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Efficiency Maine
Multifamily Efficiency Program Evaluation
Final

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With subcontractor

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1. Executive Summary

1.1 Evaluation Objectives

Efficiency Maine Trust contracted with Opinion Dynamics and subcontractor Lexicon Energy Consulting (the evaluation team) to conduct a comprehensive independent evaluation of the Multifamily Efficiency Program (MEP) to assess progress and impacts and to inform potential continuation and expansion of the program. Through this evaluation, the Trust seeks both a systematic assessment of program implementation and verification of the energy savings achieved.

This evaluation also fulfills the requirements as outlined in the Better Buildings State Energy Program (SEP) grant contract between the Trust and the Department of Energy.

The evaluation period for this report comprises the launch of the program in July 2012 through September 30, 2013.

1.2 Evaluation Methods

The evaluation team conducted a variety of activities supporting this evaluation of the Multifamily Efficiency Program (MEP). They include:

- Engineering reviews of 33 projects
- Site visits of 10 projects
- Review of the MEP Prescriptive Tool
- Assessment of net impacts
- Assessment of cost-effectiveness
- Interviews with MEP implementation staff
- Interviews with MEP Program Partners
- Survey of participating MEP building owners

1.3 Key Findings

Gross Impact Results

We estimated program-level *ex post* (evaluated) gross impacts by developing separate realization rates for fossil fuel and electricity savings for a sample of evaluated projects. We then multiplied these realization rates by *ex ante* (program-reported) estimates of program-level fossil fuel savings and program-level electric savings, respectively. The estimated realization rates along with annual *ex ante* and *ex post* gross savings are listed in Table 1-1 for projects completed during the evaluation period (July 2012 through September 2013). Evaluated fossil fuel savings were 69% of reported savings and evaluated electric savings were 107% of reported savings.

Table 1-1. Annual Program-Level *Ex Ante* and *Ex Post* Gross Impacts

	Fossil Fuel Savings (MMBtu)	Electric Savings (kWh)
Ex Ante Gross Savings	10,995	258,754
Realization Rate	0.69	1.07
Ex Post Gross Savings	7,567	277,844

Net Impact Results

Based on participant surveys, the evaluation team estimated a program net-to-gross ratio (NTGR) of 0.90 for the evaluation period. A NTGR of 0.90 means that 90% of verified (*ex post*) gross savings can be reliably attributed to the program.

Table 1-2. Multifamily Efficiency Program NTGR

Component	Value
Free-Ridership (FR)	0.11
Participant Spillover (SO)	0.01
NTGR = (1- FR - SO)	0.90

Net program impacts are calculated by multiplying the NTGR by *ex post* gross program savings. This calculation yields annual program-level net impacts for the evaluation period of:

- 6,779 MMBtu of fossil fuel savings (103 MMBtu per project)[1] and
- 248,916 kWh of electric savings (3,771 kWh per project).

Cost-Effectiveness Analysis

Our analysis of the MEP through September 2013 found that the program is cost-effective for all three tests performed: the Total Resource Cost test (TRC), the Program Administrator Cost Test (PACT), and the Participant Cost Test (PCT). All tests show a positive net present value and a benefit-cost ratio that exceeds 1.0. This analysis is based on the 66 projects that were completed between the launch of the program and September 2013.

Estimated benefit-cost ratios for the program are:

- TRC = 1.16
- PACT = 1.23
- PCT = 3.62

Other Impact Findings

- As part of our engineering review of the 33 sampled projects, we carefully examined all project documentation and materials supporting the project application. Overall we found project

[1] 103 MMBtu are equivalent to 744 gallons of heating oil.

documentation to be good. However, we identified a few types of required post-project documentation that was generally not present (post-inspection blower door test results) or not fully reported (post-inspection reports). More consistent inclusion of this type of information would provide better estimates of savings for some measures, enhance program quality control efforts, and facilitate the impact evaluation process.

- We found that the program's Excel spreadsheet for calculating energy savings for the prescriptive path (i.e., the "Prescriptive Tool") agrees well with the MEP Technical Reference Manual (TRM) and correctly implements the algorithms in the TRM for the energy efficiency measures that were part of our gross impact sample.
- Implementation staff closely followed the procedures outlined in the TRM to estimate ex ante savings. However, we identified several issues with the Prescriptive Tool and the TREAT software used by the program that systematically generated higher estimates of program-reported (ex ante) savings relative to evaluated (ex post) savings.
  - With respect to the Prescriptive Tool, we found that: (1) the Tool can generate total project energy savings estimates nearly as great as the total fossil fuel energy consumed annually at the site or greater than the portion of the fossil fuel used for heating; (2) the Tool does not take into account interactive effects between certain measures that would reduce total savings; and (3) the Tool produces very high estimates of savings from low flow device savings.
  - With respect to TREAT, we found that the modeling software predicts high MMBtu savings for duct sealing (between 30% and 45% of a building's annual heating fuel usage) and for wall/foundation insulation (considerably greater than insulation savings in the Prescriptive Tool) .
- At the site visits to completed projects, we generally found very good agreement between the program-reported energy improvements and the observed improvements on site.
- Several buildings that participated in the MEP during the evaluation period also received an incentive through Efficiency Maine's Natural Gas Program for the installation of new high efficiency boilers or furnaces. We found that the MEP did not follow the agreed-upon method of allocating savings between the two programs that was in effect at that time; as a result, the MEP over-claimed savings for several boilers/furnaces. We made adjustments to allocate savings between the MEP and the Natural Gas Program consistent with the program guidelines at the time; these accounted for the single largest reduction of *ex ante* fossil fuel savings and significantly affected the realization rate for boilers/furnaces and for the program overall.[2]

Process Evaluation

Program Participation

- During the evaluation period, 35 building owners completed 66 building retrofit projects (comprised of 638 apartment units) through the MEP. In addition, the program benchmarked 2,795 units and approved ERPs for 1,779 units. By September 30, 2013, the original end date of the program, the

[2] It should be noted that as of December 2013, the MEP no longer allows participants to receive an incentive through the MEP and the Natural Gas Program for the same boiler or furnace.

MEP had achieved 112% of its goal set for benchmarked units, but had not yet met its goals for units with approved ERPs (81%) and units retrofitted (35%).[3]

- The most common measures installed through the program were air sealing (76%), roof/attic insulation (68%), low-flow devices (59%), and boilers/furnaces (58%).
- Thirteen Program Partners had approved MEP ERPs as of August 14, 2013.

Partner Experience

The following themes emerged from our interviews with seven Program Partners:

- **The ERP development and review process got mixed reviews.** Some Partners cited this process as a major barrier to their participation in the program (causing a few of them to stop participating in the program as of the time of the interview). Other Partners cited the process as a primary strength of the program as it ensures quality and depth of savings.
- **The upfront charge for the energy assessment is not a barrier to participation for building owners.** Interviewed Partners followed two different strategies with respect to the pricing of the energy assessment. About half provided them at a loss, for $100 to $200 (hoping they would recover the loss through the retrofit phase, which generally did not work out). The other half charged between $300 and $400 for the assessment, with some variations in terms of flat fees versus per unit fees and discounts after a certain number of units.
- **The Prescriptive Tool is generally easy to use.** However, a few partners commented on the results the Tool produced, specifically in relation to interactive effects between measures, thermal insulation savings projections, and results being very different from those produced by other software.
- **Partners generally expressed a desire for more TREAT training.** TREAT has a steep learning curve. However, Partners thought it was relatively easy to use once you learn how to use it.
- **The program encouraged deeper retrofits.** Interviewed Partners thought that some new heating systems would have been installed in the near future without the program (although possibly at a different level of efficiency) because the existing systems were old and needed to be replaced. However, Partners also reported that without the program, many or all of these projects would have had their scope significantly reduced, losing the deeper savings achieved through the program.
- **Overall Partner satisfaction with the MEP was mixed.** Four of the seven interviewed Partners reported being very satisfied or somewhat satisfied with the program, while three reported being not at all satisfied or not very satisfied. The difference in Partner satisfaction generally centered around their opinion of the ERP review and development process (described above).

[3] The program received an extension of the grant period and is ongoing. As of February 11, 2014, 3,231 units had been benchmarked (129% of goal), 2,373 had an approved ERP (108% of goal), and 1,250 were retrofitted (75% of goal).

Building Owner Experience

The following themes emerged from our interviews with participating building owners:

- **Word-of-mouth is an important method of promoting the MEP.** Nearly half of interviewed building owners (41%) reported initially learning about the program through business partners or other building owners.
- **Financial factors are the major barrier for building owners to make energy efficiency upgrades to their buildings.** Building owners, as well as Program Partners, cited financial factors (including the upfront cost and lack of financing) as the major barrier to making buildings more energy efficient. Accordingly, both building owners and Partners reported financial reasons to be the primary motivator for participation in the program.
- **Building owners are very satisfied with the MEP.** All but one interviewed building owner said that they would recommend the MEP to other building owners.
- **Upgrades installed through program resulted in lower energy bills and increased tenant comfort.** Building owners who pay their building's energy bills reported almost unanimously that their energy bills went down after making the energy efficiency improvements. Some participants also reported positive feedback from the tenants, including increases in comfort and reduced tenant energy bills.

1.4 Opportunities for Program Improvement

Based on the evaluation activities and findings summarized in this report, the following are opportunities for program improvement Efficiency Maine may wish to consider:

Impact Evaluation

- **Prescriptive Tool.** If, going forward, the MEP continues to offer a prescriptive path that considers savings as a percentage of baseline fuel usage, we recommend the following:
  - More closely review projects that have a high ratio of savings to total annual fuel use or heating fuel use.[4]
  - Build consideration of interactive effects into the MEP TRM and the Prescriptive Tool, e.g., in the form of factors that are applied when measures are installed in certain combinations.
  - Conduct further research into the MEP TRM values for low flow devices.[5]
- **Use of TREAT Model.**
  - Duct Sealing: For purposes of meeting the required minimum savings to qualify for the retrofit incentive, consider capping duct sealing at no more than 20% of estimated heating fuel usage.

[4] According to the implementation team, a newer version of the Prescriptive Tool (released after the evaluation period), includes a more visible check of projected savings as a percentage of fuel usage.

[5] According to the implementation team, the algorithms for low flow devices and pipe insulation have been corrected in a new version of the TRM and Prescriptive Tool.

- Consider applying an adjustment factor for "wall insulation" savings estimated in TREAT so that claimed savings that better reflect the insulation actually installed.

- **General.**
  - For boilers and furnaces that also receive an incentive through the Efficiency Maine Natural Gas Program, ensure that only the MEP share of savings is claimed for this program.[6]

Process Evaluation

- Continue to provide TREAT training on an ongoing basis and encourage Partners new to TREAT to complete the training before participating in the program.
- Promote the streamlined participation process available under the Program for prescriptive projects among Partners and among former and prospective participants, who might be reluctant to participate in the program given what they have heard about the original participation process.

[6] As of December 2013, the MEP no longer allows participants to receive an incentive through the MEP and the Natural Gas Program for the same boiler or furnace.

2. Introduction

2.1 Evaluation Objectives

Efficiency Maine Trust contracted with Opinion Dynamics and subcontractor Lexicon Energy Consulting (the evaluation team) to conduct a comprehensive independent evaluation of the Multifamily Efficiency Program (MEP) to assess progress and impacts and to inform potential continuation and expansion of the program. Through this evaluation, the Trust seeks both a systematic assessment of program implementation and verification of the energy savings achieved.

This evaluation also fulfills the requirements as outlined in the Better Buildings State Energy Program (SEP) grant contract between the Trust and the Department of Energy.

The evaluation period for this report comprises the launch of the program in July 2012 through September 30, 2013.

2.2 Program Description

The Efficiency Maine Multifamily Efficiency Program (MEP) offers building owners free benchmarking of their buildings and incentives for the development of an Energy Reduction Plan (ERP) and the installation of energy efficiency measures in small to medium (5- to 20-unit) multifamily buildings. The program is funded by a $4.5 million grant awarded under a U.S. Department of Energy (DOE), State Energy Program (SEP) Special Project funds competitive solicitation. In the summer of 2013, the program received an extension of the grant period from September 30, 2013 to March 31, 2014.

A team of implementation contractors – including TRC, the Sparhawk Group, and Vreeland Marketing – delivers the MEP. The program delivery contract commenced in May 2012. In addition to the implementation team, the program also leverages a network of approved Program Partners to market the program among their customers and implement projects. Program Partners are not required to conduct the benchmarking, but have to develop the ERP and be involved in the retrofit phase of any project.

Under the program design in effect from program inception through December 2013 (covering all of the evaluation period), the program required all projects to go through benchmarking and completion of an energy assessment and approval of an ERP. Two incentives were offered: the first after completion of an energy assessment and approval of an ERP, and the second after the installation of energy efficiency measures in accordance with the ERP. To be eligible for incentives, projects were required to have estimated energy savings of at least 20% of their baseline fuel consumption. The program offered two options (or paths) to estimate project savings and develop the ERP: 1) the prescriptive path, for which savings are calculated based on algorithms embedded in an Excel based tool developed by the program (the “Prescriptive Tool”) and 2) the modeling path, for which savings are calculated using the Targeted Retrofit Energy Analysis Tool (TREAT) modeling software.

In January 2014, Efficiency Maine modified the program design to add a discrete set of prescriptive measures for which incentives are available without the requirement of the upfront energy assessment or the minimum project-level energy savings threshold of 20%. Under “MEP 2.0,” participants have the added option of engaging a Program Partner to install prescriptive measures falling into 10 different measure categories and receive an incentive of up to $1,000 per retrofitted apartment; the previously existing approaches (development of an ERP using the Prescriptive Tool or TREAT) are also still available.

It should be noted that these program design changes were implemented after our evaluation activities had been completed and are therefore not directly considered in this report. However, where applicable, we acknowledge these modifications, especially in the context of recommendations that more directly apply to the original (and now defunct) program design.

2.3 Organization of Report

The remainder of this report is organized as follows:

- **Section 3: Evaluation Data and Methodology** presents information on the data used in this evaluation, including a description of the primary data collection efforts, as well as the methodologies used for the assessment of program impacts.
- **Section 4: Impact Evaluation** presents the results of the gross and net impact analyses of the MEP, as well as the cost-effectiveness analysis.
- **Section 5: Process Evaluation** presents findings from the process evaluation, including information gathered from Program Partners and participating building owners.
- **Section 6: Findings and Recommendations** summarizes the findings from our research efforts and provides recommendations for program improvement.

