Evaluation of the Efficiency Maine Trust PACE Loan Program:

Interim Impact Report

Final

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1.1 EVALUATION OBJECTIVES

Efficiency Maine contracted with Opinion Dynamics Corporation and subcontractors Dunsky Energy Consulting, Johnson Consulting Group, and Mad Dash to conduct an independent evaluation of their Property Assessed Clean Energy (PACE) Loan Program, which provides loans to Maine homeowners to finance the cost of making eligible energy saving improvements to their property. The evaluation also includes the companion PowerSaver Loan Program, which covers the same home energy improvements as PACE, but offers a wider range of loan amounts and has slightly different eligibility criteria, and Efficiency Maine's Residential Direct Install (RDI) Program, which provides homeowners who complete an energy audit with a rebate towards air sealing and insulation work.

The Trust has two main objectives for this evaluation:

(1) To examine the design and delivery and market effects of the Maine PACE Loan Program and identify opportunities to increase the program's success, including the PowerSaver Loan and Residential Direct Install programs the Trust has introduced in conjunction with PACE; and

(2) To quantify and verify the energy savings achieved through the PACE and PowerSaver loan programs and the RDI Program as well as the cost-effectiveness of those savings.

This Interim Impact Report follows an Interim Process Report completed in November 2012, and is the second milestone in the overall evaluation project. The focus of the Interim Impact Report is to assess:

- Energy savings achieved through the PACE and PowerSaver Loan Programs through September 2012;
- Energy savings achieved in the first eight months of the RDI Program (April 2012 – November 2012); and
- Program cost-effectiveness for both the PACE/PowerSaver and RDI programs for FY2012.

The third and final phase of this evaluation will include further analysis of program impacts and processes, with additional focus on the growing RDI Program. The Final Evaluation Report (September 2013) will integrate findings from the two Interim Reports and any additional research efforts.

1.2 EVALUATION METHODS

The Evaluation Team conducted a variety of evaluation activities supporting this Interim Impact Report:

- in-depth interviews with program and implementation staff;
- review of program databases;
- assessment of gross and net impacts; and
- review of Efficiency Maine's cost-effectiveness model and assessment of cost-effectiveness and macroeconomic effects of the PACE/PowerSaver and RDI programs.

1.3 KEY FINDINGS

1.3.1 PACE / POWERSAVER LOAN PROGRAM

Program Activity

Over the first 18 months (April 2011 through September 2012), 284 participants received loans through Efficiency Maine's PACE and PowerSaver Loan Programs. This includes 273 PACE loans, six Secured PowerSaver loans, and five unsecured PowerSaver loans.

- **Loan amounts.** Through September 30, 2012, the mean loan amount was $12,931, with a median of $14,277. The most frequent loan amount (41%) was $15,000, the maximum allowable under PACE; 79% took out loans between $10,000 and $15,000, inclusive. Eight of the 11 PowerSaver loans were outside of the PACE loan range, with six above $15,000 and only two below $6,500.

- **Measures.** The most common measures financed with a PACE or PowerSaver loan during this period were insulation (87%), followed by HVAC equipment (boilers, furnaces, heat pumps, central A/C, and ventilation fans) (52%), and air sealing (29%). The number of measures per home, financed with a loan, ranged from one (26% of projects) to six (1% of projects), with an average of two measures per home.

- **Heating fuels.** The vast majority (88%) of PACE and PowerSaver participants use oil as their primary heating fuel. In addition, natural gas and propane each account for 5% of participants' primary heating fuel.

Gross Impacts

Verified first-year, annual gross savings for the PACE/PowerSaver Program through September 2012 are 16,332 MMBTU, or an average of 57.5 MMBTU for each of the 284 projects completed during this time period.[1] On average, these savings represent 28.6% of pre-project whole-house energy usage.

The overall realization rates for PACE/PowerSaver gross savings are as follows:

- Program Realization Rate = 0.90. This means that verified gross savings for the 284 projects completed are 90% of the total savings reported in the RHA database.

- RHA Project Realization Rate = 0.75. This means that verified gross savings for the 239 projects modeled in RHA are 75% of the total savings reported for those projects in the RHA database.

[1] 57.5 MMBTU are equivalent to 417 gallons of heating oil.

Net Impacts

The net-to-gross ratio for the PACE/PowerSaver Program through September 2012 is estimated to be 1.07. This means that energy savings attributable to the program are 107% of verified gross savings. The net-to-gross ratio results from free-ridership of 0.08 and partial participant spillover of 0.16.

Applying the net-to-gross ratio of 1.07 to verified gross savings of 16,332 MMBTU yields annual program-level net impacts of approximately 17,500 MMBTU, or 61.7 MMBTU per project for the 284 projects completed during the study period.

Cost-Effectiveness Analysis and Macroeconomic Effects

Our analysis of the PACE/PowerSaver Program for FY2012 found that the program is cost-effective for all three tests we conducted, 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 well exceeds 1.0. Estimated benefit-cost ratios for the program are:

- TRC = 1.61
- PACT = 4.80
- PCT = 2.27

Total PACE/PowerSaver FY2012 program spending of $3.4 million (excluding adjustments for early retirement, economic cost of lending, and evaluation costs) resulted in an estimated $15.6 million increase in Gross State Product and the creation of 238 job-years.[2]

Databases

Review of the two databases that are maintained for the PACE/PowerSaver Program – the AFC First database and CSG's RHA database – revealed significant differences with respect to the documented measures. The RHA database reflects measures *recommended* after the energy audit. The information in AFC First's database appears to provide a more accurate representation of the measures *installed* with the PACE/PowerSaver Loan, but does not always capture all improvements made as a result of the energy audit. Neither of the two databases captures a full list of the final set of installed measures and their savings. This presented challenges for our gross impact analysis and generally makes it difficult to accurately report on program results. In addition, since program eligibility is determined based on the RHA database, if the measures ultimately installed differ from the recommended measures documented in RHA, then the initial eligibility determination that the project meets the energy savings eligibility requirements (based on the RHA estimated savings) might no longer be valid.

[2] One job-year is one full time job for a period of one year.

1.3.2 RESIDENTIAL DIRECT INSTALL PROGRAM

Program Activity

During the first eight months of the RDI Program (April 2012 through November 2012), 754 participants received an RDI incentive for air sealing and insulation work. The number of projects increased significantly in October and November, with November accounting for almost half of all RDI projects to-date. This sharp increase in RDI activity followed an increase in the RDI incentive from $300 to $600 implemented in September of 2012.

- **Measures.** Air sealing (99% of projects; including weather stripping) and insulation of foundation sills (20% of projects) were the top two RDI measures completed. On average two measures were completed per project. Other measures directly tracked by the program (insulating piping, programmable thermostats, tank wrap, and low flow shower heads) were implemented at 3% or fewer of RDI projects.

- **Blower Door Tests.** Pre and post installation blower door tests are a key requirement of the RDI Program. According to program data, air sealing through RDI reduced the share of "leaky" homes (defined as a CFM50 value above 4,000) from 29% to 20% and increased the share of "tight" homes (defined as a CFM50 value less than 1,500) from 10% to 19%, among RDI participants.

- **Heating Fuels.** Oil (64%) and kerosene (18%) are the most commonly used primary heating fuels among RDI participants. A little over half (56%) of participants do not use a secondary type of heating fuel. Among those who do, wood (34%), oil (28%), and propane/LPG (27%) are the most common.

Gross Impacts

Estimated first-year, annual gross savings for the RDI Program through November 2012 are 7,366 MMBTU, or an average of 9.77 MMBTU per project for the 754 projects completed during this time period.[3] This includes 6,800 MMBTU in savings (92%) from airsealing (or 9.02 MMBTU per project) and 565 MMBTU in savings from other RDI measures (or 0.75 MMBTU per project).

Cost-Effectiveness Analysis and Macroeconomic Effects

Our analysis of the RDI Program for FY2012 found that the program is cost-effective for all three tests we conducted, 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 well exceeds 1.0. Estimated benefit-cost ratios for RDI are:

- TRC = 2.64
- PACT = 3.58
- PCT = 6.66

[3] 9.8 MMBTU are equivalent to 71 gallons of heating oil.

Total RDI FY2012 program spending of $90,816 resulted in an estimated $418,978 increase in Gross State Product, as well as the creation of 5.9 job-years.

Database

We found the RDI database to be very comprehensive and well populated for most of the key data fields.

1.4 OPPORTUNITIES FOR PROGRAM IMPROVEMENT

The key opportunities for program improvement that we identified through this impact evaluation center on the PACE/PowerSaver Loan Program tracking databases. Making these improvements would help ensure that the program has access to program data that 1) accurately reflects the measures installed through the program as well as their savings and 2) accurately documents that projects meet savings thresholds.

Efficiency Maine should consider putting the following improvements into place:

- **Expand information on the "HESP Review for PACE Projects" form.** The program should modify the "HESP Review for PACE Projects" form, which is populated by CSG based on data in the RHA database, to include: 1) total project savings, 2) savings by measure, 3) whole-house energy usage, and 4) heating/hot water energy usage. This would allow AFC First (who receives these forms as part of the loan approval process) to re-calculate the projected savings percentages if certain recommended measures are not ultimately installed. AFC First can then identify projects that do not meet the program-required savings thresholds and request that modifications be made to the proposed improvements to meet the thresholds.

- **Enter RHA savings estimates into the AFC First database.** If measure-level savings estimates are provided by CSG to AFC First, these should be added into the AFC First database.

- **Enter all improvements into the AFC First database.** The program should require all improvements (measures) listed on Specification Sheet(s) for each project to be entered in the AFC First database. In parallel, at post-project inspections, PEAs should fill out a checklist, which lists all types of measures, to document measures actually installed.

- **Check measure eligibility based on efficiency levels.** AFC First should require that performance values are entered in the database for all measures for which efficiency standards exist. These performance values should be checked against the efficiency standards, and measures that do not meet the standards should not be accepted as part of the project financed with the loan.

2. INTRODUCTION

2.1 EVALUATION OBJECTIVES

Efficiency Maine contracted with Opinion Dynamics Corporation and subcontractors Dunsky Energy Consulting, Johnson Consulting Group, and Mad Dash to conduct an independent evaluation of their Property Assessed Clean Energy (PACE) Loan Program, which provides loans to Maine homeowners to finance the cost of making eligible energy saving improvements to their property. The evaluation also covers the PowerSaver Loan Program, which offers loans with different requirements than the PACE Loan Program, and the Residential Direct Install (RDI) Program, which provides homeowners who complete an energy audit with a rebate towards air sealing and insulation work.

The evaluation is intended to fulfill the statutory requirements that the Trust arrange for an independent evaluation, at least once every five years, of each program that has an annual budget of more than $500,000, including an evaluation of the program's effectiveness in achieving goals specified in the law governing the Trust (35-A MRSA section 10104, subsection 10). In addition, the evaluation was part of the Better Buildings Grant application to DOE and will fulfill the requirements of that grant.

The Trust has two main objectives for this evaluation:

(1) To examine the design and delivery and market effects of the Maine PACE Loan Program and identify opportunities to increase the program's success, including the PowerSaver Loan and Residential Direct Install programs the Trust has introduced in conjunction with PACE; and

(2) To quantify and verify the energy savings achieved through the PACE and PowerSaver loan programs and the RDI Program as well as the cost-effectiveness of those savings.

This Interim Impact Report is the second milestone in the evaluation of the PACE Loan Program and follows the Interim Process Report, completed in November 2012. The focus of the Interim Impact Report is to assess (a) energy savings achieved through the PACE and PowerSaver Loan Programs through September 2012; (b) energy savings achieved in the first eight months of the RDI Program (April 2012 – November 2012); and (c) program cost-effectiveness for both the PACE/PowerSaver and RDI programs for FY2012.

It includes findings from several evaluation activities:

- in-depth interviews with program and implementation staff;
- review of program databases;
- assessment of gross and net impacts; and
- review of Efficiency Maine's cost-effectiveness model and assessment of cost-effectiveness and macroeconomic effects of the PACE/PowerSaver and RDI programs.

The third and final phase of this evaluation will include further analysis of program impacts and processes. The Final Evaluation Report (September 2013) will integrate findings from the two Interim Reports and any additional research efforts, including additional focus on the growing RDI Program.

2.2 PACE / POWERSAVER OVERVIEW

The Maine PACE Loan Program provides loans to Maine homeowners to finance the cost of making eligible energy saving improvements to their property. This program is designed to provide a financing option that makes energy improvements more feasible for homeowners.

Legislation enacted in 2010 established the legal framework for the Property Assessed Clean Energy (or PACE) Loan Program (Maine PACE Act, PL 2009, c.591). To qualify for a PACE loan, the homeowner's property must be located in a municipality that has adopted a PACE ordinance authorizing the program. As of February 10, 2013, a total of 158 Maine municipalities had passed PACE ordinances and entered into an agreement with Efficiency Maine to administer the loan program on their behalf.

Efficiency Maine applied for and won a competitive grant from the U.S. Department of Energy (DOE), to capitalize, administer, and market the PACE Loan Program. This grant is funded with American Recovery and Reinvestment Act of 2009 (ARRA), Energy Efficiency and Conservation Block Grant (EECBG) funds administered through the DOE BetterBuildings Program. With the EECBG BetterBuildings grant, Efficiency Maine has established a $20.4 million revolving loan fund for the PACE and PowerSaver Loan Program. As homeowners pay back the loans, the loan fund will be replenished so that Efficiency Maine can issue loans or procure additional funding to finance home energy savings improvements for the next round of homeowner applicants.

PACE Loan Features

Maine PACE loans range in value from $6,500 to $15,000 and offer a repayment period of 5, 10, or 15 years at a fixed interest rate of 4.99% APR, with no processing fees. What makes a Maine PACE loan different from other home equity loans is that the PACE loan stays with the property. PACE loans in Maine are different from those in other states because Maine's PACE law dictates that the loans do not have a senior priority over a primary home mortgage, original or new, and that loan assessments (payments) will not be added to or treated like a property tax.

PACE loans are available for residential buildings with one to four units located in municipalities that have passed a PACE ordinance. Homeowners must meet underwriting requirements set by the PACE Loan Program. These underwriting requirements include:

- a debt-to-income ratio of no more than 45%;
- a loan-to-value ratio less than 100%;
- property tax and sewer payments being current; and
- no outstanding liens; no reverse mortgages; and no mortgage default, foreclosure, or delinquency.

Maine PACE loans are available for home energy projects that meet the requirements of Efficiency Maine's Home Energy Savings Program (HESP). During 2010 and 2011, the HESP program offered cash incentives (rebates), funded by an ARRA State Energy Program (SEP) grant to homeowners for completion of home energy efficiency projects. For several months in 2011, when the SEP-ARRA funds for HESP rebates were winding down, Efficiency Maine paired the Maine PACE loan financing with HESP rebates for energy improvements. However, as of the fall of 2011, rebates were no longer available.

PACE-eligible energy improvements include, but are not limited to: insulation, air sealing, energy efficient heating systems, lighting and appliances, windows and doors, and solar energy systems. Under current program guidelines, the homeowner's package of energy efficiency improvements must generate savings of at least 20% of home energy usage or 25% of heating and hot water energy usage to qualify for a PACE loan.

Program Delivery Structure and Components

The PACE Loan Program is delivered by a team, led by the Trust, that includes financial services vendor AFC First, the Conservation Services Group (CSG), and a network of Participating Energy Advisors (PEAs) and Registered Vendors (RVs) who work directly with homeowners. The financial side of the PACE Loan Program is provided as a contractual service by AFC First. AFC First's responsibilities include originating, processing, closing, and servicing PACE loans on behalf of Efficiency Maine, including the functions of master provider and master servicer.[4] Specific duties include, but are not limited to: maintaining a call center and online application system; receiving and processing PACE loan applications; performing underwriting analyses and determining loan approval or denial based on underwriting standards established by the Trust; and disbursing loan proceeds and managing loan servicing activities.

The home energy improvements side of the PACE Program is delivered through a network of PEAs and RVs. CSG also plays a key role as the reviewer of the proposed work scope and associated energy model for each project. As part of the loan approval process, the program requires approval by CSG of project work scopes and projected savings estimates. Efficiency Maine designated PEAs perform energy audits and on-site post-installation verification inspections, which include blower door tests and general inspection of the work performed. All PEAs must go through specific training and be certified by the Building Performance Institute (BPI). The installation of energy efficiency measures on PACE loan projects must be conducted by a Registered Vendor, who has completed a Registered Vendor agreement with Efficiency Maine and supplied necessary supporting documentation. Many PEAs are also RVs.

The PACE Loan Program currently involves the following components and steps for participants:

1. Have a home energy audit by a PEA
2. Obtain contractor bids for the energy improvements
3. Submit PACE loan application forms and related documents
4. Close loan, following approval
5. Complete energy savings improvements with an Efficiency Maine RV (30% of the project cost is available the week following closing)
6. Have project completion verified by a PEA
7. Submit project completion forms
8. Receive the balance of the loan
9. Make monthly loan repayments for up to 15 years

To increase the pool of eligible participants and provide more options to Maine homeowners, Efficiency Maine added two new offerings in the spring of 2012, supplementing the existing PACE Loan Program: the PowerSaver Loan Program and the RDI Program. Both programs are funded by the BetterBuildings grant.

[4] The terms "master provider" and "master servicer" indicate that AFC First is the sole entity that provides and services the loans in the program.

PowerSaver Loan Program

Efficiency Maine's PowerSaver Loan Program covers the same home energy improvements as PACE, but offers a wider range of loan amounts, is available statewide, and has slightly different eligibility criteria. Loans can range up to $25,000. For loans under $7,500, there is no homeowner equity requirement. However, homeowners must have a minimum median credit score of 660 and have a debt-to-income ratio of less than 45% to qualify for a PowerSaver loan of any amount. The interest rate for PowerSaver loans is the same as that for PACE, 4.99%.

The Department of Housing and Urban Development (HUD) created the national PowerSaver Pilot Program in 2011 to help lenders provide customers with low cost loans to make energy saving improvements to their homes. The loans are backed by Federal Housing Administration (FHA), which covers up to 90% of the loan amount in the event of default. As part of the program, HUD provides up to $25 million in grants as incentives to participating lenders.

In early 2012, Efficiency Maine became a "HUD Title 1 Government Lender" allowing the organization to offer PowerSaver loans to customers in Maine. Efficiency Maine's PowerSaver Program launched on April 11, 2012. As a provider of PowerSaver loans, AFC First is granted funds from HUD to offset the costs associated with servicing the PowerSaver loans, such as the appraisal and inspection fees.

PowerSaver participants complete the same general participation steps as PACE participants (see previous section).

2.3 RESIDENTIAL DIRECT INSTALL PROGRAM OVERVIEW

Efficiency Maine's RDI Program offers an "air sealing incentive" for completion of at least six hours of air sealing and insulation work in homes that have had an energy audit. Homes that had an energy audit after April 27, 2012 were eligible for an incentive payment of up to $300. The incentive amount was later increased to $600 for homes that completed air sealing and insulation work after September 9, 2012.[5]

The RDI program aims to provide immediate savings to homeowners by identifying and addressing the most pressing energy loss issues in the home. Improvements supported by the program include targeted air sealing and insulation in the attic, basement and around chimney and plumbing chases as well as weather stripping of doors and windows, and caulking and foaming of exterior openings.

