Six-Year Evaluation Plan for Core Energy Efficiency Programs: Final Report

Prepared for The New Hampshire Public Utilities Commission

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Submitted by

TecMarket Works
165 West Netherwood Road
Oregon WI 53575
(608) 835-8855

**Subcontractors: Paul Horowitz, PAH Associates,
Pete Jacobs, BuildingMetrics,
H. Gil Peach, Ph.D.,
Richard Ridge, Ph.D., Ridge & Associates,
and Ralph Prahl, Prahl & Associates**

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1. Executive Summary

In June 2014, TecMarket Works (Team) was contracted by the New Hampshire Public Utilities Commission (Commission) to "develop an energy efficiency program evaluation plan that can be clearly understood by regulators, policy makers, utility evaluation staff, program administrators, and other stakeholders."[1] The contents of the plan are to include the following elements:

(a) A statement of the specific objectives and priorities developed through research and analysis during the project that guided the development of the Monitoring and Evaluation (M&E) plan.
(b) A detailed description of evaluation projects and budgets for the 2015-2016 Core energy efficiency program implementation period
(c) The identification of specific evaluation projects and assigned priorities that can be completed by January 1, 2020.

The evaluation plan was intended to be submitted to the Commission through three deliverables:

1. A market assessment framework which includes indicators of progress toward market transformation, defines assessment and evaluation goals, and sets priorities for program evaluation and market assessment. The report was submitted to the Commission on July 22, 2014.
2. Evaluation recommendations for the 2015-2016 program implementation period by July 31, 2014, needed to meet the utilities' 2-year program filing requirement. The report was submitted to the Commission on July 31, 2014, and a revised report provided on August 10, 2014, based on Commission staff feedback.
3. An evaluation plan covering the period 2015-2019 for each program or customer sector that takes into account the priorities of multiple parties.[2]

In addition, the Team established an evaluation framework and conducted a gap analysis both of which contributed to our recommendations.

For the 2015-2016 period, the Team recommends that impact evaluations of six of the Core programs be undertaken. Our objective with these recommendations has been to conduct those impact studies necessary to bring all the programs' evaluation documentation within the Independent System Operator New England's (ISO-NE's) five year timeframe. This strategy will provide both the time and budget in the subsequent period to examine other important areas that will support the Core programs. Table 1 shows the programs, types of study, and estimated budgets.

[1] TMW Contract, Exhibit A, Scope of Services, p. 1
[2] Ibid., p. 2

Table 1. Summary of M&E Recommendations and Budgets for 2015-2016

Core Programs	Impact	Process/Market Assessment	Cost 2015	Cost 2016	Total
Large Business Energy Solutions	n/a*	n/a	n/a	n/a	n/a
Small Business Energy Solutions	X	X	$300,000	$275,000	$575,000
Energy Star Appliances	X		$150,000	$150,000	$300,000
Energy Star Lighting	X	X	$200,000	$200,000	$400,000
Municipal	X	X	$100,000	$50,000	$150,000
Energy Star Homes	n/a	n/a	n/a	n/a	n/a
Home Energy Assistance	X	X	$100,000	$200,000	$300,000
Home Performance with Energy Star	X	X	$100,000	$150,000	$250,000
Total			$950,000	$1,025,000	$1,975,000

* Refers to the fact that a program will not be evaluated in 2015 or 2016 since an impact/process evaluation of the program is or will be soon be underway.

If the recommendations for 2015 and 2016 presented above are followed, the requirement that each Core program be evaluated every five years will have been met, i.e., the impact evaluations will be up to date. This frees up available funds for 2017-2019 to be allocated to a variety of projects other than program oriented evaluations. Such projects include market characterization studies, market assessment studies, saturation studies, EM&V protocol development, utility program database consistency, and utility program database documentation. Table 2 presents a summary of the recommended studies and associated budgets for each of the three years.

Table 2. Summary of Evaluation Projects and Budgets for 2017, 2018 and 2019

M&E Activities	2017	2018	2019
Utility Program Database Consistency Project	$75,000		
Utility Program Tracking Database Documentation Project	$100,000		
Development of Program Theory and Logic Models	$80,000		
EM&V Protocol Development	$25,000		
Commercial Saturation Survey	$300,000	$300,000	$150,000
Large and Small Business Energy Solutions Market Characterization and Assessment Study	$250,000	$200,000	$100,000
Impact Evaluation of the Large Commercial Energy Solutions Program			$400,000
Residential Saturation Survey		$250,000	$100,000
Residential Lighting Market Characterization and Assessment Study		$125,000	$125,000
Tracking HEA/Low-Income Weatherization Metrics	$35,000		
Investigation of Emerging Issues	$50,000	$50,000	$50,000
Total	$915,000	$925,000	$925,000

- In addition, the Team makes a number of recommendations regarding integrating evaluation results into future program designs, developing a technical reference manual that contains a consistent set of algorithms and assumptions for utility savings claims, streamlining the hiring and management of evaluation contractors, enhancing Commission staff M&E capabilities, and identifying and tracking key market indicators. The Team also identifies a set of emerging issues that the Commission might wish to investigate, including net savings, participant and non-participant spillover, HVAC interaction effects, effective useful life, issues surrounding the identification of the correct baseline in estimating energy and demand impacts, and ways to leverage market characterization and assessment studies conducted in other nearby states such as Massachusetts and New York.

2. Introduction and Purpose of Study

2.1 Project Tasks and Deliverables

In June 2014, TecMarket Works (Team) was contracted by the New Hampshire Public Utilities Commission (Commission) to "develop an energy efficiency program evaluation plan that can be clearly understood by regulators, policy makers, utility evaluation staff, program administrators, and other stakeholders."[3] The contents of the plan are to include the following elements:

(a) A statement of the specific objectives and priorities developed through research and analysis during the project that guided the development of the Monitoring and Evaluation (M&E) plan.
(b) A detailed description of evaluation projects and budgets for the 2015-2016 Core energy efficiency program implementation period
(c) The identification of specific evaluation projects and assigned priorities that can be completed by January 1, 2020.

The evaluation plan was intended to be submitted to the Commission through three deliverables:

1. A market assessment framework which includes indicators of progress toward market transformation, defines assessment and evaluation goals, and sets priorities for program evaluation and market assessment. The report, summarized below and included in Appendix A, was submitted to the Commission on July 22, 2014.
2. Evaluation recommendations for the 2015-2016 program implementation period by July 31, 2014, needed to meet the utilities' 2-year program filing requirement. The report, summarized below and included in the Appendices, was submitted to the Commission on July 31, 2014, and a revised report on August 10, 2014 based on Commission staff feedback.
3. A 6-year Evaluation Plan for each program or customer sector that takes into account the priorities of multiple parties.[4] A draft of this report was submitted to Commission staff on August 22 and, following a public presentation and opportunity for comments, finalized and submitted to the Commission on September 15, 2014.

2.2 Tasks Undertaken in Support of the Development of the 2015-2020 Evaluation Plan

The research and analyses which the Team undertook during the course of this project followed the three-step process highlighted in both the Commission's Request for Proposal for this project and the team's subsequent workplan. The results of this work contributed to the team's recommendations regarding the M&E activities that should be conducted both during the 2015-2016 program cycle and during the 2017-2019 period. The steps we undertook are described below.

[3] TMW Contract, Exhibit A, Scope of Services, p. 1
[4] Ibid., p. 2

Step 1 involved a top-down review of evaluation and information needs of the Commission, the M&E Team[5], other concerned parties, and the information requirements of ISO-NE, as observed by the Team through the conduct of the activities herein and discussions with Commission staff and several stakeholders from the public and private sectors. A central feature of Step 1 included a thorough review of past evaluation efforts to benchmark existing levels of evaluation data. This gap analysis included an examination of the current and anticipated near term program portfolios offered by the electric and gas program administrators, to identify any changes in program design or emphasis, or recently available energy efficiency products (e.g., LEDs), that may indicate a need to focus future evaluation in these areas. The two year energy efficiency program cycle in New Hampshire enables M&E studies to be launched early in the first of the two program years, typically in time to be completed in time to inform the next program planning cycle. The Team's research focused on identifying information gaps in both the short-term and over the long-term, to respond both to the need for M&E recommendations for the upcoming 2015-16 energy efficiency program planning period and to the overall multi-year evaluation plan which spans the next five years.

Step 2 involved the development of a market assessment framework. The analysis began with a review of the 1999 framework. The indicators for a market framework indicate when to enter or exit a market, at the measure, program, sector, or portfolio level. The framework is intended to be used by the M&E Team, preferably with the support of an evaluation contractor or informed facilitator, to prioritize indicators which are of current or potential value to the energy efficiency portfolio and to initiate an on-going process of monitoring and reporting so that feedback can be provided back to the programs. The results of Step 1 and Step 2 provide the goals, principles, and evaluation and market frameworks to orient the evaluation plan.

Step 3 involved the development of the evaluation plan, including Step 1 and Step 2 information as orienting elements.

2.3 Report Components

The remainder of this current document presents the results of the following three tasks that formed the bases of our evaluation recommendations:

- Gap Analysis
- Evaluation Framework
- Market Assessment Framework
- Draft multi-year evaluation plan

[5] The M&E Team includes the Commission staff, electric and gas utility staff, and interested parties that are engaged in the monitoring and evaluation activities related to the Core energy efficiency programs.

3. Gap Analysis

Task 1.2*: Gap Analysis.* A gap analysis was conducted to identify high priority Core program evaluations and other relevant studies that will focus on the program and market performance metrics that will inform policy and program decisions[6]. The evaluation recommendations for 2015-2016 also reflect the results of the analysis. The gap analysis explored four types of gaps: 1) gaps in available data necessary for program evaluation, 2) gaps in available data to inform program performance, including the impacts of longer-term market transformation efforts, 3) gaps in the applicability of evaluation results (e.g., results from evaluations conducted more than five year ago), and 4) gaps in the level of confidence and precision for key programs such as installation rates and realization rates.

The gap analysis consisted of seven main activities: 1) review of the market assessment framework presented in the *Report to the New Hampshire Public Utilities Commission On Ratepayer-Funded Energy Efficiency Issues in New Hampshire Docket No. DR 96-150;* 2) review of past evaluations; 3) review of current program-tracking databases; 4) review of 2008 potential study, *Additional Opportunities for Energy Efficiency in New Hampshire: Final Report;* 5) review of *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources;* 6) review of VEIC's 2011 *Independent Study of Energy Policy Issues* report[7]; and 7) discussions with the Commission staff to obtain perspective and information on possible or anticipated changes in energy efficiency program or policy direction, or other influences that might affect the overall range of performance indicators obtained through the evaluation studies that will be conducted under the new evaluation plan. Each of these components is briefly discussed below.

Review of Market Assessment Framework. The 1999 *Report to the New Hampshire Public Utilities Commission On Ratepayer-Funded Energy Efficiency Issues in New Hampshire Docket No. DR 96-150* included the last effort to identify both approaches and indicators that stakeholders believed at the time would be relevant to examine in an M&E context over time. Two approaches were offered in that report. We examined both frameworks to identify, in the context of the other documents reviewed in this task, limitations in the market indicators that are include in those frameworks in the context of our assessment of current needs. The results of this review established the needs that were addressed in the proposed Market Assessment Framework (in Step 2 below).

Review of Past Evaluations. We reviewed past evaluation studies, in particular those released after 2008, to determine a number of key factors (e.g., date of publication, uncertainty around installation rates and realization rates) that would influence the Team's recommendations for

[6] The gap analysis included ***Task 1.1****: Review NH Core Energy Efficiency Program Goals & Provide Recommendations for Program Performance Metrics and Evaluation Goals.* As part of this review, which was undertaken in the same manner as the gap analysis described below, we investigated whether savings from any emerging technologies, such as LEDs, have been underestimated; if they were, we suggest possible market studies for such technologies.

[7] Vermont Energy Investment Corporation, Jeffrey H. Taylor & Associates, Inc., and Optimal Energy. (2011). *Independent Study of Energy Policy Issues*. Prepared for the New Hampshire Public Utilities Commission at the direction of the New Hampshire Legislature.

M&E studies over the 2015-2020 period.[8] These included the length of time since the last evaluation of one or more aspects of each energy efficiency program. This was a key factor for several reasons. Each of the electric utilities participates in the regional ISO-NE Forward Capacity Market auctions, in which it bids demand resources derived from its energy efficiency programs. The ISO-NE's guidance for any supporting M&E program impact studies is that they be reported within five years of the utility's Measurement and Verification Plan submittal date to the ISO.[9] The Team therefore examined the vintages of the impact evaluation studies in order to identify those program evaluations that would need to be conducted in the nearer and longer term. Changes in program design over time, or changes in other factors which might have large impacts on savings results of past studies also influence the timing of future studies. As a result the Team reviewed appropriate documents, in particular program descriptions and Commission orders related to program design, to highlight any such factors that would suggest when and which type of studies might be appropriate.

The level of sampling uncertainty for gross savings or for key parameters in the calculation of gross savings can influence key elements of future impact evaluations, in particular the sample size and sample design, both of which can have a significant influence on a study's cost. Our review of past studies did not reveal undue sampling uncertainties with respect to key measure or program savings, but it was apparent that budget constraints limited what could be studied. This was understandable given the potential associated costs of different choices. These results were noted in the development of the evaluation framework, described in Section 6 of this report. The past studies were also reviewed to assess the level of suspected bias due to the other sources of error such as measurement error and non-response bias. While no obvious issues related to these kinds of bias were noted during our review, these factors remained important as we considered recommendations for future studies.

The Team also examined available logic models from the 2013-2014 core programs to confirm that performance indicators associated with the most recent version of the programs were included in those models; this would have indicated likely inclusion of those indicators in future evaluations. We found that the logic models were developed at the sector level rather than the program level and, while they included useful information about market barriers, program intervention strategies, they were not directly oriented to individual program designs.

Review of Potential Study. The most recent energy efficiency savings potential study for New Hampshire, prepared by GDS in 2009 (*Additional Opportunities for Energy Efficiency in New Hampshire: Final Report*) was reviewed with a primary focus on the Potentially Obtainable scenario. The scenario is defined as an estimate of the potential for the realistic penetration over time of energy efficient measures that are cost effective according to the NH Total Resource Cost (TRC) test, taking customer behavior into consideration (including consideration of priorities and price). Our objective was to examine the report to highlight changes in the energy efficiency marketplace (products, product acceptance, placement, price, standard practices, etc.)

[8] See the list of studies at: http://www.puc.state.nh.us/Electric/Monitoring%20and%20Evaluation%20Reports/Monitoring_Evaluation_Report_List.htm

[9] ISO New England Inc. (2014). *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual M-MVDR: Revision: 6 Effective Date: June 1, 2014.*, Section 15.2(1)

that the study had not anticipated, so that proposed M&E studies might consider addressing them. The report notes that ". . . while the measures lists are extensive and represent most, if not all, commercially available, and some emerging, energy efficient measures, they are not exhaustive, particularly for peak electric demand reduction measures and potential fuel oil and propane savings" (p. 4). That is, new technologies not considered commercially viable at the time of the report may now be viable. For example, while the 2009 potential study considered emerging technologies such as LEDs, it could not have accurately forecasted the rapid reduction in product costs, the utilities' inclusion of LEDs in their programs, or the resulting impact on program savings. More recent M&E based information with respect to LEDs might be needed to better understand changing baseline conditions about customer awareness and lamp penetration and saturation.

Review of 2013 ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources. The ISO New England Manual was reviewed to make sure that the technical requirements of the ISO with respect to statistical confidence and precision and unbiased estimates of gross demand reductions are appropriately addressed in the evaluation plan and associated relevant impact studies.

Review the VEIC Independent Study of Energy Policy Issues (Policy Report). This report is a comprehensive examination of the landscape of issues associated with energy use in New Hampshire. The focus of our review was on the aspects of the report that address energy efficiency and related topics (e.g., community planning, building codes and their enforcement). In addition to noting the recommendations embedded throughout the report, we particularly noted the seven policy steps or actions discussed at length in the concluding chapter. As we examined the report, reviewed Commission documents that addressed this report, and discussed it with Commission staff, it became apparent that the report's recommendations were at the policy level, in line with the report's focus, and that they either were addressed and their implications absorbed into the energy efficiency programs or they had yet to be addressed. Our review of the report did not suggest any modifications to our M&E recommendations.

4. Market Assessment Framework

One of the questions regularly asked in the deployment of energy efficiency programs is when it is appropriate to introduce a program, a new technology or service, or a new component of the customer market. Equally important, questions arise on when it is appropriate to remove an element of the energy efficiency portfolio. The proposed market assessment framework, included as Appendix A, is intended to help frame how one could use M&E activities to inform a decision-making process about these questions.

The development of the framework began, as requested by the Commission, with a review of the existing market assessment framework that was developed in 1999, as part of a year-long stakeholder working group process. We found that the study group had prepared two frameworks which overlapped to some degree. Both approaches highlighted ways to determine how to identify market barriers that could be addressed by one or more available energy efficiency actions. Although we found no formal documentation of their application, the Core programs and M&E studies have generally relied on a mix of market metrics from the two frameworks.

The proposed Market Assessment Framework is fashioned after the previous framework that is more closely aligned with the way in which the energy efficiency programs are structured in New Hampshire. We distinguish four general segments, or perspectives, of the panorama of energy efficiency activity in the state, through which consideration or changes to the existing portfolio can be viewed: 1) Customer and institutional; 2) Timing of energy related events; 3) Products, services, and practices; and 4) Infrastructure. M&E studies can be undertaken to examine the status of aspects of programs from these several perspectives to gain insights into the merits of changes to the program elements.

5. Evaluation Framework

The evaluation framework was established through a process that was designed to be both systematic and transparent. This overall evaluation framework was guided by four basic criteria:

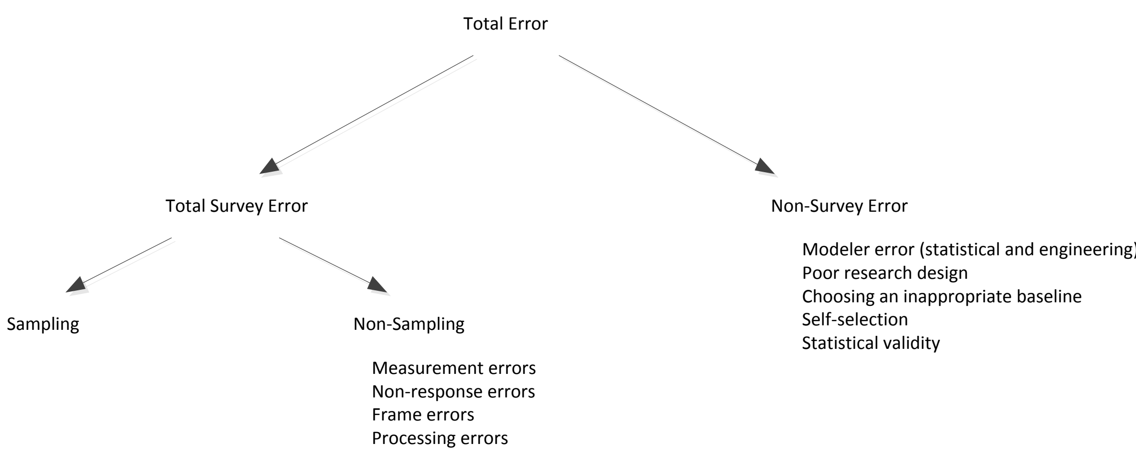
- Uncertainty (i.e., random and systematic error) surrounding the installation rate and realization rate
- Expected size of program-level savings
- Evaluation frequency (i.e., the period of time since the last evaluation of a given program)
- Degree of innovation (e.g., even a small pilot program might merit a rigorous evaluation if it is expected that the program, if successful, will be dramatically scaled up in the future)

Much of the information relevant to these criteria was provided by the gap analysis and the market assessment framework discussed earlier.