The report has the following appendices:

- **Appendix A: Other Supporting Information for Gross Impact Analysis** presents more detailed gross impact results by path of participation (prescriptive or modeling).
- **Appendix B: Building Owner Survey Dispositions** presents the disposition as well as the response and cooperation rates for the participating building owner survey.

3. Evaluation Data and Methodology

3.1 Evaluation Data

The impact and process evaluations of the MEP rely on several data sources, including the program tracking database and primary data collected through in-depth interviews with Program Partners, a survey of participating building owners, and on-site audits. Each data source is described in the following subsections.

3.1.1 Program Tracking Data

The MEP is supported by a tracking database (the Portal) developed and maintained by TRC. The Portal contains a host of information on all MEP projects in different phases of completion (application, ERP, construction, complete). The implementation team uses the Portal to manage the program and track the status of individual MEP projects. It includes information on project timelines, installed measures, and savings. It also includes much of the supporting documentation for each project, including application forms, utility data, and the completed ERP. In addition, Program Partners have access to the "Partner Portal," where they can view their projects and access general program information such as program announcements and news, forms and tools, and other documents and information designed to help Partners navigate the program participation process.

The evaluation team relied on the Portal for information needed to develop the samples for the desk reviews, site visits, and the building owner survey, and for project-specific information about the 33 projects sampled for a desk review. In addition, the evaluation team received project documents not available on the Portal (e.g., site inspection reports and photo documentation) directly from the program implementation team.

3.1.2 Interviews with Program Partners

Opinion Dynamics conducted seven in-depth interviews with Program Partners in August and September of 2013. Topics of these interviews included program participation, barriers to participation, customer awareness of the MEP, marketing and outreach, discussion of the modeling software and/or prescriptive tool used in the program, pricing of energy assessments, the retrofit process, and satisfaction with the program.

Sampling

The sample for the Program Partner interviews was based on 13 Program Partners who had approved ERPs under the program as of August 14, 2013. Three of these Partners had only one approved ERP; we excluded these Partners from our sample frame in an effort to interview Partners who had greater experience with the MEP. We attempted to reach all 10 Partners with two or more approved ERPs (census attempt) and completed interviews with seven of them.

Partner Characteristics

The seven interviewed contractors represented a broad range of activity in the program:

- The interviewed Partners reported completing between one and 41 building retrofits through the program, and benchmarking between zero and 43 buildings.
- Three of the interviewed Partners have 10 or more employees, while the other four Partners have fewer than five employees.

- Five of the seven interviewed Partners are primarily auditing and/or consulting firms; these firms do not perform construction and/or retrofits as a primary part of their business.
- Two of the interviewed Partners report that they no longer pursue jobs through the MEP.[7]

3.1.3 Survey of Participating Building Owners

Opinion Dynamics conducted a computer-assisted telephone interviewing (CATI) survey with 18 building owners that participated in the MEP during the evaluation period. This survey supported the process and net impact evaluations presented in this report.

The survey explored a variety of aspects of participants' experiences, including program marketing and communications; perceptions of and satisfaction with the program participation process (including their experience working with Program Partners and contractors); barriers to participation; changes in energy use since participating in the program; and recommendations for improving program delivery. In addition, the survey collected general building information and explored attribution of energy efficiency installations to program efforts (free-ridership and participant spillover).

Opinion Dynamics' Utah-based telephone interviewing center conducted the interviews in December 2013. In order to complete interviews with as many building owners as possible, TRC reached out to all participating building owners via email and phone before Opinion Dynamics attempted to contact them. The overall response rate was 53%, with a cooperation rate of 75%—both high, indicating that this outreach was effective in improving cooperation. (See Appendix B for information on how the response and cooperation rates were calculated.)

Sampling/Weighting

The sampling unit for the survey was the unique building owner. The sample was based on the 35 unique building owners who had completed projects by September 30, 2013 (in total, they had completed 66 projects). One of these building owners was on Opinion Dynamics' "do-not-call" list and was therefore removed from the sample frame. The sample frame for this survey therefore included 34 participating building owners, and we attempted to reach all of them (census attempt).

In support of the net impact analysis, the survey asked building owners about their decision-making for one completed project. For building owners in the sample frame who had more than one completed project, we randomly selected the project about which we asked.

Because our sampling strategy was a census attempt, there is no sampling error associated with the survey results. We weighted net impact results by the savings of the sampled projects.

[7] We include information about these partners, reported for the timeframe in which they were active in the program.

3.1.4 On-Site Visits

The evaluation team conducted 10 site visits of buildings with a completed MEP project during the evaluation period. These site visits support the analysis of gross impacts presented in this report. The site visits verified the installation and proper operation of the energy efficiency improvements installed with incentives from the MEP.

Sampling/Weighting

The sampling unit for on-site visits was the completed project. The sample was based on the 66 projects completed by September 30, 2013. Of these, 37 projects had been developed using the prescriptive path (i.e., using the Prescriptive Tool to estimate savings) and 29 had been developed using the modeling path (i.e., using TREAT to estimate savings). To select the sample for the impact analysis, we randomly sorted the 66 projects. The first 10 projects in this randomly sorted list were selected for a site visit, setting quotas of six prescriptive and four modeling projects (reflecting the respective shares of the 66 projects that used the two paths).

The gross impact analysis combines site visit results with desk review results (see discussion below). As such, we did not calculate a separate sampling error for the site visits. Overall gross impact results were weighted by the savings of the sampled projects.

3.2 Methodology

3.2.1 Gross Impacts

The gross impact evaluation included desk reviews for a random sample of 33 of the 66 projects completed by September 30, 2013 and site visits to 10 of these projects. The review of each project consisted of the following steps:

1. Program data: We extracted *ex ante* (or program-claimed) savings, by measure, from the Portal. We also reviewed detailed project documentation received from the implementation team.

2. Comparison to TRM calculations: For each measure, we independently calculated savings based on the program's TRM and compared the results to the values in the program database.

3. Holistic review of projects: For each project, we compared savings estimates to building fuel usage and reviewed savings across measures within a site.

We then aggregated findings across all sampled projects to develop measure-level realization rates and to develop program-level impacts. The following subsections provide more detail on the various steps of the gross impact analysis.

Program Data

We extracted *ex ante* savings, by measure, from the Portal database. The Portal database contains usage savings, cost savings, and total measure costs by technology and unit of savings (MMBtu, kWh, or kGallon). It should be noted that the Portal does not track savings by fuel type (e.g., oil or natural gas); rather, for fossil fuels, savings are expressed in MMBtu. We only included electric savings (kWh) and fossil fuel savings (MMBtu) in our analysis; we did not include water savings (kGallon). Table 3-1 presents an example of the project data extracted from the Portal.

Table 3-1. Example of Project Data Extracted from the Project Portal

Measure	Unit	Sum (Usage Savings)	Cost Savings	Total Measure Cost
Roof/Attic Insulation	MMBtu	32	$865.00	$4,917.00
Roof/Attic Insulation	kWh	197	$0.00	$4,917.00
Air Sealing	MMBtu	26	$701.00	$3,638.00
Air Sealing	kWh	167	$0.00	$3,638.00
Clothes Washers	MMBtu	4	$173.00	$1,770.00
Clothes Washers	kWh	198	$0.00	$1,770.00
Clothes Washers	kGallon	16	$0.00	$1,770.00
Refrigerators	kWh	2,650	$0.00	$1,000.00
Other	MMBtu	18	$476.00	$500.00

Source: Portal

We also downloaded utility data from the Portal, and we received detailed project documentation from the implementation team, including application forms, the completed ERPs, TREAT input and output files, invoices, inspection forms, and photo documentation.

Comparison to TRM Calculations

For each project in the sample, the evaluation team used the detailed project documentation and site visit findings as inputs to develop an independent estimate of savings by measure based on the program's TRM algorithms.[8] This was done for both prescriptive path projects and modeling path projects. For prescriptive path projects, for which program claimed savings are calculated using the Prescriptive Tool, we conducted a systematic comparison of each measure's claimed savings in the program database (Portal) relative to our independent calculation of savings. For modeling path projects, for which program claimed savings are calculated using the TREAT modeling software (which is not based on the program TRM), we downloaded TREAT model results from the Portal and compared these values to our re-estimated savings based on the TRM algorithms and project inputs documented in program data (from the ERP report or the TREAT file). While the modeling outputs are not expected to match the Prescriptive Tool outputs, this exercise was done to test comparability and reasonableness of modeled results versus the prescriptive results.

For each measure included in the sampled projects, we also reviewed the information available from the ERP report, invoices, inspection reports, and photo documentation in an attempt to confirm that each measure was installed as proposed.[9] For the 10 projects for which we conducted site visits, this review was more comprehensive, as we were able to better assess quantities of installed measures. If we found discrepancies between the information used in calculating program tracked savings (ex ante savings) and the information found in project documentation or at the site visits, we recalculated savings based on the revised inputs.

For each measure in the sampled projects, we compared our independently calculated savings results with the values in the Portal database. If the results from our calculation differed substantially from those reported

[8] Efficiency Maine "Prescriptive Path Technical Reference Manual, Version 2013.2" (dated April 11, 2013)

[9] In some cases, the documentation was not sufficiently detailed to confirm proper installation, and we could only assess whether the input seemed reasonable.

in the Portal, we attempted to diagnose the source of the discrepancy, analyzing assumptions for baseline and efficient case energy consumption. If the results were similar, then the evaluation team assigned a preliminary realization rate of 100% for the measure.

While the scope of this evaluation did not include a comprehensive review of the MEP TRM, we did assess the reasonableness of the results of the TRM calculations for the sample of projects. In cases where we judged that the program TRM produced unreasonable savings estimates, we adjusted the savings based on engineering judgment and, in some cases, consideration of the values produced by the TREAT model for that measure. Similarly, in cases where we judged that the TREAT software produced unreasonable savings estimates, we made adjustments based on engineering judgment and consideration of the TRM approach.

Holistic Review of Projects

For each project we compared the building's total fuel usage – and, if available, its heating fuel usage – to the ex ante savings for the project. If we found total project savings to be an unreasonably high percentage of total or heating energy usage, we proceeded to review the project in greater detail. In some cases, this review led to further adjustments of data inputs for specific measures. In two projects, the savings of no one measure in particular appeared to be unreasonable, but combined, project-level savings were unreasonably high. For these two projects, we reduced savings for all heating measures (including boiler/furnace, air sealing, wall/foundation insulation, roof/attic insulation, and low flow devices) by 50% to provide a more realistic project-level savings estimate.[10]

During the review of projects, it became apparent that the Prescriptive Tool does not account for interactive effects of installed measures. In the development of ex post savings values for prescriptive projects, we did account for interactive effects. For consistency of our evaluation approach, we looked at measure savings at each project site using the following measure order: shell insulation, air leakage, windows, boiler reset control, programmable thermostats, low flow devices, clothes washers, pipe insulation, insulate hot water tanks, boiler/furnace replacement, water heater replacement, refrigerators, and lighting. To avoid double-counting of savings, we adjusted the savings of each subsequent measure if it had interactive effects with a measure already analyzed. The order was chosen to first estimate fuel savings from measures which are not calculated as a direct function of fuel usage. Then these savings were subtracted from the usage known from utility bills, before using such billing data to calculate the savings for replacing boiler, furnace, and/or water heating equipment.

Measure-Level Realization Rates

For each measure implemented within the 33 sampled projects, we divided our ex post savings estimate by the ex ante savings value in the program data to arrive at a project-specific, measure-level realization rate. We then summed all ex ante savings values and all ex post values for each measure type (by type of savings (MMBTU or kWh) across projects, and divided total ex post savings by total ex ante savings to develop an overall measure realization rate.

It should be noted that the overall measure-level realization rates are, in some cases, based on a small number of projects. Our analysis did not intend to provide statistically significant results at the measure-level. As a result, this report provides detailed explanations of the drivers of the realization rate results for each measure

[10] This level of reduction was selected based on our best professional judgment of a reasonable total project savings value relative to baseline fuel usage.

type. These explanations should be used in combination with the numerical measure-level realization rates to guide future program planning.

Program-Level Impacts

We estimated program-level impacts by developing separate program-level realization rates for fossil fuel (MMbtu) and electricity (kWh) savings, and then multiplying these rates by the ex ante estimates of program fossil fuel savings and electric savings, respectively. For both fuel types, we first developed separate realization rates for prescriptive path and modeling path projects and applied these to ex ante program savings for prescriptive and modeling path projects, respectively. This initial step ensured the proper weighting of results for prescriptive and modeling path projects to reflect our sampling by those two types of projects.

3.2.2 Net Impacts

The analysis of net impacts for the MEP included a quantitative analysis of free-ridership and participant spillover. The scope of this evaluation, did include estimation of non-participant spillover.[11]

Free-Ridership

In the context of the MEP, free-riders are program participants who would have made the energy-efficient improvement(s) included in their project without the presence of the program. The free-ridership analysis is based on self-reported information from the building owner survey, conducted in December 2013. The survey collected free-ridership data for 29 MEP projects completed by 18 building owners who participated during the evaluation period.

We assessed free-ridership by asking participants a series of questions that explore 1) the influence of five program components in making the energy-efficient installations and 2) likely actions they would have taken, had the program not been available. For building owners who had more than one building with a completed retrofit during the evaluation period, we asked these questions for only one randomly selected building.

Influence of Program Components

We asked respondents to rate the influence of five program components on their decision to make the energy-efficient improvements to their building:[12] 1) the information provided by the benchmarking done for the building, 2) information provided by the audit and ERP, 3) information provided by the participant's Program Partner, 4) the incentives provided by the MEP, and 5) access to a qualified Program Partner.

The *Program Components* part of the free-ridership score is calculated as:

$$\text{FR Score}_{\text{ProgComp}} = 1 - (\text{Maximum rating of any of the five components} / 10)$$

The *Program Components* free-ridership scores thus range from 0 (0% free-ridership, 100% program attribution) to 1 (100% free-ridership, 0% program attribution). Greater influence of the program components means a lower level of free-ridership.

[11] Any non-participant spillover would increase net impacts.

[12] On a scale of 0 to 10, where 0 is "not at all influential" and 10 is "very influential."

Likely Action without Program

We asked respondents a series of questions about the improvements for which they received an MEP incentive. We first asked, for each MEP-incented improvement, how likely it is that the respondent would have made the improvement without the program (independent of the efficiency level). Participating building owners who responded "not very likely" or "not at all likely" for *all* of the incented improvements received a free-ridership score of "0" for the *Likely Action without the Program* score, and were skipped over the rest of the questions in that sub-module.