The RDI Program is promoted on Efficiency Maine's website as a limited-time discount on air sealing and currently involves the following components and steps for participants:

1. Home energy audit, including a blower door test, is performed by a PEA.
2. At least six hours of air sealing and/or insulation work are completed.
3. Contractor performs post project blower door test to measure the new air flow in the home and project energy savings.

[5] Under the RDI Program, Efficiency Maine also offers a $100 incentive per project to PEAs for reporting "test out" data to the Trust on completed weatherization projects financed through the PACE or PowerSaver loan programs as well as other projects where the projected savings exceed 20% of home energy usage.

4. Contractor either discounts customer the rebate amount at the completion of the work or submits the necessary paperwork and provides customer with the rebate after it has been processed.

2.4 ORGANIZATION OF REPORT

The remainder of this report is organized as follows:

- **Section 3: PACE/PowerSaver Impact Evaluation** presents a descriptive analysis of PACE and PowerSaver projects completed through September 2012, an analysis of the program's tracking databases, as well as the methodology and results for the gross and net impact analyses.
- **Section 4: RDI Impact Evaluation** presents a descriptive analysis of RDI projects completed through November 2012, an analysis of the program's tracking database, as well as the methodology and results for the gross impact analysis.
- **Section 5: Cost-Effectiveness and Macroeconomic Effects** presents the methodology and results of the cost-effectiveness and macro-economic effects analyses for the PACE/PowerSaver and RDI programs.
- **Section 6: Findings and Recommendations** summarizes the findings from our research efforts and provides recommendations for program improvement.

The report has three appendices:

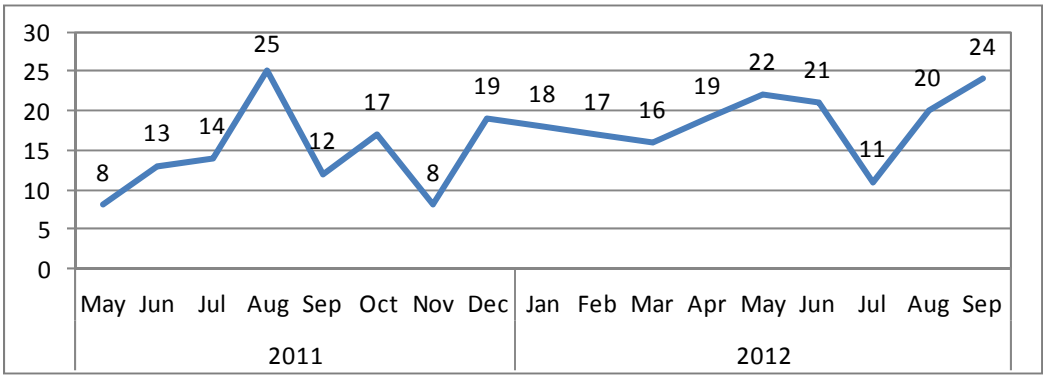
- **Appendix A: Comparison of PACE/ PowerSaver and RDI** provides additional information about projects completed through the PACE/PowerSaver and RDI programs, respectively.
- **Appendix B: Supporting Information for PACE/PowerSaver Gross Impact Analysis** provides additional information on two analyses conducted for the PACE/PowerSaver Program, measure eligibility and "other" measures in the AFC First database.
- **Appendix C: Supporting Information for RDI Gross Impact Analysis** provides additional information that supports the air sealing gross impact analysis for the RDI Program.

3. PACE / POWERSAVER IMPACT EVALUATION

3.1 DESCRIPTIVE ANALYSIS OF PROJECTS

Over the first 18 months (April 2011 through September 2012), 284 participants received loans through Efficiency Maine's PACE and PowerSaver Loan Programs. This includes 273 PACE loans, six Secured PowerSaver loans, and five unsecured PowerSaver loans. The number of loans closed per month ranges from eight to 25, with participation trending upward.[6]

Figure 3-1. Number of PACE/PowerSaver Loans Closed per Month

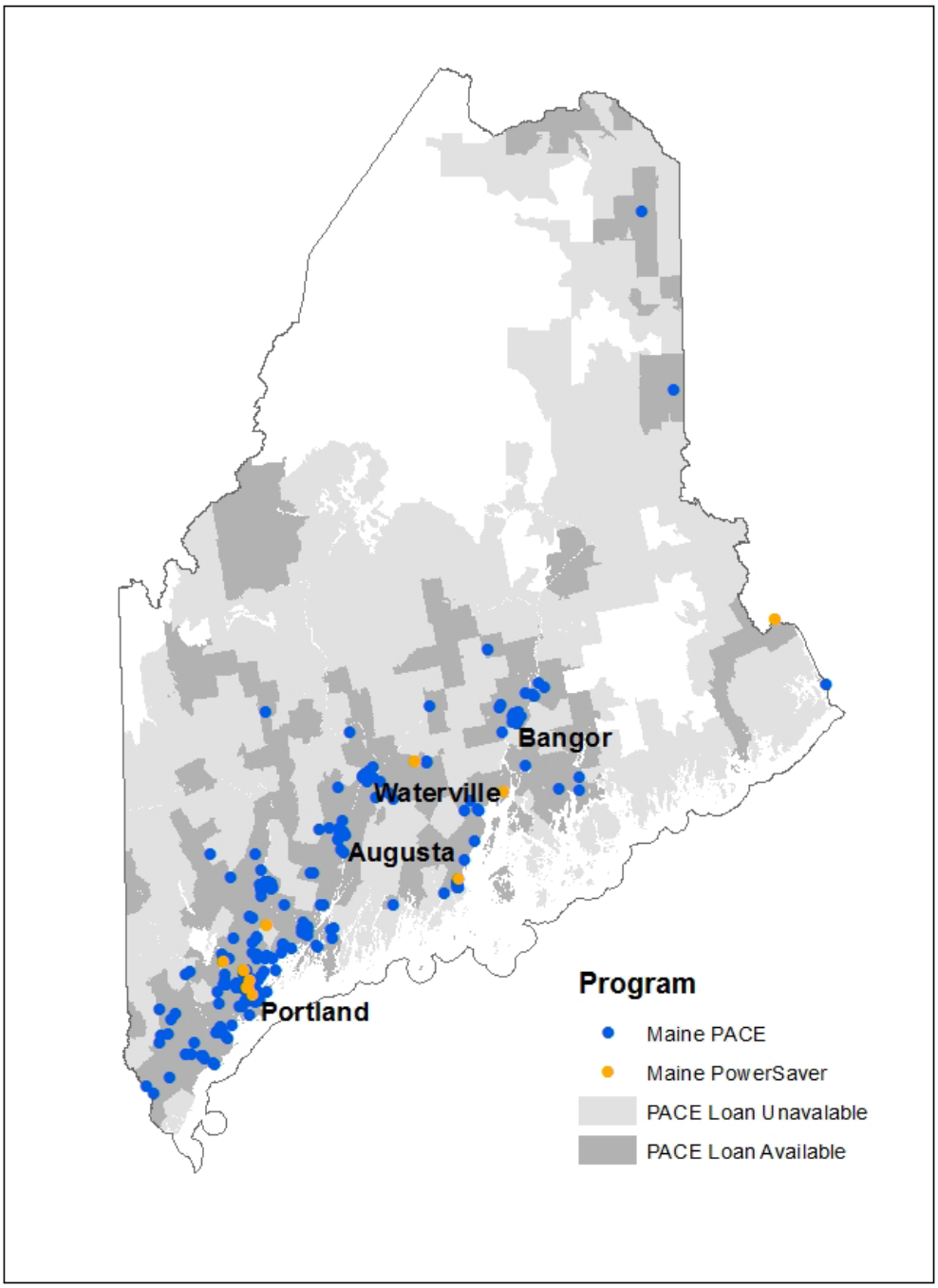


Source: AFC First Tracking Data (as of September 30th, 2012)

Figure 3-2 shows the geographic distribution of the PACE and PowerSaver loans closed through September 30, 2012. Most participants are located in the southern part of the state and are clustered around the populated areas of Portland, Augusta, Waterville, and Bangor. The dark gray areas represent towns that have passed a PACE ordinance. Notably, only one of the 11 PowerSaver loan participants as of September 2012 lives in a town that does not also offer PACE loans.

[6] The month represents the first payment (30% of total loan amount) to the contractor, rather than the final payment at the completion of the project.

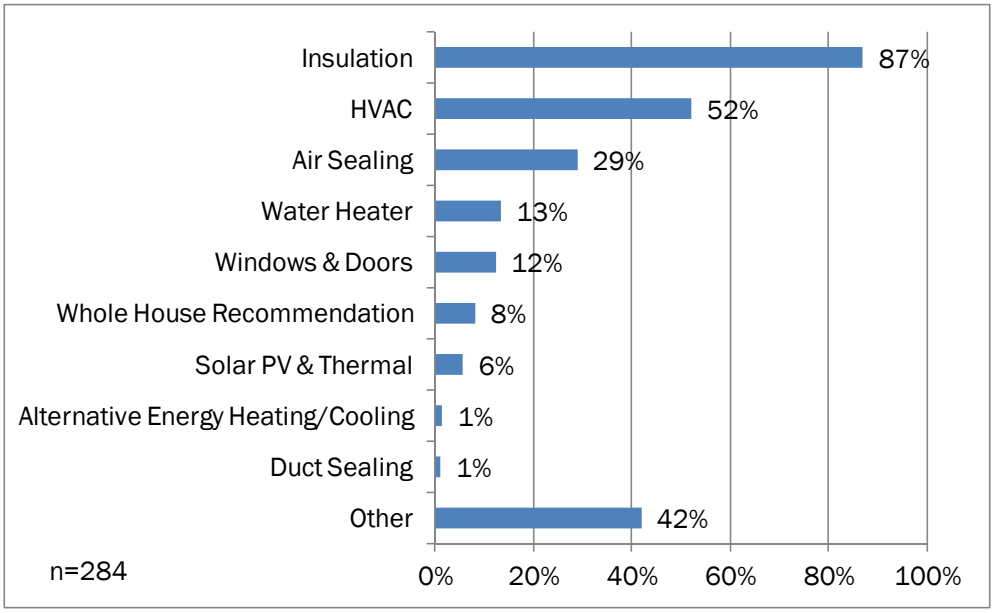
Figure 3-2. Geographic Distribution of PACE/PowerSaver Projects



Source: AFC First Tracking Data (as of September 30th, 2012)

The most common measures financed with a PACE or PowerSaver loan during this period were insulation (87%), followed by HVAC equipment (boilers, furnaces, heat pumps, central A/C, and ventilation fans) (52%), and air sealing (29%). The number of measures per home, financed with a loan, ranged from one (26% of projects) to six (1% of projects), with an average of two measures per home.

Figure 3-3. Measures Installed by PACE/PowerSaver Participants

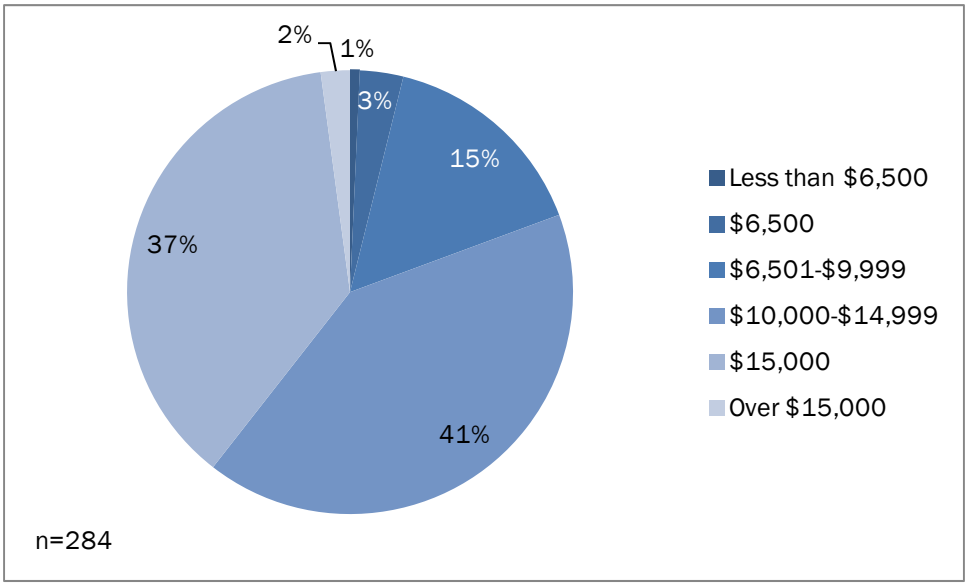


Source: AFC First Tracking Data (as of September 30th, 2012)

*HVAC measures include boilers (36%), furnaces (12%), heat pumps (4%), split central A/C systems (<1%), and ventilation fans (<1%).

Through September 30, 2012, the mean loan amount was $12,931, with a median of $14,277. The most frequent loan amount (41%) was $15,000, the maximum allowable under PACE; 79% took out loans between $10,000 and $15,000, inclusive. Eight of the 11 PowerSaver loans were outside of the PACE loan range, with six above $15,000 and only two below $6,500.

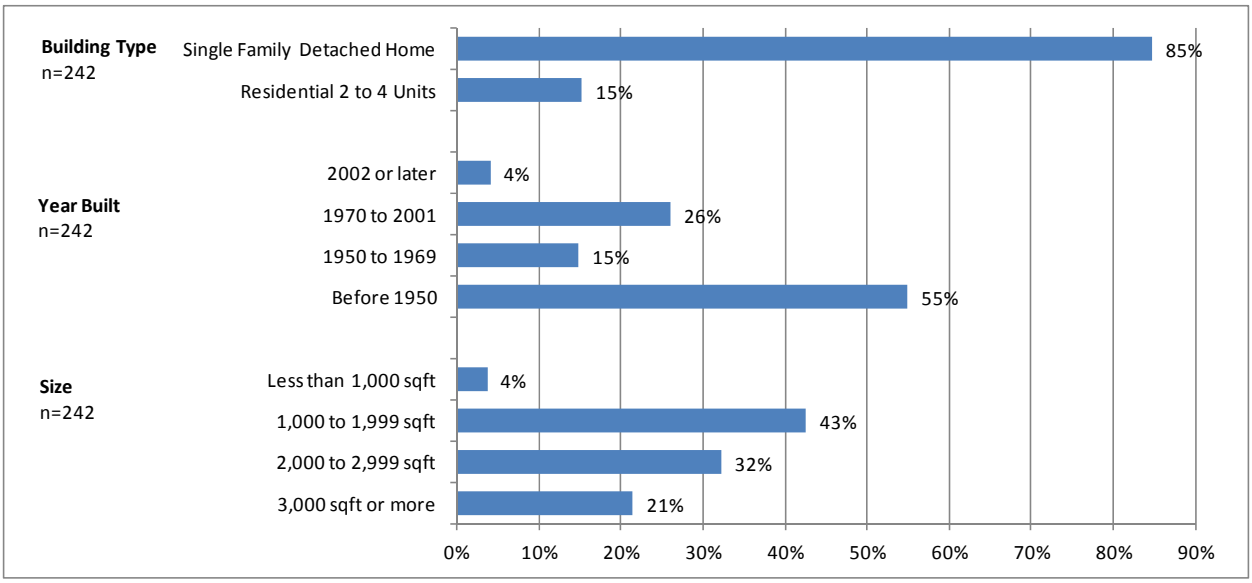
Figure 3-4. Loan Amounts of PACE/PowerSaver Participants



Source: AFC First Tracking Data (as of September 30th, 2012)

Single family homes built before 1950 account for the bulk of PACE/PowerSaver participant homes. The large majority of homes (75%) are between 1,000 and 3,000 square feet.

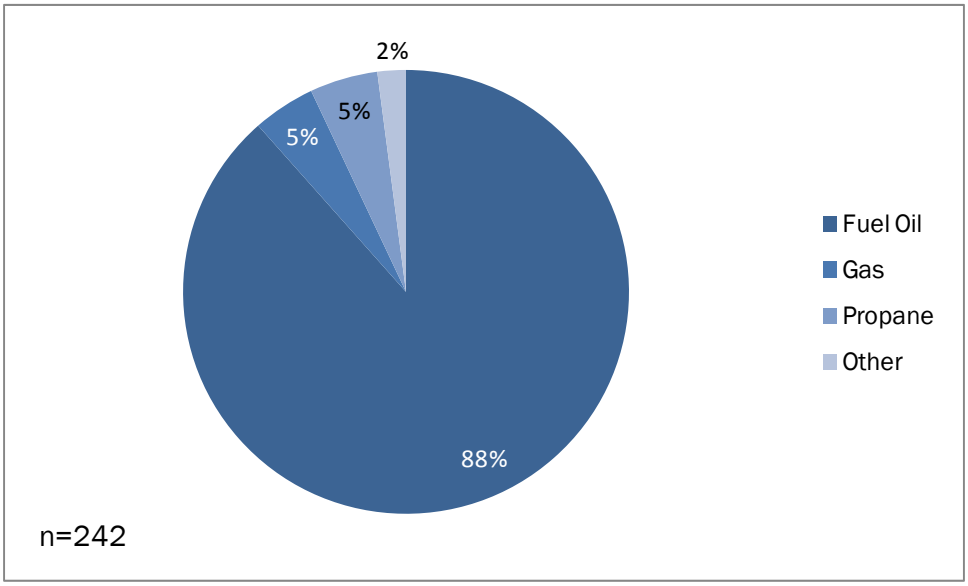
Figure 3-5. Building Characteristics of PACE/PowerSaver Participants



Source: CSG Tracking Data (as of October 4th, 2012)

The vast majority (88%) of PACE and PowerSaver participants use oil as their primary heating fuel. In addition, natural gas and propane each account for 5% of participants' primary heating fuel.

Figure 3-6. Primary Heating Fuel of PACE/PowerSaver Participants



Source: CSG Tracking Data (as of October 4th, 2012)

3.2 DATABASE REVIEW

There are two separate program databases that support the PACE/PowerSaver Programs, one compiled by the financial services vendor AFC First and one compiled by the Conservation Services Group (CSG). The AFC First database is designed and maintained to support the loan application, approval, and servicing process. Among other things, this database documents the energy improvements financed with the loan. The CSG database, on the other hand, is designed to support and document the energy audit and the energy improvements recommended to the customer as a result of the audit (for projects modeled with CSG's RHA software) and the associated savings projections. Both databases include other information about each project.

We reviewed these databases with respect to the type of data collected, how well key fields are populated, and the database's adequacy for program tracking and evaluation purposes.

Our review found significant discrepancies between the two databases with respect to the measures listed for many projects, and neither database contains a complete set of measures installed following the energy audit.

The subsections below summarize our findings from this database review.

3.2.1 AFC FIRST DATABASE

In support of this evaluation, Efficiency Maine provided the Evaluation Team with a data extract from AFC First's tracking database. This extract included 284 projects funded through the end of September 2012 (based on the date of the project's first loan check). The information in AFC First's database is based on the data reported on the "Specification Sheet for Maine PACE Loan Program," which is the agreement between the customer and the contractor regarding the installation of program eligible improvements. However, review of a sample of projects showed that for some projects there is a discrepancy between the AFC First database and the Specification Sheets, with some measures listed on the Specification Sheet but not in the database, and vice versa (see Section 3.3, below).

Project-Level Data

Key project-level data recorded and stored in the AFC First database includes Application ID, participant contact information, project funding status, loan type (PACE, PowerSaver Secured, or PowerSaver Unsecured), Contractor, Auditor, Better Buildings ID, Projected Savings, and the dates of first and last checks. These fields are generally well populated. As expected, fields related to the loan servicing (contact information, funding status, loan type and amount, first check and last check, and Contractor) are fully populated for all 284 projects. Fields that are less well populated include Projected Savings (83%) and Auditor (57%).

