demand savings. In addition to energy savings, demand savings, and avoided air emissions there are other potential benefits of energy efficiency. The Guide lists:

- Avoided transmission and distribution capital costs and line losses
- Reliability net benefits
- Voltage support and power quality benefits

- Environmental net benefits (in addition to air pollution and climate impacts, the most common considerations relate to water)
- Energy price effects
- Economic impacts (e.g., employment, income, trade balances, tax revenues).

An important category of "co-benefits" that is addressed is participant non-energy benefits (NEBs). Participant NEBs can include some of the items listed above as well as non-market goods, such as comfort and safety, as well as water savings and reduced operation and maintenance costs. Other possible positive NEBs include reduced eyestrain due to improved lighting quality and higher resale value associated with energy-efficient building upgrades. However, non-energy benefits can also be negative. An example of a negative NEB is the increased maintenance costs due to unfamiliarity with new energy-efficient equipment.

The Guide acknowledges that co-benefits are frequently not quantified in program evaluations. This is likely due to the lack of standardized and agreed-upon methods for quantifying these benefits, the cost of doing such quantification, and the sense that the majority of financial benefits are associated with saved energy costs. The perspective of regulators on these matters often dictates the extent to which co-benefits are documented, particularly in cost-effectiveness analysis. Some regulators support the "monetization" of co-benefits to facilitate a full accounting of costs and benefits. While not all program impacts may be amenable to valuation, the Guide suggests that a listing of non-quantified co-benefits can be included in evaluation reports.

Persistence

Another important evaluation issue addressed by the Guide is the period of time for which energy savings are expected to last (persist) once an energy efficiency activity has taken place. A persistence study measures changes in the net impacts over time. These changes are primarily due to retention and performance degradation, although in some instances changes in codes or standards or the impact of "market progression" can also reduce net savings. Effective useful life (EUL) is a term often used to describe persistence. EUL is an estimate of the median number of years that the measures installed (or activities implemented) under a program are still in place and operable.

Persistence studies can be expensive undertakings. Past experience indicates that long periods of time are needed for these studies, so that large samples of failures are available. Also, long study periods allow for technology failure and removal rates to be better documented and used to make more accurate assessments of failure rates. The selection of what to measure, when the measurements should occur, and how often they should be conducted is a critical study planning consideration (CPUC 2006).

The Guide describes the following basic approaches for assessing persistence:

- Use of historical and documented persistence data, such as manufacturer's studies or studies done by industry organizations such as The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- Laboratory and field testing of the performance of energy-efficient and baseline equipment
- Field inspections, over multiple years, of efficiency activities that constitute a program

- Non-site methods such as telephone surveys and interviews, analysis of consumption data, or use of other data (e.g., data from a facility's energy management system)
  The California Evaluation Protocols contain a complete section on persistence analyses and can be used to learn more about this subject.

Uncertainty

Perhaps the greatest challenge in evaluating energy efficiency programs is the impossibility of direct measurement of the primary end result—energy savings. Energy savings are the reduction from a level of energy use that did not happen. What can be measured is actual energy consumption after, and sometimes before, the energy efficiency actions. Consequently, the difference between (a) actual energy consumption and (b) what energy consumption would have been had the efficiency measures not been installed is an *estimate* of energy (and demand) savings.

Since program evaluations seek to reliably determine energy and demand savings with reasonable accuracy, the value of the estimates as a basis for decision-making can be called into question if the sources and level of uncertainty of reported savings estimates are not fully understood and described. While additional investment in the estimation process can reduce uncertainty, tradeoffs between evaluation costs and reductions in uncertainty are inevitably required.

Thus evaluation results, like any estimate, are reported as expected values including some level of variability (i.e., uncertainty). Uncertainty of savings level estimates is the result of two types of errors, systematic and random, both of which are described in detail in the Guide.

Evaluation Plan

The final chapter of the Guide builds on preceding chapters and presents the steps involved in planning an impact evaluation. These include the development of evaluation approaches, budgets, and a schedule. The first section discusses how evaluation planning and reporting is integrated into the program implementation process, while the second section presents seven key issues and questions that help determine the scope and scale of an impact evaluation. The last section provides guidance on preparing an evaluation plan and includes model outlines and checklists for conducting an evaluation plan. The latter material can be used in preparing an evaluation plan, but may be best applied to oversee the evaluation process as implemented by professional evaluators (either internal staff or outside consultants).

The Guide lays out seven primary issues that need to be addressed in order to prepare a jurisdiction-specific evaluation plan or protocol for a single program or portfolio of programs. These issues include:

- Defining evaluation goals and scale. (This includes deciding which program benefits to evaluate.)
- Setting a time frame for evaluation and reporting expectations.
- Setting a spatial boundary for evaluation.
- Defining a program baseline, baseline adjustments, and data collection requirements.
- Establishing a budget in the context of expectations for the quality of reported results.

- Selecting impact evaluation approaches for gross and net savings calculations, and avoided emissions calculations.
- Selecting who (or which type of organization) will conduct the evaluation.

Recommendations

The Guide can provide a valuable resource for US and international efforts to document the benefits of energy efficiency, particularly for jurisdictions just getting started with efficiency programs. The need for rigorous evaluation approaches is accentuated given the importance of efficiency in meeting climate stabilization goals. In particular, as efficiency is implemented as part of climate change mitigation efforts compliance and evaluation become more critical. These subjects have been raised in programs such as the various utility and state efficiency programs in the US, the UNFCCC Clean Development Mechanism, and the European Union's commitments to efficiency (Schiller 2007b).

Therefore, the following recommendations have been identified by the authors as important next steps for improving confidence in efficiency as a "real," high-quality, and reliable energy resource:

- ***Invest in developing data, tools and technology for cost-effective EM&V***. Example: document and maintain databases of deemed savings values
- ***Train more professionals on evaluation***. Example: Efficiency Valuation Organization's Certified M&V Professional Program (www.evo-world.org)
- ***Develop consistent international terminology***. Example: Definitions of terms and approaches.
- ***Share experience.*** Examples: websites of evaluation documents (e.g., www.calmac.org) and workshops/forums (e.g., www.iepc.org)

Conclusion

The *Model Energy Efficiency Program Impact Evaluation Guide* provides a single resource for best practices on *program* evaluation that can be used by entities ramping up efficiency efforts or revisiting their current evaluation objectives and approaches. The Guide synthesizes previously disparate information on *program* evaluation into a single resource that builds on existing *project* protocols – such as the IPMVP and FEMP Guidelines – to address *program* evaluation. It also addresses "issues of special interest" in the evaluation process, including co-benefits, persistence of savings, and uncertainty. Another factor that differentiates the Guide is a clear explanation of how emission factors can be calculated and applied to energy savings to determine avoided emissions.

The primary application for the Guide is helping individual entities establish a structure for calculating energy, demand, and emissions savings resulting from their facility (non-transportation) energy efficiency programs. Potential consumers of this information include program designers and evaluators employed by cities, states, utilities, companies, and other entities positioned to run programs. By describing a set of best practices and a set of consistent procedures and terminology, the Guide can help these entities adopt, assess, and improve their efficiency programs.

An additional use is to support regulators and others interested in understanding the principles of evaluation, including how it can be used to establish common approaches for emerging policies that treat energy efficiency as a resource. Similarly, the Guide can be referenced by agency staff in their efforts to educate policy-makers about the reliability of efficiency and its proper role in the regional energy mix. After reading the Guide, readers with some evaluation experience may be able to prepare a complete plan for conducting a program impact evaluation.

References

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