Respondents who said they would have been "very likely" or "somewhat likely" to install at least one of the MEP-incented measures without the program were asked a series of follow-up questions about the likely timing, efficiency, and quantity of the improvements, if they had happened without the program.

1. Timing: We asked about the likely timing of the overall project (i.e., if the respondent would have made the improvement(s) at the same time, later, or earlier). If the improvement(s) would have been made earlier or later, we asked how much earlier or later.

2. For each of the improvements the respondent would have been "very likely" or "somewhat likely" to make without the program, we then asked:[13]

    a. How likely is it that the improvement would have been of the same efficiency without the program?

    b. Without the program, would you have installed the same quantity, fewer, or more of the improvement? If fewer or more, we asked how many.

Using these responses, for each installed measure, the *Likely Action without the Program* component part of the free-ridership score is calculated as follows:

<u>If "not very likely" or "not at all likely" to install without the program:</u>

$$FR\ Score_{LikelyAct} = 0$$

<u>If "somewhat likely" or "very likely" to install without the program:</u>

$$FR\ Score_{LikelyAct} = Timing\ Score * Efficiency\ Score * Quantity\ Score$$

Where the timing, efficiency, and quantity scores are developed as:

[13] Note that the efficiency and quantity questions were only asked for improvements where these concepts apply and where the respondent could be expected to provide an answer. For example, the efficiency question was not asked for low-flow devices, as these are inherently efficient. Quantity questions were not asked for insulation or sealing improvements, where amounts installed are more difficult to quantify.

Table 3-2. Scoring of Timing, Efficiency, and Quantity Questions

FR Component	Survey Question	Score
Timing[a]	FR2b. How much later would you have made these improvements if you had not received the incentives from the Multifamily Program? Would you say…	Within 6 months = 1.0 6 months to 1 year later = 0.8 1 - 2 years later = 0.6 2 - 3 years later = 0.4 3 - 4 years later = 0.2 4 or more years later = 0.0 (Don't know) = 1.0 (Refused) = 1.0
Efficiency	FR3. How likely is it that the new […] would have had the same level of efficiency?	Very likely = 1.0 Somewhat likely = 0.67 Not very likely = 0.33 Not at all likely = 0.0 (Don't know) = 1.0 (Refused) = 1.0
Quantity[b]	FR4. Now thinking about the quantity of the improvements you made. Would you have installed the same number, fewer, or more […], if you had NOT received the incentives from the Efficiency Maine Multifamily Program. If fewer or more: FR5. How many […] would you have installed?	FR5 response / Quantity actually installed

[a] No respondent reported that the improvements would have been made *earlier* without the program.

[b] No respondent reported that a *greater quantity* would have been installed without the program.

The project-level *Likely Action without the Program* score is the savings-weighted average of each improvement's score. As with the *Program Components* score, the *Likely Action without the Program* score values range from 0 to 1. Later implementation, lower efficiency levels, or smaller quantities without the program mean a lower level of free-ridership.

Building-Level Free-Ridership Score

The overall free-ridership score for each survey respondent is the average of the *Program Components* and *Likely Action without the Program* scores.

Decision-Making Process for Other Buildings

Building owners who had more than one building participate in the MEP during the evaluation period were asked if their other building(s) went through the same or a different decision-making process compared to the building about which the FR module asked. The survey differentiated between buildings that are located at the same address and buildings that are located at a different address. If the building owner reported that the building(s) went through the same decision-making process, we applied the FR score of the building about which the FR module asked.

Overall Free-Ridership Score

To estimate program free-ridership, we aggregated the building-level free-ridership scores, weighted by each building's verified gross energy savings.

Participant Spillover

Participant spillover refers to energy efficiency installations that were influenced by the program but did not receive an incentive. An example of participant spillover is a building owner who completed improvements through the MEP and, as a result of the positive experience, makes additional energy efficiency improvements to the building, but does not receive an incentive for those additional improvements.

For the participant spillover analysis, we considered improvements that were:

1. Recommended by a Program Partner during the ERP development, but that the building owner declined to implement as part of the MEP project;
2. Installed following the MEP project;
3. Influenced by the MEP (i.e., the respondent rated the importance of the experience with the MEP on the decision to make the improvements a 7 or higher, on a scale of 0 to 10); and
4. Could be expected to lead to energy savings.

For each improvement that qualified as participant spillover, we estimated savings to be the average energy savings for that improvement, based on all MEP projects with that improvement completed within the evaluation period. Table 3-3 summarizes the average ex post gross savings of the most commonly installed MEP measures.

Table 3-3. Average Ex Post Gross Savings of Most Common MEP Measures

Measure	Number of Projects with Measure	Average per Project Savings (MMBtu)
Air Sealing	50	18.5
Roof/Attic Insulation	45	23.3
Low-Flow Devices	38	26.6
Boilers	36	70.0
Wall Insulation	29	15.3
Apartment Lighting	11	20.9
Common Lighting	10	3.8
Gas Water Heaters	16	22.1

Source: MEP Tracking Data (as of September 27, 2013); gross impact analysis

To determine the program-level spillover rate, we divided the estimated savings of the improvements installed by survey respondents outside of the program (but influenced by the program) by the savings all survey respondents realized through the program.

$$Spillover\ Rate = \frac{Energy\ Savings\ (Improvements\ by\ Respondents\ Outside\ Program)}{Energy\ Savings\ (Improvements\ by\ Respondents\ Through\ Program)}$$

3.2.3 Cost-Effectiveness

The evaluation team conducted a cost-effectiveness analysis for the MEP for the evaluation period July 2012 through September 2013,[14] using Efficiency Maine's Benefit/Cost Screening Model (version 2.2) developed by GDS Associates.

Initial program inputs for the cost-effectiveness analysis were provided by Efficiency Maine.[15] The evaluation team used the Benefit/Cost model to develop results for 1) the Total Resource Cost test (TRC),[16] which is the test used by Efficiency Maine; 2) the Program Administrator Cost Test (PACT); and 3) the Participant Cost Test (PCT). Each test calculates a benefit-cost ratio by taking the present value (PV) of benefits and dividing them by the first-year costs applicable for each test. NPV discounts for the time value of money (i.e., savings that accrue in the future are less valuable than immediate savings).

Total Resource Cost Test (TRC)

The TRC examines the costs and benefits of an energy efficiency program from a societal perspective. It compares net energy-savings benefits (avoided costs) to the net costs incurred by the program administrator, as well as net costs incurred by the participant, such as the incremental cost of purchasing the program measure. The TRC views program incentives/rebates as transfers at the societal level, and not as program costs.

Program Administrator Cost Test (PACT)

The PACT examines the costs and benefits from the perspective of the program administrator. It compares the net benefits to the net costs incurred by the program administrator, including any rebate/incentive costs but excluding any net costs incurred by the participant, such as the actual measure cost.

Participant Cost Test (PCT)

The PCT examines the costs and benefits from the perspective of the customer installing the energy efficiency measure (homeowner, business, etc.). Benefits include bill savings realized by the customer from reduced energy consumption, and the incentives received by the customer, including any applicable tax credits. Costs include the incremental cost (borne by the customer) of purchasing and installing the efficient equipment rather than standard equipment. In some cases incremental operations and maintenance costs (or savings) are also included.

[14] Note that the cost-effectiveness analysis only included costs incurred during the evaluation period. It excludes program start-up costs of approximately $210,000.

[15] Avoided costs are based on Synapse Energy Economics' *Avoided Energy Supply Costs in New England: 2013 Report*, which provides avoided costs for 2013-2043.

[16] Note that the TRC values are estimated without accounting for the value of CO_2 under the Regional Greenhouse Gas Initiative (RGGI).

4. Impact Evaluation

This section presents the results of gross and net impacts analyses, as well as the cost-effectiveness analysis for the MEP.

4.1 Gross Impact Analysis

The gross impacts analysis examined MEP savings for fossil fuels (tracked by the program in MMBtu) and for electricity (tracked in kWh). We conducted three subtasks contributing to the gross impact analysis: 1) a desk review of a sample of 33 projects, 2) site visits to a sample of 10 projects, and 3) a comparison of the Prescriptive Tool to the MEP TRM. The methods used for each component were discussed in Section 3.2.1 of this report.

4.1.1 Summary of Gross Impacts

For each of the prescriptive and modeling projects sampled, the evaluation team conducted an engineering review of the existing data and calculations in the files and tracking database. For 10 of the 33 sampled projects, we also collected additional information through onsite visits. We used this information to estimate ex post (i.e., verified) fossil fuel and electricity savings for each project, along with the associated realization rates. We then aggregated results 1) by prescriptive and modeling path projects (i.e., by the two sampling strata); 2) by technology; and 3) for the MEP overall.

Table 4-1 summarizes the ex ante (i.e., program-reported) and ex post fossil fuel and electric savings and associated realization rates (RR) for prescriptive and modeling projects, respectively. We weighted the realization rates for each stratum (prescriptive and modeling) proportionally to the stratum's energy savings, resulting in the overall program-level realization rates of 0.69 for fossil fuel savings and of 1.07 for electric savings.

Table 4-1. Summary of Gross Impact Realization Rates

Sampling Strata	Sample Size (n)	Gross Energy Savings Fossil Fuels (MMBtu)			Gross Energy Savings Electricity (kWh)		
		Ex Ante	Ex Post	RR	Ex Ante	Ex Post	RR
Prescriptive	19	2,778	2,207	0.79	27,162	23,184	0.85
Modeling	14	2,338	1,391	0.60	37,844	48,395	1.28
Total MEP	33			0.69			1.07

Table 4-2 applies these weighted realization rates to the programs' ex ante gross fossil fuel and electric savings. We estimate that the MEP, through September 30, 2013, realized annual savings of approximately 7,600 MMBtu (fossil fuel) and 277,800 kWh (electric). These results have a relative precision of 8.3% for fossil fuel savings and of 7.9% for electric savings, at a 90% confidence level.

Table 4-2. Program-Level Adjusted Gross Impacts

	Fossil Fuel Savings (MMBtu)	Electric Savings (kWh)
Ex Ante Program Savings	10,995	258,754
Realization Rate	0.69	1.07
Ex Post Program Savings	7,567	277,844
Relative Precision (@90%)	8.3%	7.9%

The following subsection provides more detailed gross impact results by technology and savings type (fossil fuel vs. electric). *Appendix A: Other Supporting Information for Gross Impact Analysis* presents more detailed results for the prescriptive and the modeling paths, respectively.

4.1.2 Analysis of Technologies

Table 4-3 shows the contribution of the various technologies incented through the MEP to ex ante program savings. Boilers and furnaces (34%) account for the largest share of ex ante fossil fuel savings, followed by air and duct sealing (16%), low flow devices (13%), and roof insulation (13%). On the electric side, lighting accounts for the largest share of savings (29%) followed by "other" measures (23%).[17]

Table 4-3. Summary of Ex Ante MEP Savings by Technology

Technology	Ex Ante MEP Savings			
	Fossil Fuel (MMBtu)	%	Electricity (kWh)	%
Boilers/Furnaces	3,741	34%	5,922	2%
Air and Duct Sealing	1,778	16%	9,417	4%
Low Flow Devices	1,470	13%	-	0%
Roof/Attic Insulation	1,410	13%	21,358	8%
Wall/Foundation Insulation	975	9%	1,576	1%
Gas Water Heaters	431	4%	15,689	6%
Pipe Insulation	367	3%	-	0%
Windows	87	1%	34,473	13%
Clothes Washers	11	0%	2,086	1%
Lighting	(9)	0%	74,737	29%
Refrigerators	(48)	0%	33,144	13%
Other	781	7%	60,352	23%
TOTAL	10,995	100%	258,754	100%

[17] The "other" category includes a variety of measures not individually tracked by the program, e.g., variable frequency drives (VFD), programmable thermostats, and boiler reset controls. However, in some cases, it also includes measures that are individually tracked, e.g., low flow devices.

Our analysis shows significant differences in realization rates between the different measures as well as between fossil fuel and electric savings. For fossil fuels, realization rates range from 50% for wall/foundation insulation to 100% for windows and clothes washers; rates for the top four contributors to program savings range from 63% to 96%. For electric savings, realization rates range from 0% for gas water heaters[18] to 136% for clothes washers.

Table 4-4 summarizes ex ante and ex post savings as well as the resulting realization rates by measure. Following the table, we provide an overview of the key drivers of the realization rates by measure. It should be noted that the measure-level realization rates are, in many cases, based on a small number of projects. Our analysis did not intend to provide statistically significant results at the measure-level. As a result, we provide detailed explanations of the drivers of our results for each measure. Measure-level realization rates should only be used in the context of these explanations to guide future program planning.[19]

Table 4-4. Gross Impacts by Technology (Sampled Projects)

Measure	# of Sampled Projects with Technology	Fossil Fuel Savings (MMBtu)			Electric Savings (kWh)		
		Ex Ante	Ex Post	RR	Ex Ante	Ex Post	RR
Boilers/Furnaces	19	1,702	1,077	63%	-	-	-
Air and Duct Sealing	27	759	654	86%	1,889	1,732	92%
Low Flow Devices	17	521	498	96%	-	-	-
Roof/Attic Insulation	24	816	681	83%	2,834	2,247	79%
Wall/Foundation Insulation	20	437	220	50%	1,049	881	84%
Gas Water Heaters	8	283	144	51%	3,071	-	0%
Pipe Insulation	6	257	151	59%	-	-	-
Windows	5	15	15	100%	40	24	61%
Clothes Washers	2	11	11	100%	2,086	2,832	136%
Lighting	9	33	(5)	n/a	21,037	26,999	128%
Refrigerators	4	(10)	(3)	n/a	7,036	3,978	57%
Other	17	291	155	53%	25,964	32,885	127%

Boilers / Furnaces

The MMBtu realization rate for boiler/furnace replacement is 63%. Realization rates for this measure range from 0% to 116%.

[18] This is due to an apparent data entry error. The MEP does not claim kWh savings for gas water heaters.

[19] While results are not statistically significant at the measure level, the measure-level analysis was rolled up into the program-level results presented in Table 4-1.