- Projected Savings is an important field for both program management and evaluation and should always be recorded. However, review of this field in the AFC First database showed that it was not fully populated and the projected savings values do not consistently match those in the RHA database. In fact, based on the data in this field, 47% of projects with a savings value (113 out of 238) met neither of the program's savings thresholds (20% energy savings relative to whole-house energy usage or 25% energy savings relative to heating and hot water energy usage). It is therefore not clear if and how the data in this field is used by the program.

- Where the Auditor field is blank, it is possible that the same company acts as both the contractor and the auditor for the project. However, we found that for some projects the same company is listed in both fields, so it is not clear if a blank Auditor field is an omission or if the auditor is the same company as the contractor. Better population of this field would be desirable for future evaluation activities.

In both cases, recording of this information has improved over time as shown in Table 3-1 below. Nearly all projects completed in FY2012 had Projected Savings and just over two-thirds listed the Auditor.

Table 3-1. Share of Records with Select Fields Complete

Year*	Total Projects	Records With Projected Savings	Records With Auditor Information
2011	116	64%	40%
2012	168	97%	68%
Total	284	83%	57%

Source: Analysis of AFC First Tracking Data (as of 9/30/2012)

*Based on date of first check

Measure-Level Data

Measure-level data captured in the AFC First database includes the type of measure, manufacturer, model, serial number, and performance value. While initial versions of the data extract provided by AFC First did not include measure-level costs and financed amount, this information is documented in the full database and was subsequently provided to the evaluation team.

Measure Type

According to the AFC First database, the PACE and PowerSaver Loan programs financed 654 measures ("improvements") for the 284 projects completed during the evaluation period.[7] The database captures the following 23 categories of improvements:

- Insulation
- Air Sealing
- Duct Sealing
- Water Heater
- Central Air Split System
- Ductless Heat Pump
- Air Source Heat Pump
- Geothermal Heat Pumps
- Gas Boiler
- Oil Boiler
- Other Boiler
- Gas Furnace
- Oil Furnace
- Other Furnace
- Programmable Thermostat
- Ventilating Fans
- Windows
- Doors
- Solar PV
- Solar Thermal
- Alternative Energy Heating/Cooling (excluding Solar)
- Other (Whole House Recommendation)
- Other

[7] Multiple improvements of the same type, for a single project, were counted as one improvement.

Two aspects of this categorization of improvements in the AFC First database posed challenges in our evaluation:

1. **Measures classified as "Other" or "Other (Whole House Recommendation).** 106 of the listed measures (13%) were identified in one of the two "other" categories. Review of Specification Sheets showed that most measures listed as "other" (72%) are home improvements or actions that do not generate savings. However, of the remaining 28%, two-thirds are measures that should have been classified in one of the existing categories. (See also analysis of "other" measures in Appendix B.) More accurately capturing what these measures are would allow better program tracking and better comparison between the AFC First and RHA databases. In addition, tracking measures that are not expected to generate energy savings (e.g., health and safety improvements) under a separate "Other – no energy savings" category, when possible, would also facilitate program tracking and estimation of program savings.

2. **Insulation Measures.** The AFC First database has a single category for "insulation" measures. In contrast, the RHA database differentiates between four types of insulation: attic, attic hatch, basement/floors, and walls. According to the RHA data, both the incidence and the per-project savings of the different types of insulation vary considerably. As such, identification of the type of insulation in the AFC First database would facilitate estimation of program savings.

Manufacturer, Model, and Performance Data

The "Manufacturer" and "Model" fields are relatively well populated for major equipment-type improvements (furnace/boiler, water heater, heat pump, CAC). The completeness of the performance related fields in AFC First's database varies by type of improvement. As long as this database is the best representation of actual installations through the program, complete performance information is important, both to verify measure eligibility and to assess savings. We observe the following regarding performance data fields:

- **Insulation:** Performance rating is blank for 17% of projects. All insulation improvements should list the R value.
- **Furnaces/boilers:** Performance rating is blank for 13% of projects. All furnaces and boilers should list the equipment's AFUE rating.
- **Water heaters:** Performance rating is blank for 63% of projects. The values for water heaters that are present are not populated consistently (some are represented as a ratio and some as a percentage, e.g., 0.82 and 82). The efficiency factor should be listed for all water heaters.
- **Heat pumps:** Performance rating is blank for 40% of projects. All heat pumps should list the equipment's SEER, EER, or HSPF rating.
- **Solar PV:** Performance rating is blank for 60% of projects. All solar PV installations should have information on the system's capacity.
- **Windows:** Performance rating is blank for 88% of projects. All window improvements should list the U value.

3.2.2 RHA DATABASE

In support of this evaluation, Efficiency Maine provided the Evaluation Team with a data extract from CSG's tracking database. The information in CSG's database is based on energy modeling done by

Energy Advisors in support of their customers' application for PACE/PowerSaver loans. The database includes all measures recommended by the Energy Advisor following the audit, but only for projects modeled with CSG's RHA software (84% of projects are modeled using RHA; the remaining 16% are modeled using other software and are not included in the database). The RHA extract included 239 projects and represented information captured in the database as of October 4, 2012.

Project-Level Data

Project-level data in the RHA database includes:

- General information about the project, e.g., project ID, site ID, audit date, and, if applicable, the CSG inspection date
- Information about the house, e.g., address, year built, number of occupants, and square footage
- Information about the site's existing energy use, e.g., heating degree days, original CFM50, heating-related MMBTUs, hot water-related MMBTUs, electric MMBTUs, and total MMBTUS
- Information about the existing heating equipment, e.g., both primary and secondary heating systems
- Information about the proposed heating and hot water systems
- Estimated energy savings

Most fields in this extract are populated for all 239 projects (with the exception of fields that are not applicable to all projects, such as secondary fuel type, CSG inspection date, and proposed new heating equipment). There is a very low incidence of missing data in the RHA database.

Measure-Level Data

Measure-level information contains records for 2,078 recommended measures for the 239 projects. Measure-level data includes measure type, quantity, and description; location of the improvement; the savings to investment ratio; customer price (generally a default value); savings type, such as oil, propane, or electric; annual savings in fuel units, dollars, and MMBTUs; and the effective useful life of the measure. Types of measures tracked in the database are:

- Insulation: Attic
- Insulation: Basement/Floors
- Insulation: Walls
- Attic Access: Existing
- Airsealing
- DHW: System
- DHW: Pipe Insulation
- DHW: Appliance
- DHW: Aerators
- DHW: Showerheads
- DHW: Tank Wraps
- DHW: Temperature Turndown
- HVAC: System
- HVAC: Ducts
- HVAC: Efficiency Upgrade
- HVAC: Pipe Insulation
- HVAC: Thermostats
- Lighting: Bulbs & Torchieres
- Lighting: Fixtures
- Refrigeration
- Windows
- Doors
- Miscellaneous Parts & Fees

All data fields in the measure-level worksheet are populated for all 2,078 measures (with the exception of fields that are not applicable to or required for all measure types, such as the installation location for programmable thermostats).

3.2.3 COMPARISON OF AFC FIRST AND RHA DATABASES

Since the RHA database captures recommended measures based on the energy audit and the AFC First database captures installed measures financed by the loan (but not always all of the installed measures included in the project), the measures listed in the two databases may not match for a given project. We conducted a comparison of the two databases, assessing: 1) the percentage of measures in the AFC First database that are also present in the RHA database and 2) the percentage of measures in the RHA database that are also present in the AFC First database. The first comparison provides insights on measures that were installed but not recommended, while the second comparison provides insights on measures that were recommended but not installed.[8]

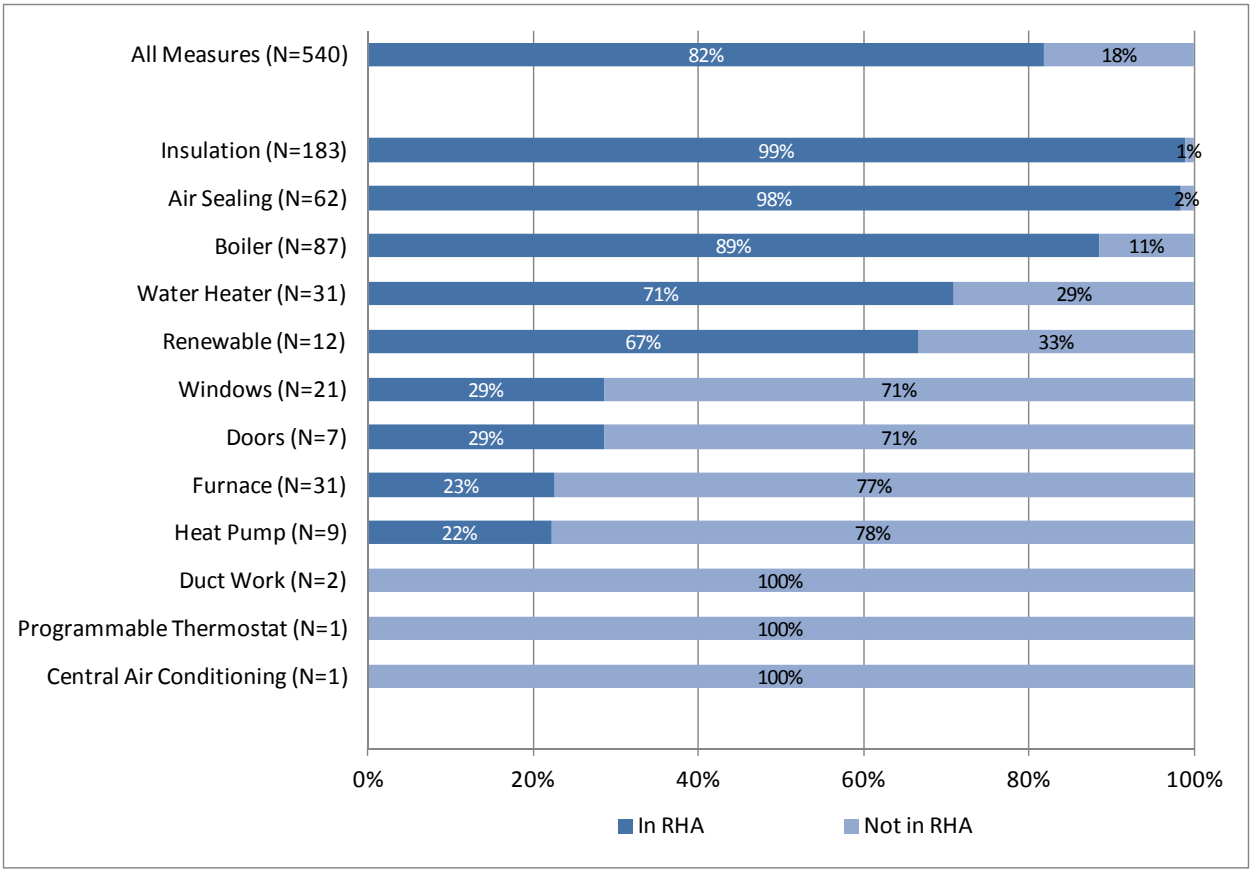
The first comparison showed that, overall, 82% of measures documented in the AFC First database were also present in the RHA database.[9] In general, there is a very close match between the two databases for insulation (99%) and air sealing (98%), two of the key measures promoted by the PACE/PowerSaver program and recommended by PEAs as a result of energy audits. A majority of boilers (89%), water heaters (71%), and renewable energy measures (67%) documented in AFC First's database are also present in the RHA database. For all other measure categories, less than one-third of measures in the AFC First database were present in the RHA database, meaning that these installed measures were generally not recommended by the energy audit.

Figure 3-7 summarizes the overlap of measures in the AFC First database compared to the RHA database.

[8] Note that this comparison does not take into account adjustments made to the AFC First list of measures based on our comparison of the database and Specification Sheets for a sample of 35 post-inspection projects (see also Section 3.3).

[9] Note that this comparison includes only projects modeled with RHA and excludes measures classified as "Other" or "Other (Whole House Recommendation)" in the AFC First database.

Figure 3-7. Match of AFC First Improvements to RHA Database



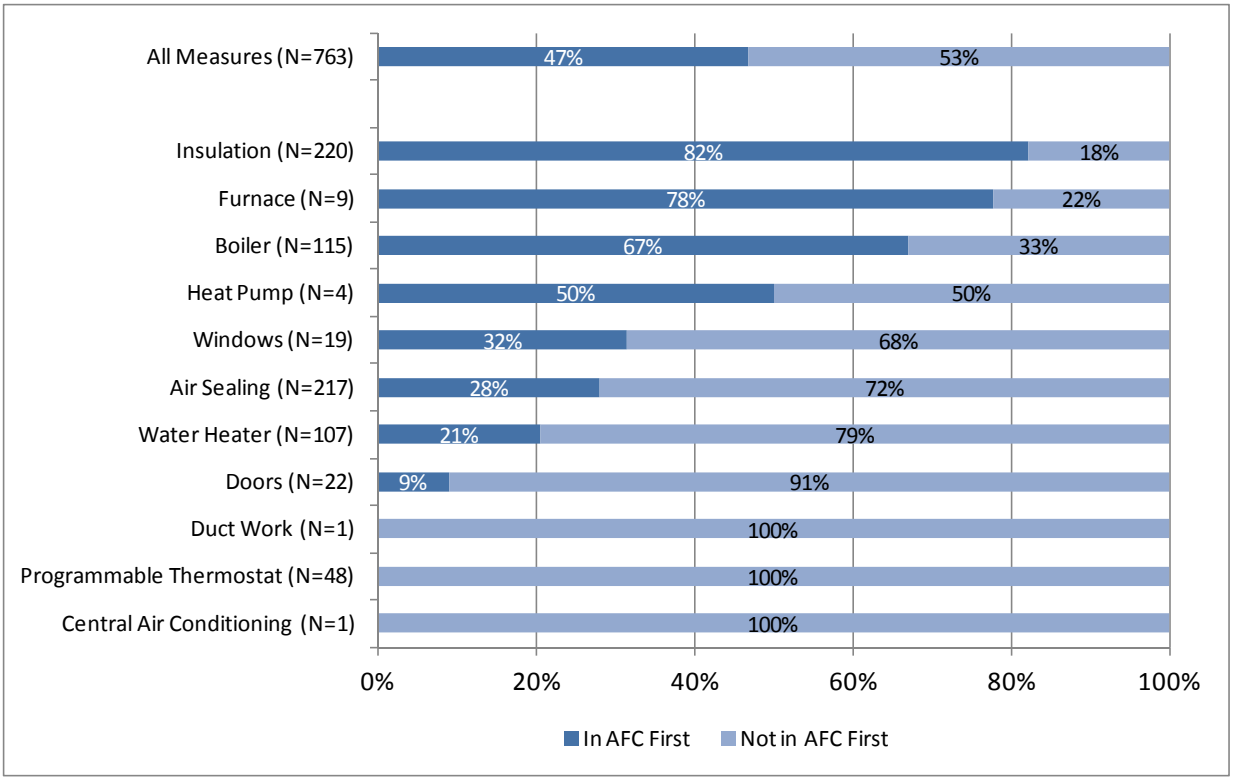
Source: Comparison of AFC First Tracking Data (as of September 30, 2012) and CSG Tracking Data (as of October 4, 2012)

The second comparison showed that, overall, only 47% of recommended measures in the RHA database were documented as installed measures in the AFC First database.[10] The AFC First database most closely aligns with the RHA database for three measures: insulation, furnaces, and boilers; for these, over two-thirds of recommended measures in the RHA database appear as installed measures in the AFC First database. For all other measure categories, 50% or fewer of the recommended measures documented in RHA resulted in an installation tracked in the AFC First database.

Figure 3-8 summarizes the overlap of measures in the RHA database compared to the AFC First database.

[10] Note that this comparison excludes RHA measures that are not categorized in the AFC First database, such as lighting upgrades, energy efficient appliances, and measures related to water heaters (e.g., pipe insulation, tank wrap, aerators, and low-flow showerheads). Also excluded are renewable energy sources which are not included in the measure-level RHA data.

Figure 3-8. Match of Recommended Measures in RHA Database to AFC First Database



Source: Comparison of CSG Tracking Data (as of October 4, 2012) and AFC First Tracking Data (as of September 30, 2012)

Under the program's current processes, AFC First relies on the projected energy savings estimates from RHA (based on the recommended measures) to determine if the project for which a loan application is submitted meets the program-required energy savings thresholds (i.e., 20% of whole-house energy usage or 25% of heating/hot water energy usage). The noted differences between the RHA documented recommended measures and the AFC First documented installed measures presents a challenge. Specifically, if the measures installed differ from the recommended measures modeled in RHA, then the determination, based on the RHA estimated savings, that the project meets the program savings requirements might no longer be valid. In fact, in our sample of 35 QA-inspection projects, we found that seven (or 20%) did not meet either savings threshold based on installed measures as verified at the inspection. (See Section 3.3 for details on our estimation of gross impacts.)

To better understand the issue of measure discrepancies between the two databases and how these might be resolved, we took a closer look at the data flow between AFC First, CSG, and the PEAs. We found the following:[11]

- CSG reviews the initial model runs of project savings for recommended measures, conducted by the PEAs, and captures the results in their RHA database. CSG then transmits to AFC First

[11] It should be noted that since our evaluation began and we began sharing information about data tracking procedures with Efficiency Maine, some changes to data flow have been made.

information about each project on their "HESP Review for PACE Projects" form. Key information on this form includes 1) estimated project savings as a percentage of whole-house energy usage and of heating/hotwater energy usage, and 2) a list of recommended measures, including details about quantity, price, dollar savings, and Savings to Investment Ratio for each recommended measure. However, the form does not include the values for total project savings (in energy units), savings by measure, whole-house energy usage, or heating/hot water energy usage; only the savings as a percentage of use are listed.

- AFC First receives Specification Sheets from customers and their PEAs as part of the loan application. These forms document the improvements the customer has agreed to make, and must be signed by the customer and the PEA. From the Specification Sheets, AFC First enters improvements that are financed with the loan into their database. There may be other improvements listed on the Specification Sheets that are not financed by the loan; in some cases, but not always, improvements that are part of the project, but that are not part of the loan, are entered as well.

These data flows do not include any systematic reconciliation between the list of recommended measures modeled and reported in the RHA database and the list of installed measures documented on the Specification Sheets and entered into the AFC First database. There is no feedback loop to update the measure list and savings estimates in the RHA database with the final set of measures agreed upon for installation. As a result, there is no program tracking database that captures a full list of installed measures and the associated project savings. This presented challenges for our gross impact analysis, as described in detail in Section 3.3.

3.2.4 QUALITY ASSURANCE

The program has an established goal of conducting Quality Assurance (QA) inspections of 15% of projects. As of November 15, 2012, CSG had conducted inspections of 50 projects (21% of RHA projects), exceeding their goal of a 15% inspection rate. These 50 inspections included post-installation inspections of 36 properties with a total of 47 units and three pre-installation inspections. Of the 47 post-installation inspections, CSG conducted 11 in 2011 and 36 in 2012.

According to the CSG program manager, the post-installation QA inspections include a blower door test to verify airsealing improvements, visual verification of installed measures (against the list of recommended measures documented in RHA), and verification of compliance with BPI combustion safety requirements. As part of the inspection, the inspector also asks the homeowner to rate their contractor's adherence to the Efficiency Maine Contractor Code of Conduct.