5.1. Sampling and Uncertainty

One of the important considerations in developing the evaluation plan for 2015-2016 was the recognition that there are many sources of uncertainty or error in estimating energy and savings in any evaluation. Figure **1** presents a typology of the various sources of error. Some evaluators focus almost exclusively on reducing sampling error, often described as a certain level of confidence (e.g., 90%) and a certain level of precision (e.g., ±10%), by insisting on large samples. Relatively little attention is devoted to addressing the many other sources of error. As a result, some studies achieve a high level of confidence and precision around a biased estimate.

Figure 1. Sources of Error in Evaluations



This evaluation framework recognizes that, lacking an unlimited budget, a balance must be struck in order to minimize the sources of error that are considered to be the most critical for any given study. The same issues surround the estimates of other parameters associated with impact, market effects, and process evaluations of programs. The reliability of information produced by these studies is equally important and is addressed in this framework.

To address the need for balance in addressing error sources, this framework sets confidence and precision targets[10] whenever possible for a variety of parameters, including savings.[11] Confidence and precision targets are recommended rather than required since bias could be much more important than precision in estimating the reliability of the savings or calculating cost-effectiveness.[12] In addition, as any evaluation study proceeds, the data collected could contain much more error from other sources than originally thought, requiring more resources to be devoted to reducing this bias and fewer resources devoted to achieving the required statistical precision. Alternatively, the variability in the savings could be so great that it would be impossible to meet the precision requirement. The evaluator must have the flexibility to respond to data issues as they arise in order to maximize the reliability of the savings, which is a Commission objective.

The specific approaches to maximizing sampling precision are left up to the independent evaluator. For example, one can choose from a variety of sampling procedures recognized in the statistical literature, such as sequential sampling, cluster sampling, multistage sampling, and stratified sampling with regression estimation. Any of several books on sampling techniques can be used as reference (Cochran, 1977; Sarndal, Swensson and Wretman, 1992; Thompson, 1992.)[13]

It is also important to note that once a particular evaluation is launched, it is possible that the initial plan will be adjusted mid-course to maximize savings reliability. For example, the coefficients of variation (CVs or error ratios)[14] for certain key parameters, measures, end-uses, or interventions might actually be better (smaller) than anticipated or the random and/or systematic measurement error might be worse. As data are collected and assessed, decisions can be made regarding the reallocation of resources.

Once a particular impact or process evaluation is completed, the Commission, utilities, ISO New England and other stakeholders can review the achieved precision and the results of efforts to

[10] A confidence and precision target is a goal established at the beginning of an evaluation based in large part on initial estimates of uncertainty. If an evaluator fails to actually achieve the targeted level of confidence and precision, there will be no penalties since the assumptions underlying the sample sizes proposed in each evaluation plan will have been *clearly presented and carefully documented*. A failure to meet the confidence and precision target for a given program will only require an adjustment of the input assumptions prior to the next evaluation cycle and, if necessary, a reallocation of evaluation dollars to support increased sample sizes.
[11] New York EM&V Guidelines and the *California Evaluation Framework*, while proposing requirements or targets, also recognized that there might be legitimate reasons why such requirements or targets cannot be met.
[12] *California Evaluation Framework*, p. 296.
[13] Cochran, William G. (1977). *Sampling Techniques*. New York: John Wiley & Sons; Sarndal, Carl-Eric, Bengt Swensson and Jan Wretman. (1992). *Model Assisted Survey Sampling*. New York: Springer-Verlag. Thompson, Steven K. (1992). *Sampling*. New York: John Wiley & Sons.
[14] The CV is calculated as the sample standard deviation divided by the sample mean. The error ratio is another measure of variability similar to the CV and is associated with stratified ratio estimators. See page 320 of the *California Evaluation Framework*.

minimize bias and recommend how evaluation resources can be reallocated for the next evaluation cycle.

5.2. Allocating a Study Budget to Maximize Value

This section discusses the criteria by which the budget assigned to a given evaluation or market characterization/assessment can be optimally allocated (i.e., how to achieve the greatest benefit for a fixed evaluation budget) in order to improve the design and implementation of initiatives and interventions and to produce reliable estimates of energy savings. Allocating a fixed budget always involves trade-offs that necessitate the interpretation of information from various sources (e.g., past evaluation studies, intervention databases, and initiative/intervention designs) and expert judgment. While there are various ways to allocate a fixed budget, the Commission is expected to propose and defend a systematic and transparent allocation. While there might be more, this framework lists four key criteria that should be at least considered:

1. Size of savings
2. Level of uncertainty about the savings
3. Degree of innovation
4. Frequency

This evaluation framework was intended to be a systematic, consistent and transparent way of thinking about the allocation of available EM&V funds for the 2015-2016 period. It was not intended to be used mechanistically to allocate funds as there will always be a fair amount of judgment involved in the decision-making process.

This framework was only partially used to think about allocating available EM&V funds for the remaining four years, as other considerations were involved such as the need to consider market metrics and market characterization and assessment studies.

5.2.1. Size of Savings

The first criterion is the size of the expected life-cycle benefits as a percent of the total expected life-cycle benefits for all Core programs. Programs with large expected savings are always candidates for evaluation. However, if a program with large expected savings is mature and stable, and concerns about its day-to-day functioning and the reliability of its estimated savings are relatively small, then neither a process nor an impact evaluation might be warranted. What constitutes "large" and "stable" are, of course, open to discussion with Commission staff since there is no universally accepted definition of either[15]. The expected electric and gas savings for 2013 and 2014 are presented in Table 3 and Table 4.

[15] Stable might mean low expected uncertainty in installation rate or realization rate estimates. In which case, the ranking by contribution to variance is a way to reconcile these terms.

Table 3. Expected Electric Lifetime Savings, by Core Program, 2014

Core Programs	Expected Lifetime Savings 2014 (kWh)	Percent of Portfolio
Large Business Energy Solutions	303,225,329	52%
Small Business Energy Solutions	115,232,974	20%
Municipal	59,745,222	10%
Energy Star Appliances	42,629,864	7%
Energy Star Lighting	36,770,539	6%
Energy Star Homes	15,627,623	3%
Home Energy Assistance	7,130,142	1%
Home Performance with Energy Star	4,210,218	1%
Total	584,571,911	100%

The Large Business Energy Solutions Program is by far the largest, accounting for 52% of total portfolio savings. The next largest is the Small Business Energy Solutions Program which accounts for 20% of the total portfolio savings.

Table 4. Expected Gas Lifetime Savings, by Core Program, 2014

Core Programs	Expected Lifetime Savings 2014 (MMBtu)	Percent of Portfolio
Large Business Energy Solutions	994,844	43%
Small Business Energy Solutions	487,635	21%
Home Performance with Energy Star	361,137	16%
Energy Star Appliances	249,256	11%
Home Energy Assistance	153,278	7%
Energy Star Homes	42,852	2%
Total	2,289,002	100%

For the six gas Core programs, the first and second largest programs are the Large Business Energy Solutions Program and the Small Business Energy Solutions Program. The second two largest programs, Home Performance with Energy Star and Energy Star Appliances capture significant savings of 16% and 11%, respectively.

5.2.2. Uncertainty of Savings

One of the main purposes of any evaluation is to reduce uncertainty about key parameters associated with energy savings. The uncertainty around two key parameters, installation rates and realization rates should help to guide the allocation of finite evaluation dollars. For example, if there is a fair amount of confidence in the installation rate but not in the realization rate, then more evaluation resources should be allocated to estimating the latter. The detailed evaluation plan developed by an evaluation team could determine which parameter associated with the realization rate (delta watts or operating hours) is more uncertain and devote more evaluation resources to it. By doing so, the uncertainty around the energy savings of lighting measures will be minimized cost-effectively.

Any given initiative has hundreds of measures and thousands of parameters. Identifying how to allocate evaluation dollars requires two basic steps. First, systematically identify those measures that have the greatest expected life-cycle benefits as a percent of total expected life-cycle benefits for the initiative or intervention. Next, for these high-impact measures, identify those parameters about which there is the greatest uncertainty in the calculation of gross energy savings, which can be reduced cost-effectively through measurement and verification (M&V) activities. These parameters should receive a larger portion of the evaluation budget.

The data available for conducting the analysis are listed below:

- **Reported and forecast energy savings by program and by measure**. Workbooks were compiled by each of the utilities as part of their energy efficiency filings. These workbooks contain a list of each measure included in each program, the number of installations, unit energy savings estimates, realization rate adjustments, and effective useful life. The Team combined the workbooks created by each utility into a master workbook for this project. The master workbook is included as a companion to this document.
- **Evaluation reports filed on the NH PUC website**. The most recent reports (i.e., those completed within the last five years) were reviewed and information on the uncertainties in the reported savings was compiled for the analysis.

The electricity and gas savings calculations used in the utility workbooks are fairly straightforward. There are four parameters in each calculation:

$$\Delta kWh = units\ x\ UES_{kWh}\ x\ RR\ x\ EUL \qquad (1)$$

$$\Delta MMBtu = units\ x\ UES_{MMBtu}\ x\ RR\ x\ EUL \qquad (2)$$

where:

units	= quantity of measures installed
UES	= unit energy savings, or the expected savings for each measure installed. Note: the “units” on the unit energy savings (such as square feet of insulation, tons of air conditioning and so on) should be the same unit of measure as the quantity term.
RR	= expected or measured realization rate
EUL	= measure effective useful life

The evaluation studies generally focused on estimating two parameters – the installation rate and the gross savings realization rate. In our analysis, the uncertainty in the installation rate is expressed as an uncertainty in the number of measures installed. To simplify the model, the uncertainty in the unit energy savings was combined with the uncertainty in the realization rate. The measure effective useful life is also a source of uncertainty, but EUL studies generally require significant budgets and many years to conduct and may be more suitable to a regional study. Thus the EUL uncertainty was not considered.

The combined master workbook contains nearly 1,100 individual measure savings estimates. Rather than assigning uncertainties uniquely to each of these entries, the measures were grouped by categories where the uncertainties are expected to be similar.

Recent evaluation reports were examined to obtain estimates of uncertainties in the installation rate and realization rate parameters. These parameters were either identified in the reports or calculated from the sample sizes used in the studies. If these data were not reported, default uncertainty values of 5% for installation rate and 20% for realization rate were used. The uncertainties are expressed as relative precision at 90% confidence. The assumptions used by program and measure group, along with the details of the uncertainty calculations are shown in Appendix B.

The total electricity savings by program, the estimated uncertainty in the program savings, the program uncertainty contribution to the total portfolio variance, and the parameter uncertainty contribution to the program variance are shown in Table 5.

Table 5. Electricity Savings by Core Program (Electric Measures Only), 2012-2014

Core Programs	Total Lifetime Savings (kWh)	% total kWh	Relative Precision	Program Contribution to Portfolio Variance	Installation Rate Contribution to Program Variance	Realization Rate Contribution to Program Variance
Energy Star Appliances	115,578,068	5.8%	5.3%	1.7%	7.5%	92.5%
Energy Star Homes	58,638,613	2.9%	5.4%	0.4%	0.3%	99.7%
Energy Star Lighting	131,599,611	6.6%	5.2%	2.1%	9.1%	90.9%
Home Energy Assistance	31,855,416	1.6%	7.8%	0.3%	6.6%	93.4%
Home Performance with Energy Star	24,848,681	1.2%	6.4%	0.1%	5.3%	94.7%
Large Business Energy Solutions	929,153,297	46.5%	3.6%	49.4%	0.2%	99.8%
Municipal	293,235,985	14.7%	9.8%	37.0%	6.1%	93.9%
Small Business Energy Solutions	413,461,651	20.7%	3.4%	9.0%	2.8%	97.2%

Additional tables showing these data by measure group across each program are shown in Appendix B. These tables can be used during evaluation study planning to identify measure group priorities within each program.

5.2.3. Degree of Innovation

Recent initiatives/interventions that are considered to be innovative are far more likely to have implementation challenges compared to mature initiatives. Such initiatives/interventions, if they are estimated to have large market potential, should receive, all things being equal, a larger portion of the assigned evaluation budget. Assessing the degree of innovation is somewhat subjective. On a scale of 1-5, a new program, or a mature program that has made significant changes in its design and delivery, receive the highest score, 5. Mature programs that have made no significant changes in the design and delivery receive the lowest score, 1. Programs that have varying degrees of changes in the design and delivery are assigned intermediate values of 2, 3, and 4. Based on our review of the Core programs, we concluded that except for the Municipal Program, they are all mature programs. The Municipal program received a score of 4. The other Core programs each received a score of 2 rather than 1 since there is always some degree of uncertainty due to changes in mix of technologies and customers.

5.2.4. Frequency

ISO New England requires that ". . . all reports, studies, specifications and other documents referenced in the Project Sponsor's Measurement and Verification Plan shall have been prepared and published within five years of the Measurement and Verification Plan's submission date to the ISO" (p. 15-2).[16] However, there might be programs that within the last five years have modified their program designs, program procedures, the types of customers targeted, or the measures they incent. For these programs, an impact evaluation or a process evaluation might still be warranted. Table 6 presents the most recent program years evaluated, by Core program.

Table 6. Most Recent Evaluations of Core Programs, by Publication Dates and Program Years

Program	Publication Date	Program (Calendar) Year Analyzed
Energy Star Homes	2016[a]	An RFP for an impact evaluation is expected to be issued before the end of 2014.
Home Performance w/Energy Star	2011	2009-2010 Program Evaluation HPwES (Cadmus &NMR) Process & Impact
Home Energy Assistance	2006	2005 Low Income Retrofit Program Impact Evaluation (Opinion Dynamics)
Energy Star Lighting	2012	2009-2010 Energy Star Lighting Program Evaluation (KEMA)
Energy Star Appliances	2005	2007 Residential Room AC Coincident Factors for bidding into ISO Forward Capacity Market (cross-cutting NEEP study)(RLW)
Small Business Energy Solutions	2012	2010 SBES Program Evaluation (KEMA)
Large Business Energy Solutions	2014	2012-2013 Current Large C&I Program Evaluation (DNV GL)
Municipal	N/A	Not evaluated as yet

[a] 2016 is the expected publication date

Any program that has not received an impact evaluation published within the last five years is assigned the highest score, a five. For other programs with publication dates within the last five years, the longer the period since the publication, the greater the likelihood that the utility staff have modified the program design, have changed program procedures, focused on different customer segments, or added new measures. Programs with impact evaluations published four years ago receive a score of 4. Programs with evaluations published three years ago receive a score of 3. Programs with evaluations published two years ago receive a score of 2. Programs with impact evaluations published one ago receive a score of 1.

5.2.5. Data Integration

Given that there are multiple attributes for eight core programs a method was used that allowed each program's score on each of these attributes to be incorporated into a single index of evaluation priority (the IEP). The IEP was developed using the following five attributes:

[16] ISO New England Inc. (2014). *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual M-MVDR: Revision: 6 Effective Date: June 1, 2014.*

1. Frequency
2. Installation rate uncertainty
3. Realization rate uncertainty
4. Expected lifetime savings
5. Degree of innovation

Each attribute was assigned a weight that reflected its importance. Table 7 presents these weights. Because of the ISO New England requirements, the period of time since the last completed evaluation was assigned the highest weight, followed by the magnitude of the expected savings and the realization rate. The degree of innovation was assigned a relatively low weight since all the programs are mature. The installation rate was also assigned a relatively low weight since they are typically very high with little variation.

Table 7. Attributes and Weights

Attributes	Weights
Last Time Evaluated	0.40
Installation Rate	0.05
Realization Rate	0.20
Expected Savings	0.25
Degree of Innovation	0.10
Total	1.00

The final evaluation priorities in rank order are presented in Table 8. This table includes the score for each attribute as well as the overall IEP.

Table 8. Final Electric-Based Scores, by Attribute and Overall Index of Evaluation Priority

Core Programs	Last Time Evaluated	Uncertainty: Installation Rate	Uncertainty: Realization Rate	Expected Savings Electric	Degree of Innovation	Electric-Base IEP
Municipal	5	4	3	4	4	4.2
Energy Star Appliances	5	5	2	4	2	3.9
Small Business Energy Solutions	3	2	4	5	2	3.6
Home Energy Assistance	5	4	3	2	2	3.5
Large Business Energy Solutions	1	1	5	5	2	2.9
Energy Star Lighting	3	5	1	4	2	2.9
Home Performance with Energy Star	4	3	3	1	2	2.8
Energy Star Homes	1	1	5	3	2	2.4

Since the Large Business Energy Solutions Program is currently being evaluated and an RFP to evaluate the Energy Star Homes Program is expected to be issued by the end of 2014, the Team does not recommend that they receive any attention in the near-term. Given this, the Municipal Program, the Energy Star Appliances Program and the Home Energy Assistance Program received the highest scores. These were followed by the Energy Star Lighting Program and the Home Performance with Energy Star Program.

After reviewing these results of our analysis, the Team identified the high priority programs that should be evaluated in the near term and allocated the M&E funds for 2015-2016. These results, combined with other considerations such as the need to consider market metrics, market characterization and assessment studies, and saturation studies, were used to identify the activities that we proposed for consideration in 2017, 2018 and 2019.

6. Evaluation-Related Recommendations for 2015

We present below a number of evaluation-related recommendations to be addressed starting in 2015.

- A common topic of interest among regulators and stakeholders is whether the results and recommendations that are presented in formal M&E studies are systematically reviewed and addressed by the sponsoring utilities. In the absence of a systematic way to obtain that information, it is often difficult to learn how those recommendations are being addressed. We recommend that the Commission consider requiring the utilities to submit a report shortly after the completion of each evaluation study that indicates how they (collectively or individually) will address each of the recommendations.

- We recommend that each M&E report be accompanied by a brief summary report (2-3 pages). This will facilitate access to the reports by policy makers and others who do not wish to read the complete reports.