Seven of the 19 sampled boilers also received an incentive through Efficiency Maine's Natural Gas Program. In this case, the two programs split the savings. According to program staff, the MEP share of savings is based on the difference in efficiency between the existing boiler and a new standard efficiency boiler.[20] However, our analysis found that the MEP claimed all savings associated with the new boilers. As a result, we reduced savings for those seven boilers. For three of them (all >300 MBtu/hr and within the same building complex), MEP savings were set to zero as the existing boiler efficiency was 75%, i.e., equal to the split point. It should be noted that adjustments made to correctly allocate savings between the MEP and the Natural Gas Program accounted for the single largest reduction of *ex ante* fossil fuel savings and significantly affected the realization rate for boilers/furnaces and for the program overall.[21]

For most of the 11 sampled prescriptive projects with this measure, we reduced ex ante savings to account for interactive effects that are not accounted for within the Prescriptive Tool. When boilers/furnaces are installed in combination with measures such as insulation and air/duct sealing, total project savings are no longer the sum of the savings of the individual measures.[22] In developing our savings estimates for prescriptive projects with boilers/furnaces, we also made the following changes: 1) calculating savings directly based on fuel usage (as compared to using the EFLH look-up table from the Prescriptive Tool); 2) reallocating savings between the boiler/furnace measure and the hot water heater measure, if the boiler supplied domestic hot water as well as hydronic heating; and 3) re-estimating savings using different equipment efficiencies (as found in the photo documentation or in the text of the ERP report).

For the modeled projects, we generally found ex ante boiler/furnace savings to be reasonable. For two boilers, ex post savings were reduced due to higher pre-retrofit boiler efficiencies in project documentation than was modeled. In addition, we reduced savings for one project to account for interactive effects resulting from a separate project that was completed at the same building in a different phase.

Air and Duct Sealing

The MMBtu realization rate for air and duct sealing is 86%. For most sampled projects (20 out of 24), the realization rate for air sealing is 100%. In two cases, we increased savings to account for post-construction blower door test results that were better than assumed in the calculation of ex ante savings.[23] For two prescriptive projects, overall ex ante project savings were unreasonably high relative to the building's total annual heating fuel usage. For these projects, we reduced savings for multiple heating-related measures, including air sealing, to 50% of ex ante values to more reasonably reflect the order of magnitude of savings that can be achieved. For one prescriptive project with air conditioning, we reduced ex post kWh savings for

[20] The agreed upon "split point" for allocating savings between the two programs is 80% Et for boilers ≤300 MBtu/hr and 75% Et for boilers >300 MBtu/hr.

[21] It should be noted that as of December 2013, the MEP no longer allows participants to receive an incentive through the MEP and the Natural Gas Program for the same boiler or furnace.

[22] For consistency of our evaluation approach, we looked at measure savings at each project site using the following measure order: shell insulation, air leakage, windows, boiler reset control, programmable thermostats, low flow devices, clothes washers, pipe insulation, insulate hot water tanks, boiler/furnace replacement, water heater replacement, refrigerators, and lighting. To avoid double-counting of savings, we adjusted the savings of each subsequent measure, if it had interactive effects with a measure already analyzed.

[23] According to program staff, ERP savings estimates are not updated, if the post-construction blower door test exceeds the predicted result.

cooling from air sealing to 25% of ex ante savings because only approximately 25% of the building is air conditioned (with window units).

The program claimed kWh savings for air sealing for all 16 sampled prescriptive projects with air and duct sealing. The Portal listed these as "cooling" savings, although program implementation staff later clarified that these savings did not represent cooling savings but heating-related savings associated with reduced HVAC load (e.g., fans and pumps) that were mis-labeled. While we did not adjust these savings from the ex ante values, we note the following: 1) The program claims kWh savings for air sealing based on an appendix in the New York TRM, upon which the MEP TRM is based. However, the main body of the NY TRM suggests that kWh savings should not be claimed for air sealing as the algorithm includes a factor that is unique to cooling. 2) Claiming kWh savings for air sealing is inconsistent with some other MEP program practices; for example, the Prescriptive Tool claims no similar kWh savings for boilers and furnaces (which should have higher kWh savings than air sealing) nor does TREAT claim non-cooling kWh savings for any heating-related measures. 3) We acknowledge that there are possible kWh savings associated with reduced fan and pump usage, but we were not able to verify the magnitude of the savings claimed by the MEP.

Only three sampled projects, all using the modeling path, included duct sealing and claimed MMBtu savings. For these projects, we found TREAT to predict unreasonably high MMBtu savings of between 30% and 45% of annual heating fuel usage. We reduced ex post duct sealing savings for these projects to 20% of total fuel usage, which we believe is still a somewhat high estimate.[24]

Low Flow Devices

Low flow devices have a high MMBtu realization rate of 96%. For 13 of 17 sampled projects, the realization rate is 100%. For two projects using the modeling path, we increased ex post savings for low flow devices to match those of a third modeled project in the same complex, for which assumptions for hot water usage per person per day, and the resulting savings, were more reasonable. For two prescriptive projects, we reduced ex post savings to approximately half of their ex ante values. In one case, we re-calculated savings using inputs based on the ERP, which differed from inputs used by the Prescriptive Tool for this project. In the other case, we reduced savings for low flow devices by 50%, along with other heating-related measures, because total ex ante project savings were larger than the annual heating fuel usage of this building.

While ex post savings were unchanged from the ex ante values for low flow devices for most of the sampled prescriptive projects, we note that the Prescriptive Tool/TRM produces savings that are generally three times those estimated by TREAT for this measure. The difference between TREAT and TRM savings is due in part to differences in assumed hot water usage per person per day, but is also affected by overall system efficiency assumptions.[25] Given that low flow devices account for the third largest share of program MMBtu savings, and that this measure is slated to be offered under the new prescriptive approach recently rolled out by the program, further research into TRM values may be warranted.[26]

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[24] Based on Energy Star (http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_ducts_benefits) "leaky ducts can reduce heating and cooling system efficiency by as much as 20%."

[25] The TRM assumes 75% water heating efficiency for all fuels while TREAT appears to consider the efficiency of the installed system.

[26] According to implementation staff, the algorithm for low flow devices has been modified in a newer version of the TRM.

The program did not claim any kWh savings for low flow devices.

Roof/Attic Insulation

The MMBtu realization rate for roof and attic insulation is 83%. For most sampled projects (19 out of 24), the realization rate is 100%. For two modeled projects, we determined that TREAT savings estimates for roof insulation were unreasonably high (based on our engineering judgment) given the amount of insulated roof area reported in the ERP). To address this, we re-estimated savings for these two sites using the TRM prescribed algorithm and inputs from the ERP to arrive at our ex post values.[27] For two prescriptive projects, we found the area of insulation to be overstated in the calculations, one based on a site visit and the other based on available photo documentation. For these two projects, we re-estimated savings using the smaller area assumption. For one of the prescriptive projects, as well as a third one, we also reduced roof/attic insulation savings by 50%, along with other heating-related measures, because total ex ante project savings were unreasonably large, given the annual heating fuel usage of the buildings. For one prescriptive project with air conditioning, we reduced ex post kWh savings for cooling from roof/attic insulation to 25% of ex ante savings because only approximately 25% of the building is air conditioned (with window units).

The program claimed kWh savings associated with reduced HVAC load for all 16 sampled prescriptive projects with roof/attic insulation. See the discussion under "Air and Duct Sealing" above.

Wall/Foundation Insulation

The MMBtu realization rate for wall/foundation insulation is 50%, the lowest of any measures with fossil fuel savings. This result is driven by projects modeled in TREAT (9 out of 20 sampled projects) which – based on the engineering judgment of the evaluation team – provides unreasonably high savings for this measure. Generally, the wall insulation in these projects consists of insulating two to three feet of foundation wall or attic knee wall. For all of the sampled, modeled projects, the results from TREAT were considerably greater than the TRM would predict, often by a factor of five or six. We re-estimated savings for these two sites using the TRM prescribed algorithm and inputs from the ERP and the TREAT model files.

For most prescriptive projects, the realization rate for wall/foundation insulation is 100%. For two prescriptive projects, we reduced wall/foundation insulation savings by 50%, along with other heating-related measures, because total ex ante project savings were unreasonably large, given the annual heating fuel usage of the buildings.

The program claimed kWh savings associated with reduced HVAC load for all 11 sampled prescriptive projects with wall/foundation insulation. See the discussion under "Air and Duct Sealing" above. For one prescriptive project with air conditioning, the insulation was applied to the basement foundation wall and will not have any effect on AC usage.

Gas Water Heaters

The realization rate for gas water heaters is 51%. Eight sampled projects included a gas water heater measure, and a few more replaced boilers which also supply domestic hot water but did not list a water heating measure. For three sampled modeling projects, all at the same address, we reduced savings to better allocate the combined boiler and gas water heater savings between the two measures. One of these projects also had

[27] For one of the two sites, we first reduced the amount of roof area insulated based on review of photo documentation.

an apparent data entry error as it claimed kWh savings for the gas water heater, which appear to belong to the lighting measure at that site, while the lighting measure showed MMBtu savings belonging to the gas water heater.

For three of five sampled prescriptive projects with gas water heaters, we reduced savings based on the fuel usage for heating domestic hot water[28] and to account for interactive effects of other measures included in those projects which also save hot water.

Pipe Insulation

The realization rate for pipe insulation is 59%. Six sampled projects included pipe insulation, five prescriptive and one modeled. The realization rate for the modeled project is 100%. For the prescriptive projects, we found the TRM to overstate pipe insulation savings.[29] We estimated ex post savings for pipe insulation in prescriptive projects by 1) re-estimating the savings of the modeled project, using the TRM algorithm, 2) determining the ratio of modeled to prescriptive savings (54%) for that project, and 3) applying this ratio to the ex ante prescriptive pipe insulation savings.

If pipe insulation is going to be offered under the new prescriptive approach recently rolled out by the program, further research to update the TRM may be warranted.[30]

The program did not claim any kWh savings for pipe insulation.

Windows

The MMBtu realization rate for windows is 100%. Although the modeling and prescriptive paths predicted different savings values, both appeared to be within reason. For one prescriptive project with air conditioning, we reduced ex post kWh savings for cooling from the windows to 25% of ex ante savings because only approximately 25% of the building is air conditioned (with window units).

The program claimed kWh savings associated with reduced HVAC load for the three sampled prescriptive projects with window replacement. See the discussion under “Air and Duct Sealing” above.

Clothes Washers

The MMBtu realization rate for clothes washers is 100%, based on two sampled prescriptive projects that included this measure.

Ex post kWh savings for the two sampled projects are substantially higher than ex ante savings, resulting in a kWh realization rate of 136%. It should be noted that this difference is not the result of an adjustment to the TRM algorithm, which we found to be reasonable. Rather, for one of the two projects, the program did not claim savings for the clothes dryer. Since high efficiency clothes washers extract more water from the clothes, substantial dryer savings are realized from high efficiency clothes washers since the dryer has a lighter load

[28] Fuel usage for domestic hot water heating was either directly provided in the project documentation (where different fuels are used for space heating and hot water heating) or was estimated based on summer time oil/natural gas fuel usage.

[29] Ex ante pipe insulation savings for these prescriptive projects accounted for 31% to 48% of hot water fuel usage.

[30] According to implementation staff, the algorithm for low flow devices has been modified in a newer version of the TRM.

post-retrofit. We calculated dryer savings of 944 kWh for this project, more than quadrupling the ex ante kWh savings estimate for the project.

Lighting

The kWh realization rate for lighting measures (including CFL fixtures, T8s, and LEDs) is 128%. For most sampled projects (7 out of 9), the realization rate is 100%. The additional ex post savings were identified in two modeled projects. For one, the ERP described measures with substantially more savings than were claimed in the modeled savings. For the other, it appears there was a data entry error: this site claimed MMBtu savings for lighting, which appear to belong to the gas water heater at that site, while the gas water heater showed electric savings belonging to the lighting measure. The ex post savings assign kWh savings for lighting.

The MMBtu realization rates for lighting measures vary widely among the nine sampled projects. The project that erroneously claimed MMBtu savings (from the gas water heater) affects the results significantly, resulting in overall positive ex ante MMBtu savings from lighting for the sample. For the remaining projects, which posted negative MMBtu savings (i.e., a heating penalty), the ex post penalty is generally smaller than the ex ante penalty. The heating penalty is estimated directly from the ex post kWh savings and based on the assumption that 10% of the power input to the lights provides useful heat.[31]

Refrigerators

The kWh realization rate for refrigerators is 57%, based on four sampled projects with this measure (two modeled and two prescriptive). One project, for which an older version of the TRM was used,[32] significantly affects this realization rate. We re-estimated savings for this project based on the inputs in the ERP and the algorithm in the updated TRM. Excluding this one project increases the realization rate for the refrigerator replacement measure to 77%. For one modeled project, we revised pre-retrofit usage assumptions to more closely align with Energy Guide values resulting in reduced kWh savings.

The negative MMBtu values for the refrigeration measures represents the heating penalty. We added a small penalty for three of the four sampled projects and reduced it for the only project that had accounted for it ex ante. The heating penalty is estimated directly from the ex post kWh savings and is based on the assumption that 20% of the power input to the refrigerator provides useful heat.[33]

Other

“Other” measures include a variety of measures not individually tracked by the program, e.g., variable frequency drives (VFD), programmable thermostats, outdoor lighting, and boiler reset controls. However, the “other” measures also include some measures that are individually tracked by the program, e.g., low flow devices and LED lighting, but that were not tracked under their category in the database. Seventeen sampled projects had measures characterized as other. The program claimed MMBtu savings for 13 of these projects

[31] This is based on best professional judgment and the engineering assumption that heating is used approximately half of the year and that only about 20% of the heat provided by lighting is useful since lights are generally near the ceiling.

[32] The TRM was subsequently updated and the methodology improved.

[33] This is based on best professional judgment and the engineering assumption that heating is used approximately half of the year and that only about 40% of the heat provided by the refrigerator is useful to offset building heat.

and kWh savings for eight. The MMBtu realization rate for other measures is 53%, and the kWh realization rate is 127%.

4.1.3 Comparison of Prescriptive Tool and TRM

The purpose of this task was to assess how well the Prescriptive Tool implements the algorithms of the TRM. As part of our engineering review of the sample of 33 projects, we re-estimated savings based on the TRM algorithms and compared them to the output from the Prescriptive Tool. This review found that the Prescriptive Tool agrees well with the TRM and correctly implements the TRM's algorithm for the measures that were part of our gross impact sample.

4.2 Net Impact Analysis

Net program impacts are calculated by multiplying the net-to-gross ratio (NTGR) by ex post gross program savings. The NTGR, which represents the percentage of gross program savings that we can reliably attribute to the program, is calculated as NTGR = (1 – Free-Ridership + Participant Spillover).[34]

Based on the estimated levels of free-ridership and participant spillover, we estimate the NTGR for the MEP, for projects completed through September 2013, to be 0.90. Table 4-5 summarizes the NTGR results.