CSG has a separate tracking database for the results from the QA inspections. This database includes: basic site details, inspection details, key dates, building tightness data, percentage of airsealing installed, percentage of measures installed (in terms of modeled MMBTUs), BPI health and safety measures, and additional comments. Based on the on-site inspection findings, CSG develops a realization rate for each measure, which is then aggregated into a weighted project-level realization rate.[12]

When discrepancies are found between the measures included in RHA (based on the recommended measures) and the measures verified during the inspection, CSG notes the differences in the

[12] As explained in Section 3.3, our gross impact analysis relied on the results of the CSG post-installation QA inspections.

inspection database. In the past, the QA inspection results were not incorporated into the RHA database. However, according to program staff, CSG began doing so in October 2012.[13]

Overall, the QA inspection database is well populated, with nearly all fields populated with valid entries. For fields that are not fully populated, the reason for a missing value is generally provided in the "Additional Comments" field. One exception to this finding is the rating of compliance with Efficiency Maine's Contractor Code of Conduct, where only 23 of the 36 post-inspections provide this information. However, this customer rating is not vital for verifying installation of equipment.

3.3 GROSS IMPACT ANALYSIS

In 2011, the PACE predecessor program, HESP, underwent a detailed impact evaluation, including site visits, modeling, and engineering desk reviews of residential retrofit projects. Given that the program design and implementation of PACE/PowerSaver is largely the same as that of HESP,[14] it was initially decided to limit this interim impact analysis to the application of realization rates from the HESP evaluation to the program-estimated savings for PACE/PowerSaver projects (rather than conduct primary data collection and a full assessment of gross impacts at this stage of the PACE/PowerSaver evaluation).

However, as described above, our review of the two PACE/PowerSaver program tracking databases revealed that estimated savings values reflecting projects' *installed* measures were not readily or systematically available. Of the two program databases, CSG's RHA database contains measure-level savings estimates for all *recommended* measures, and that database is not systematically updated to reflect only the measures the customer actually installed. The AFC First database, on the other hand, better represents measures actually installed (it is based on a signed contract between the contractor and the customer), but it does not always include *all* of the measures installed by the customer. For example, if the maximum loan amount was reached with a subset of the measures or if the customer did not want to finance all installed measures, this database may underreport installed measures. In addition, the AFC First database only contains savings estimates at the project level (not the measure level); these savings values are only present in the database for some projects and they often do not match savings in RHA, even where measures match.

Given the absence of program-estimated gross savings values for installed measures in the PACE/PowerSaver databases, the strategy for calculating verified gross savings was revised. Instead of applying HESP realization rates to PACE/PowerSaver program-estimated savings, we had to build the estimate of verified gross savings through several steps, using information from several sources. These data sources were: the AFC First database; the CSG RHA database; CSG Quality Assurance (QA) inspection data for 35 projects; and data from project "Specification Sheets" collected by AFC First as part of the loan file.

3.3.1 SUMMARY OF GROSS IMPACTS

Verified first-year, annual gross savings for the PACE/PowerSaver Program through September 2012 are 16,332 MMBTU, or an average of 57.5 MMBTU per project for the 284 projects completed

[13] This change in practice was not implemented in time to be evaluated as part of this report.

[14] The key difference between the two programs is the financial aspect; HESP offered a cash rebate while PACE/PowerSaver offers a loan.

during this time period. On average, these savings represent 28.6% of pre-project whole-house energy usage.

We based the verified gross savings estimate on savings reported for 239 projects in the RHA database but applied four adjustment factors:

- QA-Inspection Factor ($Factor_{Insp}$). This factor accounts for the fact that not all recommended measures documented in RHA were installed. It reflects the savings of verified installed measures (from QA inspections by CSG) as a percentage of savings from the recommended measures in RHA.
- Additional AFC First Project Factor ($Factor_{AddAFC}$). This factor accounts for measures that are documented in the AFC First database but that are not included in the RHA database.
- Eligibility Factor ($Factor_{Elig}$). This factor accounts for measures that do not meet the program's efficiency standards.
- Non-RHA Projects ($Factor_{NonRHA}$). This factor is used to extrapolate results for the RHA-modeled projects to the full population of projects.

Verified gross program savings are calculated as:

$$Verified\ Gross\ Savings = RHA\ Savings * Factor_{Insp} * Factor_{AddAFC} * Factor_{Elig} * Factor_{NonRHA}$$

Table 3-2 summarizes the four adjustments made to RHA reported gross savings and the resulting savings estimates. Each savings estimate is derived by multiplying the preceding estimate by the factor.

Table 3-2. Summary of PACE/PowerSaver Gross Impact Analysis

Gross Impact Estimate / Adjustment	Value of Factor	Savings (MMBTU)
A. Reported RHA Gross Savings		18,242
QA-Inspection Factor ($Factor_{Insp}$)	*0.68*	
B. Inspection-Adjusted RHA Gross Savings		12,442
Additional AFC First Project Factor ($Factor_{AddAFC}$)	*1.13*	
C. AFC Adjusted RHA Gross Savings		14,096
Eligibility Factor ($Factor_{Elig}$)	*0.98*	
D. Verified RHA Gross Savings		13,744
Non-RHA Projects ($Factor_{NonRHA}$)	*1.19*	
E. Verified Program Gross Savings		16,322
Overall Gross Realization Rate – All Projects (E/A)	*0.90*	
Overall Gross Realization Rate – RHA Projects (D/A)	*0.75*	

Source: Gross Impact Analysis

The table shows that, overall, verified program savings are 90% of the savings reported in the RHA database (calculated as E/A in Table 3-2). The QA-Inspection Factor has the biggest impact on verified program gross savings, reducing RHA reported savings by 32%. Inclusion of ineligible measures reduces savings by another 2%. Additional installed measures (i.e., those not documented in RHA) increase savings by 13%. Projects modeled with software other than RHA contribute another 19% to overall savings.

The overall realization rate for the 239 projects in the RHA database (calculated as D/A in Table 3-2 above) is 0.75. This means that verified savings for these 239 projects are 75% of the savings listed in the database.

The next section provides additional detail on each of the four adjustments made to RHA-reported savings.

3.3.2 GROSS IMPACT ADJUSTMENT FACTORS

QA Inspection Factor

The RHA database contains savings estimates for all measures recommended following the energy audit. By including all recommended measures, some of which are not installed, this estimate overstates actual savings. To develop savings values that reflect *installed* measures, we relied on QA inspections of 35 completed PACE and PowerSaver projects conducted by CSG.[15] These inspections included blower door tests as well as visual verification inspections of all recommended measures listed in the RHA database. Based on the inspection, CSG assigned a "% Measure Installed" ratio for each measure that reflects the actual installation relative to what was initially modeled and included in the RHA database. In effect, CSG developed a realization rate for each measure in the RHA database for the inspected sites. CSG then aggregated measure-level realization rates to compute a weighted average project-level realization rate for each of the 35 inspected projects.

For each of the 35 projects (i), we estimated inspection-adjusted savings by multiplying the savings reported in the RHA database (RHA $Savings_i$) by the project-level realization rate (RR_{Insp_i}). We then developed the overall QA-inspection factor ($Factor_{Insp}$) by dividing the sum of inspection-adjusted savings for the 35 projects by the sum of RHA reported savings for the 35 projects. We used the following equation for this calculation:

$$Factor_{Insp} = \sum_{i=1}^{35} (RHA\ Savings_i * RR_{Insp\_i}) \ / \ \sum_{i=1}^{35} RHA\ Savings_i$$

Based on this analysis, 68% of estimated project savings listed in the RHA database could be confirmed. Project-specific realization rates in the sample range from 12% to 106%.[16] Low project-level realization rates often result from some of the recommended measures listed in the RHA database not having been installed.

Table 3-3 shows the distribution of post-inspection realization rates for the 35 projects.

[15] According to CSG, projects are generally chosen for inspection on a random basis, although some are targeted as a result of customer concerns or requests.

[16] CSG's spreadsheet included measure and project level realization rates for inspected projects. The range of realization rates presented here is slightly different from those calculated by CSG due to corrections made to the spreadsheet during the evaluation process.

Table 3-3. Distribution of Post-Inspection Realization Rates

Realization Rate	# Projects	% Projects
< 25%	2	6%
25% to <50%	6	17%
50% to <75%	6	17%
75% to <95%	10	29%
95% or greater	11	31%
Total	35	

Source: Gross Impact Analysis

Factor for Additional Installed Measures

When comparing the RHA database with the AFC First database, we found that, in some cases, the AFC First database included measures that are not listed in the RHA database for a given project. Omitting these installed measures would understate program savings. To account for any installed measures not listed in the RHA database, we compared measures documented in RHA and AFC First for the 35 PACE and PowerSaver projects for which a post-project QA inspection had been completed, and we determined savings for the additional measures.

We first developed a final AFC First measure list for the 35 projects. This involved a comparison of the AFC First database and the "Specification Sheet for Maine PACE Loan Program" for these projects. In general, the information in AFC First's database is based on the Specification Sheets, which represent the agreement between the customer and the contractor on the installation of program eligible measures. However, in some cases, not all installed measures are entered into the AFC First database, e.g., if the maximum loan amount was reached with a subset of the measures, or if the customer did not want to finance all measures. To capture all measures installed following the energy audit, we examined the Specification Sheets for the 35 projects and noted any differences in installed measures compared to the AFC First database. We updated the AFC First measure list for each of the 35 projects with information from the Specification Sheets, adding measures that were not already in the database and taking out measures that were in the database but not on the Specification Sheets.

Table 3-4 summarizes our comparison of the AFC First Database and the Specification Sheets for the 35 QA inspection projects.

Table 3-4. Summary of Comparison of AFC First Database and Specification Sheets

Measure Category	Number of Projects with Measure...	
	on Specification Sheet, Not in AFC First Database	in AFC First Database, Not on Specification Sheet
Air Sealing	8	-
Other	7	1
Insulation	4	1
Boiler	2	3
Renewable	1	-
Water Heater	1	2
Doors	1	-
Ducts	-	1
Furnace	-	1
Total	24	9

Source: Gross Impact Analysis

We then compared this final list of AFC First measures to the measures in the RHA database for each project and identified those measures that were not already included in RHA. Since the AFC First database does not contain measure-level savings, we had to develop and assign savings estimates for the additional measures documented by AFC First but not already included in RHA for a given project. In general, we used the average per project savings for the measure based on all RHA projects with that measure. For example, if AFC First listed Measure X for Project Y, the average savings value for Measure X across all projects in RHA would be assigned to Project Y.

Among the 35 QA inspection projects, we identified 23 additional measures that were not included in the RHA database. The most common measures missing from the RHA database, with 13 incidences, is in the "other" category.[17] However, six missing heating system measures (heat pumps, furnaces, and boilers) account for more than 80% of savings associated with additional measures.

Table 3-5 summarizes our findings.

[17] For measures categorized as "Other" or "Other (Whole House Recommendation)" in the AFC First database, no comparable average RHA savings value exists. We conducted a separate analysis for these measures to 1) identify what measures are included in these two categories, 2) assign a savings estimate to them, and 3) calculate an average savings value for projects with "other" measures. This analysis is described in Appendix B.

Table 3-5. Summary of Additional Measures and Their Savings

Measure Category	Additional AFC First Measures	Per Unit Savings (MMBTU)	Total Additional Savings (MMBTU)
Boiler	3	24.4	73.1
Furnace	2	40.6	81.1
Heat Pump	1	85.8	85.8
Doors	1	1.2	1.2
Windows	1	3.4	3.4
Renewable	2	12.7	25.4
Other	13	2.3	29.3
Total	23		299.3

Source: Gross Impact Analysis

Based on these results, we calculated the adjustment factor for additional measures documented by AFC First ($Factor_{AddAFC}$), based on the 35 projects with QA inspections, as follows:

$$Factor_{AddAFC} = 1 + (\sum_{i=1}^{35} Additional\ AFC\ First\ Savings_i \ / \ \sum_{i=1}^{35} InspectionAdj\ RHA\ Savings_i)$$

Or:

$$Factor_{AddAFC} = 1 + \frac{299.3}{2{,}252} = 1.13$$

Factor for Eligibility of Installed Measures

The AFC First database contains two fields related to the efficiency level of installed measures: "Performance Measure" and "Performance Value." To determine if the installed measures met program eligibility guidelines, we compared listed performance values to efficiency levels required by the program, i.e., efficiency levels required to obtain Energy Star rating. We determined eligibility for the following measures: central air conditioning systems, heat pumps, boilers, furnaces, water heaters, and windows. We did not determine eligibility for measures for which an objective efficiency level does not exist (e.g., doors or fans) or which are inherently efficient or improve the efficiency of the home (e.g., programmable thermostats, renewable systems, insulation, or air or duct sealing). Table B-1 in Appendix B summarizes the program eligibility criteria based on Energy Star efficiency levels.

Performance data was missing for 80 of 213 installed measures (38%) in the end-use categories for which we assessed eligibility. For these measures, we assumed that they meet program eligibility criteria. Of the 133 measures we could assess, we determined 121 (91%) to be eligible and 12 (9%) to be ineligible.

Table 3-6 summarizes measures in the AFC First database found to not meet program efficiency standards and their savings.

Table 3-6. Summary of Measure Eligibility Analysis

Measure Category	# Ineligible Measures	Performance Standard	Performance Values of Ineligible Measures	Savings of Ineligible Measures (MMBTU)
Gas Furnace	7	AFUE ≥ 95%	AFUE 82 - 92.5	269
Air Source Heat Pump	1	HSPF ≥8.0 / SEER ≥14.0	SEER 13	86
Gas Boiler	2	AFUE ≥ 85%	AFUE 82, 84	36
Oil Boiler	1	AFUE ≥ 85%	AFUE 80	5
Central Air Split System	1	SEER ≥14.5	SEER 13	1
TOTAL	12			397

Source: Energy Star Program (http://www.energystar.gov); Gross Impact Analysis

We deducted savings for the ineligible measures from total savings in the AFC First database and divided by total savings, giving us an eligibility factor ($Factor_{Elig}$) of 0.98.

$$Factor_{Elig} = \frac{15{,}887 - 397}{15{,}887} = 0.975$$

Extrapolation Factor for Non-RHA Projects

The RHA database only contains projects modeled with the RHA software (239 out of 284 projects through September 2012), and therefore does not capture all projects for which a PACE or PowerSaver loan has been provided. The AFC First database, on the other hand, contains all projects for which a PACE or PowerSaver loan has been provided (284 projects through September 2012).

To represent projects not present in the RHA database, we developed a factor that is equal to the quotient of the number of projects in the AFC First database and the number of projects in the RHA database:

$$Factor_{NonRHA} = \frac{284}{239} = 1.19$$

Applying this factor assumes that RHA-modeled projects are representative of projects not modeled in RHA, i.e., that both types of project have similar average savings, inspection realization rates, and overlap in measures with the AFC First database. Based on a comparison of projects in the AFC First database that were modeled with RHA and those that were modeled with another software, we believe that this is a reasonable assumption.

3.4 NET IMPACT ANALYSIS

The analysis of program net impacts for the PACE/PowerSaver Program through September 2012 included a quantitative analysis of free-ridership and partial participant spillover. We did not quantify participant spillover because our gross impact methodology already takes into account improvements that were made following the energy audit but that were not included in the loan. As such, our verified gross impact estimate already includes savings that, in the context of program

evaluation, are often considered participant spillover. In this evaluation, we did not measure non-participant spillover.[18]

3.4.1 Summary of Net Impacts

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

Based on the estimated levels of free-ridership and partial participant spillover, the NTGR for the PACE/PowerSaver Program through September 2012 is estimated to be 1.072. Table 3-7 summarizes the NTGR results.

Table 3-7. PACE/PowerSaver NTGR (through September 2012)

Component	Value
FR	0.083
Partial Participant Spillover	0.155
NTGR	1.072

Source: Net impact analysis.

Applying the NTGR to verified gross program savings of 16,332 MMBTU (see Table 3-2) yields annual program-level net impacts of approximately 17,500 MMBTU, or 61.7 MMBTU for each of the 284 projects completed during the study period.

3.4.2 Free-Ridership and Spillover Results

Free-Ridership

In the context of the PACE/PowerSaver Loan Program, free-riders are program participants who would have made the energy efficient home improvement(s) included in their loan, even without the program. The free-ridership analysis is based on self-reported information from the participant survey, conducted in May/June of 2012 in support of the Interim Process Evaluation Report. The survey collected data for 61 PACE projects completed through May 16, 2012. Since the PowerSaver Program had just started at the time of our process evaluation, the participant survey only included PACE Program participants, not those who received a PowerSaver loan. However, given that the two programs are almost identical, with the exception of loan limits and some of the financing details, we assume that free-ridership findings for PACE participants also apply to PowerSaver participants.

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

Influence of Program Components

We asked respondents to rate the influence of four program components (on a scale of 0 to 10, where 0 is not at all important and 10 is very important) on their decision to make the PACE-funded

[18] Any non-participant spillover would increase the NTGR.

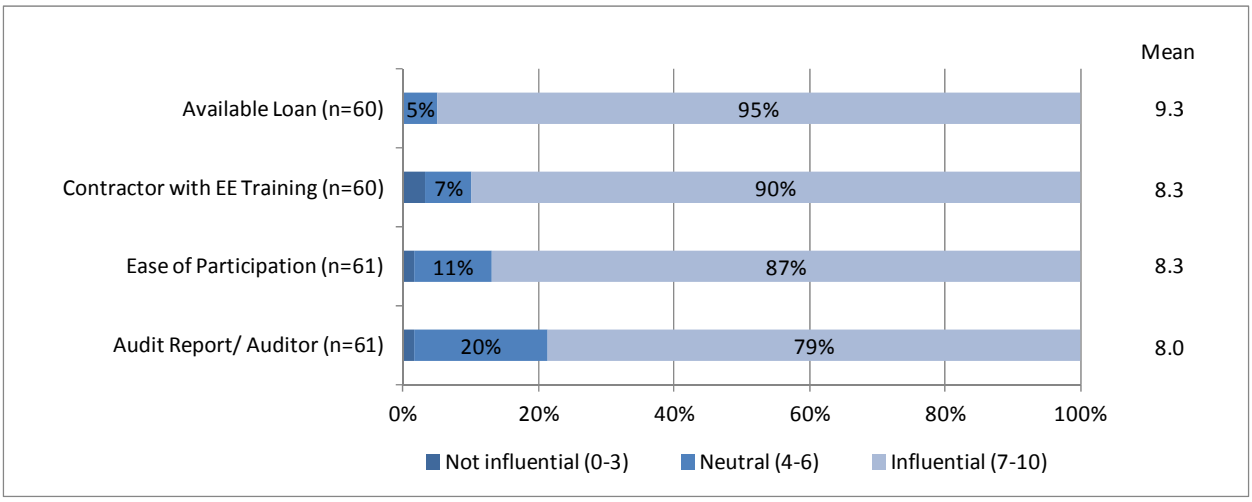
improvements to their home: 1) the information provided by the home energy audit or the Energy Advisor, 2) the availability of the PACE loan, 3) access to a contractor with specific training in energy efficiency, and 4) the ease of participation. The free-ridership score is calculated as:[19]

1 – (Maximum rating of any of the four components / 10)

Free-ridership values 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.

Participants generally gave high ratings to the influence of program components on their decision to make the energy improvements to their home. Almost all participants (95%) rated the loan as influential (a rating of 7 to 10 on a scale of 0 to 10), with 65% giving the highest rating of 10. Having access to a contractor trained in energy efficiency and an easy participation process were also important in customers' decision-making.

