NAVIGANT

Impact Evaluation of the Efficiency Maine Trust 2010-2011 Large Projects Grant Program: Funded by the American Recovery and Reinvestment Act of 2009 (ARRA)

Prepared for:
Efficiency Maine Trust

efficiency MAINE

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Executive Summary

This report presents the results of an impact evaluation of Efficiency Maine Trust's (EMT's) Large Projects Grant Program for the 2010-2011 time period. The program provides competitive matching grants for custom electric and fossil fuel energy efficiency and renewable energy projects. The program was implemented in response to the funding opportunities made available from the American Recovery and Reinvestment Act of 2009, State Energy Program (ARRA-SEP). Funding of up to $1 million per project was awarded through a competitive review and selection process conducted by EMT. The program disbursed $12.4 million through January 31, 2012.

Navigant Consulting, Inc. (Navigant) and Turner Building Science were selected by EMT to conduct an impact evaluation of the program results to date. Navigant's scope of work focused on quantifying and verifying the energy savings, greenhouse gas reductions, and peak demand reductions achieved by the program. This work explicitly did not include any process evaluation objectives. Specific research objectives included:

- Measure and verify energy savings, including:
    - Site and source[1] energy savings and greenhouse gas reductions for all projects
    - Fossil fuel savings, including fuel oil savings
    - Electric demand savings
    - Renewable capacity generation for renewable projects
    - ISO-NE Peak Demand Savings
- Analyzing the attribution of impacts to the SEP/ARRA-funded grants to Large Projects and impacts on job creation
- Analyzing the cost effectiveness of the individual projects and program overall according to the Maine TRC test and the U.S. Department of Energy (DOE) SEP Recovery Act benefit/cost test.

As summarized in Table ES-1, the verified greenhouse gas impacts of the program found a gross realization rate of 1.20 and a net-to-gross ratio (freeridership adjustment only) of 0.67.

[1] Source energy refers to the total energy consumed through the entire process of mining, transporting, and burning fuel to provide a given fuel at the home. For a fuel like natural gas with very little energy input outside of the fuel delivered, the ratio between source energy and energy delivered might only be 1.02 to 1.1. For electricity, where fossil fuels are converted at the expense of significant thermodynamic losses, the ratio of source energy to energy provided is closer to 3.

Table ES-1: Verified Program Impacts

Metric	Reported Gross Savings	Verified Gross Savings	Gross Realization Rate	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Greenhouse Gas Reductions (metric tons CO2e)	75,756	91,266	1.20	0.67	60,987
Lifetime Greenhouse Gas Reductions (metric tons CO2e)	N/A	2,492,483	N/A	0.67	1,660,687

Source: Note: Savings are in CO2-equivalent metric tons.

Projects included fossil fuel savings, renewable energy generation and electrical savings. In round one of the RFP was fuel neutral and resulted in a broad diversity of projects. In round two, separate RFP's were released for GHG reductions and kWh reductions. Projects included in the evaluation were stratified for purposes of sampling, as summarized in Table ES-2.

Table ES-2: Projects Included in Evaluation

Strata	Number of Projects	Types of Projects Included
Large Sites without ISO-NE Savings	6	Biomass boilers, process heat recovery
Large Sites with ISO-NE Savings	6	Combined Heat and Power, Paper Process, Drives
Small Sites without ISO-NE Savings	8	Heat recovery, HVAC, Miscellaneous
Small Sites with ISO-NE Savings	6	Drives, Lights, HVAC, Process

Table ES-3 presents verified program impacts by the different fuel type savings.

Table ES-3: Detailed Program Impacts

	Metric	Reported Gross Savings	Verified Gross Savings	Verified Net Savings
Overall Program Annual Savings	Site Energy Savings (MMBtu)	N/A	867,596	580,965
	Greenhouse Gas Savings (metric tons CO2e)	75,756	91,266	60,987
Overall Program Lifetime Savings	Site Energy Savings (MMBtu)	N/A	23,771,812	15,850,797
	Greenhouse Gas Savings (metric tons CO2e)	N/A	2,492,483	1,660,687
Annual Electricity Savings	Energy (MWh)	37,457	44,562	34,950
	Summer Peak Demand (kW)	N/A	4,589	3,579
	Winter Peak Demand (kW)	N/A	5,330	4,159
Lifetime Electricity Savings	Energy (MWh)	N/A	1,235,551	971,352
Annual Fossil Fuel Savings	Total Fossil Fuel Savings (MMBtu)	N/A	715,302	464,646
Lifetime Fossil Fuel Savings	Total Fossil Fuel Savings (MMBtu)	N/A	19,503,879	12,585,073
Annual Renewable Energy Impacts	Installed Electric Capacity (kW)	N/A	547	409
	Annual Electricity Generation (kWh)	N/A	5,750,353	4,289,821
	Annual Energy Production (MMBtu)	N/A	154,230	102,820
Lifetime Renewable Energy Impacts	Lifetime Electricity Generation (kWh)	N/A	162,505,574	121,218,172
	Lifetime Energy Production (MMBtu)	N/A	4,089,042	2,726,028

Source: Note: CO2e refers to CO2-equivalent tons; Source energy savings may be found in Section 3.5; Fossil Fuel Savings includes Oil, Natural Gas, and Propane converted to MMBtu

Because the program was able to generate significant high value propane and fuel oil savings, the program had a very high total resource cost (TRC) benefit to cost ratio result, 8.0, as shown in Table ES-4.[2] The SEP Recovery Act Cost (SEP-RAC) test measures the net source energy impacts attributable to the

[2]For comparison, the Business Incentive Program TRC results for FY2011 was 1.9. *Evaluation of the Efficiency Maine Business Incentive Program*, prepared for Efficiency Maine Trust, Opinion Dynamics Corporation, 2011.

SEP-ARRA funds compared to the SEP-ARRA funds. The program SEP-RAC test result of 77.4 far exceeds the DOE goal of SEP-RAC tests greater than 10.

Table ES-4: Cost-Effectiveness Results

Cost-Effectiveness Tests	Result
Maine TRC Test	8.0
SEP Recovery Act Cost Test (Source MMBtu/$1000 SEP-ARRA Funds)	77.4

Source: Navigant analysis.
Note: The Maine TRC Test uses gross benefits and costs. The net TRC is 7.8. Source MMBtu refers to the total energy consumed from extraction through consumption. For example, for each unit of electricity consumed, between 3 and 3.5 units of fossil energy input are generally required to produce and deliver that electricity.

Given the strong energy savings and cost-effectiveness performance of this program, it is advisable to continue the electricity portion of this program, as planned, and explore opportunities for funding the GHG portion of the program again.

1. Introduction

1.1 Objectives

This report presents the results of an impact evaluation study of the Efficiency Maine Trust's (EMT) ARRA funded Large Projects Grant Program over the 2010-2011 time period. Navigant Consulting, Inc. (Navigant) and Turner Building Science (Turner) were selected to conduct the evaluation.

Navigant's scope of work was designed to provide a comprehensive impact evaluation that focused on quantifying and verifying the energy savings and greenhouse gas reductions achieved by the program. This work explicitly did not include any process evaluation objectives. Specific research objectives included:

- Measure and verify energy savings, including:
  - Site and source[3] energy savings and greenhouse gas reductions for all projects
  - Fossil fuel savings, including fuel oil savings
  - Electric demand savings
  - Renewable capacity generation for renewable projects
- Analyzing the attribution of impacts to the SEP/ARRA-funded grants for Large Projects and impacts on job creation
- Analyzing the cost effectiveness of the individual projects and program overall according to the Maine TRC test and the U.S. Department of Energy (DOE) SEP Recovery Act benefit/cost test.