Table 4-5. Multifamily Efficiency Program NTGR

Component	Value
Free-Ridership	0.11
Participant Spillover	0.01
NTGR	0.90

Applying the NTGR to ex post gross program savings of 7,567 MMBtu and 277,844 kWh (see Table 4-2) yields annual program-level net impacts of:

- 6,779 MMBtu of fossil fuel savings (103 MMBtu per project)[35] and
- 248,916 kWh of electric savings (3,771 kWh per project).

4.2.1 Free-Ridership

We assessed free-ridership by asking participating building owners a series of questions that explore 1) the influence of various program components in making the energy efficient installations and 2) likely actions had the program not been available.

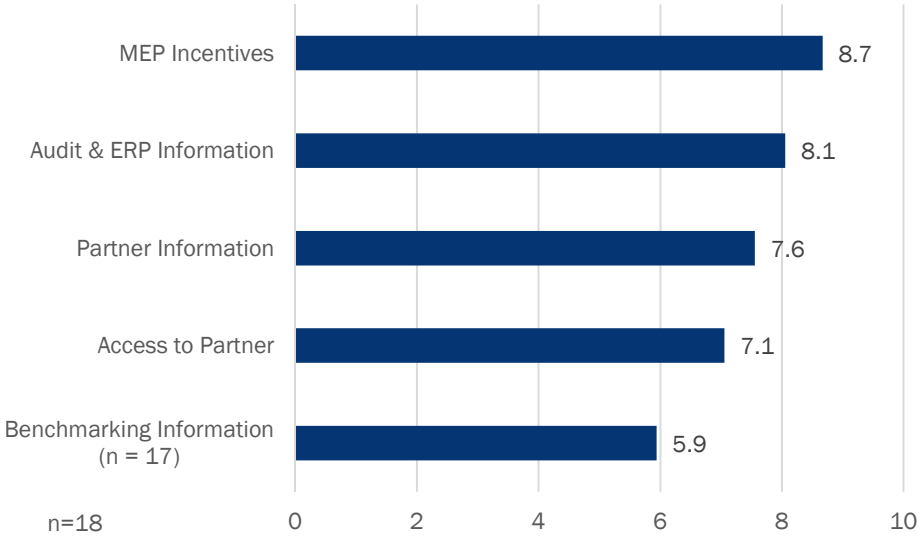
[34] The scope of this evaluation did not include estimation of non-participant spillover. Any non-participant spillover would increase net impacts.

[35] 103 MMBtu are equivalent to 744 gallons of heating oil.

Influence of Program Components

Interviewed building owners reported a strong influence of the program, and its incentives in particular, on their decision to make the energy efficient improvements. Eleven of the 18 respondents gave the maximum score of 10 to at least one of the five components.[36] Overall, respondents rated the MEP incentives as most influential (a mean rating of 8.7), followed by the information provided by audit and ERP (a mean rating of 8.1). Figure 4-1 summarizes the mean influence scores for each of the five program components included in the survey.

Figure 4-1. Mean Influence of Program Components on Participants



Likely Action without Program

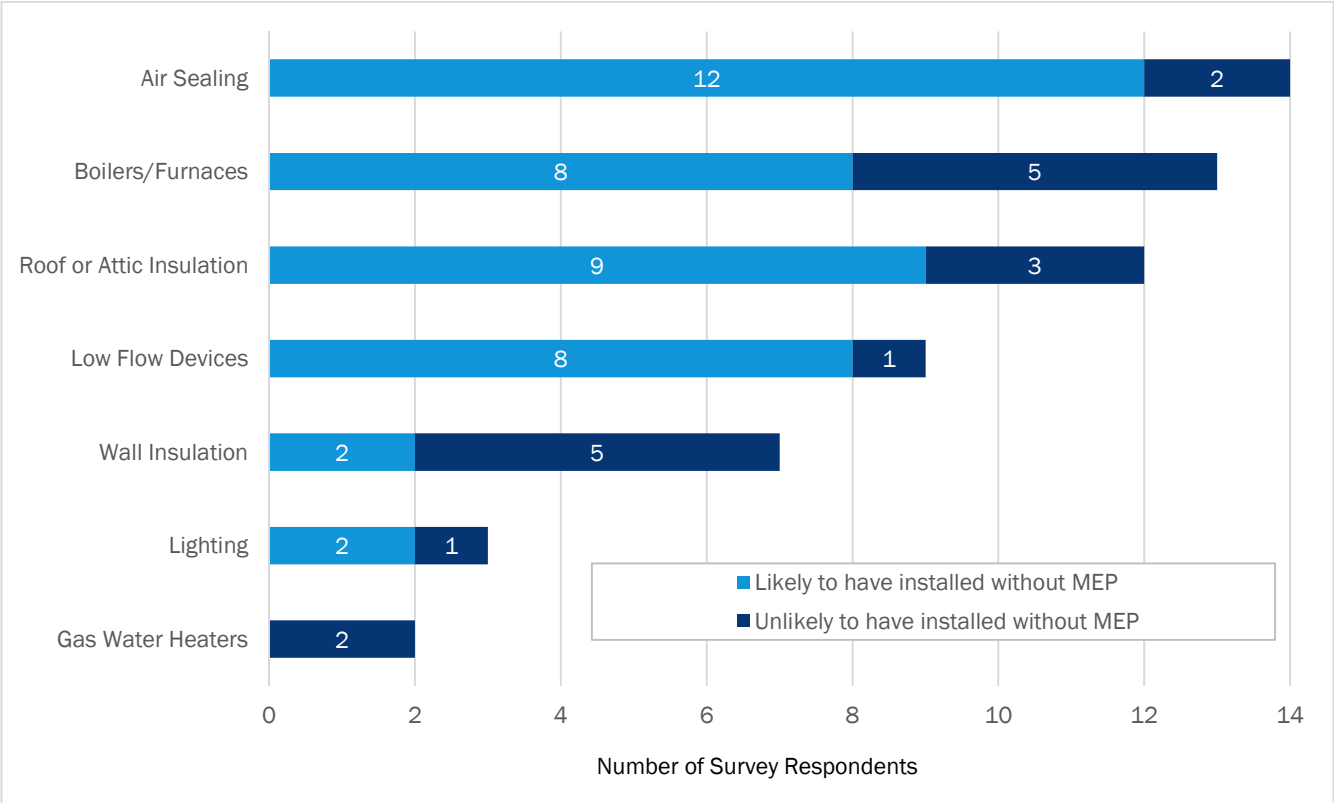
For each MEP-incented measure, participating building owners reported on the likelihood that they would have installed the measure even without the support of the MEP. Figure 4-2 shows, for the improvements most commonly made through the MEP, how many survey respondents reported being likely to have made the improvement on their own and how many were unlikely.[37] It should be noted that for measures that have different levels of efficiency (i.e., boilers/furnaces, lighting, and water heaters) this question was asked independent of the efficiency level, i.e., would they have installed any new <measure> on their own.

Responses to these questions indicate that most participants would have made at least some of the improvements on their own.

[36] On a scale of 0 to 10, where 0 is "not at all influential" and 10 is "very influential."

[37] Likely is defined as "very likely" and "somewhat likely" while unlikely is defined as "not very likely" and "not at all likely."

Figure 4-2. Likelihood to Make Improvements without the MEP



When asked about the level of efficiency, the timing, and the quantity of improvements they would likely have made on their own, survey respondents reported the following:

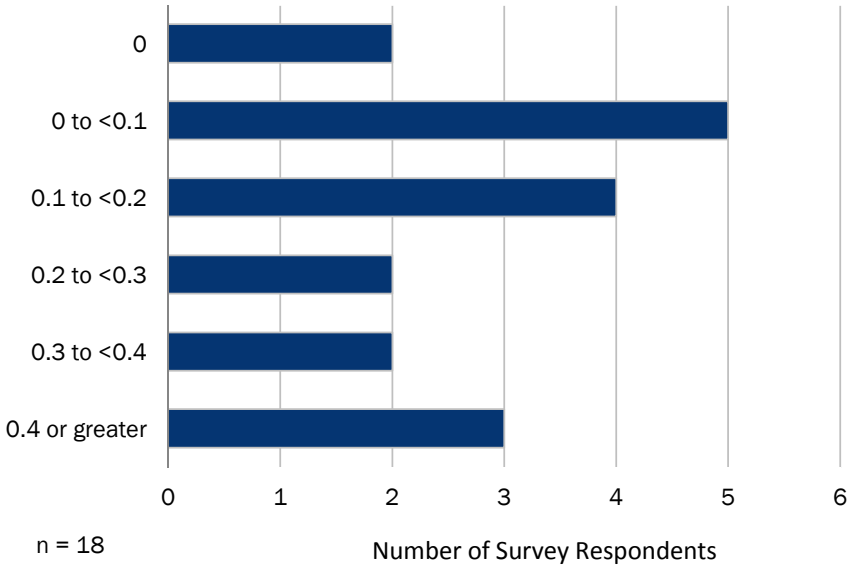
- Almost all respondents reported they would have been likely to install the same level of efficiency, had they made the improvement(s) on their own.
- All respondents reported they would have installed the same quantity.
- Thirteen out of 18 respondents (72%) reported they would have made the improvement later without the MEP. Most of these would have delayed the improvement for at least two or three years.

These results suggest that while the program influenced some participants to make a retrofit or the efficiency level of the retrofit, the largest impact was to accelerate the timing of the project.

Building-Level Free-Ridership

We derived the building-level free-ridership score for each respondent by averaging their *Program Components* score and their *Likely Action without the Program* score. Results show a low level of free-ridership for the majority of survey respondents, with 11 of 18 respondents (61%) having a free-ridership score of less than 0.2. Figure 4-3 summarizes these findings.

Figure 4-3. Distribution of MEP Free-Ridership Scores



Decision-Making Process for Other Buildings

Three of the 18 building owner survey respondents reported that they used the same decision making process for additional buildings besides the building which was the focus of the survey. There were a total of 11 such additional buildings with completed retrofits during the evaluation period. We added these 11 buildings to the free-ridership analysis, assigning each the free-ridership score estimated for the building about which their owner answered the free-ridership questions. Because two of the three owners had very low levels of free-ridership (0 and 0.03, respectively), adding these additional projects lowered the program-level free-ridership score.

4.2.2 Participant Spillover

Our analysis of participant spillover found that 10 out of 18 interviewed building owners (56%) received recommendations for additional improvements from their Program Partner beyond what was included in their MEP project. However, only four of these 10 building owners made any of the recommended additional improvements on their own, and only two attributed the program with influencing their decision. Of the two buildings with program influenced additional improvements, one included improvements that would lead to energy savings and was included in our spillover analysis.

The interviewed building owner with participant spillover reported installing "ceiling insulation" as a result of their participation in the MEP (but without an incentive). We assigned this project spillover savings of 23.3 MMBtu, based on the average ex post savings of all completed MEP projects with roof/attic insulation.

The spillover rate is equivalent to the estimated spillover savings divided by the verified gross savings all survey respondents realized through the program, or 1%:

$$Spillover\ Rate = \frac{23.3\ MMBTU}{2{,}399\ MMBTU} = 1.0\%$$

4.3 Cost-Effectiveness

Our analysis of the MEP through September 2013 found that the program is cost-effective for all three tests performed: the Total Resource Cost test (TRC), the Program Administrator Cost Test (PACT), and the Participant Cost Test (PCT). All tests show a positive net present value and a benefit-cost ratio that exceeds 1.0. This analysis is based on the 66 projects that were completed between the launch of the program and September 2013.

Table 4-6. Summary of Cost-Effectiveness for the MEP

	TRC	PACT	PCT
PV of Costs (million $) (A)	1.7	1.6	0.8
PV of Benefits (million $) (B)	2.0	2.0	2.8
NPV (million $) (B-A)	0.3	0.4	2.0
Benefit/Cost Ratio (B/A)	1.16	1.23	3.62

5. Process Evaluation

5.1 Program Participation

Participation Process

The participation process consists of three distinct phases: 1) benchmarking, 2) assessment and development of the ERP, and 3) retrofit. Participants receive an incentive (Incentive #1) following approval of the ERP and a second incentive (Incentive #2) at the completion of the retrofit. In addition to the implementation team – consisting of TRC, the Sparhawk Group, and Vreeland Marketing – the program leverages a network of approved Program Partners to market the program and implement projects. Program Partners are not required to complete the benchmarking, but have to be involved in the remaining phases of any project.

To complete a project through the program, an applicant goes through the following steps:

Phase 1: Benchmarking

1. The applicant completes a benchmarking application for their building, with or without the assistance of a Program Partner, and submits it to Efficiency Maine.
2. Efficiency Maine processes the application and delivers a benchmarking report to the applicant.

Phase 2: Assessment and ERP

3. If the applicant decides to move to the assessment phase of the program, they are required to select a Program Partner. The Partner and applicant decide whether the project will go through the modeling path or prescriptive path.
4. The Partner performs the energy assessment and creates an ERP.
5. The Partner submits the ERP to TRC for review. If needed, TRC provides comments and returns the ERP to the Partner for revision.
6. Once TRC approves the ERP, the applicant receives Incentive #1, a per-unit incentive of $100 per unit for projects in the prescriptive path and $200 per unit for projects in the modeling path.