Figure 3-9. Influence of Program Components on Decision to Make Improvements



Source: Participant telephone survey.

Likely Action without Program

We asked respondents up to four questions about the home improvements for which they received a PACE loan: 1) would they have made the improvement(s) without the program (independent of the efficiency level); if yes, 2) how likely is it that the installation(s) would have been of the same efficiency without the program; 3) when would they have made the installation(s) without the program; and 4) if the installation(s) would have been made later, how much later.

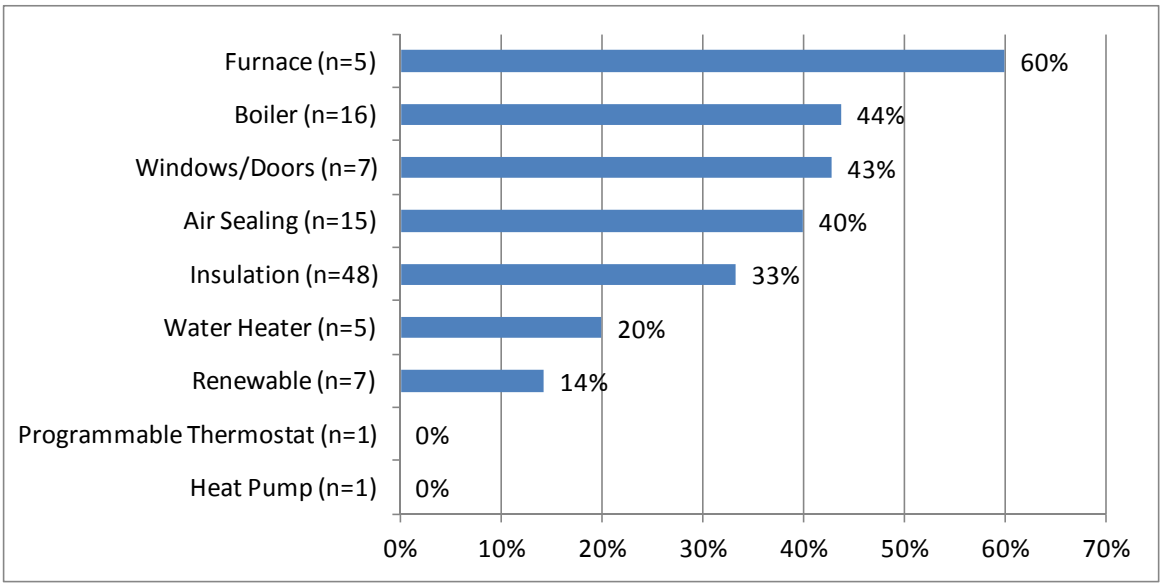
Participants who would *not* have made any improvements without the program are not a free-rider. For those who would have made at least one installation without the program, we estimated the percentage of total project savings that the installation(s) they would have made without the

[19] We reduced the rating for the importance of information provided by the home energy audit or the Energy Advisor by 50%, if the participant was "very likely" to have had an audit without the program.

program accounted for. This share was then adjusted, based on the responses to the level of efficiency and timing, to determine the level of free-ridership. As with the Program Components Score, free-ridership values range from 0 (0% free-ridership, 100% program attribution) to 1 (100% free-ridership, 0% program attribution). Lower efficiency levels or later implementation without the program means a lower level of free-ridership.

Participants generally indicate that they would not have made most of the home improvements without the loan program. As shown in Figure 3-10, participants are more likely to report that they would have installed equipment such as furnaces and boilers without the loan program, compared to insulation or measures such as water heaters or renewable energy sources. This is typical for a home performance type of program, because the need to replace old or broken equipment is often what initially attracts customers to the program. While these customers might have planned to install a new furnace or boiler anyway, they often learn about other measures through the energy audit. However, based on survey results, even those measures that participants would have installed without the program would often have been less efficient or installed later if the program had not been available.

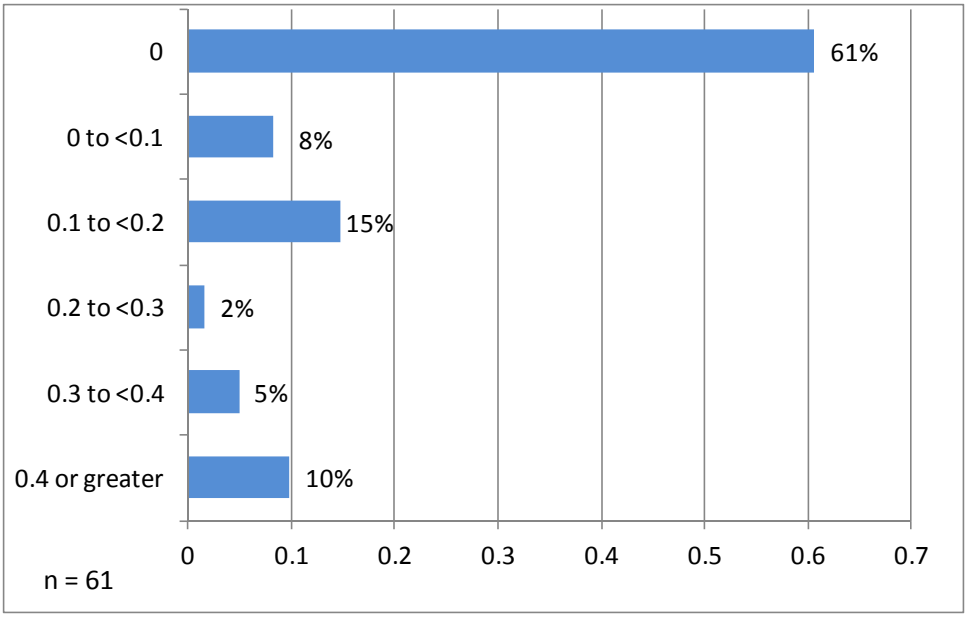
Figure 3-10. Percent of Installations that Would Have Happened Without Program



Source: Participant telephone survey.

The overall free-ridership score for each respondent is the average of the two scores. To estimate program free-ridership, we aggregated the respondent-level free-ridership scores, weighted by savings. Free-ridership scores for the 61 surveyed projects range from 0 to 0.75. Notably, we estimate a free-ridership score of 0 (no free-ridership) for 61% of participants. Only 10% of participants have a free-ridership score of 0.4 or greater. Figure 3-11 summarizes these findings.

Figure 3-11. Distribution of PACE Free-Ridership Scores



Source: Participant telephone survey, net impact analysis.

The resulting program-level estimate of free-ridership is 0.08 (meaning 92% of savings are attributable to the program).

Partial Participant Spillover

Partial participant spillover refers to home energy improvements undertaken by program drop-outs that were influenced by the program but were not funded by a PACE loan. An example of partial participant spillover is when a customer who withdrew their application before receiving a loan, but after receiving a home energy audit, makes recommended improvements on their own because of the information received from the audit report.

Through our survey of program drop-outs,[20] we assessed partial participant spillover by asking a series of survey questions about the recommended improvements the customer made without a loan:

- What, if any, energy-related home improvement projects were completed since applying for the PACE loan?
- Was a home energy audit completed before dropping out of participation in the program?
- How influential was the energy audit in the decision to make the improvements (on a 0 to 10 scale where 0 means no influence and 10 means great influence)?

[20] The drop-out survey was conducted in June of 2012, in support of the Interim Process Evaluation Report, and collected information from 56 participants that began the loan application process but dropped out before closing the loan.

We estimated partial participant spillover for any program drop-out who 1) made energy-related home improvement projects that were completed after applying for the PACE loan, 2) had a home energy audit completed, and 3) rated the importance of the energy audit on the decision to make the improvements a 7 or higher (on a scale of 0 to 10). For each of these drop-outs, we applied average RHA savings by measure to the energy-related improvements made by the customer.

Survey results showed that about half of program drop-outs (54%) completed energy-related home improvements since they first applied for the PACE loan. These improvements included insulation (53%), windows/doors (37%), high efficiency furnaces (23%), and air sealing (20%). Among program drop-outs who had an audit and completed energy upgrades (n=15), about half (47%, or 13% of all drop-outs) considered the audit to be influential in their decision to make those improvements (a rating of 7 to 10, on a scale of 0 to 10).

Table 3-8 summarizes improvements made by program drop-outs that were influenced by the audit. The table also shows the estimated savings of those improvements.[21] The table shows that insulation accounts for almost half of all partial participant spillover. Other improvements contributing significantly to spillover include furnaces, air sealing, and renewable energy sources. Total estimated savings for the sample of drop-outs are 301 MMBTU, or 5.4 MMBTU per drop-out.

Table 3-8. Summary of Partial Participant Spillover

Improvement	# Installed	Per Measure Savings (MMBTU)	Total Savings for Sample (MMBTU)
Insulation	4	35.2	140.7
Furnace	2	40.6	81.1
Air sealing	2	23.8	47.7
Renewable	2	12.7	25.4
Windows/Doors	2	2.2	4.5
Appliance	1	1.8	1.8
New roof	1	-	-
TOTAL	14		301.1

Source: Participant telephone survey, net impact analysis.

Based on AFC First records, there were a total of 471 drop-outs through September 2012. Extrapolating the estimated per drop-out savings to that population yields an estimated 2,533 MMBTU (5.4 MMBTU/drop-out * 471 drop-outs). Dividing this estimate by the verified program gross savings estimate of 16,322 (see Table 3-2) results in a partial participant spillover score of 0.16. The following equation summarizes this calculation.

$$Partial\ Participant\ Spillover\ Score = \frac{5.4\ MMBTU * 471}{16{,}322\ MMBTU} = 0.16$$

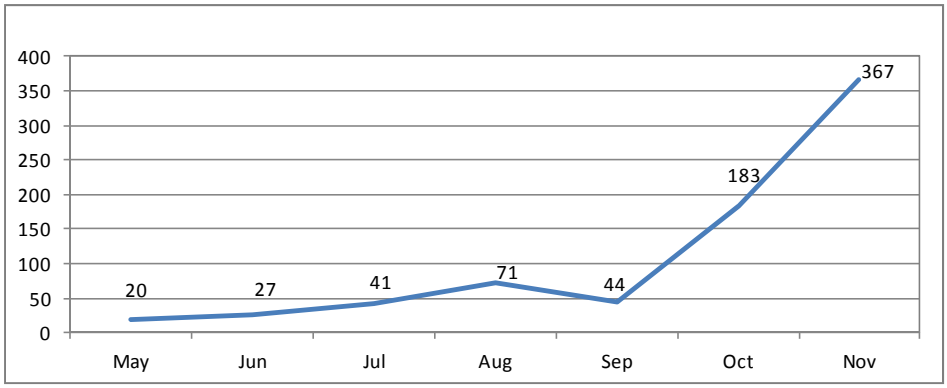
[21] Per measure savings are average savings based on all RHA projects with that improvement.

4. RDI IMPACT EVALUATION

4.1 DESCRIPTIVE ANALYSIS OF PROJECTS

Over the RDI program's first eight months (April 2012 through November 2012), 754 participants received an RDI incentive for air sealing and insulation work.[22] The number of projects increased significantly in October and November, with November accounting for almost half of all RDI projects to-date.[23] This sharp increase in RDI activity followed an increase in the RDI incentive from $300 to $600 implemented in September of 2012.

Figure 4-1. Number of RDI Projects per Month



Source: RDI Tracking Data (as of December 3, 2012)

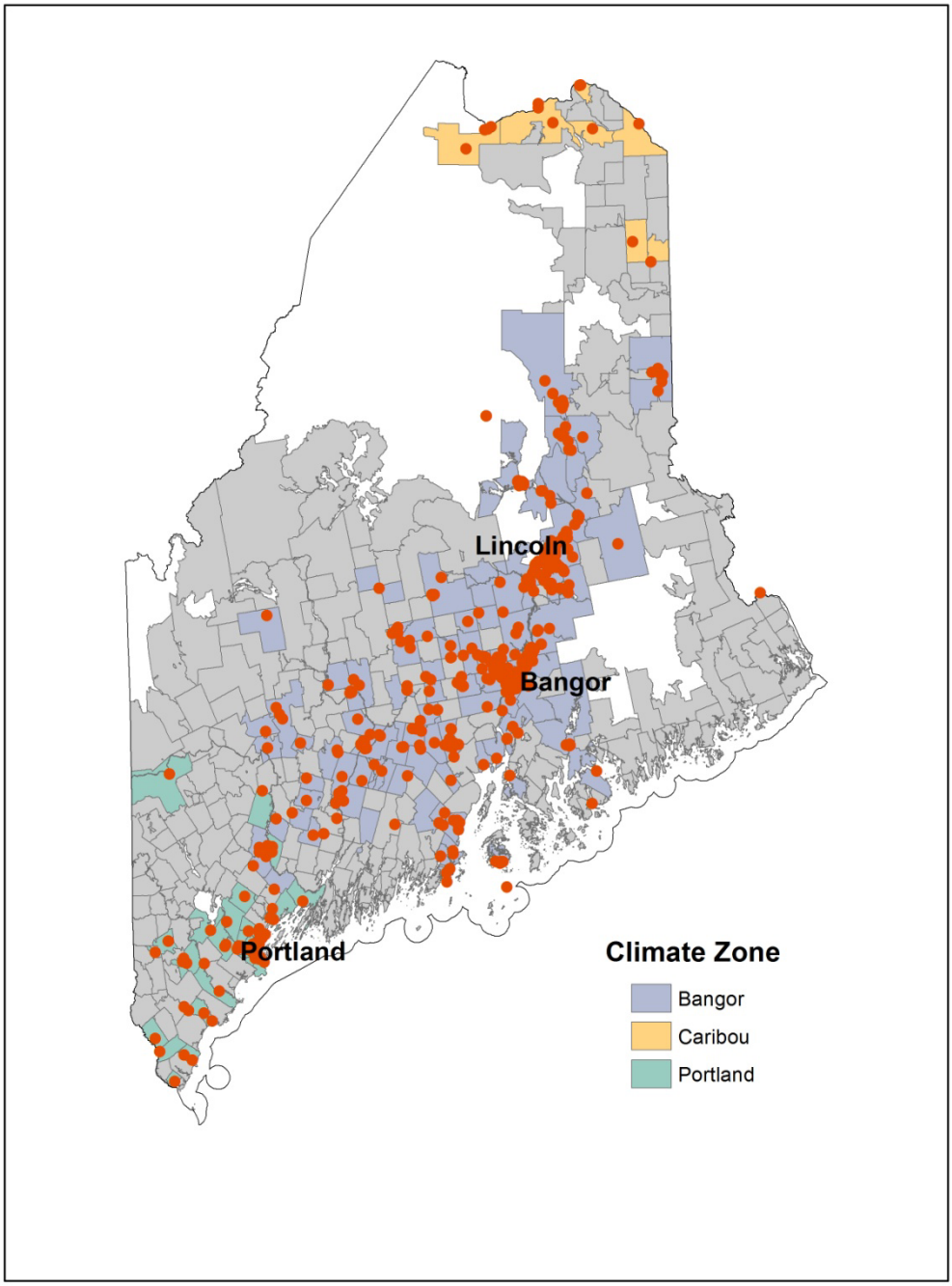
The majority of RDI projects (90%) took place in the "Bangor" region, with clusters in the Bangor and Lincoln areas. This is mainly the result of one very active Participating Energy Advisor who operates in this region, and who accounted for 59% of all RDI projects. Another 8% of projects are located in the "Portland" region, and only 2% took place in the northern "Caribou" region.[24]

[22] According to program documentation, eligible PACE projects include those with air sealing and insulation work that received an energy audit *after April 27, 2012*. Of the 754 projects, 16 have an audit date prior to April 27, 2012. While these projects might technically not be eligible for a program incentive, they are included in this interim impact analysis.

[23] The month represents the date the project was submitted to Efficiency Maine and might be different from the date of the audit or work completion. Efficiency Maine uses this date as a proxy for project completion.

[24] The three regions are based on the impact analysis for air sealing and reflect different climate zones in Maine.

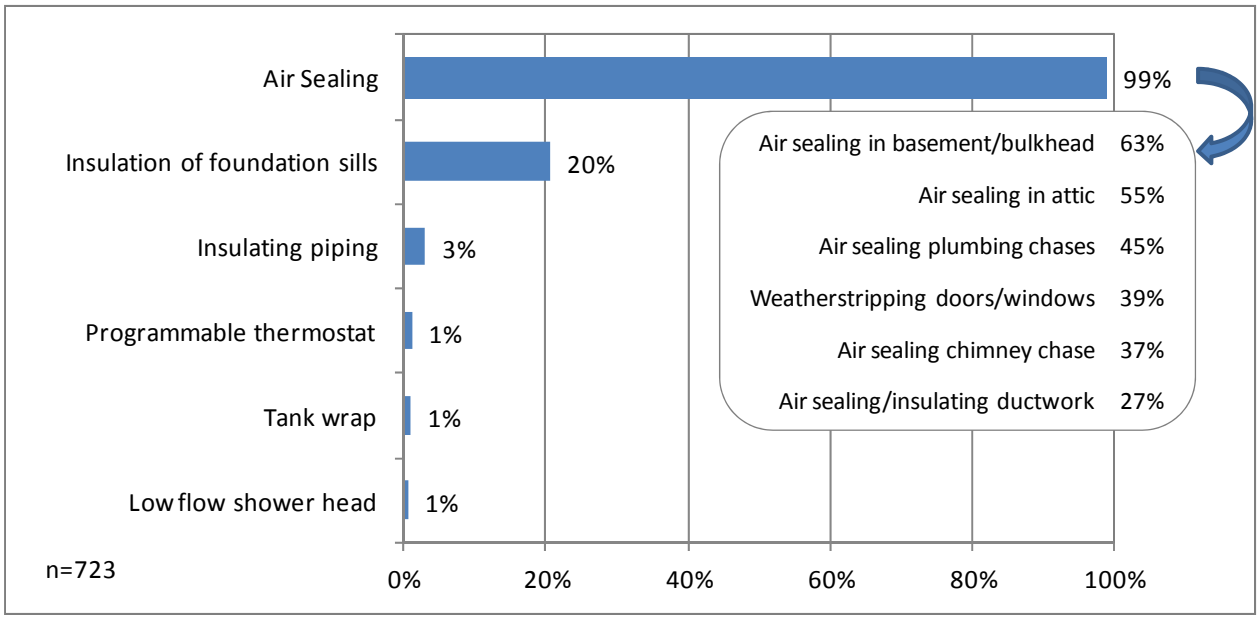
Figure 4-2. Geographic Distribution of RDI Projects



Source: RDI Tracking Data (as of December 3rd, 2012)

Air sealing (99% of projects; including weather stripping) and insulation of foundation sills (20% of projects) were the top two RDI measures completed. On average two measures were completed per project. Other measures directly tracked by the program (insulating piping, programmable thermostats, tank wrap, and low flow shower heads) were implemented at 3% or fewer of RDI projects.