1.2 Background

Efficiency Maine's Large Projects Grant Program provides competitive matching grants for large custom energy efficiency and greenhouse gas reduction projects in the state of Maine. The program was implemented in response to the funding opportunities made available from the American Recovery and Reinvestment Act of 2009, State Energy Program (ARRA-SEP) and Energy Efficiency and Conservation Block Grant(ARRA-EECBG), and the Regional Greenhouse Gas Initiative (RGGI). To date, the program has administered two rounds of grants in January and July 2010 respectively, for a total of 30 projects. In each round, funding was awarded through a competitive review and selection process by Efficiency Maine. Grants were awarded primarily on the basis of annual electric energy savings or greenhouse gas reductions per $1 of grant funds, while project readiness, economic viability and other factors were also considered.

[3] Source energy refers to the total energy consumed through the entire process of mining, transporting, and burning fuel to provide a given fuel at the home. For a fuel like natural gas with very little energy input outside of the fuel delivered, the ratio between source energy and energy delivered might only be 1.02 to 1.1. For electricity, where fossil fuels are converted at the expense of significant thermodynamic losses, the ratio of source energy to energy provided is closer to 3.

The impact evaluation of the program was conducted by Navigant and Turner from May-December 2011. Of the total 30 projects awarded grants, 26 were completed by January 31, 2012. The program had disbursed $12.4 million to these projects as of the end of 2011. The evaluation covers these 26 projects.

Round one of the the EMT's Large Projects Grant Program was fuel neutral and grants where grants could be used for electricity conservation, fossil fuel conservation, and renewable generation projects. Round two of the program segregated the funding in two RFP's; one for kWh savings and one for GHG savings. As a result of the program design and focus on custom projects and the prevalence of oil and propane use in Maine, the program generates energy savings from a wide variety of fuels and project types. This results in high variability in the impacts across projects. It also means that impacts are measured in a variety of units. Given this variability, the evaluation of program impacts required a combination of oversampling of projects with a given type of fuel savings and also converting all savings to a common baseline, which is site energy measured in British Thermal Units (Btu).[4] Only greenhouse gas and electricity savings were reported for each project. These two metrics plus site energy are the best indicators of the program's performance.

1.3 Approach

Out of the original 30 projects reported, the evaluation covered the 26 projects that had reported savings and were completed as of January 31, 2012. All of these projects were included in the evaluation sample and ultimately received detailed site-level savings analysis, as shown in Table 1-1.

Table 1-1: Status of Projects

Status of Projects	Number of Projects
Original Reported Projects	30
Sampled Completed Projects	26
Other Completed Projects as of 1/31/2012 (Not Included in Evaluation)	1
Projects Delayed until 2012	3
Projects Cancelled	0

Note: The initial sample drawn included 30 projects; 3 of these projects did not complete installation within the evaluation period and are not included in the final evaluation sample; these projects are counted in "Projects Delayed until 2012". One small project was completed as of 1/31/2012, but had not completed in time to be evaluated.

The 26 projects sampled were analyzed using a variety of data collection and analysis methods. All of the 26 projects sampled received phone verifications and attribution surveys. In a phone verification, a Navigant engineer reviews project documentation and savings assumptions and then conducts a phone interview with the grant recipient and/or contractor staff to collect project data for developing phone-verified energy savings calculations. In the attribution survey, Navigant asked questions about what the grant recipient would have done without the program, in order to determine the extent of attribution and freeridership, as well as questions to gather data on funding and inputs for cost-effectiveness

[4] Site energy refers to the thermal energy content of energy consumed in the building, not including any upstream or downstream energy consumption of energy.

analysis . As detailed in Table 1-2, out of the 26 projects with phone verifications, 18 projects received additional on-site measurement and verification. During on-site measurement and verification, Navigant field staff visited the project site to collect key information about the installed equipment and facility characteristics in order to develop site-verified energy savings calculations. The details of the site level analysis and results are documented in individual site reports.

Table 1-2: Data Collection Methods

Data Collection Method Applied	Number of Projects (Sample Size)
Phone Verifications	26
Attribution Surveys	26
On-site Measurement and Verification	18

Source: Navigant analysis.

2. Methodology

2.1 Impact Evaluation Approach

Navigant's measurement and verification strategy included a document review and phone interview verification, including the attribution survey, for a sample of projects, followed by on-site measurement and verification at a sub-sample of projects.

2.1.1 Sample Design

To satisfy the key evaluation objective of estimating site energy savings for all projects, a stratified ratio estimation method was used, in which a best fit of the program realization rate was calculated by comparing the reported savings to the verified savings for each project in the sample. In this method, the larger projects have a larger influence on the program results and are sampled at a higher proportion.

In this evaluation, site energy savings had a target two-tailed confidence and precision of 90/10, consistent with DOE guidance for evaluations of ARRA-SEP funded programs. In addition, the sample was stratified to help in the evaluation of ISO-NE peak demand savings. This stratification ensured that a sufficient number of sites with ISO-NE peak demand savings were sampled in order to generate these peak demand impacts.

The evaluation used a variation on a two-step method, known as the double ratio estimation method[5], that relied on phone interview verification (step one) and on-site verification (step two). The overall sample of projects for source energy savings analysis (n=26) received phone interview verifications, which help reduce the uncertainty in the estimate of energy savings and reduce the accompanying coefficients of variation (CVs) for the on-site verification sub-sample.[6] This method is especially useful when reported savings are likely to have errors. In this particular case, all available projects were given phone verifications, which allowed savings impacts to be calculated for every site before performing onsite verification.

The projects were stratified first according to the size of greenhouse gas savings measured in tons, and then by the presence of ISO-NE peak demand savings. This created four strata total, large sites with ISO-NE peak demand savings, large sites without ISO-NE peak demand savings, small sites with ISO-NE peak demand savings, and small sites without ISO-NE peak demand savings. The sample stratification is shown in Table 2-1.

[5] R.L. Wright et al. "Double Ratio Analysis: A New Tool for Cost-Effective Monitoring." 1994 ACEEE Summer Study. http://eec.ucdavis.edu/ACEEE/1994-96/1994/VOL08/263.pdf.

[6] The coefficient of variation is defined as the standard deviation of a population divided by the mean of the population. It provides an estimate of the underlying variability in the population, which drives the overall sampling uncertainty.

Table 2-1: Sample Stratification

Strata	Annual Reported Gross Greenhouse Gas Savings (metric tons CO2e)	Number of Projects	Phone Verifications	Field Verifications
Large Sites without ISO-NE Savings	32,524	6	6	5
Large Sites with ISO-NE Savings	29,956	6	6	6
Small Sites without ISO-NE Savings	8,346	8	8	3
Small Sites with ISO-NE Savings	4,930	6	6	4

Source: Navigant analysis.

Table 2-2 shows the types of projects that are contained in each of the strata. This information is useful for interpreting the stratum-level results found in Section 3 of this report.

Table 2-2: Project Types by Stratum

Strata	Number of Projects	Types of Projects Included
Large Sites without ISO-NE Savings	6	Biomass boilers, process heat recovery
Large Sites with ISO-NE Savings	6	Combined Heat and Power, Paper Process, Drives
Small Sites without ISO-NE Savings	8	Heat recovery, HVAC, Miscellaneous
Small Sites with ISO-NE Savings	6	Drives, Lights, HVAC, Process

Source: Navigant analysis.