Phase 3: Retrofit

7. If the applicant decides to implement the scope of work specified in the ERP, the installation of measures commences. Applicants are not required to have a Program Partner complete the installation work.
8. The Program Partner ensures that work specified in the ERP is completed.
9. Once the installation of project measures is complete, the Partner submits an inspection request to Efficiency Maine, and the implementation team conducts the inspection.[38] If the project passes the inspection, the applicant receives Incentive #2, a per-unit incentive of $1,400 per unit or 50% of the

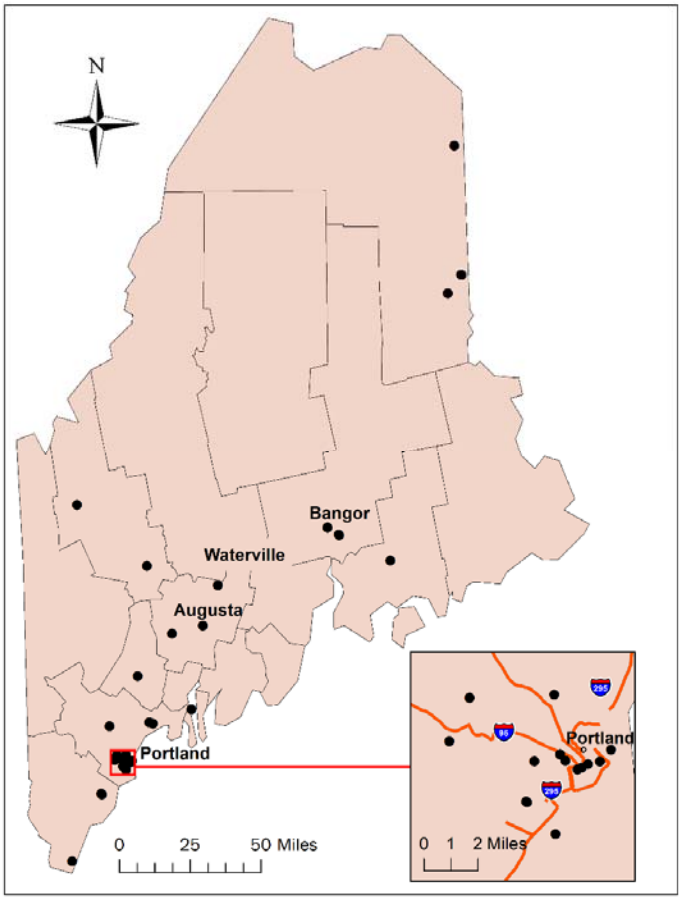
[38] All projects are inspected.

project cost, whichever is smaller.[39] If the project does not pass the inspection, the participant has the opportunity to correct the problem and reapply for inspection.

Participation through September 2013

During the evaluation period, 35 building owners completed 66 building retrofit projects (comprised of 638 apartment units) through the MEP. In addition, the program benchmarked 2,795 units and approved ERPs for 1,779 units. Figure 5-1 shows the geographic distribution of the 66 buildings with completed MEP retrofits as of September 30, 2013.

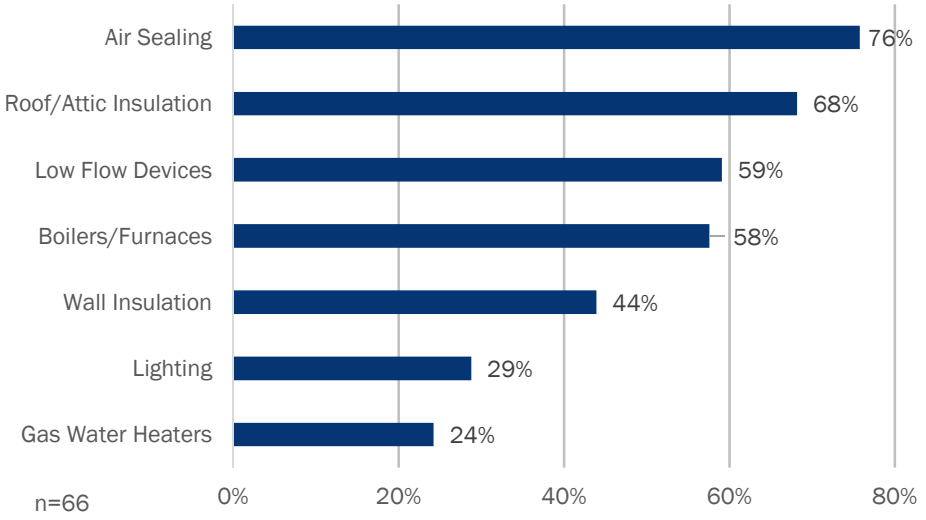
Figure 5-1. Geographical Distribution of Projects



Air sealing (76%) and roof/attic insulation (68%) were the most common improvements included in MEP projects. Other measures installed in more than 50% of projects were low-flow devices (59%) and boilers or furnaces (58%). Figure 5-2 shows the most common improvements made in the 66 participating buildings.

[39] In July 2013, the program increased Incentive #2 by $150 to a total per unit amount of $1,550. This increase was designed as an incentive to get projects completed by September, the original program end date.

Figure 5-2. Most Common Improvements Made Through the MEP



Note: This graph includes measures installed in least 20% of participating buildings. Measures also itemized by the MEP but installed in fewer than 20% of buildings include windows, refrigerators, pipe insulation, duct sealing, floor/foundation insulation, and clothes washers.

Based on the building owner survey, buildings that participated in the MEP have the following characteristics:

- Most buildings (78%) were built before 1950.
- Almost three-quarters of buildings (72%) have a vacancy rate of 10% or less.
- One-third of buildings (33%) included switching the building's primary heating fuel as part of the MEP project.
- In most cases, either tenants (44%) or building owners (39%) pay the entire electric bill; in only 17% of buildings are tenants and owners each responsible for part of the electric bill.
- Building owners almost always (89%) pay their building's heating fuel and water fuel bills, providing a strong incentive for the implementation of thermal efficiency measures.

Interviewed building owners were most often motivated to participate in the MEP by saving money (44%), saving energy or improving the energy efficiency of their building (28%), and by the program incentive (22%).

Goals

The MEP has established goals for the number of units that complete each of the three key participation phases: 1) benchmarking, 2) assessment and ERP, and 3) retrofit. As of September 30, 2013, the original end date of the program, the MEP had exceeded its goal for benchmarked units (112%) but was still short on approved ERPs (81%) and completed retrofits (35%). According to program staff, a delayed launch of the program contributed to the shortfall in approved ERPs and completed retrofits by the original end date of the grant. It should be noted that Efficiency Maine received an extension of the grant period to March 31, 2014.

Table 5-1 presents MEP goals and progress toward them during the evaluation period.

Table 5-1. Program Goals and Progress (as of September 30, 2013)[1]

Metric (# of Apartment Units)	Program Goal	Number of Units Completed	% of Goal Attained
Units Benchmarked	2,500	2,795	112%
Units with Approved ERP	2,200	1,779	81%
Units Retrofitted	1,800	638	35%

[1] The program received an extension of the grant period and is ongoing. As of February 11, 2014, 3,231 units had been benchmarked (129% of goal), 2,373 had an approved ERP (108% of goal), and 1,250 were retrofitted (75% of goal).

Source: MEP Status Report, September 27, 2013

5.2 Marketing and Outreach

Program Marketing Efforts

Efficiency Maine and various members of the implementation team collaborated on the marketing of the MEP. According to program staff, the program did not have a formal marketing plan, but marketing efforts were based on the implementation team's prior experience in the multifamily market sector, including Sparhawk's prior experience working with the multifamily sector in Maine. Program marketing and outreach was implemented in two phases. During the first phase, outreach focused on potential Program Partners in order to develop a strong Partner network. The program leveraged Sparhawk's experience, relationships, and reputation with multifamily energy efficiency stakeholders in Maine, as well Efficiency Maine's prior experience developing a partner network for their single-family program. Implementers also used trade groups to reach out to potential Partners as well as Southern Maine Community College, which had recently offered a multifamily building analyst training.

During the second phase, marketing and outreach efforts shifted toward potential program participants: building owners and managers. Marketing efforts included the program website, direct mail, email, and outreach to landlord association groups across the state. The program held five informational breakfasts across the state, using tax assessor records to specifically target owners of five- to 20-unit buildings. Program Partners attended these meetings as well. According to program staff, these meetings were the most effective form of outreach because potential participants and Partners could make immediate connections at these meetings. Other marketing and outreach activities included efforts to gain mass media coverage (resulting in an article in Maine Biz and TV coverage of an early project by two TV stations in Bangor), attendance at trade shows, and distribution of case studies, door hangers, and other program materials.

All interviewed Program Partners reported learning about the MEP through direct contact from Efficiency Maine. Two Partners reported being aware of the program from the time that Efficiency Maine issued the RFP for program delivery.

Nearly half of interviewed building owners (41%) reported initially learning about the MEP through business partners or other building owners, with smaller numbers reporting learning about the program through a contractor or Program Partner (18%), newspaper, radio, or TV ads (18%), or the Efficiency Maine website (12%). Only one survey respondent said they initially learned about the program via email. However, 59% of respondent said the best way to reach them about energy efficiency programs and opportunities generally *is* email, with others preferring telephone contact (24%) or updates to the website (12%). These responses indicate that while email may not be an ideal method to increase awareness of a new program, it is a good way to provide further program updates and opportunities.

Program Partners interviewed for this study reported variation in building owners' awareness of the MEP. Some Partners reported almost all of their potential clients as being aware of the program, but having different levels of knowledge, ranging from very uninformed to fairly familiar with how the program works. Other Partners reported that very few of their potential clients are even aware of the program. One Partner noted that he found public officials completely unaware of the program. While these are not specifically targeted by MEP outreach, they often are in contact with building owners and could be a good source of information about the program.

Partner Marketing Efforts

Interviewed Partners reported using different ways of obtaining customers. Some Partners reported that they generally pursue customers themselves, while others reported that most potential customers contact them initially. For customers who were already aware of the program, Partners reported the program website, program breakfasts, referrals through landlord groups, and referrals from Efficiency Maine to be the primary sources of information about the program.

All but one Partner we interviewed reported that they market the program to any potential client they encounter. Five Partners reported that they utilize some form of direct marketing (e.g., cold calls, emails, face-to-face conversations) to bring potential clients into the program; one Partner reported that they market only to clients they encounter as part of their other business.

Only one interviewed Partner reported using Efficiency Maine's program materials to market the program, but approximately half of the interviewed Partners reported a desire for additional marketing materials. Desired materials mentioned were a basic flyer that outlines the program "in a nutshell" and additional case studies. In the words of one Partner:

> *"You tell a Mainer what somebody else saved, that's where it's at. Give them a street address and a picture, budda bing, budda boom, done! … They want to see it from [Efficiency Maine]. They don't want to see it from me. Efficiency Maine says it and it occurred on this street, that's where it's at."*

Partners also noted that they thought the program could conduct more targeted marketing and mass-media marketing (TV), leverage Efficiency Maine branding more, and increase Efficiency Maine's presence at landlord association meetings.

Overall, interviewed Partners reported that while increased tenant comfort and other specific upgrades do hold some interest for property owners, money was the overwhelming primary reason why a property owner would participate in the program. As a result, financial savings is far and away the most successful way for a Partner to sell the program.

> *"All they care about is the bottom line. And that's what I sell."*

5.3 Program Partners

5.3.1 Partner Participation and Services Provided

Program Partners reported that when they assisted a participant with benchmarking, they nearly always completed an ERP for the building. The lone exception was a Partner working with one specific building owner, who benchmarked all of their buildings and then prioritized specific buildings to have ERPs completed based

on the results of the benchmarking. All but one interviewed Program Partner reported that assisting with the benchmarking phase in at least 50% of the projects for which they completed ERPs.

For buildings that have completed the benchmarking phase, Program Partners generally conduct an initial "screening" of a potential project before conducting a full assessment. This typically consists of a quick look at the building by the Partner, after which the Partner lets the building owner know whether they think the building will meet program requirements. This practice helps Partners to minimize cases where they conduct an assessment but are then unable to generate an ERP (either due to a lack of potential savings or because of a client changing their mind). One interviewed Partner reported conducting a significant number of assessments but completing only one ERP; this Partner reported the time-consuming nature of the ERP review process was a barrier to moving further with these potential projects.

Partners generally reported completing retrofits in approximately 50% of the buildings for which they developed ERPs. The primary reason for not completing retrofits was the cost to the building owner. One Partner specifically called out their clients' inability to get financing. Individual partners also mentioned their clients' lack of understanding of the projected savings from the retrofits and the projected burden on the client to complete the project (e.g., paperwork) as reasons for not completing retrofits.

5.3.2 Prescriptive and Modeling Path Projects

Of the Program Partners we interviewed, three completed projects through the prescriptive path only, two through the modeling path only, and two used both paths.

Interviewed Partners who used the Prescriptive Tool generally found it relatively easy to use. However, Partners had complaints about results the tool produced, specifically in relation to interactive effects between measures and thermal insulation savings projections. One Partner also reported that the tool produced very different estimates than other modeling software, including Real Home Analyzer (RHA) and REM/Rate. Partners generally reported choosing to complete jobs through the prescriptive path over the modeling path because it takes less time to complete an ERP and does not require the use of TREAT.

The four interviewed Partners who use the modeling path all use TREAT as their modeling software, and three of them are reasonably satisfied with it. The one unsatisfied Partner did not have prior TREAT experience before participating in the MEP. One Partner who did not complete any modeling path projects also expressed that he specifically avoided the modeling path because of TREAT.

Interviewed Partners generally thought that TREAT has a steep learning curve, but is relatively easy to use once you learn how to use it. Partners generally expressed a desire for more TREAT training. They noted that the training would have been more effective if it had been offered when the program first began, rather than midway through the program (which Partners reported was when the program began to offer TREAT training).

Interviewed Partners were split on whether they thought energy modeling helped sell retrofit projects and participation in the MEP to customers. One Partner, focused primarily on larger projects, mentioned that he thought modeling provided additional value for large projects because the cost of mistakes for these projects would be significantly higher. This Partner also noted that modeling provides ongoing value for an existing relationship between the Partner and the building owner. Partners generally thought the modeling added value but was so time-consuming and cumbersome that it is not cost-effective.

5.3.3 Pricing of Energy Assessments

Three of the seven interviewed Partners reported pricing at least some energy assessments at a level where they would be covered entirely by the program's Incentive #1 (i.e., free to the customer). Two of these three Partners charged $200 per unit for energy assessments, and completed projects primarily through the modeling path of the program, while the third charged $100 per unit for assessments and completed projects only through the prescriptive path. All three of these partners reported that the price they charged for assessments did not cover their costs. Notably, two of these three Partners no longer pursue projects through the program. These Partners also reported that they had initially planned to sell assessments at a loss and recoup their losses through retrofit activities, but found this to be an untenable strategy. The third Partner who had sold energy assessments at a loss noted that they would increase their per-unit charge for assessments significantly if any new projects were undertaken.

The other four Partners generally reported charging about $300-$400 per unit to conduct energy assessments. While most Partners charge a flat fee per unit, some charge an upfront fee and then a lower per-unit rate after a certain number of units. One Partner charges additional fees if more equipment is needed (e.g., extra blower doors). Another Partner reported using a "payment plan" where the client pays half the cost of the energy assessment after completion of the assessment and the second half after completion of the ERP. This Partner also reported charging a flat fee of $350 to conduct benchmarking activities, which is refunded to the client if an ERP is completed.

With the exception of one individual, interviewed Partners did not feel that the upfront charge to for an energy assessment dissuades potential participants.