- The utilities rely on planning assumptions about a large number of programs and measures in preparing their proposed program savings goals for each program cycle and the annual updates. These assumptions, which are derived from engineering algorithms and/or informed by previous evaluation studies, form a key component of the overall calculation of the proposed savings. The challenge for Commission staff, other interested stakeholders, and evaluation contractors is that these data are generally located within each utility's website and they are not readily accessible for review and analysis. In addition, whatever documentation there is that provides information on the sources of the data and support for the assumptions made is also difficult to obtain. Finally, because of the location of this information across the utilities, it is not readily possible to determine if similar savings assumptions are being used across the utilities. We recommend that the utilities be required to make these data more accessible and usable, and that the data be well documented. This may be best accomplished through the development of a common technical reference manual (TRM). While the initial development of a TRM is typically not a trivial exercise, the subsequent updates can be more readily prepared. We note, for example, that in the recent C&I new construction baseline evaluation report, the New Hampshire utilities were advised to adopt inputs from the Massachusetts TRM for the near term, pending more local M&E studies[17]. Without simple and transparent access to the data, staff cannot determine whether the utilities have responded to that M&E report's recommendation.

- Over the evaluation plan period, should our recommendations be accepted, the number of studies and associated evaluation contractors will grow significantly compared with past M&E activity. Selecting contractors is typically a somewhat long process and time-consuming for all those involved, but especially for the utility personnel who are involved in the procurement process. To overcome these administrative challenges, we

[17] ERS, Final Report *prepared for the* New Hampshire Commercial & Industrial New Construction Baseline Study for the NH Monitoring and Evaluation Team, March 2014, pp. 1-3 through 1-17.

recommend that the Commission consider establishing two or three sector or topical teams of M&E consulting firms, each contracted for a specified period, such as three years. This would enable them to participate in the strategic planning of studies within their area of responsibility, to look across studies as they are being conducted, and to focus on the conduct of the studies rather than having to repeatedly compete for individual M&E projects in New Hampshire. It also eliminates the need for different contractor teams to repeatedly come up to speed on issues specific to individual programs.

- In early 2006 the NH Public Utilities Commission approved a proposed settlement among the parties that, among other issues addressed, transferred responsibility for program monitoring and evaluation from the utilities to the Commission itself, through its staff.[18] Noting that the Settlement Agreement made clear that the M&E work would continue on a collaborative basis, it ". . . concluded that transferring responsibility for the monitoring and evaluation efforts to the Commission will result in more independent oversight." Since the issuance of the order the Commission staff has assumed that oversight role within the collaborative context contemplated by the Commission's order. The utilities have taken the lead in proposing specific evaluation studies, in taking on the administrative responsibilities necessary to procuring M&E contractors to undertake the studies, and in coordinating the opportunities for Commission staff and stakeholder input into the various documents necessary to procure M&E contractors and that are developed in the course of conducting the studies.

  The staff of the Electric Division of the New Hampshire is responsible for carrying out the duties associated with energy efficiency program monitoring and evaluation. During the course of working on this project, the Team held a number of exchanges with staff about the range of topics that we have been addressing in the course of preparing this plan. One of the challenges staff expressed is their need to gain a greater level of expertise about M&E matters in order to carry out those responsibilities fully and ably, while continuing to fulfill their other regulatory duties.

  We offer several options that the Commission may wish to consider to enhance the ability of staff to carry out the M&E responsibilities. Two focus on growing the staff's knowledge and expertise about the range of topics involved in program monitoring and evaluation. The first involves training current staff sufficiently so they can knowledgeably engage in the range of M&E activities that arise during the year, including the research and statistical topics that are at the core of energy efficiency evaluation. While there are a variety of ways that staff can obtain such training, it will involve a serious time commitment. However, with the number of studies that are proposed for the next years, staff will need to dedicate what can be expected to be a noticeable amount of time toward the M&E work.

[18] DE 05-157 Order No. 24,599, Granite State Electric Company, New Hampshire Electric Cooperative, Public Service Company of New Hampshire and Unitil Energy Systems, Petition for Approval of 2006 "Core" Energy Efficiency Programs, March 17, 2006. See pp. 9-11.

Another approach is to establish a staff position predominantly dedicated to M&E responsibilities, with strong experience in M&E as a prerequisite for the position.

A third approach is for the Commission, through a competitive bidding process, to contract with a small team of M&E experts to serve as advisors to staff and provide the expertise needed to support the Commission's on-going engagement in the M&E activities related to the Core energy efficiency programs. This would enable staff to maintain a higher level of involvement in overseeing the planning, monitoring and evaluation of the programs than they have had recently, while bringing the appropriate level of expertise to the interactive process with the utilities and other stakeholders and with the evaluation contractors who will be conducting the studies.

- As noted in the Market Assessment Framework, it will be important to prioritize the implementation of the framework. M&E and related tools can be used to identify those perspectives[19] which appear to have the greatest potential impact on their respective markets and on the energy efficiency portfolio. We recommend that the process of identifying candidate segments be completed by no later than mid-2016, so that field M&E activity - tracking indicators, baseline studies, surveys, etc. - can be planned for early 2017 launch. The identification process can take place among the Commission staff, utilities, and interested stakeholders, guided by available program data and other market information that can give initial insights into which aspects within one or more of the perspectives warrant nearer or later term attention.

[19] From the Market Assessment Framework in Appendix A, the perspectives (or segments) are 1) customer and institutional; 2) timing of energy related events; 3) produces, services, and practices; and 4) infrastructure.

7. 2015-2019 Multi-Year Plan

7.1. Limited M&E Annual Budgets Require Strategic Choices

Deciding how to prioritize among competing areas of M&E focus, especially the timing of studies and emphasis on types of studies, is a common challenge. It is particularly so in New Hampshire, where the total electric and gas Core program budgets, which are used to define the M&E budget (no more than 5 percent of the program budget), are limited in size. The annual M&E budget has in recent years been in the $1.1-$1.2 million range. A variety of other costs is included in this budget, so the available budget for new evaluations focused on the Core programs is less that those totals.[20, 21] Further, the New Hampshire electric utilities participate in the ISO-New England's Forward Capacity Market (FCM) auctions and have done so since demand resources have been able to be bid into the regional demand resource market. To participate, each utility is expected to meet ISO-NE's rules regarding confidence and precision of bids that rely on sample-based evaluated estimated savings, as well as, note previously, the guidance indicating that evaluation studies that support the bids should be completed within five years of submittal of the monitoring and verification plan. For at least that period, the program evaluation studies that have been conducted have focused on impact evaluation studies and market studies to support the FCM bid filings[22]. Yet, quite a number of the Core energy efficiency programs have not been evaluated from an impact perspective for the past five years. The recommended M&E studies for 2015-2016, described in Section 7.2, continue this focus, but with greater intensity – six programs are proposed for study over this two year period. While this may seem somewhat of a change of pace, it is for a purpose.

One of the areas of interest to the Commission in this project has been a review and proposal for a new or updated market assessment framework, which can be used to structure and identify market indicators of relevance to the delivery of the programs and to their performance in relation to naturally occurring efficiency activity. Until all the Core programs have current impact studies that can be used to support the utilities' participation in the FCM process, it will not be possible to allocate meaningful resources to implementing an updated market assessment framework or to the examining other aspects of the efficiency programs. We believe that the

[20] The cost categories include 1) Evaluation Planning; 2) Measurement and Verification of New Hampshire CORE Energy Efficiency Programs; 3) Regional Measurement and Verification Projects; 4) Regional Avoided Energy Supply Cost Studies; 5) Miscellaneous Research; and 6) CORE EE Program Tracking and Reporting. See NHPUC 12-262, Core EE Program filing, 12/14/12, pp. 59-61.

[21] On July 24, 2014 PSNH requested Commission approval to transfer $734,283 of its 2013 Core Energy Efficiency Program year-end surplus funds of $1,491,809 to the 2014 residential sector budget to enhance program activity ($223,771 to the 2014 HEA program sand $510,512 to the ENERGY STAR Lighting Program budget) rather than carry it forward to the 2015 budget, The remainder of the funds ($757,526) was proposed to be included in the 2015/2016 C&I sector program budget. The Commission approved the requests on August 7, 2014.

The increase in the 2015-2016 program budget will also produce a higher overall M&E budget for those years. However, the magnitude of the potential M&E budget increase is not so large as to affect the recommendations in this report. See "DE 12-262 CORE Energy Efficiency Programs: PSNH Request to Transfer 2013 Carryover Funds" and "Order Approving Public Service Company of New Hampshire's Request to Transfer 2013 Surplus Core Funds to 2014 and 2015 Program Years, Order 25,702, August 7, 2014."

[22] Of course, the Commission, the utilities and other stakeholders are also interested in energy impacts.

M&E recommendations for 2015-2016 will move the evaluation cycle to a place over the next few years so that these other priorities can begin to be more fully addressed in the 2017-2019 timeframe. Recommendations for the 2017-2019 period are presented in Section 7.3.

It is important to note that the proposed M&E studies for the Core programs will not be the only program-oriented M&E activities supported by New Hampshire in this period, as there are other monies that fund the state's continued support of the Northeast EM&V Forum. We see the EM&V Forum as a significant resource for New Hampshire, particularly in light of the state-level resource limitations discussed above. Broadly speaking, the Forum's activities can be divided into two categories: efforts to help standardize methods and reporting, and collaborative primary research done at a regional level. The extent and shape of New Hampshire's ongoing support for the first of these two categories is a policy issue to be determined by the Commission. In the case of the second category, collaborative primary research, we believe the Forum has established a useful regional niche to date in performing research that is too expensive to be easily undertaken by any single state and can be structured to produce results that are either transferable or adaptable across states within the Northeast. Examples of such research that the Forum has successfully performed in the past include measure cost studies, loadshape research, and research into emerging technologies.

Since the 2017-2019 period is further into the future than the upcoming program cycle, developing detailed recommendations for M&E activities during that period is a challenge. While there is currently no known consideration of significant changes to program budgets, program design, strategic direction, or policy guidance that will alter the energy efficiency programs three years hence, it is possible that any or all of these elements could change enough to affect the recommendations for M&E activity during the 2017-2019 period. There are currently considerations of an energy efficiency resource standard, which could lead to significant increases in Core program budgets.

Since the 2017-2019 period is further into the future than the upcoming program cycle, developing recommendations for M&E activities during that period is a challenge. There are currently no known significant changes to program budgets, program design, strategic direction, or policy guidance that will alter the energy efficiency programs three years hence. However, it is possible that any or all of these elements could change enough to affect the recommendations for M&E activity during the 2017-2019 period, and perhaps in the earlier 2015-2016 period as well. Commission staff is preparing a straw man proposal for an energy efficiency resource standard (EERS), based on broad-based research and extensive interviews with stakeholders. It is expected that a Commission process will be established to review the proposal. This may lead to the establishment of a New Hampshire EERS. The assumption is that any such standard would lead to significant increases in Core program budgets. See section 7.4 for a presentation of options for effective use of those funds

Program design and implementation strategies can change in response to a variety of factors, including program costs and continued efforts to deliver programs cost-efficiently. These could lead to changes in how existing programs are delivered or to greater interest in transforming specific New Hampshire markets. An increased focus on the prudent use of public and ratepayer monies for energy efficiency, or an interest in estimating the net environmental benefits of the programs, could result in an emphasis on measuring net program savings. These are but a few of the possibilities that could affect the Team's recommendations for M&E activity in 2017-2020. We include a section as part of the evaluation plan which discusses the M&E aspects of these and other factors which are not now part of the Core energy efficiency portfolio but which may require further attention at some point in the future.

7.2. Evaluation Plan for 2015-2016

The Team prepared recommendations for 2015-2016 M&E activities associated with the Core energy efficiency programs, in response to the Commission's desire to have an M&E plan available for the utilities to include in their fall 2014 filings of their proposed 2015-2016 Core energy efficiency programs. As noted in the previous section, our objective with these recommendations has been to conduct those impact studies necessary to bring all the programs' evaluation documentation within ISO-NE's five year timeframe. This strategy will provide both the time and budget in the subsequent period to examine other important areas that will support the Core programs.

We recommend that impact evaluations of six of the Core programs be undertaken in the next two years. Table 9 shows the program, type of study, and estimated budget. A full presentation of the 2015-2016 recommendations report is included in Appendix C.

Table 9. Summary of M&E Recommendations and Budgets for 2015-2016

Core Programs	Impact	Process/Market Assessment	Cost 2015	Cost 2016	Total
Large Business Energy Solutions	n/a*	n/a	n/a	n/a	n/a
Small Business Energy Solutions	X	X	$300,000	$275,000	$575,000
Energy Star Appliances	X		$150,000	$150,000	$300,000
Energy Star Lighting	X	X	$200,000	$200,000	$400,000
Municipal	X	X	$100,000	$50,000	$150,000
Energy Star Homes	n/a	n/a	n/a	n/a	n/a
Home Energy Assistance	X	X	$100,000	$200,000	$300,000
Home Performance with Energy Star	X	X	$100,000	$150,000	$250,000
Total			$950,000	$1,025,000	$1,975,000

*Refers to the fact that a program will not be evaluated in 2015 or 2016 since an impact/process evaluation of the program is or will be soon underway.

In Section 6 above, we recommended that the Commission expand its M&E resources, either by enhancing staff's expertise in the field or by retaining a team of technical consultants to provide on-going M&E assistance to the Commission staff. Tasks could include establishing a common set of variables that each utility should collect in order to support evaluations, preparing M&E protocols to address concerns about evaluation methods, reviewing evaluation plans to make sure that they reflect best M&E practices, reviewing data collection instruments, and reviewing final evaluation reports. Should the Commission decide to move in this direction, we recommend that the process begin so that a team can support the staff's M&E responsibilities starting in 2015. We suggest an annual budget of $100,000 for this technical support. Note that this amount is not reflected in the budgets for 2015-2016 in Table 9 or for the budgets for 2017 through 2019 in Table 10 in Section 7.3 below.

7.3. Evaluation Plan 2017-2019

If the recommendations for 2015 and 2016 presented above are followed, the requirement that each Core program be evaluated every five years will have been met; that is, the impact evaluations will be up to date. This frees up available funds for 2017-2019 to be allocated to a variety of projects other than evaluations. Such projects include market characterization studies, market assessment studies, saturation studies, EM&V protocol development, utility program database consistency, and utility program database documentation.

Table 10 presents a summary of the recommended studies and associated budgets for each of the three years. This is followed by a more detailed discussion of each proposed study.

Table 10. Summary of Evaluation Projects and Budgets for 2017, 2018 and 2019

M&E Activities	2017	2018	2019
Utility Program Database Consistency Project	$75,000		
Utility Program Tracking Database Documentation Project	$100,000		
Development of Program Theory and Logic Models	$80,000		
EM&V Protocol Development	$25,000		
Commercial Saturation Survey	$300,000	$300,000	$150,000
Large and Small Business Energy Solutions Market Characterization and Assessment Study	$250,000	$200,000	$100,000
Impact Evaluation of the Large Commercial Energy Solutions Program			$400,000
Residential Saturation Survey		$250,000	$100,000
Residential Lighting Market Characterization and Assessment Study		$125,000	$125,000
Tracking HEA/Low-Income Weatherization Metrics	$35,000		
Investigation of Emerging Issues	$50,000	$50,000	$50,000
Total	$915,000	$925,000	$925,000

Core Program Database Consistency Project (2017: $75,000)

When evaluating Core programs, evaluators must draw on the program-tracking databases (PTB) for each of the four utilities. Consistent data across the four utilities is essential in order to effectively evaluate any program. The first step towards achieving that would be to determine what data are essential for an evaluation. These data would include such variables as participant name, address, telephone number, e-mail address, account number, meter number, measure/project name, measure/project description, measure/project quantity, rebate amount, effective useful life, installation type (replacement on burnout or early replacement), full cost of measure/project, incremental cost of measure/project, first-year annual gross energy savings, and peak kW reduction as defined by ISO New England. The format of each variable (e.g., character or numeric and length) must also be specified.

The next step would be to systematically review the individual PTBs for each Core program to determine if all the necessary evaluation data are present and routinely populated. These data must be maintained at the measure or project level and maintained in an electronic form to measure the progress of their energy efficiency programs. The participant-level data will serve as the foundation for program evaluations as well as the quarterly and annual reports required by the Commission.

Utility Program-Tracking Database Documentation ($100,000)

A review of the utility Excel spreadsheets describing the 2013-2014 Core program plans revealed little documentation of the unit energy savings (UES) values for each measure/measure group. This project would discuss with each utility the sources for each value and document each. Any inconsistencies in the UES values for common measures would be identified and resolved. For example, such differences might arise if different utilities were using different assumptions regarding effective full-load hours for commercial air conditioning. If it is decided that a New Hampshire technical reference manual is needed, then additional funds would be required. Note that compiling the database documentation will make the development of a technical reference manual much easier.

Development of Program Theory and Logic Models for Each Core Program (2017: $80,000)

It is essential that Commission staff, utility program staff, program evaluators, and other stakeholders have a shared understanding of the various activities that comprise a program and their interrelationships, and the rationale for how these activities combine to achieve the objectives of the program. One way to achieve this shared understanding is to develop a program theory and logic model. The *California Evaluation Framework* [23] defines program theory and makes an important distinction between a program theory and a logic model:

> A program theory is a presentation of the goals of a program, incorporated with a detailed presentation of the activities that the program will use to accomplish those goals and the identification of the causal relationships between the activities and the program's effects. The program theory describes, in detail, the expected causal relationships between program goals and program activities in a way that allows the reader to understand why the proposed program activities are expected to result in the accomplishment of the program goals. A well-developed program theory can (and should) also describe the barriers that will be overcome in order to accomplish the goals and clearly describe how the program activities are expected to overcome those barriers. A program theory may also indicate (from the developers perspective) what program progress and goal attainment metrics should be tracked in order to assess program effects.
>
> Program theories (PT) are sometimes called the program logic model (LM). A stricter definition would be to differentiate the program theory as the textual description while the logic model is the graphical representation of the program theory showing the flow between activities, their outputs, and subsequent short-term, intermediate, and long-term outcomes. Often the logic model is displayed with these elements in boxes and the causal flow being shown by arrows from one

[23] TecMarket Works. (2004). *California Evaluation Framework*. Prepared for the Southern California Edison Company.

> to the others in the program logic. It can also be displayed as a table with the linear relationship presented by the rows in the table. The interactions between activities, outputs, and outcomes are critical to understanding the program logic and argue for the need to have, or construct, both a program theory and a program logic model. (p. 31)

Program theory and logic models have many uses[24], including:

- Clarifying what is really intended in a project or policy
- Enhancing communication with among the Commission, the utilities, and stakeholders
- Enhancing communication among project team members
- Managing the project
- Designing an evaluation plan and determining the questions to be addressed
- Documenting a project and how it worked
- Examining a program or constellation of projects

Another key element of any logic model is the identification of key performance metrics associated with each activity, output and outcome. This would include various market assessment metrics, identified in the market assessment framework, which can be tracked over time.