2.1.2 Impact Analysis Approach Overview

In order to calculate gross and net impacts, the evaluation team performed the following eight general tasks:

1. **A stratified sample of projects was drawn for document reviews, phone verification, and on-site data collection to verify the engineering-adjusted impacts.**
   a. The sample included two levels of analysis, using a double ratio estimation method
   b. An overall sample was drawn for performing *document reviews* and *phone verifications*
   c. An on-site subsample was drawn from within the overall sample for performing *on-site verification* of phone-verified savings

2. **Conducted detailed documentation review for the *overall sample of projects* (n=26).**
   a. Acquired all available project documentation from program staff.

b. Determined the algorithm used to calculate program reported savings and determined if a different algorithm is more applicable or appropriate
c. Identified the key assumptions used in the calculation of reported savings
d. Identified places where a better source of an assumption may be available

3. **Interviewed facility staff by phone for *the overall sample of projects* (n=26).**
   a. Obtained additional project documentation
   b. Obtained available baseline data
   c. Obtained available interval meter data or EMS trend logs as available/needed
   d. Obtained details on other sources of project funding for attribution purposes
   e. Completed decision-maker surveys for attribution purposes
   f. Followed-up with facilities staff to determine the source and accuracy of assumptions

4. **For each project in the *on-site subsample*, developed a site data collection plan (n=18).**
   a. Identifed key sources of potential error in assumptions
   b. Determined appropriate International Performance Measurement and Verification Protocol (IPMVP) option for analysis
   c. Determined correct combination of spot measurements, field verification of assumptions, and data logging to be deployed at the site

5. **Collected field data from each project in the on-site subsample (n=18).**
   a. Performed on-site visit, including spot measurements, verification of baselines, and deployment of data loggers if necessary
   b. Performed a second retrieval site visit to pick up data loggers (if deployed)

6. **Analyzed document review and phone verification data and calculated phone verification rates for each stratum.**
   a. Used document review and phone verification data to refine assumptions and calculate phone-verified impacts for each site in the overall sample
   b. For each stratum, divided phone-verified impacts by reported impacts to derive a phone verification rate for each stratum

7. **Analyzed field data and calculate field verification rates for each stratum.**
   a. Used field data to refine assumptions and calculate field-verified impacts for each sampled site
   b. For each stratum, divided field-verified impacts by phone-verified impacts to derive a field verification rate for each stratum

8. **Calculated total program impacts and uncertainty.**
   a. Applied phone verification rates by strata to those projects not included in the overall sample
   b. Applied field verification rates by strata to projects not included in the on-site subsample
   c. Where reported savings were unavailable, extrapolated site-verified results to total population using ratio of one verified impact to another verified impact
   d. Summed field-verified impacts to derive the program total impact

2.1.3 Overall Site Energy

Site energy includes all energy consumed on site, converted into common thermal units (MMBtu). Site energy savings can be computed as the difference between total energy consumed at the site before and after the project's completion. In many cases for this evaluation, this computation was a direct conversion from how much fuel was used before and after the project's completion. The general algorithm for this is shown below.

where:

- is the thermal energy savings.
- is quantity of fuel consumed, in fuel-specific units
- *CF* is the conversion factor for units of fuel into thermal energy

2.1.4 Fossil Fuel Savings

Fossil fuel savings were determined based on the project type. In the cases of shell improvement and HVAC upgrade projects, the fossil fuel savings account for a change in efficiency resulting from upgraded controls, upgraded heating system or shell improvements. In the case of new renewable technologies, the fuel saved was determined by converting the amount of energy generated by the renewable system to the equivalent amount of fuel being displaced, taking into account the efficiency of the backup system. For example, a given solar system might produce 100 MMBtu of thermal energy in a year. If the backup water heating system had an efficiency of 80%, then the total fuel savings would be 100 MMBtu/ 80% = 125 MMBtu.

Projects which involve fuel conversion from one fossil fuel to another will have both positive and negative fuel savings. The replaced fuel will be positive savings and the new fuel will be negative savings. This accounts for the site still using fossil fuels.

2.1.5 Electric Energy and Demand Savings

Electrical energy savings were calculated for each sampled site with electricity savings and extrapolated to the total population. Because demand savings were not reported, demand savings had to be extrapolated using a multi-step process. First, summer and winter peak demand savings were calculated for each sampled site with electricity savings. The ratio of verified peak demand savings to verified electricity savings was calculated for summer and winter for each stratum. These ratios were then multiplied by the stratum-verified electricity savings to determine stratum and program peak demand savings.

2.1.6 Renewable Capacity and Generation

Renewable energy capacity is the thermal or electric nameplate capacity of a renewable system. This is the amount of energy that could theoretically be achieved with perfect efficiency and conditions. Renewable energy generation is the amount of energy actually produced from a system. Generation is calculated as:

where:

- *CF* is the capacity factor of the technology; the capacity factor is the average expected output of a generator expressed as a percentage of the nameplate capacity.
- η is the efficiency (assumed or proven) of the technology
- *t* is the amount of time the technology was in use.

2.1.7 Greenhouse Gas Emissions Reductions

Greenhouse gas emissions reductions were determined by calculating the difference of the carbon dioxide equivalents (CO2e) for each fuel used before and after the project's completion. The total greenhouse gas emissions considered in this evaluation include on-site combustion emissions as well as precombustion emissions associated with upstream extraction, refining, and transportation. For electricity, total emissions include all combustion and precombustion emissions associated with the production of a unit of electricity. The algorithm to determine carbon emissions reductions ( ) for each project is:

where

- *Fuel* is the amount of fuel or electricity used (in gallons, ft^3, or kWh)
- *CF* is the conversion factor between fuel units and lb of CO2e.

The conversion factors are shown in Table 2-3. Emissions were calculated using the sum of precombustion and combustion CO2e factors.

Table 2-3: Greenhouse Gas Emission Factors

Fuel Type	Precombustion CO2e	Combustion CO2e	Total CO2e
Electricity	-	-	1.166 lb/kWh
Natural Gas	0.0278 lb/ft^3	0.123 lb/ft^3	0.1508 lb/ft^3
Distillate Fuel Oil	4.1 lb/gal	22.8 lb/gal	26.9 lb/gal
Residual Fuel Oil	4.47 lb/gal	25.6 lb/gal	30.07 lb/gal
LPG	2.56 lb/gal	13.5 lb/gal	16.06 lb/gal
Propane	2.56 lb/gal	12.95 lb/gal	15.51 lb/gal
Biomass	n/a	n/a	0 lb/ton

Source: Source Energy and Emission Factors for Energy Use in Buildings (Deru and Torcellini [7])
Note: Propane precombustion value is assumed to be the same as LPG. Combustion value from EIA[8]. Electricity CO2e includes CO2 only, from 2011 Synapse report.[9] Biomass net greenhouse gas emissions have been assumed to be zero, in concordance with the results of a series of stakeholder meetings on this issue.

2.1.8 Job Creation

The Navigant team used the ACEEE Energy Stimulus Jobs Calculator[10] to estimate jobs created by Large Project Grants for DOE reporting. The ACEEE Calculator uses an input-output framework to evaluate the number of jobs created per dollar of stimulus funding invested in energy efficiency based on the following four inputs:

- **Investment –** Project investment in millions of dollars
- **Savings –** Annual energy bill savings in millions of dollars
- **Stimulus Period –** Number of years over which stimulus money is spent
- **Financing Shares –** Percent of total investment provided by federal, and out-of-pocket local and locally borrowed funds

To determine the input values, Navigant extrapolated savings and investment from the gross verified savings and incremental costs obtained from our phone verification (engineering review) sample. Financing shares were determined using participant responses to the attribution and cost-effectiveness survey.