Partners were somewhat split on their opinion of the level of Incentive #1 (received upon approval of the ERP). About half of the interviewed Partners thought it was reasonable, or could be slightly higher, and half thought the program should pay the full cost to the Partner of completing the assessment as Incentive #1. One Partner thought the incentive was on the high side. Suggestions made by Partners included to have the incentive come directly to the Partner, rather than to the participant, and to eliminate ERP incentive entirely and increase the post-retrofit incentive proportionally.

5.3.4 Retrofits

Most interviewed Partners reported that they discuss a spectrum of options for a retrofit with the participant, following the assessment process but before the ERP is generated, and that participants generally decline some of the recommended improvements. The improvements declined by participants are generally either lower return-on-investment measures, non-thermal measures (e.g., electrical measures), or comfort-related (e.g., faucet/showerhead aerators and thermostat setbacks). Partners indicated that participants would typically package the fewest measures needed to achieve the savings required to qualify for the program, generally prioritizing first by participant need in measures (typically heating equipment) and then by return-on-investment. One Partner reported that they provide participants with the best package possible by return-on-investment, and that participants did not generally tweak the measures specified at all.

Most Partners were generally satisfied with the level of Incentive #2 paid after a retrofit is completed. Partners mentioned that any increase would be welcomed, but that generally, the incentive does a good job of covering a significant portion of participant costs. One dissenting Partner desired an increase in Incentive #2, or a more detailed incentive "algorithm," and argued that buildings with fewer units are essentially penalized because the overhead for a project is similar regardless of the number of units.

Interviewed Partners generally reported the program as having a significant impact on the retrofit work they completed. Most partners reported that a large portion of their projects would not have been completed at all without the program, and those that would have been completed would have had their scope somewhat or significantly reduced, losing "deeper" savings.

5.3.5 Partner Satisfaction

Interviewed Program Partners reported varying degrees of overall satisfaction with the program. Four of the seven interviewed Partners reported being very satisfied or somewhat satisfied with the program, while three reported being not at all satisfied or not very satisfied.

The difference in satisfaction with the program generally centers around the Partners' experiences with the ERP review process. Partners who reported dissatisfaction with the program all mentioned the ERP review process and, to a lesser extent, the ERP development process as the program's major flaw(s). Partners cited the process as taking far too long, being "nitpicky" (i.e., ERPs being rejected for containing minor flaws), and being seemingly inconsistent between different program reviewers. Some Partners also mentioned specific concerns with the methodology of the reviewers, the program's modeling guidelines, and the Prescriptive Tool.

These dissatisfied Partners mentioned that the long review process costs them a significant amount of money, and, in several cases, has caused them to either drop out of the program entirely or increase the rates charged for audits. Two Partners, who provide actual construction and retrofit services, mentioned that their initial plan to sell the energy assessments at a loss and recoup their expenses through construction work did not work because of the amount of money they lost conducting the assessments.

> *"The whole review process just kind of brings me to my knees … I think a lot more could be done if the barrier of detail, technical knowledge that is required could be minimized. At the end of the day what everybody wants is to be able to see our clients achieve energy savings."*

However, those Partners who generally reported being satisfied with the program cite the ERP review process as a primary strength of the program. While they acknowledge that the review process is long, these Partners state that the comprehensive ERP development and review process provides the client with a better product, helps ensure that estimated savings will be realized, and considers the building as a whole rather than the installation of individual measures. In the words of one Partner:

> *"I think the ERP development process is pretty comprehensive, and I think it really does a good job considering a whole building retrofit. I think it has a good review process […] as frustrating as it can be at times. […] I think that the owners do get a really well vetted energy reduction scope of work."*

Another of the satisfied Partners noted that the program's substantial requirements for comprehensive ERP review were unusual, but that they did not pose a barrier to those who conduct high-quality work. This Partner believes that dissatisfaction among some Partners stems from not being able to "cut corners" given the program's review process.

5.4 Barriers to Participation

Building owners who participated in the MEP had several ideas why other building owners do not make energy efficient upgrades to their buildings. Not surprisingly, they most often cited financial factors, including upgrades being too expensive (71%) and lack of financing (47%), as the reasons they believe these upgrades are not made by other building owners. This is supported by information provided by Program Partners, who

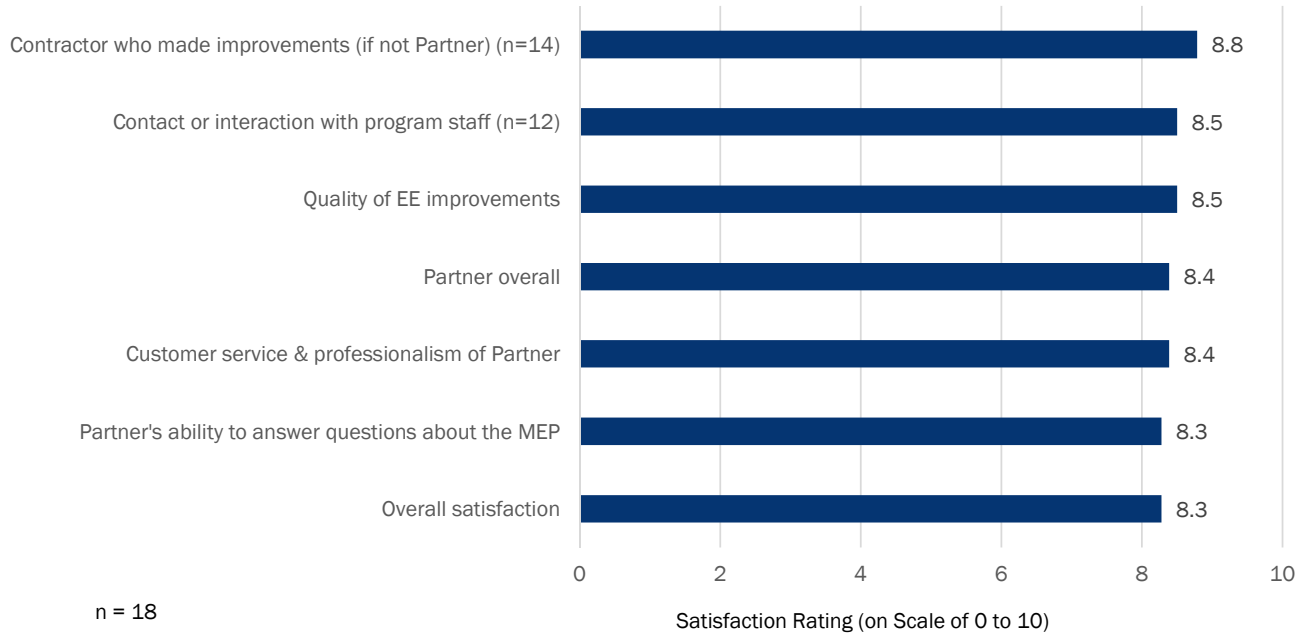
cited financial reasons as the primary barrier in moving building owners from the ERP stage of the program to a retrofit. Multiple interviewed building owners we interviewed also noted a lack of knowledge about energy efficiency and shortsightedness in terms of benefits from these upgrades as barriers.

Interviewed building owners reported multiple potential barriers to participation in the MEP for other building owners, including the difficulty of the participation process (53%), lack of awareness of the program (41%), financial reasons (35%), and lack of technical knowledge (29%).

5.5 Participant Satisfaction

Interviewed building owners were generally very satisfied with the program, reporting a mean overall satisfaction rating of 8.3.[40] All but one respondent said that they would recommend the MEP to other building owners. Building owners gave high ratings for all other facets of the program as well, indicating consistent satisfaction with the program and its various components.

Figure 5-3. Average Participant Satisfaction Scores



Interviewed building owners also reported positive feedback on the effects of the MEP-incented improvements on energy bills and tenants' comfort:

- Of the eight interviewed building owners who pay some or all of their building's energy bills, all but one reported that their energy bills went down after making the energy efficiency improvements.

[40] On a scale of 0 to 10, with 0 meaning "extremely dissatisfied" and 10 meaning "extremely satisfied."

- Seven building owners reported feedback from their tenants regarding the improvements, all positive. Of the seven, five reported increases in comfort, two reported satisfaction with the quality of the new measures, and two reported a reduction in energy bills.

Only three of 18 interviewed building owners reported having any problems during their participation in the program. In all cases, problems centered around the timeliness of the program's payouts and approval process, with one respondent also noting that their initial Partner was not sufficiently qualified.

Ten of the 18 interviewed building owners offered recommendations to improve the program. Many of these mentioned improving program processes, primarily simplifying the application process and qualifying criteria, and speeding up approvals for incentives. Recommendations given by individual respondents included tying in low interest loans to the program, incentivizing partners instead of participants, improving program outreach and communications, and lengthening the period of program availability.

6. Findings and Recommendations

6.1 Impact Evaluation

6.1.1 Impact Results

Gross Impacts

We estimated program-level *ex post* (evaluated) gross impacts by developing separate realization rates for fossil fuel and electricity savings for a sample of evaluated projects. We then multiplied these realization rates by *ex ante* (program-reported) estimates of program-level fossil fuel savings and program-level electric savings, respectively. The estimated realization rates along with annual *ex ante* and *ex post* gross savings are listed in Table 6-1 for projects completed during the evaluation period (July 2012 through September 2013). Evaluated fossil fuel savings were 69% of reported savings and evaluated electric savings were 107% of reported savings.

Table 6-1. Annual Program-Level *Ex Ante* and *Ex Post* Gross Impacts

	Fossil Fuel Savings (MMBtu)	Electric Savings (kWh)
Ex Ante Gross Savings	10,995	258,754
Realization Rate	0.69	1.07
Ex Post Gross Savings	7,567	277,844

Net Impacts

Based on participant surveys, the evaluation team estimated a program net-to-gross ratio (NTGR) of 0.90 for the evaluation period. A NTGR of 0.90 means that 90% of verified (*ex post*) gross savings can be reliably attributed to the program.

Table 6-2. Multifamily Efficiency Program NTGR

Component	Value
Free-Ridership (FR)	0.11
Participant Spillover (SO)	0.01
NTGR = (1- FR - SO)	0.90

Net program impacts are calculated by multiplying the NTGR by *ex post* gross program savings. This calculation yields annual program-level net impacts for the evaluation period of:

- 6,779 MMBtu of fossil fuel savings (103 MMBtu per project)[41] and
- 248,916 kWh of electric savings (3,771 kWh per project).

[41] 103 MMBtu are equivalent to 744 gallons of heating oil.

Cost–Effectiveness Analysis

Our analysis of the MEP through September 2013 found that the program is cost-effective for all three tests performed: the Total Resource Cost test (TRC), the Program Administrator Cost Test (PACT), and the Participant Cost Test (PCT). All tests show a positive net present value and a benefit-cost ratio that exceeds 1.0.This analysis is based on the 66 projects that were completed between the launch of the program and September 2013.

Estimated benefit-cost ratios for the program are:

- TRC = 1.16
- PACT = 1.23
- PCT = 3.62

6.1.2 Other Impact Findings

General

- As part of our engineering review of the 33 sampled projects, we carefully examined all project documentation and materials supporting the project application. Overall we found project documentation to be good. However, we identified a few types of required post-project documentation that was generally not present (post-inspection blower door test results) or not fully reported (post-inspection reports). More consistent inclusion of this type of information would provide better estimates of savings for some measures, enhance program quality control efforts, and facilitate the impact evaluation process.
  - The program requires post-construction blower door testing, yet very few reviewed projects reported the results of such testing. According to program staff, ERP savings estimates are not updated if the post-construction blower door test meets or exceeds the predicted result. If results are only updated if the test falls short of predicted results, savings for air sealing would be systematically understated. In addition, documenting the post-construction blower door test results would provide more certainty that the test was actually conducted and reported savings have been achieved.
    - We recommend that the testing be documented and the results be used to update the estimate of air sealing savings.
  - The inspection report often consists of simple statements that work was completed as proposed, without listing the completed measures or any detailed information about them.
    - To provide more certainty in the quality assurance process and reduce the need for future onsite audits, we suggest that the inspection reports be more robust and use a template that asks the inspector to list additional detail for the installed measures, such as material, area, and depth of insulation. This would allow for a better validation of savings claims by the inspection reports. We also suggest combining the inspection report with the photo documentation since both have the goal of providing verification of proper measure installation.

Prescriptive Tool

- We found that the program's Excel spreadsheet for calculating energy savings for the prescriptive path (i.e., the "Prescriptive Tool") agrees well with the TRM and correctly

implements the algorithms in the Technical Reference Manual (TRM) for the energy efficiency measures that were part of our gross impact sample.

- For several sampled projects, the Prescriptive Tool produced total project savings that were either nearly as great as the fossil fuel consumed annually at the site or greater than the portion of the fuel used for heating.
    - If, going forward, the MEP continues to offer a prescriptive path that considers savings as a percentage of baseline fuel usage, we recommend more closely reviewing projects that have a high ratio of savings to total annual fuel use or heating fuel use.[42]
- The program claimed kWh savings for windows, air sealing, and insulation measures for all prescriptive projects with those measures. The Portal reported these as "cooling" savings, although implementation staff later clarified that these savings did not represent cooling savings but heating-related savings associated with reduced HVAC load (e.g., fans and pumps). While we did not reduce these savings, we note the following:
    1) Claiming kWh savings for air sealing is based on an appendix in the New York TRM, upon which the MEP TRM is based. The main body of the NY TRM suggests that kWh savings should not be claimed for air sealing as the algorithm includes a factor unique to cooling.
    2) Claiming kWh savings for air sealing is inconsistent with other program practices as no similar kWh savings are claimed for boilers and furnaces (which should have higher kWh savings than air sealing) nor does TREAT claim non-cooling kWh savings for any heating-related measures.
    3) We acknowledge that there are possible kWh savings associated with reduced fan and pump usage, but we were not able to verify the magnitude of the savings claimed by the MEP.

    - We recommend revisiting the TRM algorithm for estimating kWh savings for windows, air sealing, and insulation measures and dropping non-cooling savings for these measures.

Site Visits

- The evaluation team generally found very good agreement between reported improvements made through the MEP and observed improvements on site.

Measure-Specific Findings

Table 6-3 below shows the percentage of ex ante program savings and the realization rate for each measure, by fuel type. Following the table, we present measure-specific key findings and recommendations only for measures that were part of the 33 reviewed projects and that account for at least 5% of total MEP fossil fuel savings or 25% of total MEP electricity savings.