Figure 4-3. RDI Measures Completed

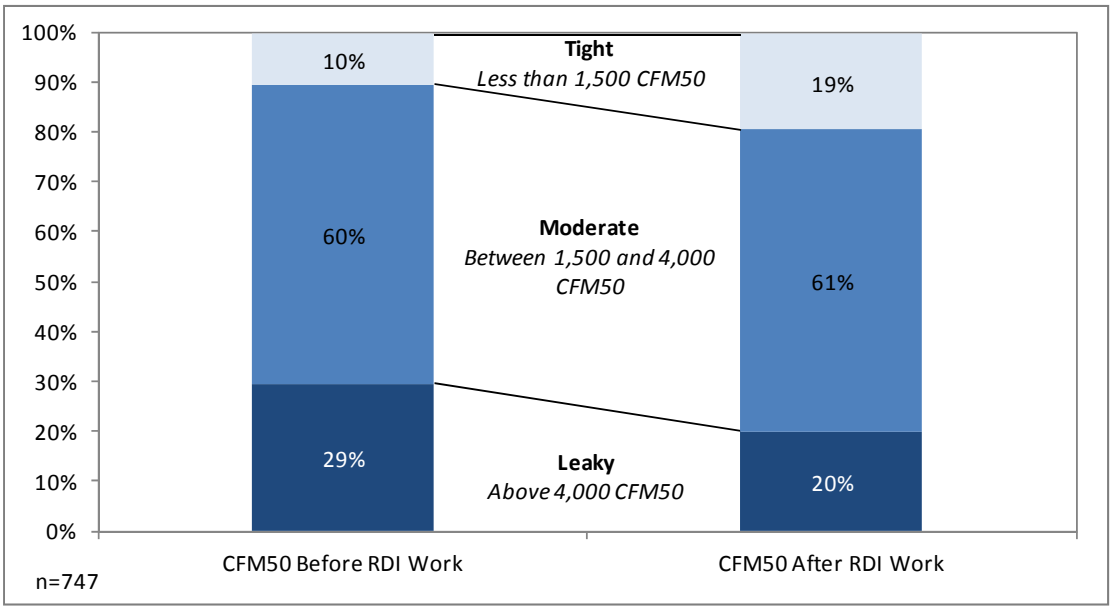


Source: RDI Tracking Data (as of December 3rd, 2012)

Pre and post installation blower door tests are a key requirement of the RDI program, and they are the basis for estimates of airsealing savings. According to information reported by Energy Advisors, the airsealing work performed through the RDI program reduced the share of "leaky" RDI homes (defined as a CFM50 value above 4,000) from 29% to 20% and increased the share of "tight" RDI homes (defined as a CFM50 value less than 1,500) from 10% to 19%.[25]

[25] CFM50 categories are based on the Pennsylvania Housing Research/Resource Center. Bill Van der Meer (2001). Builder Brief BB0201: Blower Door Testing. Retrieved from http://www.engr.psu.edu/phrc/Reports.asp

Figure 4-4. Leakiness of Homes, Before and After RDI Work

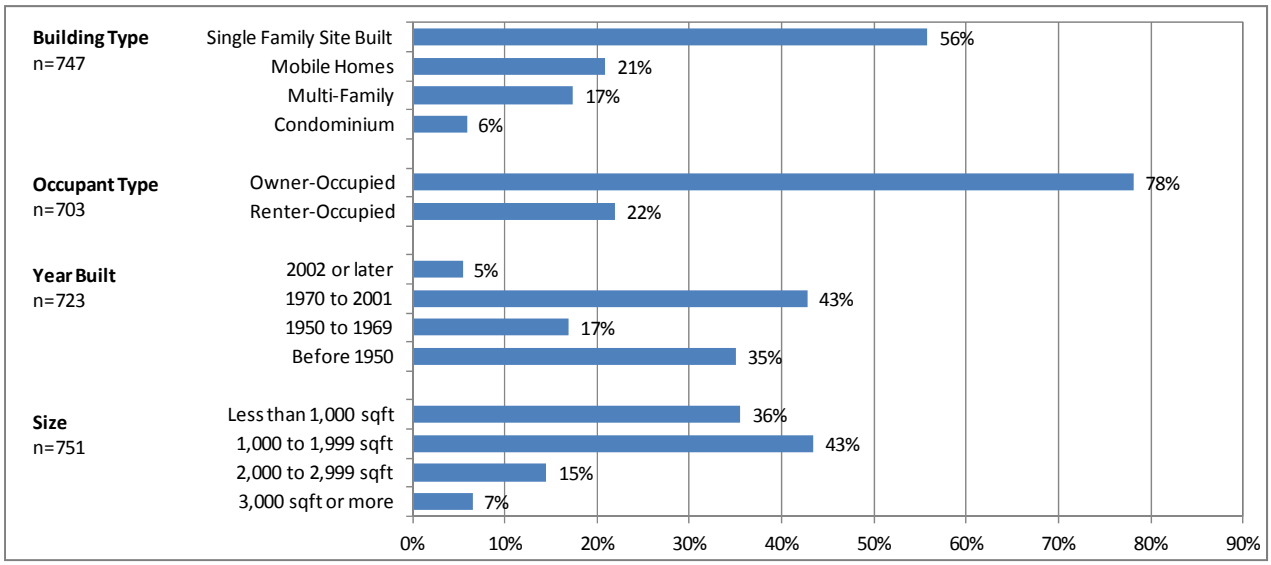


Source: RDI Tracking Data (as of December 3rd, 2012)

Detached single-family homes account for just over half of RDI participant homes (56%). While the majority of participating buildings are owner occupied (78%), 22% of RDI participants rent their home. The program therefore reaches a part of the population that is not eligible for the PACE or PowerSaver programs.

Not surprisingly, RDI participants tend to live in older homes. Nearly all (95%) were built before 2001 and 52 percent were built before 1970. The majority of homes (79%) are smaller than 2,000 square feet.

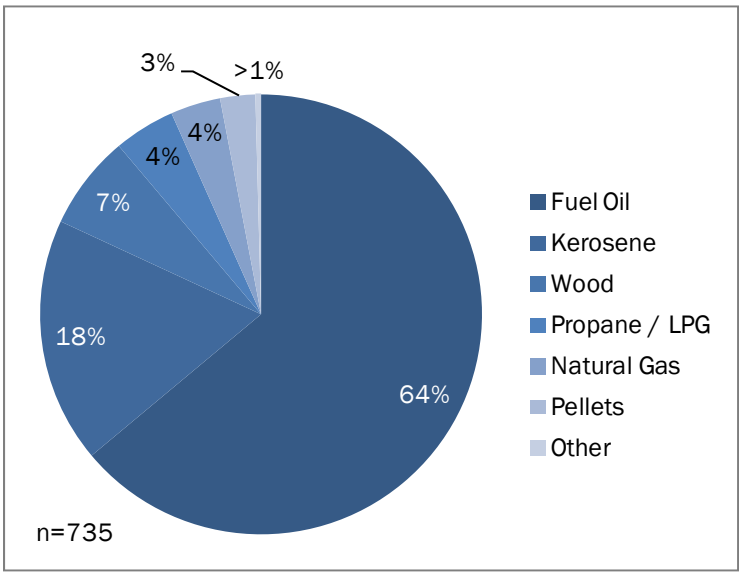
Figure 4-5. Building Characteristics of RDI Participants



Source: RDI Tracking Data (as of December 3rd, 2012)

Oil (64%) and kerosene (18%) are the most commonly used primary heating fuels among RDI participants. A little over half (56%) of participants do not use a secondary type of heating fuel. Among those who do, wood (34%), oil (28%), and propane/LPG (27%) are the most common.[26]

Figure 4-6. Primary Heating Fuel of RDI Participants

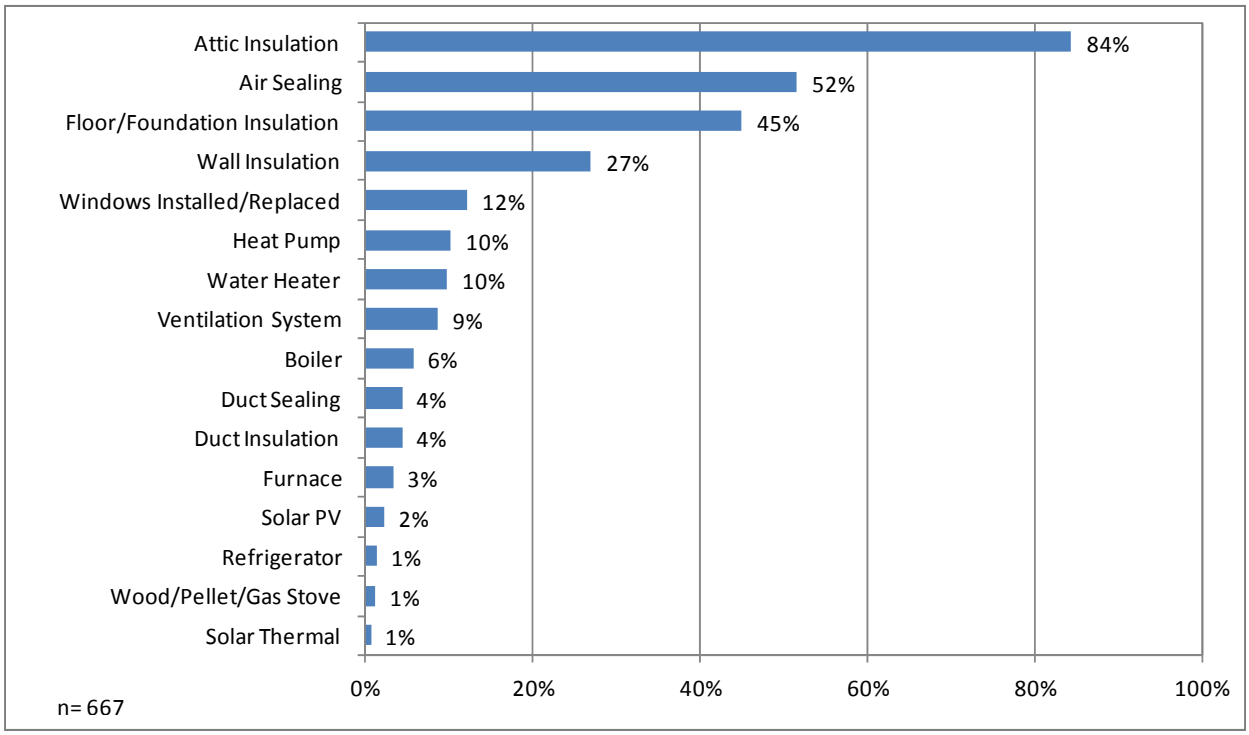


Source: RDI Tracking Data (as of December 3rd, 2012)

Participation in the RDI Program requires an energy audit, which is also required for participation in the PACE and PowerSaver loan programs. Based on the audit, Energy Advisors provide recommendations for energy improvements to customers. Recommendations are not limited to RDI supported measures but might also include the broader set of energy efficiency measures included in the PACE and PowerSaver programs (e.g., heating and cooling equipment, windows and doors, and renewable measures). The most commonly recommended measures included attic insulation (84%), air sealing (52%), floor/foundation insulation (45%), and wall insulation (27%).

[26] It should be noted that information about secondary fuel usage was missing for 35% of projects. These results are based on the 65% of projects for which information was available.

Figure 4-7. Recommended Measures/Upgrade for RDI Participants



Source: RDI Tracking Data (as of December 3rd, 2012)

A total of 31 unique companies employing PEAs participated in the program between April and November 2012. The number of audits completed by each company ranged from 1 to 444, with most (61%) completing between 1 and 5 projects. One company completed 444 projects, accounting for 59% of all RDI projects. Two other companies completed 63 and 52 projects, respectively, and two others each completed over 30 projects. Combined, these five companies accounted for 89% of all RDI projects completed through the end of November 2012.

Table 4-1. Energy Advisors Participating in RDI

Projects Completed	# of Auditors	% of Auditors	# of Projects	% of Projects
1 Project	8	26%	8	1%
2-5 Projects	11	35%	36	5%
6-10 Projects	3	10%	23	3%
11-20 Projects	4	13%	56	7%
21-50 Projects	2	6%	71	9%
51-100 Projects	2	6%	115	15%
>100 Projects	1	3%	444	59%
TOTAL	31	100%	753	100%

Source: RDI Tracking Data (as of December 3rd, 2012)

4.2 DATABASE REVIEW

The RDI Program tracks data on each project through a database populated by contractors via an on-line interface using Survey Monkey.[27] This database includes information on the improvements made with the RDI incentive, additional recommendations, and detailed information on the homeowner and the home, including fuel usage. Our review included the type of data tracked, the extent to which data fields are populated, and the adequacy of data and project documentation to perform program tracking and evaluation functions.

The RDI database is very comprehensive in terms of the type of data it collects, and it is generally very well populated. It contains all the key information required for program tracking and evaluation purposes. While the survey tool indicates a limited set of fields as required fields (these are: homeowner contact information, the year the building was constructed, and the results of the combustion safety test), RDI contractors are strongly encouraged to submit additional data about the project, such as blower door test results and other audit-related information. Based on the completeness of data in the other fields, RDI contractors generally comply with this request.

One exception is information about secondary fuels used in the home. The respondent has the option of selecting one of several fuel types or indicating that there is no secondary fuel. This information was missing for 35% of projects included in our analysis. For projects that were missing this information, we were unable to estimate RDI savings as a percentage of total home fuel usage because we could not be certain that all fuel usage was included in our analysis.

While the RDI database, as constructed and used by contractors, collects the relevant information for program tracking and evaluation, the program may wish to consider the following minor adjustments to enhance the database:

- **Mark as required all fields for which information should be provided.** While most key fields are already well populated, clearly marking each field for which information is required might make completing the survey clearer for Energy Advisors. Such fields should include, at a minimum, data needed to assess impacts, including questions about fuel type, whether a secondary fuel is used, the pre and post CFM50 results, and the types of improvements made.
- **Include "None" or "n/a" response categories for certain questions.** Being able to distinguish between "none," "not applicable," and a missing response can be important. While some questions already include these categories, others that might benefit from such categories do not. For example, for insulation questions, only the question about basement insulation includes a "none" category for the R value, the question about attic insulation does not. For basement insulation, the respondent has to select an insulation type, even when the response is "none," which might lead to confusion or non-responses. Other questions that might benefit from a "none" or "n/a" category include the energy model used and subsequent questions about model results.

[27] Efficiency Maine has also developed a second Survey Monkey database to collect test-out information for home energy improvement projects projected to exceed 20% reduction in whole home energy consumption or projects that are financed through the PACE or PowerSaver loan programs; contractors who provide this information receive an incentive of $100. The incentive is not restricted to RDI projects.

4.3 GROSS IMPACT ANALYSIS

To receive an RDI incentive, contractors have to perform a minimum of six hours of airsealing and insulation work; however, they do not have to develop an estimate of likely project savings (although some do). As a result, RDI program tracking data only contains energy savings information for a small subset of projects. In support of this report, we estimated savings for air sealing as well as for the other RDI measures that are tracked by the program.

4.3.1 SUMMARY OF GROSS IMPACTS

Estimated first-year, annual gross savings for the RDI Program through November 2012 are 7,366 MMBTU, or an average of 9.77 MMBTU per project for the 754 projects completed during this time period. This includes 6,800 MMBTU in savings from airsealing (or 9.02 MMBTU per project) and 565 MMBTU in savings from other RDI measures (or 0.75 MMBTU per project).

4.3.2 AIRSEALING RESULTS

Our estimate of air sealing energy impacts is based on the difference between the pre- and post-CFM50 values determined by the PEA (through blower door testing) and an engineering algorithm-based temperature bin method. This method was similar to that employed by Efficiency Maine to determine FY2012 RDI program savings for their Annual Report. However, our analysis expanded the FY2012 analysis to include all RDI projects through November 2012. We also used slightly different hours for each temperature bin and separated out the impacts by the three climate zones, based on the location of each project.

Our analysis consisted of the following five steps:

1. Review and Clean Delta CFM50 Values
2. Develop Hours by Temperature Bin for Three Regions
3. Apply Engineering Algorithm
4. Calculate Savings by Fuel Type and Apply System Efficiencies
5. Convert Savings into MMBTU

These steps are described in detail below.

Review and Clean Delta CFM50 Values

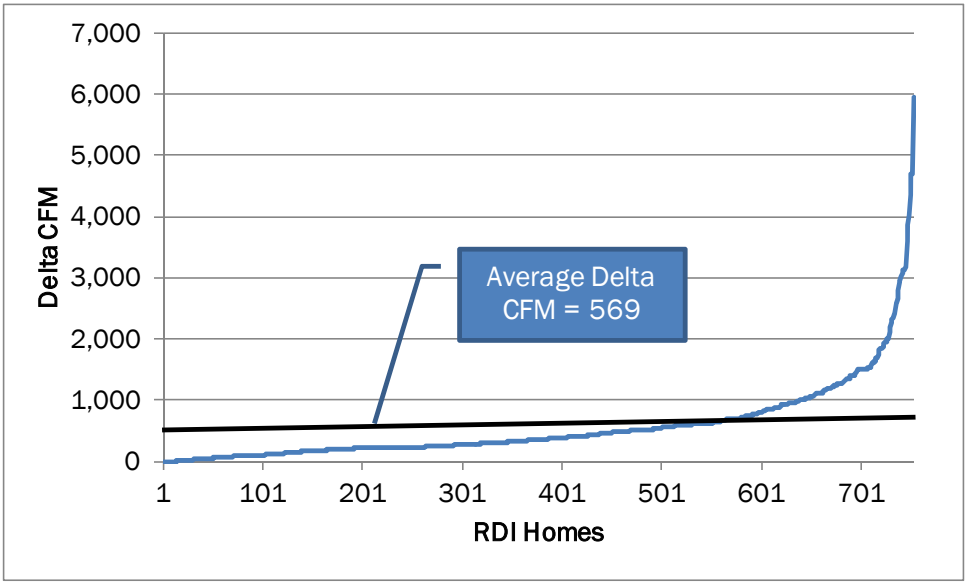
We first reviewed the pre- and post-CFM50 values for potential data anomalies. The original dataset contained 754 records, with each record representing a household that completed air sealing. After reviewing the data, we changed 10 records. All 10 appeared to be data entry errors as the post-CFM50 value was larger than the pre-CFM50 value or both values were zero.[28] Changing these 10

[28] For six cases, we reversed the values; for three cases with pre and post values of zero, we assigned the average delta CFM50; for one value, the pre-case CFM50 value was 50 and the post case value was 5,100. We also assigned the average delta CFM50 to this record.

cases made little difference to the overall results. There were also eleven instances where the pre- and post-CFM50 values were identical, leading to no savings. We made no changes to these records.

Based on the blower door test results provided by the PEAs, the average difference between the pre- and post-CFM50 is 569, an average air flow reduction of 17%. The delta CFM50 exceeds this average for approximately one-quarter of the homes, in some cases significantly (see Figure 4-8 below).

Figure 4-8. Delta CFM50 by Home for RDI Population



Source: Analysis of RDI Tracking Data (as of December 3rd, 2012)

Develop Hours by Temperature Bin for Three Regions

We used Typical Meteorological Year, version 3 (TMY3) data for each of the three regions to determine the number of hours within each temperature bin.[29] Our analysis followed the same procedure as Efficiency Maine used in its cost-effectiveness analysis of the RDI Program for the FY2012 Annual Report, using five -degree bins between 50° F and -25° F.

The hours by temperature bin and region used in the RDI gross impact analysis for air sealing are presented in Table C-1 (Appendix C).

[29] According to the National Renewable Energy Laboratory: "A typical meteorological year (TMY) data set provides designers and other users with a reasonably sized annual data set that holds hourly meteorological values that typify conditions at a specific location over a longer period of time, such as 30 years. TMY data sets are widely used by building designers and others for modeling renewable energy conversion systems." NREL/TP-581-43156, *User Manual for TMY3 Data Sets*, Revised May 2008.