2.1.9 Other Sources of Uncertainty

Throughout the evaluation, Navigant strove to reduce measurement error and/or bias. Sites were randomly selected for inclusion in the sample from within each stratum. All sites selected for the sample that had completed installation of energy-efficient equipment in time for evaluation were successfully recruited to participate in the evaluation, in some cases with recruiting assistance from EMT staff. With

[7] Deru, Michael and Paul Torcellini [2007], *Source Energy and Emission Factors for Energy Use in Buildings*, National Renewable Energy Laboratory, Golden, CO. NREL/TP-550-38617.
[8] Carbon Dioxide Emissions Factors for Stationary Combustion, Energy Information Administration [2005]. http://www.eia.gov/oiaf/1605/coefficients.html
[9] Avoided Energy Supply Costs in New England: 2011 Report, Synapse Energy Economics, Inc.
[10] www.aceee.org/press/2009/07/aceee-releases-job-calculator-energy-saving-stimulus-pro

all sampled sites participating (100% response rate), there was no possibility for response bias in the results. For each sampled site, phone surveys and data collection plans were developed and reviewed for technical accuracy by experienced engineers before they were deployed. This ensured that the best possible approach was used at each site, in order to minimize the amount of extrapolation and unverified assumptions that would be used in the analysis of results for each site.

2.2 *Attribution Approach*

The evaluation team used a self-report survey (the attribution survey) to quantify the degree of freeridership in the program. A pure "freerider" is a project that the participant reports they would have completed with or without the assistance of the program. A freeridership logic model (See Appendix B) was applied to the design of the survey and attribution analysis for this purpose. Spillover, which represents additional efficiency measures completed that were influenced by the program, but did not directly receive a grant from the program, was not quantified as part of the attribution analysis because most spillover does not occur until well after the projects are completed. Given the timing of surveys occurring shortly after or before projects were completed, any assessment of spillover at this time would underestimate actual spillover. Instead, an explicitly conservative approach was used in the calculation of the program's net-to-gross ratio (NTG), taking into account only freeridership NTG = (1 – freeridership).[11]

2.3 *Cost-Effectiveness Analysis Approach*

Navigant conducted a benefit-cost analysis of the Large Projects Grant Program through the use of the EMT benefit-cost screening tool (Version 2.2). All relevant measure and project data were verified by Navigant engineers and entered in the tool. Project cost data was obtained from customer invoices, the EMT Commercial TRM, and other regional TRM documents as appropriate. Project data was input at the individual measure level (electric and fossil fuel savings, incremental cost, and measure life) to calculate measure level savings and cost effectiveness. In the benefit-cost model calculations, electricity and fossil fuel savings at the measure level are subtotaled for each project and finally for the program as a whole. At the program level, the model calculates cost effectiveness, program incentive and non incentive costs, total program costs, and cost of conserved energy. Both net and gross TRC results were calculated by applying the NTG factor.

The State Energy Program Recovery Act Cost (SEP RAC) Test is a metric for measuring the performance of the program calculated as the annual source MMBtu saved per $1000 of ARRA funds expended.

[11] The typical approach includes spillover (SO), and is calculated using the equation NTG = 1 – FR + SO.

3. Impact Findings

The impact findings are summarized below in terms of gross savings and net savings. Gross savings refer to the entire savings realized at the customer site, while net savings consist of the savings that are attributable to the program after taking into account savings that would have occurred in the absence of the program (freeridership). In this evaluation, the estimate of net savings was calculated by subtracting estimated freeridership from gross savings. Because net savings and NTG were explicitly calculated for each site in the overall sample, the NTG value varies depending on the impact and level of aggregation.

3.1 *Verified Gross and Verified Net Site Energy and Greenhouse Gas Savings*

The overall site energy savings results for the Large Projects Grant program are summarized in Table 3-1. The site energy savings include all fuels saved in their thermal MMBtu equivalents.

Table 3-1: Site Energy Savings

Metric	Verified Gross Savings	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Site Energy Savings (MMBtu)	867,596	0.67	580,965
Lifetime Site Energy Savings (MMBtu)	23,771,812	0.67	15,850,797

Source: Navigant analysis.
Note: Values in this table are site energy savings. Source energy savings may be found in Section 3.2.5.

The NTG (1-freeridership) for annual site energy savings is 0.67. Applying the NTG to verified gross savings yields verified *net* savings of approximately 581,000 MMBtu for annual site energy savings and 16,000,000 MMBtu for lifetime site energy savings. Navigant believes these are good results given the context of the ARRA program's non-energy objectives and the relatively fast track grant approval process which was focused heavily on investing the money in the local economy consistent with the ARRA stimulus objectives. EMT did not report energy savings for all projects, since the focus of the program was on greenhouse gas and electricity savings. As a result, no realization rate was calculated for energy savings.

The verified greenhouse gas emissions reductions are higher than the amount reported by the program, with a gross realization rate of 1.2, as shown in Table 3-2. This difference between reported and verified gross emissions reductions is driven by four reasons. First, the verified savings came in higher because of the EMT adjustment factor applied[12] to the reported values. Second, Navigant used different greenhouse gas emissions factors for electricity, reflective of the updated values found in the latest Avoided Energy Supply Costs in New England Report, which are slightly lower than the values that

[12] EMT applied an adjustment factor of 0.7 to savings claimed by all projects, in order to compensate for any overly aggressive claims by the applicants and ensure that their reported savings were conservative.

were reported.[13] Third, Navigant used both combustion and precombustion emissions to account for the complete lifecycle emissions reductions associated with fuel savings in the program, which increases savings. Fourth, the program reported greenhouse gas emissions included only carbon dioxide, while the verified greenhouse gas emissions include other greenhouse gases, which also increases savings.

Table 3-2: Greenhouse Gas Emissions Reductions and Realization Rates

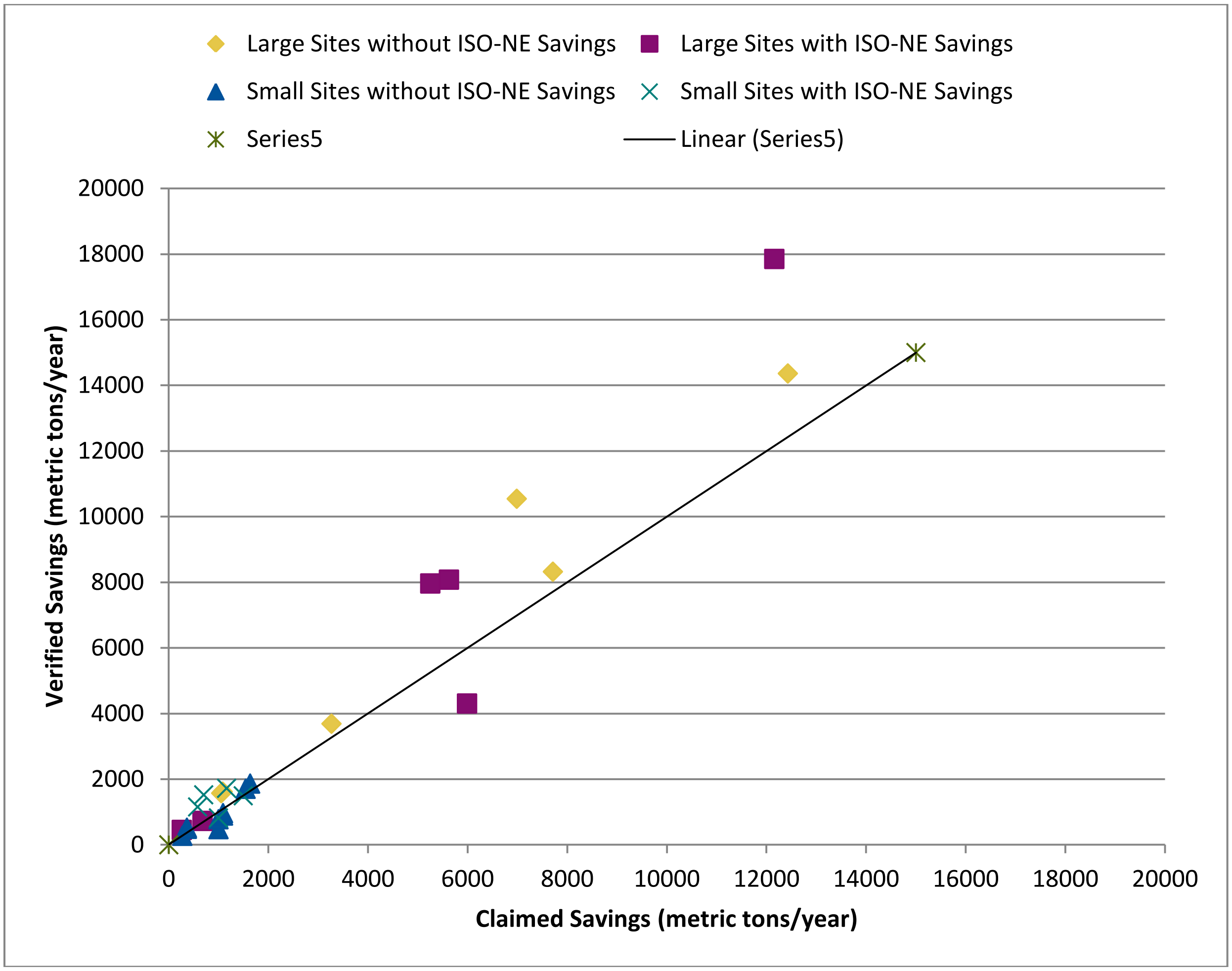
Metric	Reported Gross Savings	Verified Gross Savings	Gross Realization Rate	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Greenhouse Gas Reductions (metric tons CO2e)	75,756	91,266	1.20	0.67	60,987
Lifetime Greenhouse Gas Reductions (metric tons CO2e)	N/A	2,492,483	N/A	0.67	1,660,687