It should be noted that the measure-level realization rates are, in some cases, based on a small number of projects. Our analysis did not intend to provide statistically significant results at the measure-level. As a result, this report provides detailed explanations of the drivers of our results for

[42] According to the implementation team, a newer version of the Prescriptive Tool, not available for our analysis, includes a more visible check of projected savings as a percentage of fuel usage.

each measure. Measure-level realization rates should only be used in the context of these explanations to guide future program planning.

Table 6-3. Summary of Measure Contribution to Savings and Realization Rates

Measure	% of Ex Ante Program Savings		# of Sampled Projects with Technology	Realization Rate	
	Fossil Fuel	Electricity		Fossil Fuel	Electricity
Boilers/Furnaces	34%	2%	19	63%	-
Air and Duct Sealing	16%	4%	27	86%	92%
Low Flow Devices	13%	--	17	96%	-
Roof/Attic Insulation	13%	8%	24	83%	79%
Wall/Foundation Insulation	9%	1%	20	50%	84%
Gas Water Heaters	4%	6%	8	51%	0%
Pipe Insulation	3%	--	6	59%	-
Windows	1%	13%	5	100%	61%
Clothes Washers	<1%	1%	2	100%	136%
Lighting	--	29%	9	n/a	128%
Refrigerators	--	13%	4	n/a	57%
Other	7%	23%	17	53%	127%

Boilers/Furnaces

- Several buildings that participated in the MEP during the evaluation period also received an incentive through Efficiency Maine's Natural Gas Program for the installation of new high efficiency boilers or furnaces. We found that the MEP did not follow the agreed-upon method of allocating savings between the two programs that was in effect at that time; as a result, the MEP over-claimed savings for several boilers/furnaces. We made adjustments to allocate savings between the MEP and the Natural Gas Program consistent with the program guidelines at the time; these accounted for the single largest reduction of *ex ante* fossil fuel savings and significantly affected the realization rate for boilers/furnaces and for the program overall.
    - For boilers and furnaces that also receive an incentive through the Efficiency Maine Natural Gas Program, we recommend that implementation staff ensure that only the MEP share of savings is claimed for this program.[43]
- The Prescriptive Tool does not take into account interactive effects between boilers/furnaces and measures such as insulation and air/duct sealing. For most of the sampled prescriptive projects, we reduced boiler/furnace savings to account for interactive effects.
    - Build consideration of interactive effects into the MEP TRM and the Prescriptive Tool, e.g., in the form of factors that are applied when measures are installed in certain combinations.

[43] As of December 2013, the MEP no longer allows participants to receive an incentive through the MEP and the Natural Gas Program for the same boiler or furnace.

Air and Duct Sealing

- ERP savings estimates are not updated if the post-construction blower door test exceeds the predicted result. This understates savings for such projects.
    - We recommend that the testing be documented and the results be used to update the estimate of air sealing savings.
- TREAT predicts high MMBtu savings from duct sealing of between 30% and 45% of annual heating fuel usage.
    - For purposes of meeting the required minimum savings to qualify for the retrofit incentive, we recommend capping duct sealing at no more than 20% of estimated heating fuel usage.

Low Flow Devices

- The Prescriptive Tool (based on the program TRM) produces savings that are generally three times those estimated by TREAT. The difference between the two savings values is due in part to assumed hot water usage per person per day, but is also affected by default assumptions of overall system efficiency.
    - Given that low flow devices account for the third largest share of program MMBtu savings, and that this measure is slated to be offered under the new prescriptive approach recently rolled out by the program, we recommend further research into TRM values.[44]

Wall/Foundation Insulation

- TREAT produces MMBtu savings that are considerably greater than those estimated by the Prescriptive Tool. In the sampled MEP projects, wall insulation generally consisted of insulating two to three feet of foundation wall and/or attic knee wall.
    - We recommend applying an adjustment factor for "wall insulation" savings estimated in TREAT so that claimed savings better reflect the insulation actually installed.

Gas Water Heaters

- The Prescriptive Tool does not take into account interactive effects between gas water heaters and other measures which save hot water.
    - Build consideration of interactive effects into the MEP TRM and the Prescriptive Tool, e.g., in the form of factors that are applied when measures are installed in certain combinations.

Lighting

- Only nine of the 33 sampled MEP projects included lighting, all of them modeling path projects.

[44] According to the implementation team, the algorithms for low flow devices and pipe insulation have been corrected in a new version of the TRM and Prescriptive Tool.

6.2 Process Evaluation

In support of the process evaluation, we reviewed program materials, interviewed program and implementation staff, and conducted surveys with Program Partners and participating building owners. Since our research was completed prior to the program design changes announced in January 2014, these program changes are not reflected in information we obtained; rather, our findings pertain to the original program design.

Program Participation

- During the evaluation period, 35 building owners completed 66 building retrofit projects (comprised of 638 apartment units) through the MEP. In addition, the program benchmarked 2,795 units and approved ERPs for 1,779 units. By September 30, 2013, the original end date of the program, the MEP had achieved 112% of its goal set for benchmarked units, but had not yet met its goals for units with approved ERPs (81%) and units retrofitted (35%). It should be noted that Efficiency Maine received an extension of the grant period to March 31, 2014.

  Table 6-4 presents MEP goals and progress toward them as of September 2013.

Table 6-4. Program Goals and Progress[1]

Metric (# of Apartment Units)	Goal	Number of Units Completed	% of Goal Attained
Units Benchmarked	2,500	2,795	112%
Units with Approved ERP	2,200	1,779	81%
Units Retrofitted	1,800	638	35%

[1] As of February 11, 2014, 3,231 units had been benchmarked (129% of goal), 2,373 had an approved ERP (108% of goal), and 1,250 were retrofitted (75% of goal).

Source: MEP Status Report, September 27, 2013

- The most common measures installed through the program were air sealing (76%), roof/attic insulation (68%), low-flow devices (59%), and boilers/furnaces (58%). The high prevalence of thermal efficiency measures corresponds with a high incidence of building owners paying heating fuel bills for their building (89%). Similarly, the relatively low incidence of electric efficiency measures corresponds with the relatively low incidence of cases where the building owner is solely responsible for the electric bill (39%).
- Thirteen Program Partners had approved MEP ERPs as of August 14, 2013. Six Partners were only somewhat active in the program, completing fewer than ten ERPs. The top three Partners each completed 30 or more ERPs and were responsible for over half of all ERPs completed during the evaluation period.

Partner Experience

- The ERP development and review process got mixed reviews from interviewed Partners. Some Partners cited this process as a major barrier to their participation in the program (causing a few of them to stop participating in the program as of the time of the interview). Other Partners – while acknowledging that it can be time consuming – cited the process as a primary strength of the program, indicating that the comprehensive process provides their clients a better final product, helps ensure that estimated savings are actually achieved, and does a good job considering the building as a whole rather than each measure as a stand-alone item.

  - The design changes made to the program in January 2014 should address the issue of the ERP process and satisfy both Partners who are looking for a purely prescriptive process without the requirement of an ERP or achieving whole-house savings and Partners who prefer a more comprehensive, integrated approach.

- Interviewed Partners followed two different strategies with respect to the pricing of the energy assessment. About half provided them at a loss, for $100 to $200 (hoping they would recover the loss through the retrofit phase, which generally did not work out). The other half charged between $300 and $400 for the assessment, with some variations in terms of flat fees versus per unit fees and discounts after a certain number of units. Almost all interviewed Partners did not feel that the upfront charge for an energy assessment was a barrier to participation.
- Interviewed Partners who used the Prescriptive Tool generally found it relatively easy to use. However, a few partners commented on the results the Tool produced, specifically in relation to interactive effects between measures, thermal insulation savings projections, and results being very different from those produced by other software.
  - These statements are consistent with our observations from our gross impact analysis. We provide recommendations for addressing issues surrounding the Prescriptive Tool above.
- Interviewed Partners generally thought that TREAT has a steep learning curve, but is relatively easy to use once you learn how to use it. Partners generally expressed a desire for more TREAT training.
    - If TREAT remains the software of choice under the redesigned "Custom Path" and if the program wishes to further expand the base of Partners able to complete whole-house projects through this path, then the program should continue to provide TREAT training on an ongoing basis and encourage Partners new to TREAT to complete the training before participating in the program.
- Interviewed Partners found that the program encouraged deeper retrofits. Partners generally thought that some new heating systems would have been installed in the near future without the program (although possibly at a different level of efficiency) because the existing systems were old and needed to be replaced. However, Partners also reported that without the program, many or all of these projects would have had their scope significantly reduced, losing the deeper savings achieved through the program.
- Overall Partner satisfaction with the MEP was mixed. Four of the seven interviewed Partners reported being very satisfied or somewhat satisfied with the program, while three reported being not at all satisfied or not very satisfied. The difference in Partner satisfaction generally centered around the ERP review and development process (described above).

Building Owner Experience

- Word-of-mouth is an important method of promoting the MEP: Nearly half of interviewed building owners (41%) reported initially learning about the program through business partners or other building owners.
- Building owners, as well as Program Partners, cited financial factors (including the upfront cost and lack of financing) as the major barrier to making buildings more energy efficient. Accordingly, both building owners and Partners reported financial reasons to be the primary motivator for participation in the program. Building owners thought that the difficult participation process (53%) and lack of awareness (41%) were the main reasons that other building owners do not participate in the MEP.

- With its recent design changes, the MEP has removed, or at least mitigated, one major barrier to program participation – the difficult participation process. Given that word-of-mouth is an important way for building owners to learn about the program, the streamlined participation process should be heavily promoted among Partners and among former and prospective participants, who might be reluctant to participate given what they have heard about the original participation process.

- Building owner survey responses show a high level of satisfaction with the MEP and various aspects of the program. All but one interviewed participant said that they would recommend the MEP to other building owners.
- Building owners who pay their building's energy bills reported almost unanimously that their energy bills went down after making the energy efficiency improvements. Some participants also reported positive feedback from the tenants, including increases in comfort and reduced tenant energy bills.

Appendix A: Other Supporting Information for Gross Impact Analysis

This appendix presents gross impact results for the 33 sampled projects, by participation path. Our engineering review included 19 prescriptive path projects and 14 modeling path projects.

Section 4.1.2 above presented detailed explanations of the drivers of realization rates, by measure, distinguishing between prescriptive and modeling path projects. The tables below present the numeric results for each measure, for prescriptive and modeling path projects, respectively. Each table shows the number of sampled projects that included the measure and – separately for fossil fuel and electric savings - ex ante savings, ex post savings, and the resulting realization rate.

It should be noted that the measure-level realization rates are, in many cases, based on a small number of projects. Our analysis did not intend to provide statistically significant results at the measure level, or separately for prescriptive and modeling projects. As a result, these results might not be representative of all completed MEP projects and should only be used together with the explanations provided in Section 4.1.2.

Table A-1. Gross Impacts by Measure – Sampled Prescriptive Path Projects

Measure	Sampled Projects with Measure	MMBTU Savings			kWh Savings		
		Ex Ante	Ex Post	RR	Ex Ante	Ex Post	RR
Boilers/Furnaces	11	837	586	70%	-	-	-
Air and Duct Sealing	16	380	357	94%	1,889	1,732	92%
Low Flow Devices	10	399	367	92%	-	-	-
Roof/Attic Insulation	16	453	381	84%	2,834	2,247	79%
Wall/Foundation Insulation	11	198	167	84%	1,049	881	84%
Gas Water Heaters	5	158	126	80%	-	-	-
Pipe Insulation	5	230	124	54%	-	-	-
Windows	3	5	5	100%	40	24	61%
Clothes Washers	2	11	11	100%	2,086	2,832	136%
Lighting	-	-	-	-	-	-	-
Refrigerators	2	-	(1)	-	3,550	1,500	42%
Other	10	106	83	78%	15,714	13,968	89%

Table A-2. Gross Impacts by Measure – Sampled Modeling Path Projects

Measure	Sampled Projects with Measure	MMBTU Savings			kWh Savings		
		Ex Ante	Ex Post	RR	Ex Ante	Ex Post	RR
Boilers/Furnaces	8	865	490	57%	-	-	-
Air and Duct Sealing	11	379	297	78%	-	-	-
Low Flow Devices	7	122	131	107%	-	-	-
Roof/Attic Insulation	8	363	300	83%	-	-	-
Wall/Foundation Insulation	9	239	53	22%	-	-	-
Gas Water Heaters	3	125	18	14%	3,071	-	0%
Pipe Insulation	1	27	27	100%	-	-	-
Windows	2	10	10	100%	-	-	-
Clothes Washers	-	-	-	-	-	-	-
Lighting	9	33	(5)	n/a	21,037	26,999	128%
Refrigerators	2	(10)	(2)	n/a	3,486	2,478	71%
Other	7	185	72	39%	10,250	18,917	185%

Appendix B: Building Owner Survey Dispositions

Table B-1 presents the final disposition for the MEP participating building survey. The response rate was 53% (computed as the number of completed interviews divided by the number of eligible respondents). The cooperation rate was 75% (computed as the number of completed interviews divided by the total number of eligible sample units actually contacted).

Table B-1. Participant Survey Disposition

Disposition	Participants
Completed Interviews (I)	18
Eligible Non-Interviews	16
Refusals (R)	*5*
Mid-interview terminate (R)	*1*
Answering machine (NC)	*3*
Respondent never available (NC)	*7*
Not Eligible (e)	0
Unknown Eligibility Non-Interview (U)	0
Total Contacts in Sample	34
Response Rate	53%
Cooperation Rate	75%

Source: Opinion Dynamics Telephone Interviewing Services

We calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR).[45] For various reasons, we were unable to determine the eligibility of all sample units through the survey process, and chose to use AAPOR Response Rate 3 (RR3). RR3 includes an estimate of eligibility for these unknown sample units. The formulas used to calculate RR3 are presented below. The definitions of the letters used in the formulas are displayed in the table above.

$$E = (I + R + NC) / (I + R + NC + e)$$

Where "E" is the percentage of respondents with whom we have made contact that is eligible.

$$RR3 = I / ((I + R + NC) + (E*U))$$

The cooperation rate is the number of completed interviews divided by the total number of eligible sample units actually contacted. In essence, the cooperation rate gives the percentage of participants who completed an interview out of all of the participants with whom we actually spoke. We used AAPOR Cooperation Rate 1 (COOP1), the formula for which is shown below. The definitions of the letters used in the formulas are displayed in the table above.

$$COOP1 = I / (I + R)$$

[45] *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR, 2009. http://www.aapor.org/Standard_Definitions/1818.htm.

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