When conducting this program theory and logic model analysis, the following activities are typically performed:

- Document reviews
- Discussion with program staff to help define the logic model elements (these included identification of key program inputs, activities, market actors, outputs, outcomes, potential external influences, and other segment interactions)
- Logic model diagram construction – entailing transposition of key logic model elements into a series of boxes or circles and arrows to identify preliminary logical relationships among the elements
- Identification of barriers and context development
- Identification of potential program measurement indicators
- Follow-up discussions and feedback from program staff on an early version of the program description, relationship to goals, logic model, and indicators to help correct and refine the draft logic model

The program theory analysis takes this logic model of the program as implemented and examines the program theory and logic in the context of the experience of other similar programs and potentially relevant social science theory. Key activities performed in developing the program theory analysis typically include:

- Review of articles and proceedings to identify other potentially similar programs
- Review of recent evaluations of these other programs

[24] Frechtling, Joy A. (2007). *Logic Modeling Methods in Program Evaluation*. San Francisco, CA: Jossey-Bass.

- Review of social science literature pertinent to key theory inherent or explicitly incorporated in the program design
- Identification of researchable issues and recommendations
- Follow-up discussion of the full program analysis with program staff
- Revision of the document based on all feedback provided

While this task is currently budgeted for the 2017-2019 period, we think that, if possible, it should be addressed in 2015 since it can help in identifying market metrics for which baselines can be established.

EM&V Protocol Development (2017: $25,000)
Both consistency and transparency are needed by all stakeholders for both process and impact evaluations. While utilities hire experienced contractors to conduct their evaluations, over time there will be inconsistencies with respect to the attention given to sample error versus other sources of error, differences in the level of detail reported, differences in the variables tracked in utility databases and their formats and differences in how accessible completed reports are to interested stakeholders. Appendices D, E, and F contain illustrative guidelines that were prepared by TMW for the New York State Department of Public Service in collaboration with the 10 program administrators in New York including NYSERDA. Similar protocols could be developed by the Commission that would provide the needed guidance on key evaluation topics that would lead to consistency and transparency across studies and utilities.

Commercial Saturation Survey (2017: $300,000; 2018: $300,000; 2019: $150,000)
The overall objective of the study is to evaluate and develop a baseline of new and existing commercial building stock and associated energy use, including the saturations of energy consuming equipment (electric, gas, and other fuels), building types, the penetrations of energy efficient equipment, and energy management practices. The analytical objectives of the project should include:

- Develop estimates of end-use saturations, energy use by end use, and hourly load profiles for commercial market segments
- Collect data on end-use energy efficiency to support the design and planning of energy efficiency programs and policies
- Develop a means of designing load management strategies, building standards, alternative rate designs, and other programs and policies

The first major component of such a project would include a comprehensive on-site survey to collect information on equipment stocks, operating schedules, efficiency levels, and shell characteristics of commercial buildings. The on-site survey would include interviews with facility managers, inspection of buildings, and inspection of site documents and records. For some premises, the survey could also include the collection of time-of-use logger data on key end uses such as lighting and/or HVAC fans.

Large and Small Business Market Characterization and Assessment Study (2017: $250,000; 2018: $200,000; 2019: $100,000)
This research focuses on the market and context within which the Large and Small Business Energy Solutions Programs operate. The research seeks to test program assumptions about market characteristics, provide additional details about market structure and opportunities, and ensure that consist metrics are used over time from one study to another. Utility program staff and managers can use the evaluation results to adjust program implementation to ensure maximum market interest and uptake of program offerings.

The primary objectives of a market characterization and assessment study are to:

- Develop a comprehensive understanding of current targeted markets (e.g., lighting, HVAC and process) as well as emerging markets (e.g., market structure and market actors) for key end uses.
- Provide baseline and background information required by utilities to define and deliver programs to target markets.
- Track changes in markets over time with a specific focus on market indicators that program offerings are likely to impact

While both electricity and natural gas will be investigated, the focus will be on the former.

Examples of market characterization topics for exploration, pending data availability, include:

- Definition of the C&I efficiency services market in New Hampshire including supply chain analysis for various types of measures
- Identification of the energy service companies (ESCOs) operating in New Hampshire including insights into which are most active/influential in the energy efficiency services market
- Analysis of the number and capacity of equipment installers operating in New Hampshire
- Other information identified as important by Commission staff or the utilities as the research progresses.

Impact Evaluation of Large C/I Program (2019: $400,000)
The Large Business Energy Solutions Program accounts for slightly more than 50% of the total electric portfolio. Although evaluated in 2013 and 2014, because of its importance to the portfolio and the potential for changes in the mix of technologies and customers, and the potential introduction of new state and federal efficiency codes and standards, an impact evaluation is recommended for 2019.

Residential Saturation Survey (2018: $250,000; 2019: $100,000)
Outside of a report by Nexus Market Research, Inc. et al. (2003), little attention has been paid to statewide saturation studies in the residential sector. The primary objective of this saturation study is to develop a database of residential building characteristics, lighting and appliance saturations and efficiencies, expanded to represent the population of residential individually-metered population. The underlying research would be based on 300 onsite surveys of

representative samples of single-family, multi-family and mobile home residences in the service territories of the four utilities.

Key outputs of the study might include the following:

- Distribution of building characteristics such as square footage, room types and window types
- Distribution of type, efficiency, size and age of equipment such as ACs, refrigerators, furnaces, boilers, water heaters and so on
- Distribution of installed watts for lighting by room type and fixture type
- Distribution of plug loads by room type
- Distribution of heating fuel types
- Distribution of household demographic characteristics such as number and ages of occupants

Study results will be used to update the residential baseline information upon which program and portfolio planning and program evaluation rely.

Residential Lighting Market Characterization and Assessment (2018: $125,000; 2019: 125,000)

Market characterization can generally be defined as a qualitative assessment of the structure and functioning of a market. The primary purpose of market characterization is to understand how the market operates in order to enable program planning to consider, in an informed way, effective strategies to influence markets toward greater energy efficiency. Market characterization should precede the market assessment. The market assessment begins with baseline measurement, defined as the quantification of key market indicators that have been or can be influenced by a program intervention. The primary purpose of the baseline measurement is to provide a basis for later comparisons of the status of the market after program intervention, in order to help assess the impact of the program.

For the residential lighting market, assessment activities include surveys of both participating and non-participating retailers to obtain such information as their level of awareness of energy efficient lighting and the assortment and placement of energy efficient lighting products. Shelf-surveys could also be conducted to verify store manager self-reports. For non-participating retailers, the study should assess awareness of the program and barriers to participating for those who are aware. The general residential population could also be surveyed to determine their levels of awareness and knowledge regarding energy efficient lighting and purchase/installation of energy efficient lighting. This general population survey could be done in junction with the residential saturation survey.

Tracking HEA/Low-Income Weatherization Metrics (2017: $35,000)

We propose tracking a series of metrics for this program, to gain greater insight into the program participants, the overall low income housing market, and to support program enhancements. The metrics framework for HEA should include (a) numerical indicators for a *household perspective* and (b) numerical indicators for a *housing stock perspective*. These are two quite different ways of viewing HEA and for both, the baselines or reference framework is shifting.

Within the household perspective, it would be useful to keep data on the poverty level (such as 26%, 77%, 131%, etc.) of each household served by the program. This will enable comparison to the frequency distribution of households by federal poverty level in New Hampshire. Individual household income and family size as well as actual computed poverty level should be maintained. The shifting framework frequency distribution within which to assess this information can be developed from state level US Census data. From the household perspective, New Hampshire could benefit from an income insufficiency study, similar to those conducted for most other states.

Within the housing stock (or physical) perspective, we recommend maintaining a record of completed jobs by house type (single family detached, apartment, etc.), by type of home heating, and by tenure (rentals vs. owner-occupied). Results could be computed on a yearly basis and be assessed within statewide or utility service territory housing stock baselines (both as numbers and percentages) for these same classifications.

From a housing stock (or physical) perspective, it is important to understand energy savings and the mix of installed program measures. This series should be kept as a yearly production number and it should be broken out by house type, home heating and other housing classifications.

Investigation of Emerging Issues (2017: $50,000; 2018: $50,000; 2019: $50,000)
Over the next several years, there are a number of emerging issues that the Commission might choose to address. Below, we list a number of the issues that are likely to arise:

Net Impacts
In many jurisdictions, reported savings and benefit/cost analyses are based on estimates of net program and portfolio impacts - that is, not including the program savings that would have occurred in the absence of the program. To estimate net impacts, gross savings are first estimated and then adjusted by comparing energy use over time to a group of similar nonparticipants and adjusting the gross participant impacts using a net-to-gross ratio[25]. While current New Hampshire policy does not require estimates of net impacts, there might be some emerging interest in net impacts given that many jurisdictions use net impacts in their benefit-cost calculations and are interested in net emissions reductions. Such interest may be driven by a focus on the use of public and ratepayer monies to acquire energy efficiency savings over and above what would have been acquired without the energy efficiency programs. Alternatively, the interest may be derived from considerations of quantification of air emissions reductions from the energy efficiency programs to address state or federal requirements. If this is the case, exploring the various cost-effective methods for estimating net impacts and how these net impacts might be used for these purposes would be worthwhile.

[25] The net-to-gross ratio is a factor representing net program load impacts divided by gross program load impacts that is applied to gross program load impacts to convert them into net program load impacts. This factor is also sometimes used to convert gross measure costs to net measure costs.

Related to net impacts is the issue of participant and nonparticipant spillover. Spillover is defined in the NEEP EM&V Forum "Glossary of Terms" as:

> Reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or non-participant spillover. **Participant spillover** is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program as a result of the program's influence. **Non-participant spillover** refers to energy savings that occur when a program non-participant installs energy efficiency measures or applies energy savings practices as a result as a result of a program's influence.

Some evaluators subdivide participant spillover into "inside" and "outside" spillover. Inside spillover occurs when, due to the project, additional actions are taken to reduce energy use at the same site, but these actions are not included as program savings. Outside spillover occurs when an actor participating in the program initiates additional actions that reduce energy use at other sites that are not participating in the program. By ignoring the various types of spillover, estimates of program impacts can be underestimated. One task might be to assess from a policy perspective whether spillover should be addressed and, if so, review the various methods for estimating spillover.

Non-energy Benefits

We recommend that non-energy benefits be considered for greater attention and an EM&V focus. Non-energy benefits (NEBs) are those benefits that are derived from the implementation of energy efficiency programs that are not captured in the calculation of the energy savings. Examples include reduced arrearage costs to utilities, reduced O&M costs to businesses from use of more efficient and longer duration lighting, increased property value, and improved health. The range of the additional benefits associated with the energy efficiency activities can be extensive, although it is not always possible to adequately quantify the benefits.

The New Hampshire programs are examined for cost-effectiveness using the total resource cost test (TRC). While each regulatory jurisdiction has historically chosen to interpret which components of the TRC to use, it is reasonable to conclude that, as a matter of equity and fairness, if the costs of a particular element of the test are included, then the benefits of that element should also be included. The argument is at times made that it is too challenging to obtain reliable estimates of these benefits, so they are either not or only partially included. The benefits and costs of program participants is such an example. While participant costs and the energy savings benefits are generally included in a TRC test, the other benefits that accrue to the participant from the measure or program under review are generally not included - usually due to the perceived cost of obtaining the information. Studies of the avoided costs of low income, residential, and C&I non-energy benefits have been recently conducted in Massachusetts, and the results are now included in the application of that state's TRC test. We point this out to suggest that New Hampshire may be able to rely on some of that work, while honing in on those NEBs which would have more local avoided cost values that could be examined though the EM&V process.

HVAC Interactive Effects

The interaction of energy efficiency measures with the HVAC system in a building may cause increases or decreases in the HVAC system energy consumption. The most common example is the interaction of interior lighting with heating, and cooling energy. Energy efficient lighting systems release less heat into the building, causing a reduction in the amount of air conditioning and an increase in the amount of heating required. The same phenomenon occurs with other measures located within a conditioned space, such as energy efficient refrigerators, appliances, process equipment and so on. We recommend a study to estimate the magnitude of the HVAC interactive effects across a variety of locations, building types, HVAC system types and heating fuel types across the state. Building energy simulation modeling of prototypical buildings using a program such as DOE-2 is the recommended analytical method for estimating HVAC interactive effects. The results of this analysis should be a set of HVAC interactive effects multipliers for electricity consumption, peak demand and heating fuel interactions. The multipliers can be applied to individual projects or weighted average values can be developed according to building type distribution, HVAC system type saturation, fuel type saturations and so on. Once the magnitude of the interactive effects are calculated, we recommend convening a workshop discuss the process for integrating the HVAC interactive effects calculations into the savings calculations.

Effective Useful Life

The utility filings contain estimates of the effective useful life (EUL) of each measure, which are used to calculate lifetime energy savings. These parameters are difficult to quantify and may have high levels of uncertainty. Measure EUL estimates were specifically excluded from the uncertainty analysis due to the impracticality of addressing them within the studies considered here. However, they remain an important component of the overall uncertainty in measure savings, and may be candidates for study at a regional level. We suggest bringing this issue forward to the appropriate regional forum (such as NEEP) for a cooperative study where the costs could be shared widely across multiple utilities and program administrators. The primary data required to calculate EUL may take many years to collect, so a sustained effort will likely be required.

Baseline Issues

The identification of the correct baseline is essential for accurately estimating the gross impacts of any measure. For example, for early replacement, the appropriate baseline is the energy use of the old equipment that was replaced. For replacement on failure, new construction or an addition or remodel of an existing structure, there are various baselines that could be used including applicable local, state and federal energy codes and standards with a compliance adjustment as necessary and the market average, current practice, or industry standard practice (hereafter referred to as current practice) to represent the energy use of equipment purchased on average by consumers in the market. Once gross impacts are estimated, the next step typically is to determine what portion of the gross impacts is caused by the program. In many cases, this is done by estimating a net-to-gross ratio (NTGR) and multiplying it by the gross impacts to yield net impacts.

However, Ridge et al. (2013) have recently argued that using current practice as the baseline for estimating gross impacts and then adjusting these savings using a NTGR is a mistake since the gross savings are in many ways closer to net than gross. While the authors agree that to refer to the difference between annual energy use associated with current practice and that of the rebated measure is not purely net savings, they disagree about which solutions to recommend. They note that what counts as credible evidence in a given jurisdiction may help to decide which way to proceed.

This issue could be explored more closely for New Hampshire Core programs to determine if it is relevant. If so, the Commission could then decide how to proceed.

External Scanning of Regional Market Characterization and Assessment Studies
This evaluation plan has proposed several market characterization or assessment projects to be performed in 2017-2019. However, we note that, given the available M&E budget and competing priorities such as meeting NE ISO impact evaluation requirements, limited funding is available for market studies. At the same time, nearby larger states such as Massachusetts and New York are conducting extensive market studies that are likely to include findings relevant and useful to New Hampshire. The results of these studies ultimately become public documents. The challenge lies in monitoring these results, and assessing which may be transferable to New Hampshire. We suggest that an ongoing scanning function be established to make this assessment.

Early Replacement Versus Normal Replacement
An emerging issue in a number of jurisdictions is the correct calculation of lifetime savings for cases of early replacement versus normal replacement. Early replacement is defined as the replacement of equipment before it reaches its Effective Useful Life (EUL), whereas normal (end-of-life) replacement refers to the replacement of equipment which has reached or passed the end of its measure-prescribed EUL. Early replacement is beneficial since it accelerates savings to the grid. The correct identification of the baseline is critical for both early and normal replacement. For normal replacement, the baseline can be defined as the energy use associated with any applicable state or federal efficiency code. For early replacement, the baseline is the energy use of the replacement equipment over the remaining useful life (RUL) of the equipment. At the end of the RUL, the baseline changes to that of normal replacement. As a result, cases of early replacement have dual baselines. Various jurisdictions such as California and New York have developed methods to identify the correct baseline for both early and normal replacement so that lifetime savings can be accurately estimated. Similar methods could be developed for New Hampshire.

7.4. Options for Use of Additional M&E Funds

As discussed in Section 7.1 above, it is possible that the energy efficiency program budgets will increase significantly over the next several years. Assuming a continuation of the allocation of five percent of program budget to M&E, that budget would also increase. There are three general ways to allocate larger annual M&E budgets. These include expanding the number of studies that can be undertaken in any given timeframe; expanding the types of activities that are addressed within studies; and supporting M&E activities not directly associated with the evaluation of the Core programs. We focus here on the first two of these three options.

A variety of studies for the 2015-2019 evaluation period are proposed and described in the above sections. As the energy efficiency programs are implemented, M&E studies with associated recommendations are completed, overall program portfolio savings and other key indicator results are examined, and strategic other factors area considered, the Commission may choose to undertake additional studies that will inform and support the further development of market intelligence and program strategies. These can include targeted studies of various kinds (market characterization and assessment, technology-oriented impact, process, etc.) as well as impact studies that arise from newer energy efficiency programs (e.g., behavioral).

An equally compelling direction to which the additional M&E funds could be allocated is toward focusing more deeply on elements within the recommended studies in order to increase the general and statistical reliability of the reported results, and to examine various study groups at a more disaggregated level. We have observed that the process and impact evaluations of Core programs are typically conducted at the statewide level rather than the utility level. The reported confidence and precision of the estimated program savings are thus also at this overall level, rather than the utility level. This is generally understandable given the relative sizes of the utilities and the cost it might entail to conduct the more rigorous M&E activities based on sample sizes large enough to support more robust statistical results for each utility. However, because some programs offer measures that constitute a significant percentage of sector or portfolio savings, a more focused utility-level M&E effort might be appropriate. Additional M&E funds would also enable studies to include a greater level of disaggregation. For example, an examination of a residential program might include reporting savings across housing types. Similarly, savings in commercial programs could be reported by key building types. These kinds of activities ultimately yield stronger results and more information about the Core programs, all of which can lead to stronger and more insightful consideration of program strategies to attain the State's savings and other energy efficiency objectives.

8. Team Objectives and Priorities

The first element of the project's Scope of Services calls for statement of the specific objectives and priorities developed through research and analysis during the project that guided the development of the Monitoring and Evaluation (M&E) plan. A response to this task is based on a reflection of the results and synthesis of the research and analysis that was undertaken. We list below the key objectives and priorities that guided the development of this draft plan.

- To present a clear and coherent set of recommended M&E studies for the 2015-2019 period;
- To base the recommendations on the information gathered through the course of the project and the Team's experience both in the field of evaluation and in working in other jurisdictions;
- To provide recommendations that would provide greater transparency in the overall planning and conduct of the M&E studies and enable Commission staff to assume greater engagement in carrying out its M&E responsibilities;
- To present recommendations about M&E issues that may become more relevant with changes in energy efficiency program budgets, program design, strategic direction, or policy guidance.