Source: Navigant analysis.
Note: Savings are in CO2-equivalent metric tons and only include total emissions of all greenhouse gases.

Figure 3-1 shows a graphical comparison of verified greenhouse gas savings to reported greenhouse gas savings for each project that received a site visit. Sites with verified greenhouse gas savings equal to reported greenhouse gas savings, with a perfect realization rate (equal to 1) will lie along the solid diagonal line. Sites with low verified greenhouse gas savings relative to reported energy savings lie well below the line. In the evaluation sample, most of the sites lie along or close to the perfect realization rate line, while there are a couple of outliers that bring down the overall realization rate.

[13] *Avoided Energy Supply Costs in New England: 2011 Report*. Synapse Consulting.

Figure 3-1: Verified vs. Reported Gross Site Energy Savings



The greenhouse gas results at a stratum level are shown in Table 3-3. The variability between stratum-level results in driven primarily by the frequency of negative outliers within the stratum. The smaller sites generally had higher NTG than the larger sites. The high NTG for these strata means that the projects funded in these strata generally would not have happened without the program. The overall NTG is driven by a very low NTG for a few large projects that were already far along before program funds became available. Part of the low NTG was likely driven by the short timeline involved for some very large projects. The short timeline favored projects that had already been planned and/or had already begun.

Table 3-3: Stratum-Level Greenhouse Gas Results

Strata	Number of Projects	Reported Annual GHG Savings (MMBtu)	Verified Annual Gross Greenhouse Gas Savings (MMBtu)	Fraction of Reported Savings	Net-to-Gross (NTG)	Realization Rate of Stratum
Large Sites without ISO-NE Savings	6	32,524	33,575	44%	0.66	1.03
Large Sites with ISO-NE Savings	6	29,956	42,226	56%	0.63	1.41
Small Sites without ISO-NE Savings	8	8,346	7,705	10%	0.79	0.92
Small Sites with ISO-NE Savings	6	4,930	7,760	10%	0.80	1.57

Source: Navigant analysis.

3.2 *Other Verified Gross and Net Impacts*

3.2.1 Fossil Fuel Savings

The computation and verification of fossil fuel savings posed a significant evaluation challenge. Multiple projects involved fuel switching away from oil or towards biomass. As a result, the fuel-specific savings could be misleading. Negative natural gas savings reflect sites where fuel switching from oil to natural gas or biomass occurred. Total fossil fuel savings are more indicative of the program performance (Table 3-4).

Table 3-4: Fossil Fuel Savings and Realization Rates

	Metric	Verified Gross Savings	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Savings	Fuel Oil (gallons)	5,811,660	0.59	3,439,109
	Natural Gas (MMBtu)	(76,324)	0.24	(18,065)
	Propane (gallons)	15,322	0.83	12,768
	Total Fossil Fuel (MMBtu)	715,302	0.65	464,646
Lifetime Savings	Fuel Oil (gallons)	155,161,692	0.59	90,899,348
	Natural Gas (MMBtu)	(1,531,029)	0.11	(169,168)
	Propane (gallons)	305,039	0.83	254,200
	Total Fossil Fuel (MMBtu)	19,503,879	0.65	12,585,073

*Values shown in parentheses indicate negative savings.
Source: Navigant analysis.

3.2.2 Electric Energy and Demand Savings

Gross annual electricity savings were calculated using the data collected through document reviews, phone verification surveys, and field visits for the sample of sites. The results of this analysis in Table 3-5 show a gross realization rate of 1.19 for annual electricity savings and 0.89 for ISO-NE summer peak demand savings. The NTG for the electricity projects, 0.78, is in Naviant's opinion satisfactory, considering it only includes freeridership, with no spillover. This is comparable to other established custom programs (where routinely NTG estimates can range from 0.50 to 1.0) that did not have the extra ARRA objectives and timelines that would tend to increase freeridership.

Table 3-5: Electricity and Peak Demand Savings and Realization Rates

Metric	Reported Gross Savings	Verified Gross Savings	Gross Realization Rate	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Electricity Savings (MWh)	37,457	44,562	1.19	0.78	34,950
Overall Summer Peak Demand (kW)	4,344	4,440	1.02	0.81	3,579
Overall Winter Peak Demand (kW)	4,020	5,330	1.33	0.78	4,159
ISO-NE Summer Peak Demand (kW)	4,344	3,879	0.89	0.73	2,837
Lifetime Electricity Savings (MWh)	N/A	1,235,551	N/A	0.79	971,352

Source: Navigant analysis.

3.2.3 Renewable Capacity and Generation

Grant recipients installed a number of biomass systems that featured fuel conversion from fossil fuel (typically oil) to biomass. Some of these systems produced or offset both electricity and thermal energy savings, while others produced only thermal energy savings. The results in Table 3-6 show both electricity and thermal energy savings (does not include electricity) for these systems. EMT did not report renewable generation savings in all cases, so realization rates were not calculated.

Table 3-6: Renewable Generation and Capacity

Metric		Verified Gross Savings	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Savings	Installed Renewable Electricity Generation Capacity (kW)	547	0.75	409
	Renewable Electricity Generation (kWh)	5,750,353	0.75	4,289,821
	Renewable Thermal Energy Generation (MMBtu)	154,230	0.67	102,820
Lifetime Savings	Electricity Generation (kWh)	162,505,574	0.75	121,218,172
	Thermal Energy Generation (MMBtu)	4,089,042	0.67	2,726,028

Source: Navigant analysis.
Note: Thermal energy generation refers to non-electric thermal energy produced by renewable systems such as solar hot water or biomass

3.2.4 Source Energy Savings

Source energy savings include all of the upstream and downstream energy consumption savings associated with energy consumption savings within a facility or building, including upstream combustion and thermodynamic conversion efficiency, extraction and refining energy, and transmission and distribution losses. The annual and lifetime results are shown in Table 3-7.

Table 3-7: Source Energy Savings

Metric	Verified Gross Savings	Net-to-Gross (NTG)	Verified Net Savings (Verified Gross * NTG)
Annual Source Energy Savings (MMBtu)	1,385,590	0.69	957,531
Lifetime Source Energy Savings (MMBtu)	38,078,935	0.69	26,263,910

Source: Navigant analysis.