Apply Engineering Algorithm

Efficiency Maine provided the region (Bangor, Portland, and Caribou) for each RDI project. Based on project location, we applied the engineering algorithm shown below to calculate the total reduction in BTU for each region, R.

$$BTU\ reduction_R = Delta\ CFM50_R * \frac{Minutes}{Hour} * Hours\ in\ Temperature\ Bin_R * Delta\ Temperature * \frac{Specific\ Heat\ of\ Air}{Volume\ of\ Air}$$

Where:

BTU reduction$_R$ = the total energy reduction (in BTU) for the region, R

Delta CFM50$_R$ = the total reduction in CFM50 for the region, R

Hours in Temperature Bin$_R$ = Number of hours in the bin for the region, R

Delta Temperature = the difference between the mid-point of the temperature bin and an assumed household interior balance point of 65

Specific Heat of Air = 0.24 Btu/lb$_m$ ° F

Volume of Air = 13.2 ft^3/lb$_m$

Applying the engineering algorithm, we estimate a total of 5,408 MMBTU in savings from airsealing. The majority of savings occur in the Bangor region.

Table 4-2. MMBTU Reduction from Airsealing by Region

Region	MMBTU Savings
Bangor	4,493
Caribou	182
Portland	733
Total	5,408

Source: RDI Impact Analysis, 2012

Calculate Savings by Fuel Type and Apply System Efficiencies

In order to apply fuel-specific system efficiencies, we converted total BTU reductions into fuel-specific units. Using the algorithm below, we calculated the savings for each fuel type taking into account average system efficiencies for each fuel type, F:

$$Savings_F = \sum_{F=1}^{9} \frac{BTU\ Reduction_F}{System\ Efficiency_F * Heat\ Content_F}$$

Table 4-3 presents the savings, by fuel type and region, in their "native" units (i.e., kWh, gallons, etc).[30]

[30] See Table C-2 in Appendix C for system efficiencies and heat content by fuel type.

Table 4-3. Air Sealing Savings by Fuel Type

Fuel Type	Bangor	Caribou	Portland	Total	Fuel Unit
Coal	109	83	-	192	ton/100
Electric	1,065	-	-	1,065	kWh
Electric Heat Pump	-	-	755	755	kWh
Fuel Oil	26,778	832	4,453	32,064	gallons
Kerosene	5,326	-	67	5,393	gallons
Natural Gas	914	-	1,976	2,890	therms
Pellets	15,960	11,971	4,418	32,350	pound
Propane / LPG	2,294	-	87	2,380	gallons
Wood	3,910	41.4	64	4,015	cord/100

Source: RDI Impact Analysis, 2012

Convert Savings into MMBTU

Using the same heat content, we converted savings into MMBTU as shown below.

$$MMBTU\ Savings_F = \frac{Savings_F * Heat\ Content_F}{1{,}000{,}000}$$

We estimate a total of 6,800 MMBTU in savings from airsealing, or 9.1 MMBTU per project. The majority of savings occur in the Bangor region and are reductions in the use of fuel oil.

Table 4-4. Total MMBTU Reduction from Airsealing by Fuel Type and Region

Fuel Type	Bangor Region Savings (MMBTU)	Caribou Region Savings (MMBTU)	Portland Region Savings (MMBTU)	Total (MMBTU)
Coal	27	21	-	48
Electric	4	-	-	4
Electric Heat Pump	-	-	3	3
Fuel Oil	3,695	115	615	4,425
Kerosene	735	-	9	744
Natural Gas	91	-	198	289
Pellets	128	96	35	259
Propane / LPG	218	-	8	226
Wood	782	8	13	803
Total	5,680	240	880	6,800

Source: RDI Impact Analysis, 2012

4.3.3 Results for Other RDI Measures

Other RDI measures tracked by the program include insulation of foundation sills, insulating piping, programmable thermostats, tank wrap, and low flow shower heads. For these measures, we applied

average per project savings calculated from the RHA database for PACE/PowerSaver projects, as shown in Table 4-5 below.[31]

Table 4-5. Average Savings for Other RDI Measures

RDI Measure	Equivalent RHA Measure	# RHA Projects	Average RHA Savings (MMBTU)
Insulation of foundation sills	Basement/Floor Insulation–Rim joist	109	3.38
Programmable thermostat	HVAC: Thermostats	48	4.54
Insulating piping	DHW: Pipe Insulation	14	0.79
Tank wrap	DHW: Tank Wraps	2	1.02
Low flow shower head	DHW: Showerheads	7	1.08

Source: Developed from CSG Tracking Data (as of October 4th, 2012)

The analysis showed that insulation of foundation sills was by far the most common non-airsealing measure included in RDI projects (20% of all projects) and accounted for 500 MMBTU of savings. All other measures were included in less than 3% of projects and accounted for small shares of overall RDI energy savings. Table 4-6 below presents estimated savings of other tracked RDI measures.

Table 4-6. Savings for Other RDI Measures

RDI Measure	Average RHA Savings (MMBTU)	Number of RDI Projects with Measure	Total RDI Savings (MMBTU)
Insulation of foundation sills	3.4	148	500.2
Insulating piping	0.8	22	17.3
Programmable thermostat	4.5	8	36.3
Tank wrap	1.0	7	7.2
Low flow shower head	1.1	4	4.3
Total other RDI measures			565.3

Source: Developed from CSG Tracking Data (October 4, 2012) and RDI Tracking Data (December 3, 2012).

[31] While some of these average savings estimates are based on a very small number of PACE/PowerSaver projects in the RHA database, no additional information about the RDI projects with these measures was available that would have allowed us to develop a more precise estimate. In addition, the contribution of these other measures (except for insulation of foundation sills) to total RDI savings is minimal; we therefore judged this method to be sufficiently rigorous for the purposes of this analysis.

5. COST-EFFECTIVENESS AND MACROECONOMIC EFFECTS

5.1 METHODOLOGY

For this Interim Impact Report, the evaluation team conducted a cost-effectiveness analysis for FY2012 using Efficiency Maine's Benefit/Cost Screening Model (version 2.2) developed by GDS Associates. For the PACE/PowerSaver program, the analysis covers the full FY2012 program year (July 2011 through June 2012). For the RDI Program, however, the cost-effectiveness analysis only includes the final two months of FY2012 as the program launched in May 2012. We decided to conduct the analysis for this time period to allow for a comparison with cost-effectiveness results Efficiency Maine generated for the FY2012 Annual Report.

Initial program inputs for the FY2012 cost-effectiveness analysis were provided by Efficiency Maine. The evaluation team used the Benefit/Cost model to develop results for 1) the Total Resource Cost test (TRC),[32] 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 net present value (NPV) 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

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

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

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 costs of purchasing and installing the efficient equipment, above the cost of standard equipment, that are borne by the customer. In some cases incremental operations and maintenance costs (or savings) are also included.

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

Macroeconomic Effects

We estimated macroeconomic effects using multipliers developed by Environment Northeast (ENE) in its report for Northeastern states.[33] Job creation (job-years) and economic stimulus (increase in Gross State Product, GSP) were estimated using the programs' total spending (including both administrator and participant spending).

The macroeconomic benefits of energy efficiency occur as a result of increased spending on efficiency measures and decreased spending on energy. Lower energy costs cause other forms of consumer spending to increase. ENE modeled two scenarios for each fuel: 1) each state acts alone (the "individual" scenario); and 2) all New England states implement the program at once (the "simultaneous" scenario). For the purpose of estimating macroeconomic impacts of the PACE/PowerSaver and RDI programs, results from the individual scenario were used. It should be noted that the "simultaneous" scenario would result in slightly higher macroeconomic impacts than those presented in this report.

ENE developed multipliers for electricity, natural gas, and unregulated fuels such as fuel oil and propane. These multipliers were prorated for each program using MMBTU savings per fuel type.

Job-years created per million in spending in 2008 dollars were converted to job-years per million in spending in 2012 dollars, using a 2% yearly inflation rate. Because of inflation, spending in 2012 dollars results in a lesser economic impact.

5.2 FY2012 PACE/PowerSaver Cost-Effectiveness Results

The cost-effectiveness analysis for the PACE/PowerSaver Program is based on 188 projects completed in FY2012. We found that the program in FY2012 was cost-effective for all three tests: the TRC, the PACT, and the PCT. All tests show a positive net present value and a cost-benefit ratio that exceeds 1.0.

Table 5-1 summarizes the cost-effectiveness results for the PACE/PowerSaver Program.

Table 5-1. Summary of Cost-Effectiveness for the PACE/PowerSaver Program

	TRC	PACT	PCT
PV of costs ($)	(3,556,181)	(1,194,352)	(2,361,830)
PV of savings ($)	5,736,245	5,736,245	5,353,009
NPV ($)	2,180,064	4,541,893	2,991,179
Cost/benefit ratio	1.61	4.80	2.27

[33] Environment Northeast. 2009. Energy Efficiency: Engine of Economic Growth - A Macroeconomic Modeling Assessment.

Comparison to Results Presented in the Annual Report

Prior to our analysis, Efficiency Maine had calculated the TRC for the PACE/PowerSaver Program in support of their FY2012 Annual Report. Based on our review of the inputs and the cost-effectiveness model itself, we made the following adjustments to Efficiency Maine's assumptions and calculations for FY2012 to arrive at our results:

- **Step 1:** We replaced program reported gross energy savings used by Efficiency Maine with verified gross savings for FY2012, based on the PACE/PowerSaver impact evaluation presented in this report. Since verified gross savings were lower than program reported savings, this resulted in a lower TRC.

- **Step 2:** We expanded the measure categories from two generic measures ("Oil Weatherization" and "Natural Gas Weatherization") used by Efficiency Maine in the initial model to a series of measures covering different combinations of end-uses, energy sources, and estimated useful lives.[34] Substituting more differentiated measure categories for the two generic measures allowed us to better calculate avoided costs. This resulted in a higher TRC.

- **Step 3:** We changed how early retirement of space heating equipment is accounted for in the model. The original model used by Efficiency Maine calculated savings and costs as if the new equipment was an "early replacement" over its entire useful life. This approach does not take into account that the existing furnaces and boilers would have been replaced at some point even without the program because they would eventually have failed. In the revised model, we assume that without the program, replacement would have occurred, on average, after five years.[35,36] This change also increased the TRC ratio.

- **Step 4:** We accounted for the cost of lending and for program evaluation costs in program administration costs. Efficiency Maine provides PACE/PowerSaver loans at a 4.99% interest rate, but receives 3% interest revenue, with the difference covering loan administration costs incurred by the loan administrator. Thus, while the program receives interest revenue, there is also an economic cost as this 3% rate is less than the discount rate of 4.51%. We estimated this cost to be $259,000 and added it to program administration costs. We also accounted for FY2012 program evaluation costs. These changes reduced the TRC ratio.

- **Step 5:** We applied the net-to-gross ratio of 1.072, as estimated in the net impact evaluation, to account for free ridership and spillover. This change increased savings and the TRC ratio.

[34] Because of the large number of end-use/energy source/EUL combinations, we merged some combinations with low savings to limit the number of model entries to a manageable level. For these, we used weighted averages of EUL. The final model is using 14 combinations of energy sources and estimated useful life.

[35] We also assumed that fuel switching would have occurred anyway after five years and made similar adjustments to savings and costs.

[36] The same change should be made to water heaters. However, because the RHA database does not include the Efficiency Factor of the existing equipment (unlike the AFUE for space heating equipment), savings could not be adjusted. Given the result of this adjustment for the space heating equipment, it is likely that the cost-effectiveness ratios would have increased slightly had the same logic been applied to water heaters. Water heaters represent approximately 30% of savings for boilers and furnaces.

Table 5-2. Results of FY2012 TRC Test for the PACE/PowerSaver Program

	TRC	Change
Ratio reported in FY2012 Annual Report	1.86	--
Step 1: Use verified savings from the evaluation	1.39	- 0.47
Step 2: Expand measure categories	1.53	+ 0.14
Step 3: Revise accounting of early retirement of space heating equipment	1.79	+ 0.26
Step 4: Add real economic cost of lending money Add evaluation cost	1.57	- 0.22
Step 5: Apply net-to-gross ratio	1.61	+ 0.04

Macroeconomic Impacts

Total PACE/PowerSaver FY2012 program spending of $3.4 million (excluding adjustments for early retirement, economic cost of lending, and evaluation costs) resulted in an estimated $15.6 million increase in Gross State Product and the creation of 238 job-years.

5.3 FY2012 RDI Cost-Effectiveness Results

Our analysis of the RDI Program for FY2012 found that the program is cost-effective for all three tests, 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 well exceeds 1.0. Because the RDI Program launched in late April 2012, this analysis is based on only 47 projects that were completed between April and June 30, 2012.

Table 5-3 summarizes the cost-effectiveness results for the RDI Program.

Table 5-3. Summary of Cost-Effectiveness for the RDI Program

	TRC	PACT	PCT
PV of costs ($)	(90,816)	(66,947)	(37,969)
PV of savings ($)	239,621	239,621	252,714
NPV ($)	148,805	172,674	214,745
Cost/benefit ratio	2.64	3.58	6.66

Comparison to Results Presented in the Annual Report

Prior to our analysis, Efficiency Maine had calculated the TRC for the RDI Program in support of their FY2012 Annual Report. Based on our review of the inputs and the cost-effectiveness model itself, we made the following adjustments to Efficiency Maine's TRC calculations:

- Step 1: We replaced energy savings generated by Efficiency Maine with verified gross savings for FY2012, based on the RDI impact evaluation presented in this report. Our analysis found RDI savings to be higher than reported in the Efficiency Maine model, leading to a higher ratio for the TRC.

- Step 2: We expanded the measure categories from two generic measures ("Oil Weatherization" and "Natural Gas Weatherization") in the initial model to a series of measures covering all combinations of end-use, energy source, and estimated useful life.[37] Substituting actual measure categories for the two generic measures allowed us to better calculate avoided costs, resulting in higher avoided costs and a higher TRC ratio. This change in measure categories also increased the useful life for most measures from 20 years (the average used in the initial model for the whole RDI program) to 25 years (based on program assumptions), increasing benefits and benefit-cost ratios by adding five years of savings to the energy benefits calculations.

Table 5-4 summarizes the effects of these adjustments on the TRC ratio reported in the FY2012 Annual Report.

Table 5-4. Comparison of RDI TRC Results to Results in the FY2012 Annual Report

	TRC	Change
Ratio reported in FY2012 Annual Report	1.76	--
Step 1: Use verified savings from the evaluation	2.43	+ 0.67
Step 2: Expand measure categories	2.64	+ 0.21

Macroeconomic Impacts

Total RDI FY2012 program spending of $90,816 resulted in an estimated $418,978 increase in Gross State Product, as well as the creation of 5.9 job-years.

[37] Expanding the number of measures resulted in the addition of two new fuel types for which no avoided costs were available in either the model or from Efficiency Maine (coal and wood pellets). For these two fuel types, avoided costs were approximated using natural gas (for coal) and seasoned wood (for wood pellets). These fuel types represent 7% of energy savings from the RDI Program.

6. FINDINGS AND RECOMMENDATIONS

6.1 PACE / POWERSAVER PROGRAM

Gross Impacts

Verified first-year, annual gross savings for the PACE/PowerSaver Program through September 2012 are 16,332 MMBTU, or an average of 57.5 MMBTU for each of the 284 projects completed during this time period.[38] On average, these savings represent 28.6% of pre-project whole-house energy usage.

We based the verified gross savings estimate on savings reported for 239 projects in the RHA database but applied the following adjustments:

- QA-Inspection Factor ($Factor_{Insp}$) = 0.68. This factor accounts for the fact that not all recommended measures in RHA were installed. It reflects the percentage of savings of recommended measures in RHA that CSG verified in their QA inspections.
- Additional AFC First Project Factor ($Factor_{AddAFC}$) = 1.13. This factor accounts for measures that are documented in the AFC First database but that are not included in the RHA database.
- Eligibility Factor ($Factor_{Elig}$) = 0.98. This factor accounts for measures that do not meet the program's efficiency standards.
- Non-RHA Projects ($Factor_{NonRHA}$) = 1.19. This factor is used to extrapolate results for the RHA-modeled projects to the full population of projects.

The overall realization rates for PACE/PowerSaver gross savings are as follows:

- Program Realization Rate = 0.90 (or 0.68 * 1.13 * 0.98 * 1.19). This means that verified gross savings for the 284 projects completed are 90% of the total savings reported in the RHA database.
- RHA Project Realization Rate = 0.75 (or 0.68 * 1.13 * 0.98). This means that verified gross savings for the 239 projects modeled in RHA are 75% of the total savings for those projects reported in the RHA database.

<u>Recommendations</u>

We recommend the following:

- **Change program tracking procedures.** Current program tracking practices presented challenges in the assessment of program gross impacts. Implementing a few key changes to program tracking procedures (outlined below) would obviate the need for several of the analysis steps that were required for this gross impact assessment.

[38] 57.5 MMBTU are equivalent to 417 gallons of heating oil.

- **Check measure eligibility based on efficiency levels.** AFC First should require that performance values are entered in the database for all measures for which efficiency standards exist. In the database through September 2012, performance data was missing for 38% of installed measures (80 out of 213) in the end-use categories for which we assessed eligibility (central air conditioning systems, heat pumps, boilers, furnaces, water heaters, and windows). These performance values should be checked against the efficiency standards, and measures that do not meet the standards should not be accepted as part of the project financed with the loan.

Net Impacts

The net-to-gross ratio for the PACE/PowerSaver Program through September 2012 is estimated to be 1.07. This includes free-ridership of 0.08 and partial participant spillover of 0.16. Applying the net-to-gross ratio to verified gross program savings of 16,332 MMBTU yields annual program-level net impacts of approximately 17,500 MMBTU, or 61.7 MMBTU per project for the 284 projects completed during the study period.

Cost-Effectiveness Analysis and Macroeconomic Effects

Our analysis of the PACE/PowerSaver Program for FY2012 found that the program is cost-effective for all three tests we conducted, 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 well exceeds 1.0. Estimated benefit-cost ratios for the program are:

- TRC = 1.61
- PACT = 4.80
- PCT = 2.27

Total PACE/PowerSaver FY2012 program spending of $3.4 million (excluding adjustments for early retirement, economic cost of lending, and evaluation costs) resulted in an estimated $15.6 million increase in Gross State Product and the creation of 238 job-years.

Databases

Review of the two databases that are maintained for the PACE/PowerSaver Program – the AFC First database and CSG's RHA database – revealed significant differences with respect to the documented measures. The noted differences between the RHA documented *recommended* measures and the AFC First documented *installed* measures presents a challenge. Specifically, if the measures installed differ from the recommended measures modeled in RHA, then the determination that the project meets the program savings requirements (based on the RHA estimated savings) might no longer be valid.

We identified a few aspects of the program data flow process that seem to have contributed to these database issues:

- The information about PACE/PowerSaver projects transmitted by CSG to AFC First does not include information from the RHA database on: total project savings; savings by measure; whole-house energy usage; or heating/hot water energy usage.

- AFC First uses information from Specification Sheets as the basis for their database. There is no reconciliation between the list of measures modeled in RHA and the measures documented on the Specification Sheets and entered into the AFC First database.

- There is no feedback loop to CSG, i.e., CSG does not update the RHA database with the final list of installed measures.

