Progress Energy

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Clerk's Office
N.C. Utilities Commission

May 3, 2011

Ms. Renee Vance
Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, North Carolina 27699-4325

RE: Docket No. E-2, Sub 936

Dear Ms. Vance:

Pursuant to the Commission's April 30, 2009 order issued in Docket No. E-2, Sub 936, Progress Energy Carolinas, Inc. submits the attached report summarizing the results of the 2009 Program Year measurement & verification (M&V) efforts for its Home Energy Improvement Program.

Very truly yours,

Len S. Anthony
General Counsel
Progress Energy Carolinas, Inc.

LSA:mhm

Attachment

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Progress Energy Service Company, LLC
P.O. Box 1551
Raleigh, NC 27602

NAVIGANT

2009 EM&V Report for the Home Energy Improvement Program

Final Report

Presented to

Progress Energy Carolinas

Prepared by

Navigant Consulting
with The Cadmus Group

April 11, 2011

Prepared for:

Progress Energy Carolinas
Raleigh, North Carolina

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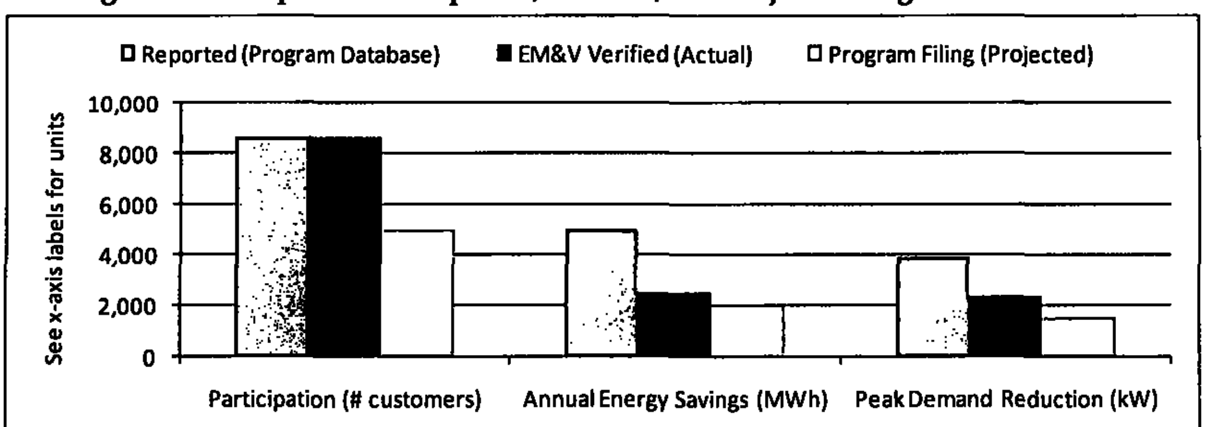
Section 1. Executive Summary

The Home Energy Improvement Program (HEIP) is part of the portfolio of energy efficiency programs initiated by Progress Energy Carolinas (PEC) beginning in late 2008. HEIP provides rebates for the retrofit and maintenance of equipment in existing homes, while other PEC offerings address efficiency opportunities in new homes and commercial buildings. This report covers evaluation, measurement, and verification (EM&V) activities for HEIP for Program Year 2009 (PY2009) projects, defined as those receiving rebates during the 2009 calendar year. The primary purpose of the EM&V assessment was to estimate **gross annual energy and peak demand impacts** associated with 2009 HEIP activity. Secondary objectives included:

- Estimating gross impacts by measure
- Providing updated unit savings values for each measure.
- Evaluating the strengths and weaknesses of current program processes and customer perceptions of the program offering and delivery
- Recommending improvements to program rules and processes that support greater savings, enhanced cost-effectiveness, and improved customer satisfaction.

Savings verified through the EM&V assessment are roughly half of the reported energy savings and nearly two-thirds of the reported demand reductions. Program performance exceeded expectations in this first full year of program operation, with verified gross savings more than 25% greater than projected in the program filing (Figure 1-1). This strong performance was due primarily to higher-than-forecasted participation, which was driven by an effective campaign to recruit participating contractors who attracted customers to the program.

Figure 1-1: Comparison of Reported, Verified, and Projected Program Performance



Sources: Navigant analysis, HEIP tracking database, and HEIP filings with the North Carolina Utilities Commission, Docket No. E-2, Sub 936, February 24, 2009 and with the Public Service Commission of South Carolina, Docket 2009-190-E, May 11, 2009. Savings are gross values that do not account for free ridership or spillover. Projected gross savings were calculated from net savings values in the program filings using PEC's assumed net-to-gross ratio of 0.80.