3.2.5 Job Creation

Table 3-8 below presents the estimated number of net jobs created or retained by the program based on the ACEEE Stimulus Jobs Calculator. Net jobs refers to jobs created or retained net of hirings and firings with the program compared to without the program. The jobs created or retained as a result of this program were primarily in the engineering and construction sectors and the largest impact is seen in Year 2.

Table 3-8: Jobs Created or Retained

Type of Jobs	Year 1	Year 2	Year 3	Year 5	Year 10
Net Jobs Created	46	435	146	140	125
Net Jobs Retained	46	435	146	140	125

Source: Navigant analysis using ACEEE Stimulus Jobs Calculator.

3.3 DOE SEP Attribution Findings

As part of the SEP-ARRA evaluation requirements, the DOE requires a calculation of the proportion of project savings that are specifically attributable to SEP-ARRA funds as opposed to other funding sources for the energy efficiency projects, such as EMT's Business Incentive Program. The "Fraction Attributable to SEP-ARRA Funds" shown in Table 3-9 can be multiplied by any of the net impacts in the report to determine the net impacts attributable to the SEP-ARRA funding. Navigant's survey attribution research with the Large Projects Grant program participants found that 36% of the project benefits are attributed to the SEP-ARRA matching grant funding.

Table 3-9. SEP-ARRA Grant Funding Attribution

Component	Number	
SEP-ARRA Grants ($)	$	4,430,912
Other Grants ($)	$	7,938,362
Total Grants ($)	$	12,369,274
Fraction Attributable to SEP-ARRA Funds		36%

Source: Navigant Analysis

3.4 Confidence and Precision of Key Impacts

The confidence and precision of the evaluation results for the program are much better than the initial evaluation target of 90/10 (see Table 3-10). This occurred because the number of sites included in the evaluation dropped, so that a large proportion of the program projects in the evaluation frame were included in the on-site sample. The resulting confidence and precision of the results is very good. The peak demand savings confidence and precision is quantified with an 80% confidence level, in keeping with ISO-NE requirements. The resulting 80/2 confidence and precision far exceeds the 80/10 ISO-NE requirement.

Table 3-10: Confidence and Precision of Gross Savings

Metric		Verified Gross Savings	Confidence and Precision for Program
Overall Program Annual Savings	Energy Savings (MMBtu)	867,596	90/7
	Greenhouse Gas Savings (metric tons CO2e)	91,266	90/5
Annual Electricity Savings	Energy (MWh)	44,562	90/2
Peak Demand Savings	Summer Peak Demand (kW)	3,879	80/2
Annual Fossil Fuel Savings	Total Fossil Fuel Savings (MMBtu)	715,302	90/8

Source: Navigant analysis
Note: See Appendix for additional confidence and precision data on source energy.

The confidence and precision of net savings estimates in Table 3-11 are very similar to the confidence and precision of verified gross savings estimates, which is indicative of there generally being more variability in the site realization rates than in the site NTG values used to obtain net savings.

Table 3-11: Confidence and Precision of Net Savings

Metric		Verified Net Savings	Confidence and Precision for Program
Overall Program Annual Savings	Site Energy Savings (MMBtu)	580,965	90/10
	Greenhouse Gas Savings (metric tons CO2e)	60,987	90/7
Annual Electricity Savings	Energy (MWh)	34,950	90/2
Annual Fossil Fuel Savings	Total Fossil Fuel Savings (MMBtu)	464,646	90/12

Source: Navigant analysis.
Note: See Appendix for additional confidence and precision data.

3.5 *Cost-Effectiveness Analysis Findings*

Total program costs through the end of calendar year 2011 are $13,400,000, of which $12,400,000 was spent on grants and $1,000,000 spent on administration.

3.5.1 Results of the Maine TRC Test

Results of the TRC benefit-cost test used by EMT were calculated on both a gross and net basis, with the NTG value applied to program savings and incremental costs for the net calculations. The results are very good overall, 8.0 for gross TRC and 7.8 for net TRC, as shown in Table 3-12.

Table 3-12: Maine TRC Test Results

Metric	Gross Value	Net Value
Benefits	$ 311,839,802	$ 210,381,508
Costs	$ 38,928,034	$ 26,831,533
TRC	8.01	7.84

Source: Navigant analysis.

The stratum-level TRC results are shown in Table 3-13. All of the strata have TRC results higher than one. In general, the larger projects and the projects focused more on fossil fuel savings had the higher TRCs, but all had solid TRC results.

Table 3-13: Stratum-Level Maine TRC Test Results – Gross

Strata	Verified Gross Site Energy Savings (MMBtu)	Unit Benefits	Unit Costs	TRC Result
Large Sites without ISO-NE Savings	348,432	$ 109,215,474	$ 7,069,829	15.45
Large Sites with ISO-NE Savings	406,275	$ 154,980,936	$17,636,251	8.79
Small Sites without ISO-NE Savings	66,082	$28,937,268	$ 5,295,166	5.46
Small Sites with ISO-NE Savings	46,807	$18,706,123	$ 7,896,425	2.37
Total	867,596	$311,839,802	$ 38,928,034	8.01

Source: Navigant analysis.
Note: The total costs include an additional $1,030,000 of program administration costs.

3.5.2 Results of the SEP Recovery Act Cost Test

The SEP Recovery Act Test computes the simple ratio of annual source energy savings compared to program dollars spent. The program results and stratum results are shown in Table 3-14 and

Table 3-15. The SEP Recovery Act Test results should be compared to the DOE ARRA goal of at least 10 MMBtu annual source energy savings per $1000 of ARRA funds spent. The Large Projects Grant program far exceeds this goal, due to the exceptional performance of this program. Every stratum also exceeds this goal with ease.

Table 3-14: SEP Recovery Act Cost Test Results

Metric	Value
Annual Net Source MMBtu	$343,006
ARRA Program Funds	$4,430,912
SEP Recovery Act Cost Test (MMBtu/$1000)	77.4

Source: Navigant analysis.

Table 3-15: DOE SEP Recovery Act Cost Test Results by Stratum

Strata	Field Verified Net Source Energy Savings (MMBtu)	Program Incentives ($)	SEP RAC Test (Net Source MMBtu/$1000 Incentive)
Large Sites without ISO-NE Savings	116,846	$829,630	140.84
Large Sites with ISO-NE Savings	153,652	$1,755,851	87.51
Small Sites without ISO-NE Savings	24,793	$1,036,774	23.91
Small Sites with ISO-NE Savings	47,714	$808,655	59.00
Total	343,006	$4,430,912	77.41

Source: Navigant analysis.

4. Conclusions and Recommendations

In conclusion, the key findings for the program impact evaluation are:

- Greenhouse gas emission reductions: realization rate = 1.20
- ISO-NE peak demand savings: realization rate = 0.89
- Electricity savings: realization rate = 1.15
- Site energy savings: NTG ratio = 0.67
- Gross TRC test = 8.0

The program's energy savings results are very good when placed in the context of the program objectives, which included significant non-energy objectives, namely quickly disbursing ARRA funds to create jobs. The greenhouse gas, ISO-NE peak demand, and electricity realization rates are all well above 1, which is primarily driven by the EMT adjustment factor of 0.7 applied to all savings claimed by projects.[14]

The NTG ratio result of 0.67 is driven primarily by a small handful of project sites at which a large degree of freeridership was estimated as a result of these projects being far along in the planning stages before the Large Projects Grant money became available . This small handful of sites brought down the overall NTG. In a non-ARRA program that did not place a strong emphasis on funding projects quickly, projects such as these would be less likely to occur.[15]

The Large Projects Grant Program returned a gross TRC of 8.0 and a net TRC result of 7.8. This high TRC for the Large Projects Grant Program was driven in part by large fuel oil savings in the program. Fuel oil projects accounted for over 75% of the site energy savings. This fuel has very high costs at the current time and generates large dollar savings for participants. In addition, many of the program savings occurred in paper mills. The paper industry has extreme capital constraints at this time, meaning that projects with simple paybacks as strong as 2 or 2.5 years are not being funded without assistance. One paper mill respondent remarked, "This project has been on the books for 3 years. It never would have happened without funding from Efficiency Maine." The project in question wound up having a simple payback of less than two years.