Recommendations

We identified several key opportunities to improve the program tracking database(s) used for the PACE/PowerSaver loan programs. These improvements would help ensure that the program has access to a database that 1) accurately reflects the measures installed through the program as well as their savings and 2) accurately documents that projects meet savings thresholds. Efficiency Maine should consider putting the following improvements into place:

- **Expand information on the "HESP Review for PACE Projects" form.** The program should modify the "HESP Review for PACE Projects" form, which is populated by CSG based on data in the RHA database, to include: 1) total project savings, 2) savings by measure, 3) whole-house energy usage, and 4) heating/hot water energy usage. This would allow AFC First (who receives these forms as part of the loan approval process) to re-calculate the projected savings percentages if certain recommended measures are not ultimately installed. AFC First can then identify projects that do not meet the program-required savings thresholds and request that modifications be made to the proposed improvements to meet the thresholds. This additional detail on the form would not address the need to re-calculate savings if non-recommended measures are added; however, this could be done by using the average savings values for the various measure categories developed for the gross impact analysis presented in this report.

- **Enter RHA savings estimates into the AFC First database.** If measure-level savings estimates are provided by CSG to AFC First, these should be added into the AFC First database. These could be project-specific modeled savings by measure or average estimates for the measure type, e.g., for projects not modeled in RHA.

- **Enter all improvements into the AFC First database.** The program should require all improvements (measures) listed on Specification Sheet(s) for each project to be entered in the AFC First database. In parallel, at post-project inspections, PEAs should fill out a checklist, which lists all types of measures, to document measures actually installed. The post-project verified measures should be transmitted to AFC First so that they can compare it to the measures listed on the Specification Sheet(s). This would serve as a final verification of the measures actually installed as a result of the PACE/PowerSaver energy audit.

6.2 RESIDENTIAL DIRECT INSTALL PROGRAM

Gross Impacts

Estimated first-year, annual gross savings for the RDI Program through November 2012 are 7,366 MMBTU, or an average of 9.77 MMBTU per project for the 754 projects completed during this time

period.[39] This includes 6,800 MMBTU in savings (92%) from airsealing (or 9.02 MMBTU per project) and 565 MMBTU in savings from other RDI measures (or 0.75 MMBTU per project).

Cost-Effectiveness Analysis and Macroeconomic Effects

Our analysis of the RDI Program for FY2012 found that the program is cost-effective for all three tests we conducted, 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 well exceeds 1.0. Estimated benefit-cost ratios for RDI are:

- TRC = 2.64
- PACT = 3.58
- PCT = 6.66

Total RDI FY2012 program spending of $90,816 resulted in an estimated $418,978 increase in Gross State Product, as well as the creation of 5.9 job-years.

Database

We found the RDI database to be very comprehensive and well populated. A few minor recommendations are provided below.

Recommendations

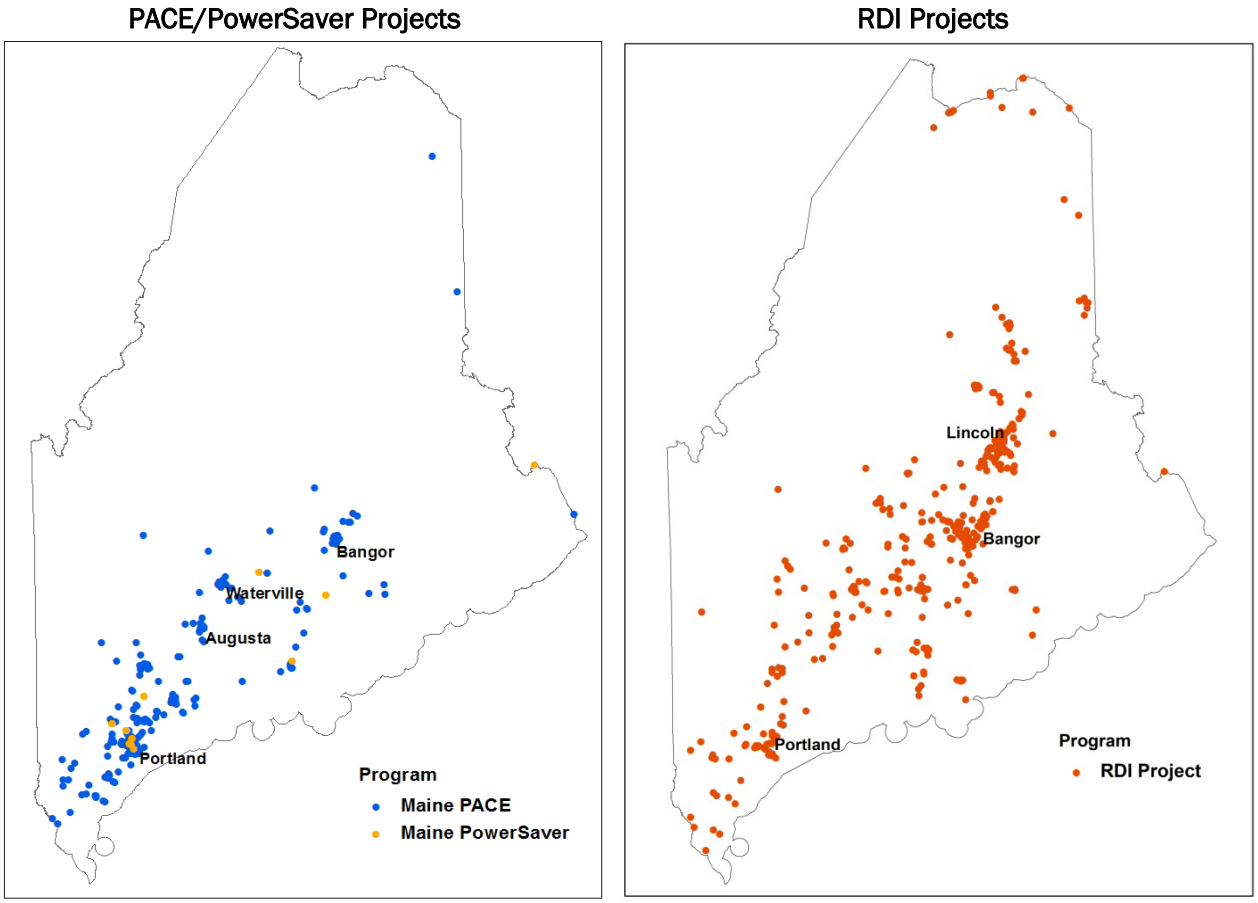
- **Mark as required all fields for which information should be provided.** While key fields are already well populated, clearly marking each field for which information is required might make completing the survey clearer for Energy Advisors. Such fields should include, at a minimum, data needed to assess impacts, including questions about fuel type, whether a secondary fuel is used, the pre and post CFM50 results, and the types of improvements made.
- **Include "None" or "n/a" response categories for certain questions.** Being able to distinguish between "none," "not applicable," and a missing response can be important. While some questions already include these categories, others that might benefit from such categories do not. For example, for insulation questions, only the question about basement insulation includes a "none" category for the R value, the question about attic insulation does not. For basement insulation, the respondent has to select an insulation type, even when the response is "none," which might lead to confusion or non-responses. Other questions that might benefit from a "none" or "n/a" category include the energy model used and subsequent questions about model results.

[39] 9.8 MMBTU are equivalent to 71 gallons of heating oil.

APPENDIX A: COMPARISON OF PACE / POWERSAVER AND RDI

Figure A-1 compares the geographic distribution of PACE/PowerSaver projects and RDI projects. While participants of both programs reside throughout the state, PACE and PowerSaver participants are more often located in the southern portion of the state, near Portland, while RDI participants are more frequently clustered around Bangor. This difference is largely due to one RDI contractor in the Bangor region, who accounted for 59% of all RDI projects.

Figure A-1. Geographic Distribution of PACE/PowerSaver and RDI Projects

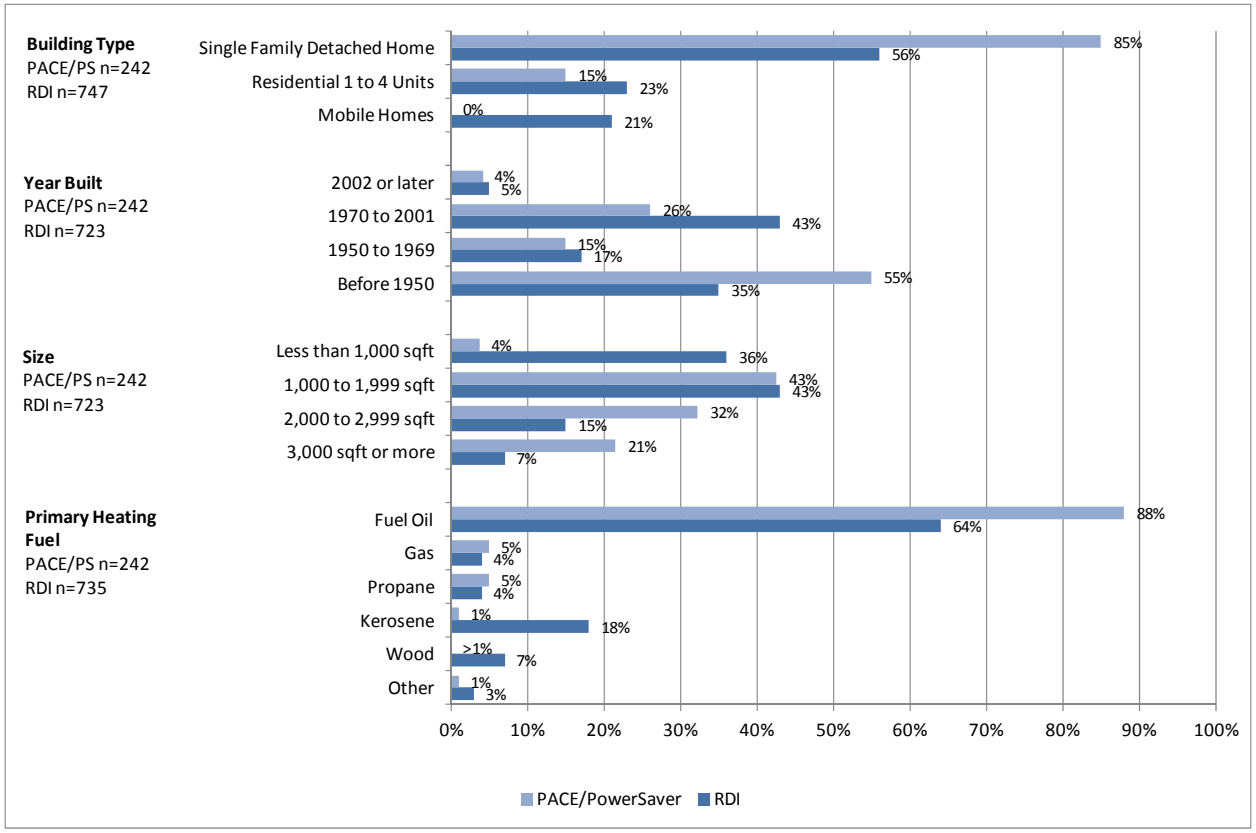


Source: AFC First Tracking Data (as of September 30th, 2012), RDI Tracking Data (as of December 3rd, 2012)

Building characteristics of participants in the PACE/PowerSaver and the RDI programs differ considerably. PACE/PowerSaver participants tend to live in older homes: more than half (55%) of their homes were built before 1950, compared to only 35% of RDI participants. Detached single-family homes account for the vast majority (85%) of PACE/PowerSaver participants compared to 56% of RDI participants. While the largest share of both groups use oil as their primary heating fuel, it is significantly more frequently used by PACE/PowerSaver participants (88%) than RDI participants (64%), who are more likely to use kerosene as the primary fuel (18%) compared to PACE/PowerSaver

participants (1%). Significantly larger shares of PACE/PowerSaver than RDI participants use propane and pellet wood.

Figure A-2. Building Characteristics of PACE/PowerSaver and RDI Participants



Source: CSG Tracking Data (as of October 4th, 2012), RDI Tracking Data (as of December 3rd, 2012)

APPENDIX B: SUPPORTING INFORMATION FOR PACE/POWERSAVER GROSS IMPACT ANALYSIS

This appendix provides additional information used in or developed for the gross impact analysis of the PACE/PowerSaver Program.

Program Eligibility Criteria Based on Energy Star Efficiency Levels

Table B-1 summarizes the efficiency levels used to assess measure eligibility for the PACE/PowerSaver Program.

In some cases, the efficiency level required for an Energy Star rating depends on the specific type of measure installed, e.g., the HSPF standard is 8.2 for split air source heat pumps and 8.0 for packaged air source heat pumps. If information on the specific type of installed equipment was not available from the AFC First database, we applied the lower standard, i.e., an HSPF of 8.0 in the case of heat pumps. In addition, if the AFC First database did not list a performance value, we assumed that the installation met eligibility criteria.

Table B-1. Eligibility Criteria Based on Energy Star Efficiency Levels

Improvement	Performance Measure	Efficiency Level for Energy Star
Central Air System	SEER	≥14.5 SEER/ ≥11 EER
Heat Pump	HSPF, SEER	≥8.0 HSPF/ ≥14 SEER/ ≥11 EER
Boiler (Gas, Oil, Other)	AFUE	≥ 85%
Gas Furnace	AFUE	≥ 95%
Furnace (Oil, Other)	AFUE	≥ 85%
Water Heater (Gas)	EF	EF ≥ 0.67
Water Heater (Electric, Heat Pump)	EF	EF ≥ 2.0
Windows	U-value	≤ 0.3

Source: Energy Star Program (http://www.energystar.gov)

Estimating Average Savings for "Other" Measures

For measures categorized as "Other" or "Other (Whole House Recommendation)" in the AFC First database no comparable average RHA savings value exists. We conducted a separate analysis for these measures to 1) identify what measures are included in these two categories, 2) assign a savings estimate to them, and 3) calculate an average savings value for projects with "other" measures. This average savings value was then assigned to all projects with additional "other" measures.

We developed savings for "other" measures based on an analysis of a sample of 46 projects in the AFC First database (separate from the sample of 35 QA inspection projects) that had a total of 85 measures classified as either "Other" or "Other (Whole House Recommendation)." Based on information from the Specification Sheets for these projects, we determined that 61 of the 85 other measures would not result in energy savings. These included measures such as carpentry, siding,

chimney lining or caps, preparation work for insulation, electrical work, or measures related to moisture containment or ventilation. Of the 24 remaining "other" measures that would generate energy savings, we found that most (16) should have been classified under one of the existing measure categories in the AFC First database; the other 8 measures did not fit into one of the existing categories and included wood stoves (5 projects), lighting (2 projects), and boiler reset controls (1 project).

To determine average savings from "other measures," we summed estimated per project savings for the 24 "other" measures (based on average savings data from RHA on the relevant measures) and divided this value by the number of projects examined (46), yielding savings of 4.75 MMBTU per project from "other" measures. We developed new average savings estimates (rather than use RHA values) for wood stoves and boiler reset controls. We made the following assumptions:

- **Wood stoves.** In our sample of 46 projects with "Other" or "Other (Whole House Recommendation)" measures, we found five wood stoves. No additional information about these installed wood stoves was available, and we did not find any sources that would provide reasonable estimates of savings to be expected from wood stoves. Absent any information to use as a basis for a savings value, we assumed that wood stoves generate half of the savings of a new efficient boiler.

- **Boiler reset controls.** Based on program information from a utility in the Northeast, a boiler reset control may achieve heating bill savings of up to 10% while a high efficiency natural gas furnace or boiler may achieve savings of up to 30%. We therefore assumed that savings from boiler reset controls would be one-third of savings from a new boiler.

The estimated savings value of 4.75 MMBTU per project for "other" measures represents *all* measures captured as "other" in AFC First's database. However, some of these should have been classified under an existing category. When reclassifying these measures, we found a match for some of them in the RHA database, i.e., they were not truly "additional" AFC First measures as initially classified.

To determine average savings of only those "other" measures that are truly additional in the AFC First database, we re-estimated the per project average of 4.75 MMBTU, this time only including savings from measures that – after reclassification – are not already included in the RHA database. Of the 24 other measures with savings in our sample of 46 projects, 9 measures were already in the RHA database and 15 were not. Total estimated savings for these 15 other measures are 103.5 MMBTU, or 2.3 MMBTU per project. This is the value that we used for any additional measures that the AFC First database classified as "other."

Table B-2 summarizes the findings from the analysis of "other" measures in AFC First's database.

Table B-2. Summary of Analysis of "Other" Measures in AFC First's Database

Measure	Average Savings (MMBTU)	*All "Other" Measures with Savings*		*"Other" Measures not already in RHA*	
		# Measures	Total Savings (MMBTU)	# Measures	Total Savings (MMBTU)
Wood stove	12.19	5	60.9	5	60.9
Water heater	9.08	5	45.4	1	9.1
Ducts	2.21	3	6.6	3	6.6
Doors	1.24	2	2.5	1	1.2
Programmable thermostat	4.54	2	9.1	2	9.1
Lighting	5.01	2	10.0	1	5.0
Insulation	35.16	1	35.2	-	-
Renewable	12.70	1	12.7	-	-
Windows	3.41	1	3.4	1	3.4
Boiler	24.37	1	24.4	-	-
Boiler reset control	8.12	1	8.1	1	8.1
TOTAL		24	218.3	15	103.5
Per project:			*4.75*		*2.25*

Source: Gross Impact Analysis

APPENDIX C: SUPPORTING INFORMATION FOR RDI GROSS IMPACT ANALYSIS

This appendix provides additional information used in or developed for the gross impact analysis of the RDI Program.

Table C-1 presents the hours by temperature bin and region, used in the RDI gross impact analysis for air sealing.

Table C-1. Number of Hours by Temperature Bin for Three Regions

Temp. Bin	Bangor, ME	Caribou, ME	Portland, ME
45 - 50	749	690	910
40 - 45	776	764	604
35 - 40	946	777	853
30 - 35	744	676	828
25 - 30	426	449	551
20 - 25	444	500	514
15 - 20	431	545	431
10 - 15	225	453	212
5 - 10	164	336	136
0 - 5	82	234	56
-5 - 0	70	200	45
-10 - -5	36	165	9
-15 - -10	21	20	1
-20 - -15	2	12	0
-25 - -20	1	6	0
Days included	213.2	242.8	214.6
Months included	7.1	8.1	7.2
Hours Below '0"	130	403	55

Source: National Solar Radiation Data Base, 1991 – 2005 Update: Typical Meteorological Year 3

Table C-2 presents system efficiencies and heat content, by fuel type, used in the RDI gross impact analysis for air sealing. Values for heat content are based on program assumptions, while values for system efficiencies are based on EIA estimates.

Table C-2. System Efficiency and Heat Content by Fuel Type

Fuel Type	Heat Content (BTU) by Heating Fuel Type	Fuel Unit	System Efficiency	Efficiency Unit
Coal	250,000	ton/100	0.75	n/a
Electric	3,412	kWh	1.00	n/a
Electric Heat Pump	3,412	kWh	2.23	HSPF
Fuel Oil	138,000	gallons	0.84	AFUE
Kerosene	138,000	gallons	0.80	n/a
Natural Gas	100,000	therms	0.84	AFUE
Pellets	8,000	pound	0.68	n/a
Propane / LPG	95,000	gallons	0.84	AFUE
Wood	200,000	cord/100	0.55	n/a

Source: Heat content from EMT program assumptions; system efficiencies from EIA Heating Fuel Comparison Calculator (version HEAT-CALC-Vsn-D_1-09.xls; www.eia.gov/neic/experts/heatcalc.xls)