9. Appendices

This section includes the following seven appendices:

9.1 Appendix A: Market Assessment Framework

9.2 Appendix B: Uncertainty Analysis

9.3 Appendix C: M&E Recommendations for 2015-2016

9.4 Appendix D: Illustrative Guideline: Sampling and Uncertainty

9.5 Appendix E: Illustrative Guideline: Reporting and Accessibility Guidance

9.6 Appendix F: Illustrative Guideline: Data to be Collected for Program Evaluation Purposes

9.7 Appendix G: NEEP Glossary of Terms

9.1 Appendix A: Market Assessment Framework

Development of a Multi-Year Monitoring and Evaluation Plan
For the New Hampshire Core Energy Efficiency Programs
2015-2020

- Market Assessment Framework -

I. Introduction

One of the questions regularly asked in the deployment of energy efficiency programs is when it is appropriate to introduce a program, a new technology or service, or a new component of the customer market. Equally important, questions arise on when it is appropriate to remove an element of the energy efficiency portfolio. An overall framework that categorizes the factors that one might want to consider can provide a structured way to approach these important questions and minimize challenges to the decisions that are made by those who plan or authorize the programs. This document is intended to propose that framework.

Our gap analysis revealed that the energy efficiency programs in New Hampshire have been designed, proposed, reviewed, and elements approved with limited reliance on an existing market assessment framework. This framework has evolved informally from work conducted in 1999 as part of a year-long stakeholder working group process.[26] The Commission has asked TecMarket Works to reconsider this somewhat informal market assessment framework in light of the many transitions which have occurred since its initial preparation in 1999 and evolution over the last 15 years. These transitions include, but are not limited to:

- Changes in personnel across the stakeholder, regulatory, and utility organizations have in part led to a de-emphasis on the structured application of an analytic and decision-making framework to inform entry and exit actions. These decisions have and are occurring in the context of vital discussion among utilities, staff and other stakeholders. So, decisions occur in the context of collaborative consultation and the informal application of frameworks rather than through a formal process employing a formal decision-making framework;
- The experience of planning, designing, and delivering energy efficiency programs to customers in New Hampshire and New England has led to an increased understanding of how the various elements of the programs can benefit from additions and withdrawals from the offerings.
- Consumers in New Hampshire – all electric and gas customers - across the sectors are more informed through information and experience than they were when the initial framework was established;

[26] 96-150 NH Energy Efficiency Working Group Final Report (1999), included as Attachment 1 to this memo

- The decisions are now more guided by broader guidelines and more group-informed agreements based on information that is more publicly accessible through the internet, product distribution channels, research, and monitoring and evaluation (M&E) activities.

Just as important a factor, the funds used to support the energy efficiency programs are ratepayer and public purpose monies, and the prudence of their use and expenditure is ultimately overseen by the Public Utilities Commission. A revitalized systematic and informed way to examine engagement or disengagement in aspects of the energy efficiency arena can provide useful input into the decisions that ultimately will enhance overall benefits to ratepayers from the efficiency activities.

In this memo we review the existing framework in the context of the current understanding of program theories that underlie the Core programs and that suggest adjustments to the indicators. We then present our proposal for a market assessment framework as well as recommendations on how to take advantage of its perspective, in the course of determining what to examine, how to conduct the examinations, and when they are most appropriate to inform the underlying questions that have emerged from the application of the framework.

II. The Existing Market Assessment Framework

The 1999 Energy Efficiency Working Group developed two "potential tools to use in assessing the eligibility of a given energy efficiency technology or practice for funding." One was "a detailed framework in matrix form…and another [a] narrative framework…the Group agreed that these two frameworks [referred to as A and B, respectively] have many similarities, are not mutually exclusive and are not yet fully fleshed-out." The Group recommended both frameworks to the Commission along with a proposed Energy Efficiency Committee for possible refinement and use.[27]

Although our gap analysis has revealed that there is no formal documentation of the application of this framework, New Hampshire has generally relied on a mix of market metrics from Frameworks A and B[28]. For example, it has focused on the sectors and markets with the highest savings (commercial lighting and HVAC) and the commissioning of evaluation studies that have focused on key program performance metrics, including broad market indicators. However, owing to the informal nature of the market assessment framework, the collection and analysis of key market metrics has not been consistently tracked and reported by evaluators.

Both approaches highlighted ways to determine how to identify market barriers that could be addressed by one or more available energy efficiency actions. Our overall assessment of the detailed elements of the Framework A and the guidance on the central indicators to track market progress in Framework B is that they were appropriate for the time; however, some reconsideration of the frameworks is warranted.

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27 Ibid., p. iii.

28 See pp. 35-44 of Attachment 1 to this memo

III. Proposed Framework

In our view a general framework with the necessary supporting infrastructure to follow through and conduct the necessary research is an appropriate approach for the New Hampshire process. We propose the following market assessment framework, which is a modification to Framework B presented in the 1999 report.

A market assessment framework exists as a way to gauge the effectiveness of organized encouragements or mandates for the more efficient use of energy. It presumes the existence of energy efficiency policy, programs, codes and standards, and other organized efforts to influence decision-making. The framework provides a structured way to identify and consider what should be included in the portfolio of energy efficient activity, when additions are appropriate, and just as much, when removing an element from that portfolio is appropriate. It is not intended to establish how to introduce the new programs or program components into the energy efficiency portfolio – that is the role of program planning and design.

The framework, however, is just that, and can be presented along a continuum from general to very prescriptive terms. We suggest that the construct be related to the resources that will be supporting the framework – is there a body of knowledge about the markets being served, the range of technologies and practices that are offered through energy efficiency programs, the capability to design and deliver relevant monitoring and evaluation studies, and the policy support to the entire effort? In examining the circumstances in New Hampshire, we believe that these resources do actively exist, and that as a result a more general framework is appropriate, fashioned similarly to the 1999 Market Framework B. We choose this framework as it is more closely aligned with the way in which the energy efficiency programs are structured in New Hampshire.

We distinguish four general segments, or perspectives, of the panorama of energy efficiency activity in the state, through which consideration or changes to the existing portfolio can be viewed.

1. Customer and institutional

From these perspectives the focus of potential barriers to participation in the energy efficiency portfolio is on the customer directly. The customers are, of course, central to all energy efficiency activity, as it is they who use the energy resources being targeted by the energy efficiency efforts. Customer segmentation, both within and out of the programs offered by the electric and gas utilities, typically includes low income, residential, business, and industry. The utility programs also distinguish between small and large commercial and industrial customers. The efficiency programs have already established that there are barriers within these sectors. From this perspective, the market assessment framework can be used to examine other disaggregations of customers that may benefit from program attention. For example, a subset of the residential market that may merit exploration under this perspective includes customers who are just above the low-income eligibility level but still struggle to maintain a living income, and thus cannot participate to any large degree in the residential programs.

Another element of this perspective, again from the customer perspective, relates to the customer's relationship to the institution or organization in which their business operates. This involves the tenant/landlord relationship in both the residential and the commercial/industrial sectors. The challenge to the customer is that, because they pay a fixed amount of rent, there is no direct benefit to them to spend monies on energy efficient measures or other energy efficiency activity; on the other side, the landlord has little incentive to make the upfront investment in energy efficient measures because he will not see the cost benefits until possibly sometime in the future. This is sometimes referred to as the split incentive market barrier.

One can expect that once a customer segment is identified as encountering barriers limiting access to energy efficient opportunities and targeted by the energy efficiency programs, it will remain the focus of attention for a considerable amount of time.

2. Timing of energy related events

The perspective through which the market assessment is conducted in this segment is that of timing of the energy related events, focused particularly on new construction and equipment failure/end-of-life situations. When a developer or custom builder (residential or commercial) starts a project, does s/he intuitively plan to incorporate, or discuss with their client, the benefits of, high efficiency options into the design? If an air conditioner fails in the middle of the summer, does the customer have sufficient willingness to buy an energy efficient unit and ready access to stores that carry such units or is a standard efficiency unit the replacement of choice because of, for example, the lack of time to acquire a high efficiency model or a lack of financial resources at the time of the failure? When a motor fails on a production line, is there a high efficiency replacement immediately available and/or does the energy manager naturally maintain a stock of such equipment or have a supply agreement with a local supplier to maintain stock?

3. Products, services, and practices

The market assessment perspective here examines the extent to which new high efficiency products and high efficiency oriented practices are being accepted by consumers without the influence of the portfolio of energy efficiency activities. This can involve new products entirely, such as the recent widespread availability of LED lights, or more energy efficient models of existing products, such are boilers and furnaces.

Services and practices often can be delivered or conducted for standard as well as higher efficient products. Building or equipment commissioning and retro-commissioning are intended to ensure that the installed equipment operates according to specification. This is particularly of interest with high efficiency equipment, as it is installed in order to reduce energy costs, but not always operated optimally, which these services can examine and correct as necessary. Duct sealing of forced air heating and cooling systems is an example of a practice that enhances the efficiency of the overall HVAC system, and reduces customer discomfort due to a loss of heating and cooling through the delivery system. This market assessment perspective can focus research on the availability and frequency of such services and practices and signal the possible need to engage with them through the portfolio of energy efficiency activities.

4. Infrastructure

An often neglected element of the overall availability and delivery of the energy opportunities is the availability and expertise of the array of contractors and supply firms who are engaged in many aspects of these efforts. Without this infrastructure even the best products can languish on supply shelves and services can be less than optimally provided. In a region such as New England, where each of the six states is actively engaged in promoting energy efficiency through utilities and other program administrators, the supply of trained contractors shifts from state to state based on business opportunities, until the contractor base grows sufficiently to meet the demand. New Hampshire may well need to examine the current contractor network through this market assessment perspective to anticipate future needs for particular types of contractors.

While the numbers of available contractors of the necessary types matter a great deal, so does the training that these contractors have obtained. This market assessment perspective may also be useful in identifying where, or if, any gaps exist in the availability of training or certification opportunities, to ensure that quality installations are the norm. Examples include expertise in residential home blower door testing and BPI certification.

IV. Applying the Market Assessment Framework – the Role of Monitoring and Evaluation

A framework for decision-making is only useful if it is applied in the context of an existing set of market circumstances along with the necessary resources and tools to acquire the information that will support the questions being asked. New Hampshire's four electric and two gas utilities deliver a portfolio of energy efficiency programs across the state to low income, residential, commercial, and industrial customers. The value of applying the Framework is that it then becomes possible to establish why and how customers may need to be supported by the energy efficiency programs. The application of the framework, from the perspectives described in Section III may reveal why and how energy efficiency choices are or are not being made in the general marketplace.

Monitoring and evaluation (M&E) studies have been conducted over the years since the efficiency programs began to be offered, focusing on program savings impacts, participation levels, program performance, and on underlying measure performance such as HVAC load curves. The scope of the studies has thus been on the program activity, and not on what efficiency behaviors may or may not be occurring outside of the programs in the broader market.

To respond to issues related to the market assessment framework, it is important to understand what the existing characteristics of products and services are in the state and region, as well as the applicable market barriers. That is, baseline studies associated with the particular elements of the four market segments discussed above would need to be conducted in order to learn about the current market conditions. This will enable analysis and decisions about whether to intervene in those particular segments of the market through the energy efficiency portfolio of activities. Periodic tracking of key measures, conditions, and other drivers to the energy efficiency portfolio objectives, while relying on the same methodological approaches over time, can provide the data that planners can use to make informed decisions about when it is appropriate to consider changes in the portfolio.

Because the energy efficiency M&E budgets are limited annually and there are other demands for the use of those funds, it will be important to prioritize the implementation of the framework. M&E and related tools can be used to identify those segments which appear to have the greatest potential impact on their respective markets and on the energy efficiency portfolio, either by ultimately including them or determining that they are gaining consumer acceptance independently of the efficiency programs. In addition, it must be recognized that many markets that may be considered for research are regional or even national (e.g., LEDs, HVAC equipment, building design training, installation certification). Assessments of energy-related components such as these cannot be examined only within the context of a New Hampshire market, but rather would need to be conducted in conjunction with other states or regions. The NEEP EMV-Forum is an example of an organization that coordinates and oversees joint, co-funded, research for the sponsoring bodies (the Forum's emerging technologies research project is an example of this type of joint research).

V. Attachments

Several attachments accompany this memo. In addition to the 1999 New Hampshire report that includes Market Assessment Frameworks A and B are several papers and selections from documents that present aspects of market assessment, selecting performance metrics, and tracking performance. Each is listed below and the files themselves are embedded below as well.

Attachment 1: 96-150 NH EEWG Final Report (1999)
Attachment 2: Guidelines for Designing Performance Metrics
Attachment 3: Examples of MT Exit Targets
Attachment 4: Data Sources for Long-Term Performance Metrics
Attachment 5: Assessing Market Barriers Missing Opportunities - Hall et al
Attachment 6: Time to transform markets - Hall

Attachment 1.pdf Attachment 2.pdf Attachment 3.pdf

Attachment 4.pdf Attachment 5.pdf Attachment 6.pdf

9.2 Appendix B: Uncertainty Analysis

The uncertainty analysis was used to assess the risk associated with achieving the energy efficiency goals and inform the allocation of EM&V activities and budgets to minimize the risk and improve the reliability of the energy saving estimates. The full set of tables is contained in the accompanying file *NH UA Model4 8-16.xlsx.*

The data available for conducting the analysis are listed below:

- Reported and forecast energy savings by program and by measure. Workbooks were compiled by each of the IOUs as part of their energy efficiency filings. These workbooks contain a list of each measure included in each program, the number of installations, installation rate, unit energy savings estimates, realization rate adjustments, and effective useful life. Workbooks created by each IOU were combined into a master workbook for this project
- Evaluation reports filed on the NH PUC website. The most recent reports were reviewed, and information on the uncertainties in the reported savings were compiled for the analysis.

The electricity and gas savings models from the IOU workbooks are fairly simple. There are four parameters in each calculation:

$$\Delta kWh = units\ x\ UES_{kWh}\ x\ RR\ x\ EUL$$
(B.1)

$$\Delta MMBtu = units\ x\ UES_{MMBtu}\ x\ RR\ x\ EUL$$
(B.2)

where:

units	= quantity of measures installed
UES	= unit energy savings, or the expected savings for each measure installed. Note: the "units" on the unit energy savings (such as square feet of insulation, tons of air conditioning and so on) should be the same unit of measure as the quantity term.
RR	= expected or measured realization rate
EUL	= measure effective useful life

The evaluation studies generally focus on estimating two parameters – the installation rate and the gross savings realization rate. In our analysis, the uncertainty in the installation rate is expressed as an uncertainty in the number of measures installed. To simplify the model, the uncertainty in the unit energy savings was combined with the uncertainty in the realization rate. The measure effective useful life is also a source of uncertainty, but EUL studies require many years to conduct and are more suitable to a regional study. Thus the EUL uncertainty was not considered.

The uncertainties around the units and RR parameters in the model were estimated, and the overall uncertainty and savings at risk for each program and groups of measures within the portfolio was calculated. The purpose of this exercise is identify the programs and measure groups that represent the biggest risk to the portfolio savings, so that EM&V activities can be focused on these groups to manage the risk.

The combined master workbook contains nearly 1,100 individual measure savings estimates. Rather than assigning uncertainties uniquely to each of these entries, the measures were grouped by categories where the uncertainties are expected to be similar.

Recent evaluation reports were examined to obtain estimates of uncertainties in the installation rate and realization rate parameters. These parameters were identified in the reports, or calculated from the sample sizes used in the reports. If these data were not reported, a default value of 5% for installation rate and 20% for realization rate was used. The uncertainties are expressed as relative precision at 90% confidence. The average values of the uncertainty estimates by program and measure group are shown Tables B-1 through B-8.

Table B-1. Energy Star Appliances

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	**Realization Rate**	**Installation Rate**	**Realization Rate**
Appliance	Air Purifier	5%	20%		
	Clothes washer	5%	20%		
	Dehumidifier	5%	20%		
	Dishwasher	5%	20%		
	Freezer	5%	20%		
	Freezer removal	5%	20%		
	Refrigerator	5%	20%		
	Refrigerator removal	5%	20%		
	Set-top box	5%	20%		
	Smartstrip	5%	20%		
	Water Cooler	5%	20%		
HVAC	Boiler	5%	20%	5%	20%
	Boiler Reset Controls	5%	20%	5%	20%
	Central AC	5%	20%		
	Combo Boiler	5%	20%	5%	20%
	Furnace	5%	20%	5%	20%
	Heat recovery ventilator			5%	20%
	Mini Split Heat Pump	5%	20%		
	Room AC	5%	20%		
	Room AC removal	5%	20%		
	Tstat	5%	30%	5%	30%
Water Heating	HPWH	5%	20%		
	Indirect water heater	5%	20%	5%	20%
	Storage water heater	5%	20%	5%	20%
	Tankless water heater	5%	20%	5%	20%

Table B-2. Energy Star New Homes

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Clothes washer	1%	20%	1%	20%
	Dishwasher	1%	20%	1%	20%
	Refrigerator	1%	20%		
HVAC	Central AC	1%	20%		
	Room AC	1%	20%		
	Tstat	1%	30%	1%	30%
Lighting	CFL	1%	20%		
	CFL Fixture	1%	20%		
	Exterior CFL Fixture	1%	20%		
WB	WB RNC	1%	20%	1%	20%

Table B-3. Energy Star Lighting

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Lighting	CFL	4%	15%		
	CFL Fixture	1%	15%		
	Exterior CFL Fixture	1%	15%		
	LED Fixture	1%	20%		
	LED Lamp	10%	20%		
	Torchiere	10%	15%		

Table B-4. Home Energy Assistance

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Refrigerator	5%	20%		
	Refrigerator removal	5%	20%		
HVAC	Boiler	5%	20%		
	Boiler Reset Controls			5%	20%
	Furnace	5%	20%		
	HVAC- Heating			5%	20%
	Tstat	5%	20%	5%	20%
Lighting	CFL	5%	20%		
	CFL Fixture	5%	20%		
Other	Ancillary	5%	20%		
	Unknown	5%	20%		
Shell	Exterior Door	5%	20%		
	Insulation			5%	20%
	Weatherization	5%	20%	5%	20%
	windows			5%	20%
Water Heating	Storage water heater	5%	20%	5%	20%
	Water heating other	5%	20%	5%	20%

Table B-5. Home Performance with Energy Star

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Refrigerator	5%	43%		
HVAC	Boiler	5%	17%		
	Central AC	5%	17%		
	Furnace	5%	17%		
	Room AC	5%	17%		
	Tstat	5%	30%	5%	30%
Lighting	CFL	5%	17%		
	CFL Fixture	5%	17%		
	Exterior CFL Fixture	5%	17%		
Other	Ancillary	5%	17%		
	Unknown	5%	17%		
Shell	Insulation	5%	50%	5%	50%
	Weatherization	5%	17%	5%	17%
Water Heating	Water heating other	5%	32%	5%	32%
	Water saver	5%	32%		
WB	WB retrofit	5%	17%	5%	17%