Navigant makes the following recommendations for this program.

- **Continued funding for this program, incorporating both electricity and GHG focused projects, is worthwhile.** This program generated a very strong TRC result in addition to having high energy saving impacts. Participants were anecdotally pleased with the program.
- **Continue performing significant technical review, similar to the Business Incentive Program review of custom projects.** EMT should perform a technical review, specifically focused on the

[14] EMT applied an adjustment factor of 0.7 to savings claimed by all projects, in order to compensate for any overly aggressive claims by the applicants and ensure that their reported savings were conservative.
[15] Given the program objectives, the 0.67 NTG compares favorably with the EMT Business Incentive Program NTG of 0.66. *Evaluation of the Efficiency Maine Business Incentive Program*, prepared for Efficiency Maine Trust, Opinion Dynamics Corporation, 2011.

project definition, assumed baseline, and fuel savings type. This should include a follow-up call to discuss technical aspects of the project with the applicant. The existing review system is working well, preventing major errors in expected savings from occurring.

- **Continue marketing this program to private industrial sites, especially paper mills.** These sites have significant capital constraints, which have prevented many investments in energy efficiency from occurring. This means that there are more likely to be cost-effective projects available that generate large benefits relative to costs.

Appendix A. Appendix A: Additional ARRA Reporting Metrics

A.1 Savings by Year

The net energy savings impact for each year over the effective useful life of the actions attributable to the projects supported by the SEP Recovery Act funds are shown in the three tables below. Savings degrade over time due to the varying lifetimes of the measures within the projects. The savings degradation schedule was developed using project-specific estimates of lifetime for the overall sample, then applied to the first year annual net energy savings.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Savings Degradation Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual Net Energy Savings (MMBtu)	206,897	206,897	206,897	206,897	206,897	206,897	206,897	206,897	206,897	206,897

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Savings Degradation Factor	0.97	0.97	0.97	0.97	0.97	0.90	0.90	0.90	0.90	0.90
Annual Net Energy Savings (MMBtu)	200,781	200,781	200,781	200,185	200,185	186,616	186,616	186,616	186,616	186,616

Year	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Savings Degradation Factor	0.56	0.56	0.56	0.56	0.56	0.18	0.18	0.18	0.18	0.18
Annual Net Energy Savings (MMBtu)	115,712	115,712	115,712	115,712	115,712	36,765	36,765	36,765	36,765	36,765

A.2 Confidence and Precision on Source Energy

The confidence and precision on gross source energy is 90/5. The confidence and precision on net source energy is 90/6.

Appendix B. Engineering Methods

B.1 Engineering Methods

Different engineering methods were used based on project types. Several of these are listed below. Assumptions for individual sites are given in each site report (under separate cover). Note that the individual site reports used a different method of calculating greenhouse gas emissions for electricity savings. These were corrected in aggregate form for inclusion in the final report.

B.1.1 Boiler Upgrades and Fuel Conversions

For projects that include an upgrade to a higher efficiency boiler, the change in efficiency from the old boiler (η_{old}) to the new boiler (η_{new}) is used to calculate the saved energy and fuel, as shown in the algorithms below. The energy saved (ΔE) is calculated by

where F_{old} is the amount in volume (ft^3 or gallons) of the old fuel and $CF_{BTU,old}$ is the conversion factor between the volume of fuel to the fuel's heat content (higher heating value). The amount of fuel used historically is usually determined from billing data and adjusted based on heating degree days for the location of the boiler change. The amount of fuel used after the retrofit (ΔF_{new}) is calculated by

where $CF_{BTU,new}$ is the heat content of the new fuel if a fuel change accompanies the upgrade. If there is no fuel change, this conversion factor will be the same for both the old and new fuel. If the boiler upgrade occurs as an early retirement (discussed in section __ of Appendix __), the retrofit savings compare the new efficiency to the old efficiency while the replace on burnout savings compare the new efficiency to the standard efficiency of the efficient equipment ($E_{base,eff}$). These savings values are multiplied by the remaining life of the replaced equipment and the rest of the new boiler's lifetime, respectively, to achieve lifetime energy savings. The two energy savings algorithms are shown below.

, and

Other HVAC efficiency upgrades to furnaces, air conditioners and heat pumps are treated similarly with the same algorithms.

B.1.2 Shell Upgrades

Shell upgrades include any high efficiency insulation, window or door installations. The total energy savings from shell upgrades is the sum of the energy savings from the new measure and the reduced infiltration that results from the insulation:

.

To determine a percent energy savings from insulation, the following equation was be used for each distinct section of the building that will have shell upgrades (*i*) and for heating and cooling (*j*).

In this equation, R_{old} and R_{new} are the thermal resistances for the baseline and the new installed insulation, respectively. These *R*-values were given in the application and confirmed during the phone or onsite verification for the project. The ΔT term in this algorithm is given by the equations below for heating and cooling energy saved, respectively. The heating and cooling degree days are based on the specific city in which the retrofit takes place.

The energy savings from the increased infiltration is calculated with the following algorithm:

In the infiltration equation, *V* is the volume of the building and *Q* is the volumetric flow of the building. The LBL factor is a factor based on climate region, number of stories of a building, and sheltering from wind which is used to convert to estimated air changes in a building by natural means, without a fan. These factors are found in common tables.

B.1.3 Lighting Upgrades

Lighting upgrades result in saving electrical energy and demand. To determine demand savings (ΔD), the following algorithm is used:

where *n* is the number of fixtures installed and *W* is the wattage of each fixture. The energy savings are determined by multiplying each term by the number of usage hours (*h*) of the area:

.

The number of fixtures and fixture types are given in the grant application. Wattages of specific fixtures can be found in lighting fixture tables, such as in the Pennsylvania Technical Resource Manual. Hours of use are determined by a customer interview.