Table B-6. Large Commercial and Industrial Retrofit and New Construction

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Refrigerator	1%	20%		
Food service	Combination oven			1%	20%
	Convection oven			1%	20%
	Conveyor oven			1%	20%
	Fryer			1%	20%
	Griddle			1%	20%
	Rack oven			1%	20%
	Steamer			1%	20%
HVAC	Boiler	1%	20%	1%	20%
	Boiler Reset Controls	1%	20%	1%	20%
	Central AC	1%	20%		
	Combo Boiler	1%	20%	1%	20%
	Furnace	1%	20%	1%	20%
	HVAC - Cooling	1%	50%		
	HVAC Unknown	1%	50%		
	HVAC- Heating	1%	50%		
	Infrared Heater	1%	20%	1%	20%
	Mini Split Heat Pump	1%	30%		
	Tstat	1%	30%	1%	30%
	Unit Heater	1%	20%	1%	20%
	VFD	1%	40%		
Lighting	CFL	1%	20%		
	LED Lamp	1%	20%		
	LED Lamps	1%	20%		
	Linear Fluorescent Lighting	1%	10%		
	Occupancy Sensor	1%	20%		
	Parking Lot Lighting	1%	20%		
Other	Custom	1%	50%	1%	50%
	Other	1%	20%		
	Unknown	1%	20%	1%	50%
Process	Compressed air	1%	40%		
	Cool Choice	1%	34%		
	Motor	1%	34%		
	Process	1%	34%		
	Snow maker	1%	34%		
	Steam Traps	1%	34%	1%	34%
Refriger-	Refrigerated Case LED	1%	20%		

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
ation					
Shell	windows			1%	20%
Water Heating	Indirect Water Heater	1%	20%	1%	20%
	spray valve			1%	20%
	Storage Water Heater	1%	20%	1%	20%
	Tankless Water Heater	1%	20%	1%	20%

Table B-7. Municipal

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Smartstrip	5%	20%		
HVAC	Boiler	5%	20%		
	Boiler Reset Controls	5%	20%		
	Central AC	5%	20%		
	Combo Boiler	5%	20%		
	Furnace	5%	20%		
	HVAC - Cooling	5%	20%		
	HVAC Unknown	5%	20%		
	HVAC- Heating	5%	20%		
	Infrared Heater	5%	20%		
	Mini Split Heat Pump	5%	20%		
	Tstat	5%	20%		
	Unit Heater	5%	20%		
	VFD	5%	20%		
Lighting	LED Lamp	5%	20%		
	Lighting Unknown	5%	20%		
	Linear Fluorescent Lighting	5%	20%		
	Occupancy Sensor	5%	20%		
	Parking Lot Lighting	5%	20%		
Other	Custom	5%	20%		
	Other	5%	20%		
	Technical Assistance	5%	20%		
Process	Compressed Air	5%	20%		
	Process	5%	20%		
	Steam Traps	5%	20%		
Water Heating	Indirect Water Heater	5%	20%		
	Storage Water Heater	5%	20%		
	Tankless Water Heater	5%	20%		

Table B-8. Small Commercial and Industrial Retrofit and New Construction

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Appliance	Refrigerator	1%	10%		
	Smartstrip	1%	30%		
Food-service	Combination oven			1%	10%
	Convection oven			1%	10%
	Conveyor oven			1%	10%
	Fryer			1%	10%
	Griddle			1%	10%
	Rack oven			1%	10%
	Steamer			1%	10%
HVAC	Boiler	1%	10%	1%	10%
	Boiler Reset Controls	1%	10%	1%	10%
	Central AC	1%	10%		
	Central HP	1%	10%		
	Combo Boiler	1%	10%	1%	10%
	Furnace	1%	10%	1%	10%
	HVAC - Cooling	1%	50%		
	HVAC Unknown	1%	50%		
	HVAC- Heating	1%	50%		
	Infrared Heater	1%	10%	1%	10%
	Mini Split Heat Pump	1%	30%		
	Tstat	1%	30%	1%	10%
	Unit Heater	1%	10%	1%	10%
	VFD	1%	10%		
Lighting	CFL	1%	10%		
	LED Lamp	1%	10%		
	Lighting Unknown	1%	10%		
	Linear Fluorescent Lighting	1%	10%		
	Occupancy Sensor	1%	10%		
	Vending occupancy sensor	1%	10%		
Other	Custom	1%	50%	1%	50%
	Other	1%	10%		
	Unknown	1%	10%		
Process	Compressed Air	1%	40%		
	Cool Choice	1%	10%		
	Process	1%	34%		
	Steam Traps	1%	34%	1%	34%

End-Use	Measure Group	Electric Measures		Gas Measures	
		Installation Rate	Realization Rate	Installation Rate	Realization Rate
Refriger-ation	Refrigerated Case LED	1%	10%		
Shell	Weatherization			1%	20%
Water Heating	Indirect Water Heater	1%	10%	1%	10%
	spray valve			1%	10%
	Storage Water Heater	1%	10%	1%	10%
	Tankless Water Heater	1%	10%	1%	10%

A propagation of error analysis was used to estimate the uncertainty in the savings estimates for each program from the parameter level uncertainty. As described above, the electricity savings are calculated from:

$$\Delta kWh = units\ x\ \ UES_{kWh}\ x\ RR\ x\ EUL \tag{B.3}$$

Using a propagation of error calculation, the error in the kWh savings is taken as the square root of the sum of the squares of the influence coefficient of each parameter times the error associated with each parameter:

$$e_{\Delta kWh} = \left[\left(\frac{\Delta kWh}{\Delta units} \times e_{units}\right)^2 + \left(\frac{\Delta kWh}{\Delta RR} \times e_{RR}\right)^2 + \left(\frac{\Delta kWh}{\Delta UES} \times e_{UES}\right)^2 + \left(\frac{\Delta kWh}{\Delta EUL} \times e_{EUL}\right)^2\right]^{0.5} \tag{B.4}$$

Since we are only evaluating the errors in the unit count and realization rate terms, this equation reduces to:

$$e_{\Delta kWh} = \left[\left(\frac{\Delta kWh}{\Delta units} \times e_{units}\right)^2 + \left(\frac{\Delta kWh}{\Delta RR} \times e_{RR}\right)^2\right]^{0.5} \tag{B.5}$$

The influence coefficient is simply the change in the savings per unit change in the input parameter:

$$\frac{\Delta kWh}{\Delta units} = RR \times UES_{kWh} \times EUL \tag{B.6}$$

$$\frac{\Delta kWh}{\Delta RR} = units \times UES_{kWh} \times EUL \tag{B.7}$$

The error associated with each parameter is calculated from the relative precision estimates:

$$e_{units} = units \times rp_{units} \tag{B.8}$$

$$e_{RR} = RR \times rp_{RR} \quad \text{(B.9)}$$

Once the error in the savings is estimated, it is useful to tabulate the relative contribution of the error in each term to the overall error. The contribution to variance (CVar) is calculated as the ratio of each individual term to the sum of all terms in the propagation of error calculation:

$$Sum = \left[\left(\frac{\Delta kWh}{\Delta units} \times e_{units}\right)^2 + \left(\frac{\Delta kWh}{\Delta RR} \times e_{RR}\right)^2\right] \quad \text{(B.10)}$$

$$CVar_{units} = \frac{\left(\frac{\Delta kWh}{\Delta units} \times e_{units}\right)^2}{Sum} \quad \text{(B.11)}$$

$$CVar_{RR} = \frac{\left(\frac{\Delta kWh}{\Delta RR} \times e_{RR}\right)^2}{Sum} \quad \text{(B.12)}$$

Similarly, savings for gas measures are calculated from:

$$\Delta MMBtu = units\ x\ \ UES_{MMBtu}\ \ x\ RR\ x\ EUL \quad \text{(B.13)}$$

The error in the gas savings calculation, using the reduced form is:

$$e_{\Delta MMBtu} = \left[\left(\frac{\Delta MMBtu}{\Delta units} \times e_{units}\right)^2 + \left(\frac{\Delta MMBtu}{\Delta RR} \times e_{RR}\right)^2\right]^{0.5} \quad \text{(B.14)}$$

The influence coefficients of the unit count and realization rate terms are:

$$\frac{\Delta MMBtu}{\Delta units} = RR \times UES_{MMBtu} \times EUL \quad \text{(B.15)}$$

$$\frac{\Delta MMBtu}{\Delta RR} = units \times UES_{MMBtu} \times EUL \quad \text{(B.16)}$$

The error associated with each parameter is calculated from the relative precision estimates:

$$e_{units} = units \times rp_{units} \quad \text{(B.17)}$$

$$e_{RR} = RR \times rp_{RR} \quad \text{(B.18)}$$

The contribution to variance of each term is calculated from:

$$Sum = \left[\left(\frac{\Delta MMBtu}{\Delta units} \times e_{units}\right)^2 + \left(\frac{\Delta MMBtu}{\Delta RR} \times e_{RR}\right)^2\right] \quad \text{(B.19)}$$

$$CVar_{units} = \frac{\left(\frac{\Delta MMBtu}{\Delta units} \times e_{units}\right)^2}{Sum} \tag{B.20}$$

$$CVar_{RR} = \frac{\left(\frac{\Delta MMBtu}{\Delta RR} \times e_{RR}\right)^2}{Sum} \tag{B.21}$$

The above examples show the propagation of error and contribution to variance calculations for an individual measure. These calculations can be summed across measures within a measure group, measure groups within a program, and programs within the overall portfolio. The contribution to variance of measure 1 in a measure group consisting of n measures is calculated from:

$$CVar_{Measure1} = \frac{\sum Sum_{Measure1}}{\sum_{Measure1}^{Measuren} Sum_{Measurei}} \tag{B.22}$$

Similarly, the contribution to variance of measure group 1 in a program consisting of n measure groups is calculated from:

$$CVar_{MG1} = \frac{\sum Sum_{MG1}}{\sum_{MG1}^{MGn} Sum_{MGi}} \tag{B.23}$$

Finally, the contribution to variance of program 1 in a portfolio consisting of n programs is calculated from:

$$CVar_{Program1} = \frac{\sum Sum_{Program1}}{\sum_{Program1}^{Programn} Sum_{Programi}} \tag{B.24}$$

The predicted mean energy savings, the uncertainty at 90% confidence for the individual program savings estimates and the contribution to variance of each program to the overall portfolio uncertainties are summarized in the following table:

Table B-9. Electricity Savings by Program (Electric Measures Only)

Program	Total Lifetime Savings (kWh)	% total kWh	Relative Precision	Contribution to Variance
Energy Star Appliance	115,578,068	5.8%	5.3%	1.7%
Energy Star New Homes	58,638,613	2.9%	5.4%	0.4%
Energy Star Lighting	131,599,611	6.6%	5.2%	2.1%
Home Energy Assistance	31,855,416	1.6%	7.8%	0.3%
Home Performance with Energy Star	24,848,681	1.2%	6.4%	0.1%
Large C&I Retrofit and New	929,153,297	46.5%	3.6%	49.4%
Municipal	293,235,985	14.7%	9.8%	37.0%
Small C&I Retrofit and New	413,461,651	20.7%	3.4%	9.0%
Total	**1,998,371,323**	**100.0%**	**2.4%**	

Table B-10. Gas Savings by Program (Gas Measures Only)

Program	Total Lifetime Savings (MMBtu)	% Total MMBtu	Relative Precision	Contribution to Variance
Energy Star Appliance	939,322	14.4%	3.9%	1.0%
Energy Star New Homes	117,682	1.8%	6.5%	0.0%
Home Energy Assistance	300,564	4.6%	6.0%	0.3%
Home Performance with Energy Star	1,122,519	17.2%	8.0%	6.2%
Large C&I Retrofit and New	2,566,708	39.3%	11.7%	69.4%
Small C&I Retrofit and New	1,492,218	22.8%	11.6%	23.1%
Total	**6,539,013**	**100.0%**	**5.5%**	

The following tables show the electricity savings, percent of total electricity savings, uncertainty and contribution to variance by measure group across each program. These tables can be used to identify measure group priorities within each program for future evaluation studies:

Table B-11. Energy Star Appliances

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Air Purifier	1,208,312	1.0%	7.2%	0.0%
	Clothes washer	64,632,252	55.9%	8.9%	89.0%
	Dehumidifier	0	0.0%	0.0%	0.0%
	Dishwasher	0	0.0%	0.0%	0.0%
	Freezer	0	0.0%	0.0%	0.0%
	Freezer removal	3,757,636	3.3%	6.8%	0.2%
	Refrigerator	25,576,672	22.1%	7.5%	9.9%
	Refrigerator removal	8,990,514	7.8%	6.0%	0.8%
	Set-top box	0	0.0%	0.0%	0.0%
	Smartstrip	430,464	0.4%	9.5%	0.0%
	Water Cooler	0	0.0%	0.0%	0.0%
HVAC	Boiler	0	0.0%	0.0%	0.0%
	Boiler Reset Controls	0	0.0%	0.0%	0.0%
	Central AC	138,843	0.1%	10.1%	0.0%
	Combo Boiler	0	0.0%	0.0%	0.0%
	Furnace	1,360,237	1.2%	6.0%	0.0%
	Mini Split Heat Pump	4,860,821	4.2%	3.6%	0.1%
	Room AC	1,437,823	1.2%	8.2%	0.0%
	Room AC removal	2,924	0.0%	9.0%	0.0%
	Tstat	55,116	0.0%	2.9%	0.0%
Water Heating	HPWH	3,126,455	2.7%	3.3%	0.0%
	Indirect water heater	0	0.0%	0.0%	0.0%
	Storage water heater	0	0.0%	0.0%	0.0%
	Tankless water heater	0	0.0%	0.0%	0.0%
		115,578,068	100.0%	5.3%	

Table B-12. Energy Star New Homes

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribution to Variance
Appliance	Clothes washer	577,483	1.0%	8.0%	0.0%
	Dishwasher	365,348	0.6%	7.8%	0.0%
	Refrigerator	1,533,636	2.6%	7.8%	0.1%
HVAC	Central AC	24,027	0.0%	13.5%	0.0%
	Room AC	0	0.0%	0.0%	0.0%
	Tstat	0	0.0%	0.0%	0.0%
Lighting	CFL	1,270,622	2.2%	6.6%	0.1%
	CFL Fixture	4,117,730	7.0%	10.3%	1.8%
	Exterior CFL Fixture	0	0.0%	0.0%	0.0%
WB	WB RNC	50,749,768	86.5%	6.1%	97.9%
		58,638,613	100.0%		

Table B-13. Energy Star Lighting

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribution to Variance
Lighting	CFL	95,612,446	72.7%	6.8%	91.5%
	CFL Fixture	6,539,693	5.0%	5.4%	0.3%
	Exterior CFL Fixture	398,218	0.3%	4.3%	0.0%
	LED Fixture	5,952,919	4.5%	13.8%	1.5%
	LED Lamp	22,849,511	17.4%	7.7%	6.7%
	Torchiere	246,824	0.2%	6.4%	0.0%
		131,599,611	100.0%	5.2%	100.0%

Table B-14. Home Energy Assistance

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Refrigerator	2,839,207	8.9%	10.2%	1.3%
	Refrigerator removal	10,775	0.0%	20.6%	0.0%
HVAC	Boiler	21,450	0.1%	5.0%	0.0%
	Furnace	18,671	0.1%	5.0%	0.0%
	Tstat	550,080	1.7%	20.6%	0.2%
Lighting	CFL	480,906	1.5%	9.3%	0.0%
	CFL Fixture	353,313	1.1%	18.9%	0.1%
Other	Ancillary	368,245	1.2%	2.1%	0.0%
	Unknown	964,717	3.0%	19.0%	0.5%
Shell	Exterior Door	182	0.0%	20.6%	0.0%
	Weatherization	26,058,105	81.8%	9.5%	97.8%
Water Heating	Storage water heater	113,130	0.4%	20.6%	0.0%
	Water heating other	76,634	0.2%	4.8%	0.0%
		31,855,416	100.0%	7.8%	100.0%

Table B-15. Home Performance with Energy Star

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Refrigerator	375,182	1.5%	4.8%	0.0%
HVAC	Boiler	0	0.0%	0.0%	0.0%
	Central AC	14,749	0.1%	5.0%	0.0%
	Furnace	0	0.0%	0.0%	0.0%
	Room AC	10,742	0.0%	5.0%	0.0%
	Tstat	1,570	0.0%	30.4%	0.0%
Lighting	CFL	4,526,534	18.2%	7.4%	4.5%
	CFL Fixture	4,636,633	18.7%	17.7%	26.8%
	Exterior CFL Fixture	56,101	0.2%	4.8%	0.0%
Other	Ancillary	346,733	1.4%	2.2%	0.0%
	Unknown	3,515,390	14.1%	11.7%	6.7%
Shell	Insulation	2,653,496	10.7%	38.6%	41.8%
	Weatherization	8,297,629	33.4%	8.6%	20.1%
Water Heating	Water heating other	0	0.0%	0.0%	0.0%
	Water saver	322	0.0%	5.0%	0.0%
WB	WB retrofit	413,600	1.7%	8.7%	0.1%
		24,848,681	100.0%	6.4%	100.0%

Table B-16. Large C&I

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Refrigerator	236,969	0.0%	20.0%	0.0%
HVAC	Boiler	0	0.0%	0.0%	0.0%
	Boiler Reset Controls	0	0.0%	0.0%	0.0%
	Central AC	0	0.0%	0.0%	0.0%
	Combo Boiler	0	0.0%	0.0%	0.0%
	Furnace	0	0.0%	0.0%	0.0%
	HVAC - Cooling	95,486,070	10.3%	15.0%	18.7%
	HVAC Unknown	3,746,596	0.4%	36.9%	0.2%
	HVAC- Heating	73,404,494	7.9%	21.8%	23.5%
	Infrared Heater	0	0.0%	0.0%	0.0%
	Mini Split Heat Pump	9,098	0.0%	23.5%	0.0%
	Tstat	0	0.0%	0.0%	0.0%
	Unit Heater	0	0.0%	0.0%	0.0%
	VFD	31,489,415	3.4%	13.3%	1.6%
Lighting	CFL	0	0.0%	0.0%	0.0%
	LED Lamp	89,304,849	9.6%	9.9%	7.1%
	LED Lamps	4,415,702	0.5%	10.1%	0.0%
	Linear Fluorescent Lighting	313,776,397	33.8%	2.6%	6.0%
	Occupancy Sensor	20,530,266	2.2%	6.4%	0.2%
	Parking Lot Lighting	54,435,013	5.9%	5.3%	0.8%
Other	Custom	24,415,513	2.6%	28.4%	4.4%
	Other	32,674,683	3.5%	9.8%	0.9%
	Unknown	13,227,120	1.4%	23.2%	0.9%
Process	Compressed air	7,106,444	0.8%	30.5%	0.4%
	Cool Choice	99,325	0.0%	34.0%	0.0%
	Motor	603,616	0.1%	26.4%	0.0%
	Process	148,817,024	16.0%	13.2%	35.2%
	Snow maker	11,783,836	1.3%	11.8%	0.2%
	Steam Traps	0	0.0%	0.0%	0.0%
Refrigeration	Refrigerated Case LED	3,590,868	0.4%	6.2%	0.0%
Water Heating	Indirect Water Heater	0	0.0%	0.0%	0.0%
	Storage Water Heater	0	0.0%	0.0%	0.0%
	Tankless Water Heater	0	0.0%	0.0%	0.0%
		929,153,297	100.0%	3.6%	100.0%

Table B-17. Municipal

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Smartstrip	30,280	0.0%	20.6%	0.0%
HVAC	Boiler	0	0.0%	0.0%	0.0%
	Boiler Reset Controls	0	0.0%	0.0%	0.0%
	Central AC	51,678	0.0%	19.9%	0.0%
	Combo Boiler	0	0.0%	0.0%	0.0%
	Furnace	0	0.0%	0.0%	0.0%
	HVAC - Cooling	87,630	0.0%	5.0%	0.0%
	HVAC Unknown	0	0.0%	0.0%	0.0%
	HVAC- Heating	0	0.0%	0.0%	0.0%
	Infrared Heater	0	0.0%	0.0%	0.0%
	Mini Split Heat Pump	543,028	0.2%	3.8%	0.0%
	Tstat	0	0.0%	0.0%	0.0%
	Unit Heater	0	0.0%	0.0%	0.0%
	VFD	0	0.0%	0.0%	0.0%
Lighting	LED Lamp	0	0.0%	0.0%	0.0%
	Lighting Unknown	256,802	0.1%	16.0%	0.0%
	Linear Fluorescent Lighting	290,907,725	99.2%	9.8%	100.0%
	Occupancy Sensor	0	0.0%	0.0%	0.0%
	Parking Lot Lighting	677,976	0.2%	5.0%	0.0%
Other	Custom	0	0.0%	0.0%	0.0%
	Other	680,865	0.2%	5.0%	0.0%
	Technical Assistance	0	0.0%	0.0%	0.0%
Process	Compressed Air	0	0.0%	0.0%	0.0%
	Process	0	0.0%	0.0%	0.0%
	Steam Traps	0	0.0%	0.0%	0.0%
Water Heating	Indirect Water Heater	0	0.0%	0.0%	0.0%
	Storage Water Heater	0	0.0%	0.0%	0.0%
	Tankless Water Heater	0	0.0%	0.0%	0.0%
		293,235,985	100.0%	9.8%	100.0%

Table B-18. Small C&I

End-Use	Electric Measure Group	Total Lifetime Savings (kWh)	% total	Relative Precision	Contribu-tion to Variance
Appliance	Refrigerator	3,999,748	1.0%	5.0%	0.0%
	Smartstrip	54,468	0.0%	16.8%	0.0%
HVAC	Boiler	0	0.0%	0.0%	0.0%
	Boiler Reset Controls	0	0.0%	0.0%	0.0%
	Central AC	58,233	0.0%	8.6%	0.0%
	Central HP	0	0.0%	0.0%	0.0%
	Combo Boiler	0	0.0%	0.0%	0.0%
	Furnace	0	0.0%	0.0%	0.0%
	HVAC - Cooling	564,777	0.1%	47.6%	0.0%
	HVAC Unknown	836,291	0.2%	25.5%	0.0%
	HVAC- Heating	81,044	0.0%	50.0%	0.0%
	Infrared Heater	0	0.0%	0.0%	0.0%
	Mini Split Heat Pump	-2,497,530	-0.6%	-30.2%	0.3%
	Tstat	0	0.0%	0.0%	0.0%
	Unit Heater	0	0.0%	0.0%	0.0%
	VFD	1,651,000	0.4%	10.0%	0.0%
Lighting	CFL	5,544	0.0%	10.0%	0.0%
	LED Lamp	0	0.0%	0.0%	0.0%
	Lighting Unknown	10,914,380	2.6%	1.0%	0.0%
	Linear Fluorescent Lighting	383,980,395	92.9%	3.7%	99.3%
	Occupancy Sensor	21,765	0.0%	10.0%	0.0%
	Vending occupancy sensor	0	0.0%	0.0%	0.0%
Other	Custom	8,970	0.0%	50.0%	0.0%
	Other	487,803	0.1%	8.0%	0.0%
	Unknown	11,673,542	2.8%	6.2%	0.3%
Process	Compressed Air	0	0.0%	0.0%	0.0%
	Cool Choice	0	0.0%	0.0%	0.0%
	Process	813,372	0.2%	25.6%	0.0%
	Steam Traps	0	0.0%	0.0%	0.0%
Refrigeration	Refrigerated Case LED	807,849	0.2%	8.4%	0.0%
Water Heating	Indirect Water Heater	0	0.0%	0.0%	0.0%
	Storage Water Heater	0	0.0%	0.0%	0.0%
	Tankless Water Heater	0	0.0%	0.0%	0.0%
		413,461,651	100.0%	3.4%	100.0%

The following tables show the gas savings, percent of total gas savings, uncertainty and contribution to variance by measure group across each program. These tables can be used to identify measure group priorities within each program for future evaluation studies:

Table B-19. Energy Star Appliances

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
HVAC	Boiler	225,325	24.0%	6.6%	16.6%
	boiler reset controls	3,599	0.4%	9.8%	0.0%
	Combo Boiler	155,138	16.5%	9.2%	15.3%
	furnace	183,039	19.5%	8.2%	17.0%
	heat recovery ventilator	924	0.1%	5.4%	0.0%
	tstat	221,868	23.6%	11.4%	47.6%
Water Heating	Indirect Water Heater	41,440	4.4%	10.8%	1.5%
	Storage Water Heater	4,395	0.5%	14.0%	0.0%
	Tankless Water Heater	103,595	11.0%	5.1%	2.1%
		939,322	100.0%	3.9%	

Table B-20. Energy Star New Homes

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
Appliance	clothes washer	475	0.4%	1.1%	0.0%
	dishwasher	323	0.3%	9.1%	0.0%
WB	WB RNC	116,885	99.3%	6.5%	100.0%
		117,682	100.0%		

Table B-21. Home Energy Assistance

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
HVAC	HVAC- Heating	2,976	1.0%	4.9%	0.0%
	tstat	4,127	1.4%	12.0%	0.1%
Shell	Insulation	43,948	14.6%	5.4%	1.7%
	Weatherization	247,422	82.3%	7.3%	98.2%
	windows	536	0.2%	20.6%	0.0%
Water Heating	Water heating other	1,554	0.5%	5.7%	0.0%
		300,564	100.0%	6.0%	100.0%

Table B-22. Home Performance with Energy Star

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
HVAC	tstat	1,747	0.2%	11.7%	0.0%
Shell	Insulation	57,928	5.2%	27.6%	3.2%
	weatherization	10,462	0.9%	8.7%	0.0%
Water Heating	Water heating other	542	0.0%	15.8%	0.0%
WB	WB retrofit	1,051,841	93.7%	8.4%	96.8%
		1,122,519	100.0%	8.0%	100.0%

Table B-23. Large C&I

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
Foodservice	Combination oven	4,133	0.2%	9.6%	0.0%
	Convection oven	1,106	0.0%	6.7%	0.0%
	Conveyor oven	2,034	0.1%	10.1%	0.0%
	Fryer	9,360	0.4%	11.8%	0.0%
	Griddle	450	0.0%	10.2%	0.0%
	Rack oven	5,068	0.2%	10.0%	0.0%
	Steamer	2,563	0.1%	10.0%	0.0%
HVAC	boiler	284,594	11.1%	3.8%	0.1%
	boiler reset controls	19,170	0.7%	7.9%	0.0%
	Combo Boiler	5,904	0.2%	14.6%	0.0%
	furnace	4,828	0.2%	11.2%	0.0%
	infrared heater	19,713	0.8%	10.0%	0.0%
	tstat	2,738	0.1%	4.8%	0.0%
	Unit heater	4,428	0.2%	20.0%	0.0%
Other	Custom	2,171,260	84.6%	13.8%	99.9%
Process	Steam Traps	8,167	0.3%	14.8%	0.0%
Water Heating	Indirect Water Heater	13,714	0.5%	7.7%	0.0%
	spray valve	7,030	0.3%	13.9%	0.0%
	Storage Water Heater	126	0.0%	14.2%	0.0%
	Tankless Water Heater	322	0.0%	0.7%	0.0%
		2,566,708	100.0%	11.7%	100.0%

Table B-24. Small C&I

End-Use	Gas Measure Group	Total Lifetime Savings (MMBtu)	% total	Relative Precision	Contribu-tion to Variance
Foodservice	Combination oven	5,422	0.4%	2.8%	0.0%
	Convection oven	10,468	0.7%	3.8%	0.0%
	Conveyor oven	6,084	0.4%	3.8%	0.0%
	Fryer	31,624	2.1%	3.0%	0.0%
	Griddle	1,110	0.1%	2.9%	0.0%
	Rack oven	12,678	0.8%	2.9%	0.0%
	Steamer	10,082	0.7%	3.7%	0.0%
HVAC	boiler	436,865	29.3%	2.3%	0.3%
	boiler reset controls	10,515	0.7%	2.2%	0.0%
	Combo Boiler	9,834	0.7%	4.1%	0.0%
	furnace	8,799	0.6%	2.3%	0.0%
	infrared heater	101,561	6.8%	4.2%	0.1%
	tstat	5,975	0.4%	2.2%	0.0%
	Unit heater	11,045	0.7%	3.4%	0.0%
Other	Custom	648,541	43.5%	26.5%	98.4%
Process	Steam Traps	55,115	3.7%	33.1%	1.1%
Shell	weatherization	23,535	1.6%	9.0%	0.0%
Water Heating	Indirect Water Heater	72,329	4.8%	5.0%	0.0%
	spray valve	15,204	1.0%	5.8%	0.0%
	Storage Water Heater	6,750	0.5%	2.9%	0.0%
	Tankless Water Heater	8,682	0.6%	2.1%	0.0%
		1,492,218	100.0%	11.6%	100.0%

9.3 Appendix C: M&E Recommendations for 2015-2016

Please double click the icon to open the embedded document below:

Team M-E Recs for 2015-16.pdf

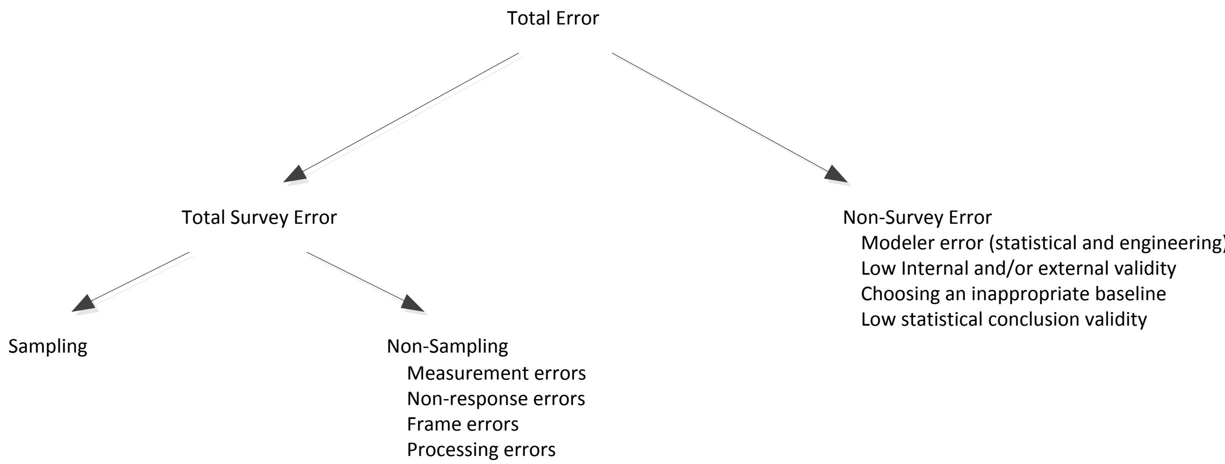
9.4 Appendix D: Illustrative Guideline: Sampling and Uncertainty

The purposes of this Appendix to the *Evaluation Plan Guidance for EEPS Program Administrators* (Guidelines) is to underscore certain methodological principles regarding the reliable estimation of savings, i.e., estimates that are reasonably precise *and* accurate, and to provide additional guidance based on DPS reviews of evaluation plans and completed reports.

Addressing the Multiple Sources of Error

In the design and implementation of any impact evaluation design, evaluators should attempt to cost-effectively mitigate various sources of error in estimating savings. Figure 1 presents a typology of some of the most important sources of error.

Figure 1. Sources of Error in Estimating Energy and Demand Savings



With respect to sampling error, for program-level samples, the minimum standards for confidence and relative precision) were set in the Guidelines at 90/10 for estimating gross energy savings and for customer surveys at the program level. The Guidelines note that if the planned or achieved confidence and precision could not or did not meet the 90/10standard, the plan or final report should clearly indicate the reasons it was not practical and offer a detailed justification. In the Guidelines, the specific approaches to sampling are left up to the evaluator. For example, one can choose from a variety of sample procedures recognized in the statistical literature, such as sequential sampling, cluster sampling, stratified random samples, and stratified ratio estimators. Any of these, and others, could be appropriate depending on the circumstances. There are many available books on sampling techniques that can be used as reference, including Cochran (1977), Thompson (2002), TecMarket Works (2004 and 2005), and Sarndal et al. (1992).

However, in any given study, the potential for bias could be much more important than sampling error (Groves, 2004; Biemer et al., 2004; Lyberg et al., 1997; Biemer and Lyberg, 2003; Lessler and Kalsbeek, 1992; Sonnenblick and Eto, 1995; California Evaluation Framework, 2004; California Protocols, 2005). Unfortunately, some evaluators make the mistake of focusing almost exclusively on reducing sampling error by insisting on large samples while devoting relatively little attention to addressing the many other sources of error. As a result, some studies achieve a high level of confidence and precision around a biased estimate which compromises the objective of obtaining reliable estimates of energy and demand impacts. As appropriate, evaluators should attempt to mitigate the various sources of error in their evaluations. To do so, the evaluator must have the flexibility to respond to data issues as they arise in order to maximize the reliability of the savings (Sonnenblick and Eto, 1995; California *Evaluation Framework,* 2004; California Protocols, 2005).

Thus, given the multiple sources of error and real world budget constraints, evaluators are frequently forced to make tradeoffs in the planning and/or implementation of an evaluation resulting, in some cases, in reduced sample sizes and lower confidence and precision or to seek additional funding for the study. Below are listed a few examples:

- A program might be so small that expending scarce evaluation dollars to achieve the 90/10 level of confidence and precision might not be cost-effective.
- The expected savings could be so uncertain that more evaluation dollars must be allocated to on-site M&V in order to achieve more accurate estimates of savings.
- The expected or observed nonresponse rate could be so high that evaluation dollars must be allocated to address potential nonresponse bias.
- In screening for particular types of customers (e.g., those who have purchased an air conditioner in the last year), the actual incidence could be so low that the planned sample size cannot be achieved.
- In some cases, the evaluator might have underestimated the actual variability in a given parameter in the population (e.g., savings, satisfaction, etc.) making it impossible to achieve the target with the planned sample size.
- After the plan is approved, the client might decide to increase the level of on-site M&V to improve the accuracy of energy and demand estimates thus forcing the evaluator to reduce the sample size.

In their evaluation plans and final reports, evaluators should clearly explain how they addressed the relevant sources of error and their rationale for allocating evaluation dollars to address them.

Weights

In the design and implementation of any sample, there are various situations when weights must be calculated to correct for differential selection probabilities, to adjust for unit non-response, for post-stratification, or for various combinations of these (Skinner et al., 1989; Groves et al., 2004; Kish, 1965; Cochran, 1977; Lee et al., 2006). Because the correct calculation and application of weights are critical, evaluators must clearly explain:

- Why weighting is or is not necessary,
- The information used to calculate the weights, and
- The formulas used to calculate the weights.

Such detailed information can be included in a technical appendix to the final report.

Detailed Guidance

More detailed guidance is provided below on topics noted during reviews of PA impact evaluation plans and reports:

1. *When sampling supply-side market actors, define the target population appropriately so that its members are reasonably homogeneous in terms of their fundamental role in the market.* This is, of course, a matter of degree, and to some extent heterogeneity is exactly what sampling is intended to help manage. For example, one would not want to define the population as something as specific as lighting contractors with 10-25 employees who do 50-75% of their work in the commercial sector. But at the same time, it typically would not be appropriate to define the population as all supply-side actors who have any potential for involvement in the program, because unless the program itself targets a very specific niche, this is likely to include fundamentally different kinds of players, causing summary statistics to have little meaning.
2. *Because there are large variations in the size of different market participants within the same category, often it is desirable to oversample larger players in order to enhance sampling efficiency, and then to down-weight these larger players in the analysis stage in order to ensure accurate representation of the population*. There are standard statistical methods for doing this effectively assuming adequate information is available on the size distribution in the market (see TecMarket Works (2004) and Cochran (1977) for discussions of stratified sampling by size).
3. *Give thought in advance to what characteristics of the market are being investigated, and shape the weighting schemes accordingly.* If the research goal is to represent overall activity and/or transactions in the market, it will generally be desirable to weight by size, reflecting the fact that each large player makes a much larger contribution to overall market activity than does each small player.[29] When the objective is to represent the overall firmographics of the population, then one should not weight by size. Because the same study often incorporates multiple research objectives, it may be appropriate within a single study to weight by size for some analyses and to not weight by size for others.
4. *In forecasting likely precision and estimating needed sample sizes, consider the potential need to disaggregate the results for individual sub-sets of the overall population.* It is relatively unusual for the analysis of an evaluation dataset to begin and end with the overall population. More often there are certain researchable questions for which only subsets of the population are of interest, and other questions that require contrasts between different subsets. When this is the case, the expected precision for the sample as a whole is not a good predictor of the reliability of the results, and a sample that is designed solely around precision objectives for the population as a whole is likely to provide results that are more uncertain than may be desired at various levels of aggregation. Subject to budget constraints, sample designs should therefore take into account what types of sub-population analyses and contrasts are likely to be of interest.