B.2 Baselines

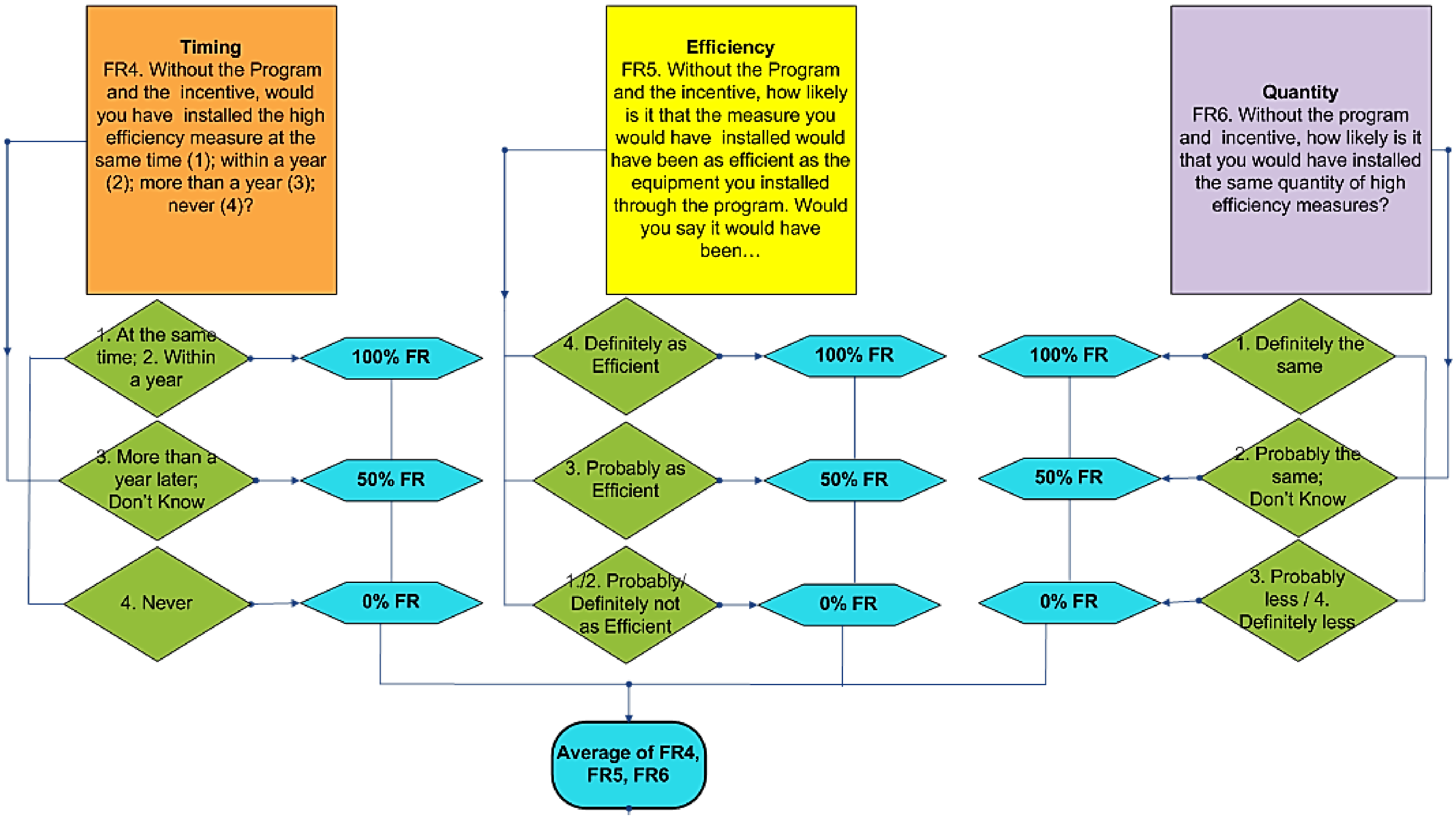
For each project that was reviewed, the engineer chose the proper baseline to determine energy savings against based upon the company's lowest labor and equipment cost to meet their required output. The baseline types are retrofit, early retirement, and replace on burnout.

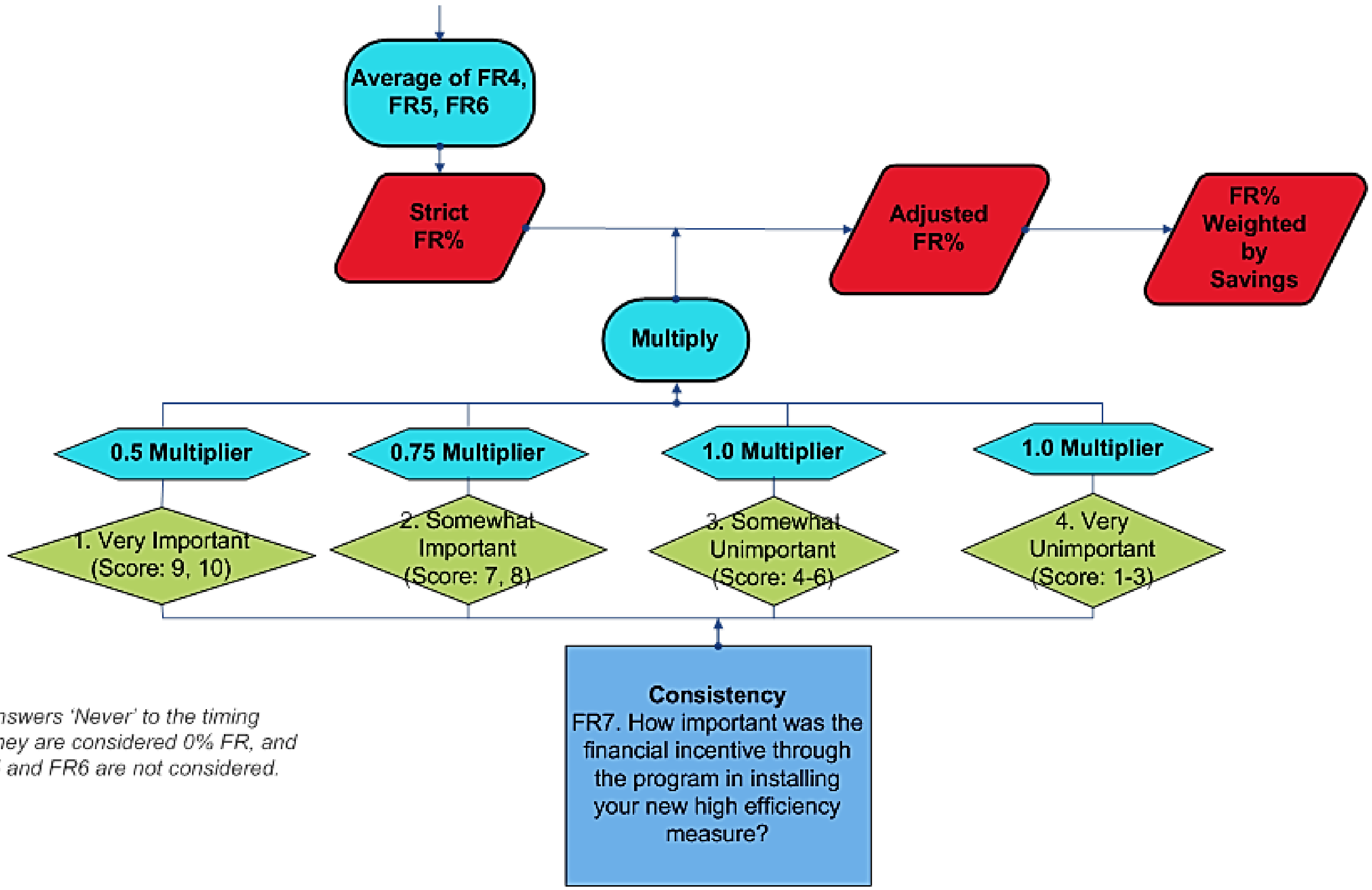
If a piece of equipment was at the end of its useful life and must be replaced for the business to continue, then it is a replace on burnout (ROB) situation. Because there is no choice about whether the equipment must be purchased, the opportunity market is lost and the new efficient equipment is compared against the standard version of the new measure. The efficiency of standard equipment is found in the applicable standard document. A new construction project is also considered in this category due to the lost opportunity market.

A retrofit is a situation in which the equipment did not need to be replaced in order for operations to proceed, but the business has opted to upgrade to a higher efficiency despite the existing equipment having several years of useful life left. In this case, the savings and costs are measured against a no-change baseline. This means that the full invoice costs are the costs, the lifetime of the new equipment is the lifetime used in evaluation, and the savings are calculated against the existing equipment.

If the business would be required to update their equipment in the future and is installing a high efficiency piece of equipment to replace an existing piece of equipment before the existing equipment has reached the end of its useful life, then it is an early retirement. In these situations, the new equipment is compared against the existing equipment for the remainder of the existing equipment's useful life. Past the existing equipment's useful life, the new equipment is measured against the standard efficiency of the new measure.

B.3 Freerideship Logic Model





Note: If respondent answers 'Never' to the timing question, FR4, then they are considered 0% FR, and their response to FR5 and FR6 are not considered.