[29] Note that weighting by size in order to accurately reflect the disproportionate contributions of large market players to overall market activity and weighting based on size in order to account for over-sampling of large players done for purposes of sampling efficiency are fundamentally distinct issues. The latter is done as part of an overall sampling strategy that includes differential sampling rates for different size categories and is done in order to enhance sampling efficiency. Such weights are referred to as *stratum* or *expansion* weights. The former is done in order to capture an accurate representation of total market activity, may occur regardless of whether or not large players have been over-sampled for purposes of sampling efficiency, and may be applied only to certain analyses. These weights are the same as those used to calculate weighted means. It is possible for both types of size-related weighting issues to arise in the same study, and even for the purpose of the same analysis. When both types of weighting occur in the same study, it is important to maintain conceptual clarity about these differences.

5. *When there is great uncertainty regarding the overall population size, use the survey itself (to be more specific, typically the screener question(s)) to refine understanding of that issue*. The sources available for the development of a sample frame does not always allow the researcher direct access to the population of interest. Often it is necessary to contact a broader set of respondents, using an up-front screener to identify those who genuinely fall into the target population. This tends to be particularly true of surveys of supply-side actors that use commercial databases such as Dun & Bradstreet. When this occurs, it is critical to use the results of the screener questions to refine the researchers' understanding of the size and firmographic characteristics of the target population. Such analyses can inform both the current study and future studies of the same market. A corollary is that it is often important to design screener questions in such a manner that, before non-qualifying cases are terminated, enough data are collected from them to use in refining understanding of the target population.
6. *Comparisons between two or more subsets of the overall sample (e.g., upstate versus downstate New York) that do not take appropriate account of sample definition and weighting issues as discussed above have significant potential to produce spurious results*. If a sample includes cases from what are in reality multiple fundamentally distinct populations, or cases that are not weighted appropriately to reflect differential sampling rates, then comparisons between key subsets of the sample will likely be inappropriate due to the potential for differences in the composition of the subsamples being compared. For example, if a single statewide sample includes both distributors and contractors, and if distributors tend to be disproportionately based upstate, then the results of unadjusted comparisons between upstate and downstate may simply reflect differences between distributors and contractors rather than meaningful differences between regions.
7. *Beware of the tendency for samples of the general population of supply-side actors to result in a disproportionate number of participants due to differential acceptance rates*. This tendency may call for financial incentives for cooperation with data collection activities, particularly for non-participants.

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9.5 Appendix E: Illustrative Guideline: Reporting and Accessibility Guidance

The purpose of this Appendix is to provide additional guidelines beyond those contained in Appendix B (Checklist for an Evaluation Plan and Report) in the *Evaluation Plan Guidance for EEPS Program Administrators* (Guidelines). These additional details are provided based on DPS review of numerous evaluation plans and reports submitted by the New York Program Administrators.

In order to be able to judge whether the savings estimates are reliable and can be used for planning purposes and assessing progress throughout the State, evaluation reports must be *reviewable* – that is, it must be possible for a reviewer to make an independent assessment of the validity of the reported findings. In order to be reviewable, reports must be clearly written, consistently present key variables and statistics of interest, and be easily accessed. For a given evaluation, the level of effort in meeting these reporting requirements will vary depending on the complexity of the evaluation design with large programs more likely to have more complex designs and, by necessity, more complicated and detailed descriptions of their methods.

Methods

In addition to complying with the methodological standards set forth in the Guidelines, each study must also include, as appropriate, the following methodological details:

- *Approach to Estimating Savings*. Each important step (one that has a substantive effect on the reported savings) in the estimation of key parameters, from data collection, to data cleaning, to construction of analysis datasets, to the analysis, and to final estimates, should be described in sufficient detail so that the analytical process can be understood by another analyst. Such understanding is essential in judging the reliability of the reported results. It is not necessary to discuss how each case was handled with respect to the various methodological issues. For example, with respect to outliers, evaluators should discuss how outliers were defined and, once those cases that met the definition were identified, how they were typically handled (e.g., deletion, weighting, etc.). These descriptions of the methods used to estimating gross and net savings should be included in appendices to the report.
- *Multiple Sources of Error*. Depending on the data collection and analysis methods used, include a description of the efforts made in the planning and implementation of the evaluation plan to address the multiple sources of error including survey error and non-survey error, such as:
    - Sampling Error
        - The sample design (e.g., simple random, stratified random and two-stage)
        - For each key parameter (e.g., energy and demand, realization rates, installation rates, etc.):
            - The achieved confidence, relative precision, and 90% confidence intervals
            - Population size,
            - Achieved sample sizes,

  - Observed variance, standard deviations, and standard errors, and associated formulas.
- Provide a table containing the detailed disposition of the sample consistent with *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys* developed by the American Association for Public Opinion Research (2009) The following rates should be reported: 1) Response Rate 1 (RR1) and 2) Response Rate 3 (RR3). Definitions of each are provided in the *Standard Definitions.* Evaluators may report any other measures of survey outcomes that they think are important such as refusal rates, cooperation rates and contact rates.
- *If the sample design was stratified*, describe the methods that were used to determine strata boundaries and, if the sample is disproportionate, explain why and how the weights were calculated.
- If any post-stratification was used, describe the methods used to determine strata boundaries, how the weights were calculated.

- Non-Sampling Error
  - Measurement error: For example, report efforts to develop valid and reliable questionnaire items (e.g., multiple internal reviews, use of proven questions, etc.), pre-test questionnaires, minimize unit and item nonresponse (e.g., multiple call backs at different times of day, incentives, the use of experienced interviewers, etc.), calibrate instruments for field measurements, etc.
  - Non-response bias: The extent of any suspected non-response bias. There could be unit non-response in which only a subset of those targeted completed the survey. There could also be item non-response in which those who completed survey did not answer all the questions. Any suspected bias should be reported as well as methods and the assumptions underlying these methods to mitigate any bias.
  - Sample frame error: For example, report efforts to construct appropriate sample frames, the extent to which the effort was successful and what the implication are.
  - Data processing errors: For example, describe the development of QA/QC systems to insure accurate collection and storing of data.

- Non-Survey Error
  - Modeler error (statistical and engineering): For example, describe efforts to provide guidelines for calibration of DOE-2 models using customer billing data or efforts to insure that regression diagnostics were routinely conducted by all modelers.
  - Internal and external validity[30]. In studies where the effort is designed to test causal hypotheses, describe how the selected research design addresses both internal and external validity.

[30] Internal validity refers to inferences about whether the experimental treatments made a difference in a specific experimental instance, i.e., it addresses the causes of the outcomes that you observed in your study. External validity addresses the ability to generalize the results of a study to other people and other situations (Shadish, Cook and Campbell, 2002).

  - Self-selection: Self-selection is such an important threat to internal validity that it deserves special mention[31]. Discuss the extent to which self-selection effects are believed to pose a significant threat to the internal validity of key findings, providing both empirical findings and/or theoretical reasoning to support the conclusions reached. If self-selection effects are believed to pose a significant threat to validity, explain how these were addressed.
  - Choosing an inappropriate baseline: Describe the baseline chosen and why it was chosen. For example, in a replacement on burnout situation, selecting the old equipment as the baseline would overestimate the gross savings.
  - Statistical conclusion validity: In studies where the effort is designed to test causal hypotheses, describe why the statistics used to establish whether the independent and dependent variables covary are appropriate.
- Data Documentation: While not required to submit the data associated with each evaluation report, PAs should be prepared to respond to DPS request for such data, particularly for programs with large savings. In anticipation of such request, the data associated with statistical and engineering approaches to estimating gross and net savings should be well documented. Each key dataset should contain a data dictionary and the role it played in the estimation of savings.

Access

Once an evaluation report is completed, it should be converted to a PDF file and links to the PDF report should be placed on a publicly accessible web site. Along with the PDF file, the following information should be provided to enable potential users to judge the relevance of the study to their needs:

- Title of Report
- Author
- Sponsoring agency
- Program operator
- Publication date
- Program year
- Customer sector (i.e., residential, commercial, industrial, agricultural)
- Abstract

References

Shadish, William R., Thomas D. Cook, and Donald T. Campbell. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. New York: Houghton Mifflin Company.

The American Association for Public Opinion Research. (2009). *Standard Definitions: Final Dispositions of Cases Codes and Outcome Rates for Surveys: Revised 2009*. http://www.aapor.org.

[31] Self-selection refers to situations in which subjects decide the treatment condition they will enter. Self-selection bias can occur when selection results in differences in subject characteristics between treatment conditions that may be related to outcome differences (Shadish, Cook and Campbell, 2002).

Yarbrough, Donald B., Lyn M. Shulha, Rodney K. Hopson, and Flora A. Caruthers. (2011). *The Program Evaluation Standards: A Guide for Evaluators and Evaluation Users*. Los Angeles, CA: SAGE Publications.

9.6 Appendix F: Illustrative Guideline: Data to be Collected for Program Evaluation Purposes

1. For each program, this list contains the data elements to be routinely collected and maintained, as applicable, for each measure for each participant in a program. These data must be maintained in electronic form by PAs to measure the progress of their energy efficiency programs. This revised list contains data elements required by the Technical Manual Appendix M and N. The program-tracking database must be maintained at the measure level. The participant-level data will serve as the foundation for the monthly, quarterly, and annual reports required by the DPS. There are a number of variables that must be included in any program-tracking database. These should be available to the DPS staff and evaluation contractors within 30 days following a data request. For details on the requirements of the program tracking database for midstream, upstream and public awareness program information, please see the reporting manual, which is available on the EEPS evaluation web page.
2. **Table: Variables Required for Participant-Level Program-Tracking Databases for Downstream Incentive Programs**

Tracking Database Variables	Definition of Variables
PA/PROGRAM INFORMATION	
Program administrator	Utility or NYSERDA
Program ID	Program ID will be assigned by DPS at a later date.
Program name	Program name
PARTICIPANT INFORMATION [1]	
Participant first name	Participant first name
Participant last name	Participant last name
Participant telephone number	Participant telephone number
Participant fax number	Participant Fax number
Participant E-Mail address	Participant E-Mail address
Service street address	Street address at which measure was installed
Service city	City in which measure was installed
Service ZIP code	ZIP code associated with the service street address and city
Weather station assignment number [2]	The weather station ID assigned to the participant service address
Account number	Utility account number affected by the installation of the efficient measures

[1] See Appendix D for the Customer Data Guidelines, which clarify the process for maintaining the confidentiality of customer data. Usually, the participant is the end user (i.e., the person on whose premises the measure was installed and who received the rebate). In some cases, the participant could be a building owner who is renting to either residential or nonresidential tenants and who receives the rebate for installing measures in apartments or offices.

[2] Weather data (heating and cooling degree days) will be obtained from PA-maintained weather stations or from NOAA weather stations which have been mapped to customer sites based on ZIP codes.

Tracking Database Variables	Definition of Variables
Meter number	The meter number associated with the account number affected by the installation of efficient measures
Service turn-on date	The date of service turn for the program participant
Rate classification	Rate classification
Site-specific primary NAICS [3]	The two-digit NAICS for the affected dwelling/building
Building type/dwelling type [4]	Description of the dwelling or building type
KEY PROJECT DATES [5]	
Program application date [6]	Program application date
Application approval date	Date on which application was approved
Post-installation inspection date	Date on which measure installation was inspected on site by program administrator. Note that post-installation inspection dates may not be available or they might only be available for a sample of program participants.
Rebate payment date	Date on which rebate check was issued.
MEASURE AND REBATE INFORMATION	
Measure-project name	Name of measure
Measure description	Description of the measure
Measure quantity	Quantity of the measure
Unit description	Description of the unit (e.g., tons, square feet, lamp)
Rebate amount per unit [7]	Rebate amount per unit
Financing amount per unit	Financing amount per unit
INSTALLATION-TYPE INFORMATION	
Type of Installation (TRC Approach)	A flag indicating whether the record is a case of normal, early, or special circumstance replacement or an add-on measure. ER=Early Replacement; NR=Normal Replacement; SC=Special Circumstance; AO=Add On.

[3] The North American Industry Classification System (NAICS) was developed as the standard for use by Federal statistical agencies in classifying business establishments for the collection, analysis, and publication of statistical data related to the business economy of the U.S. NAICS replaces the Standard Industrial Classification (SIC) system.

[4] A list of common facility or building types or codes (e.g., DOE 2 Model Types; NYSERDA list of facility types) is included in the Technical Manual.

[5] The program application date, the application approval date, and the rebate payment date must be provided. For projects in which the application is received, approved, and a rebate is paid to the participant all in the same day, the date would be the same for all three variables.

[6] The application date is the date on the application, or if that is missing, the date on which the administrator received the application.

[7] PAs could design rebates on various bases (e.g., per bulb, per refrigerator, per pool pump, per ton in the case of chillers or per cubic feet for insulation). If incentives are based on performance (whole building or custom project), the unit would be "1" and the rebate per unit would be the total rebate received.

Tracking Database Variables	Definition of Variables
Effective Useful Life (EUL)	The effective useful life (median number of years that measure is expected to remain in use based on national data) of the measure being installed, as prescribed by the Commission, or, if none prescribed, as estimated by the PA.
Remaining Functional Period	**For Add-on measures:** N/A **For normal, end of life replacements (this includes breakdowns prior to and after the EUL):** N/A **For early replacements:** The remaining useful life (RUL), which is the EUL minus the actual or estimated age of the old equipment in place. For more details, see Appendix M of the Technical Manual. **For special circumstance replacements:** The default functional period (DFP) which is ¼ of the EUL (rounded to the nearest whole number) of the efficient measure being installed. For more details, see Appendix N of the Technical Manual.
Adjusted EUL	**For Add-on measures:** N/A **For normal, end of life replacements:** N/A **For early replacements:** That number of years at full savings in which the present value of savings approximates that of the dual baseline approach set forth in tables in Appendix M of the Technical Manual. **For special circumstance replacements:** That number of years at full savings in which the present value of savings approximates that of the dual baseline approach set forth in tables in Appendix N of the Technical Manual.

Tracking Database Variables	Definition of Variables
Measure Resource cost (including installation) per unit	**For add-on measures:** The full cost of the measure **For normal, end of life replacements:** The incremental cost between the currently-on-the-market standard, minimally-compliant equipment and the new, efficient equipment[8] **For early replacements:** The adjusted full cost of the new efficient equipment. For more detail, see Appendix M of the Technical Manual. **For special circumstance replacements:** The adjusted full cost of the new efficient equipment. For more detail, see Appendix N of the Technical Manual.
Ratio of incremental savings to full savings	**For add-on measures:** N/A **For normal, end of life replacements:** N/A **For early replacements:** For more detail, see Appendix M of the Technical Manual. The ratios appear as column headers in the tables. **For special circumstance replacements:** For more detail, see Appendix N of the Technical Manual.
Ratio of incremental costs to full costs	**For add-on measures:** N/A **For normal, end of life replacements:** N/A **For early replacements:** For more detail, see Appendix M of the Technical Manual. The ratios appear as column headers in the tables. **For special circumstance replacements:** For more detail, see Appendix N of the Technical Manual.
PROJECT SAVINGS INFORMATION	

[8] If PAs can track incremental costs by measure or project in their program tracking databases, they should do so. However, this might not always be possible. In some cases, incremental costs for measures may be obtained from another source (e.g., the NYSERDA Measure-Level Database) and assigned to individual measures. Because it is assumed that PAs have reviewed the incremental costs of measures they promote as part of the technology screening process, the identification of incremental costs is expected to be relatively straightforward. Note that there may be some cases in which the installation costs of the efficient equipment are larger than the installation costs of the standard equipment. The formula for estimating incremental costs should be documented.

Tracking Database Variables	Definition of Variables
Estimated gross first-year kWh savings per unit[9]	**For add-on measures**: Use full first-year gross first-year kWh savings per units **For normal, end-of-life replacements**: Use incremental gross first-year kWh savings per unit **For early replacements**: Use full first-year gross first-year kWh savings per units **For special circumstance replacements**: Use full first-year gross first-year kWh savings per units
Source of Estimated First-Year Gross Savings	Enter "TM" for calculations based on Technical Manual, "C" for custom measures, or "O" for calculations based on some other database.
Variance from Technical Manual	For measures in the Technical Manual, what is the ratio (e.g., 0.80 or 1.0 if no difference) of the gross first-year savings reported above to the gross first-year savings calculated using the Technical Manual. If measure not in the Technical Manual, enter "NA."
Estimated gross first-year on-peak kW savings per unit (NYISO)	**For add-on measures**: Use full first-year gross kW savings per units **For normal, end-of-life replacements**: Use incremental first-year gross kW savings per unit **For early replacements**: Use full first-year gross first-year kW savings per units **For special circumstance replacements**: Use full first-year gross first-year kW savings per units
Estimated gross first-year therm (natural gas) savings per unit	**For add-on measures**: Use full first-year gross first-year therm savings per units **For normal, end-of-life replacements**: Use incremental gross first-year therm savings per unit **For early replacements**: Use full first-year gross first-year therm savings per units **For special circumstance replacements**: Use full first-year gross first-year therm savings per units
Net-to-gross ratio [10]	Net-to-gross ratio

[9] Gross savings are defined as the change in energy consumption and/or demand that results directly from program-related actions taken by participants in the DSM program. The gross savings reported by the PAs are referred to as *ex ante* values since they have not been adjusted by *ex post (after measure installation)* evaluation efforts. If the project is a custom measure then all savings can be at the project level rather than per unit.

Tracking Database Variables	Definition of Variables
Estimated net first-year kWh savings per unit [11]	Estimated net first-year kWh savings per unit
Estimated net first-year on-peak kW savings per unit (NYISO)	Estimated net first-year on-peak kW savings per unit according to NYISO peak, as defined in the Technical Manual.
Estimated net first-year therm savings per unit	Estimated net first-year therm savings per unit
Gross coal savings per unit	Gross coal savings per unit consistent with the gross first-year savings per unit reported above.
Gross kerosene savings per unit	Gross kerosene savings per unit consistent with the gross first-year savings per unit reported above.
Gross oil savings per unit	Gross oil savings per unit consistent with the gross first-year savings per unit reported above.
Gross propane savings per unit	Gross propane savings per unit consistent with the gross first-year savings per unit reported above.
Gross water savings per unit	Gross water savings per unit consistent with the gross first-year savings per unit reported above.

[10] Program Administrators should use the NTGR value (0.90) in the current Technical Manual, unless Staff has accepted a more appropriate value from a study on a case by case basis. The goal of the default NTGR is to establish a consistent starting point for all PAs.

[11] Net savings are the total change in load that is attributable to the utility DSM program. This change in load may include, implicitly or explicitly, the effects of spillover, free riders, state or federal energy efficiency standards, changes in the level of energy service, and natural change effects. The net savings reported by the PAs are referred to as ex ante values since they have not been adjusted by ex post (after measure installation) evaluation efforts.

9.7 Appendix G: NEEP Glossary of Terms

The NEEP Glossary of Terms is available at:
http://neep.org/Assets/uploads/files/emv/emv-products/EMV_Glossary_Version_2.1.pdf