1.1 *Program Summary*

The HEIP generates energy and peak demand reductions by offering rebates for the following residential measures, focused on heating and air conditioning savings:

1. HVAC Equipment Replacement (central AC, air-source and geothermal heat pumps)
2. HVAC Level 1 Tune-up (condenser coil cleaning and general maintenance)
3. Duct Sealing
4. Window Replacement
5. Attic Insulation

PEC maintains a program tracking database that identifies key characteristics of each project, including participant data, measures installed, and estimated energy and peak demand reductions[1] based on assumed ("deemed") savings values. Reported savings from PY2009 measures was approximately 5.0 GWh and 3.9 MW. The level 1 HVAC tune-up measure was the largest contributor to reported savings in 2009, making up ~40% of the total, followed by heat pump replacements, window replacements, and duct sealing. The share of peak demand reductions by measure was roughly the same as it was for total energy savings.

1.2 *Evaluation Methodology*

The EM&V assessment of 2009 program activity included impact and process evaluations. The *impact evaluation* included an on-site verification sample of measure quantity, size, and efficiency and a calculation of updated unit savings values. The onsite sample was stratified by measure and region, with the objective of getting a significant verification sample for each measure, spread across all regions, and 90/10 confidence and precision at the program level. **Field verification rates** were derived by taking the ratio of savings using the site-verified measure quantity, size and efficiency to the savings using the reported quantity, size, and efficiency.

The evaluation team also developed updated **measure unit savings** values from building energy simulation models, calibrated to energy consumption derived from HEIP participant billing data. New savings values were assigned to each measure installation in the tracking data based on efficiency level, region, and heating type. For each measure a **unit savings adjustment factor** was calculated reflecting the ratio of updated unit savings values to deemed savings values used in the program tracking database. The **gross realization rates** for each measure

[1] "Peak demand reductions" are defined as the reduction in peak power demand that is coincident with the utility system peak, which is synonymous with summer peak demand reductions in PEC's service territory.

were then calculated as the product of the **field verification rate** and the **unit savings adjustment factor**. The gross realization rate represents the percentage of reported savings verified through the EM&V activities, and was used to calculate **verified gross savings**.

The *process evaluation* used interviews of program staff, surveys of prequalified contractors and surveys of program participants to determine how well the program is working.

1.3 *Program Impact Findings: Verified Gross Energy and Peak Demand Reductions*

PEC's program tracking database provided savings values for energy and peak demand based on program participation data and assumed unit savings, or **"deemed savings"**, values. The EM&V team verified the accuracy of these reported savings values for each measure category using 1) on-site data collection to conduct field verification of measure installations, and 2) program participant characteristics, billing data, appliance saturation data, and energy simulation modeling to assess the most appropriate unit savings values. The result was a set of **verified gross savings** by measure and for the program as a whole.

The program-level **gross realization rates** for energy and peak demand reductions were 50% and 61%, respectively, resulting in verified gross energy savings of 2,494 MWh and verified gross peak demand reductions of 2.37 MW for the 2009 program year, shown in Table 1-1.[2]

Table 1-1: 2009 Gross Realization Rates and Verified Gross Savings

	Annual Energy Savings (MWh)	Coincident Demand Savings (MW)
Reported Gross Savings	5,017	3.90
Gross Realization Rate	50%	61%
Verified Gross Savings	2,494	2.37

Source: Navigant analysis

[2] HEIP's gross realization rates are not atypical for a first year residential retrofit program, due to the high degree of uncertainty around the initial savings values chosen during program design. The relatively low realization rates are more than offset by higher-than-projected participation, which resulted in realized savings exceeding project savings by more than 50% (see Figure 1-1 above). The high participation reflects a successful first year program rollout and may also be attributable to the temporary availability of federal tax credits and state appliance rebates.

1.3.1 Field Verification Rates

Field verification rates, which measure the degree to which the measures installed at sampled project sites were found to match what was recorded in the program database, are all close to 100%. This suggests that the evaluation team verified nearly all sampled measures as being installed in the expected quantities and with the expected efficiencies and quality of installation. The two measures with field verification rates below 99% were high efficiency windows (for which several sites had lower efficiency windows than reported) and duct sealing (for which several sites failed the field quality check on the work performed). Field verification rates by measure are shown in Table 1-2:

Table 1-2: Field Verification Rates by Measure

Measure	Annual Energy Savings	Peak Demand Reductions[b]
HVAC Level 1Tune-up[a]	100%	98%
Air-Source Heat Pump	99%	100%
Windows	102%	93%
Duct Sealing	92%	95%
Central AC	99%	100%
Insulation	110%	110%
Geothermal Heat Pump[a]	100%	98%
Total[c]	**100%**	**98%**

a. Verification was not performed for level 1 tune-ups, because of the uncertainty associated with attempting to measure the effects of coil cleaning, or for geothermal heat pumps, due to the small number of available sites (25). These measures were assigned the program average field verification rates, 100% and 98% for energy and peak demand, respectively.

b. The energy and peak demand field verification rates can be different because some differences in measure characteristics have a larger or smaller impact at peak times than they do on average.

c. Totals represent the weighted average field verification rates based on the relative energy and peak demand reductions reported in the database.

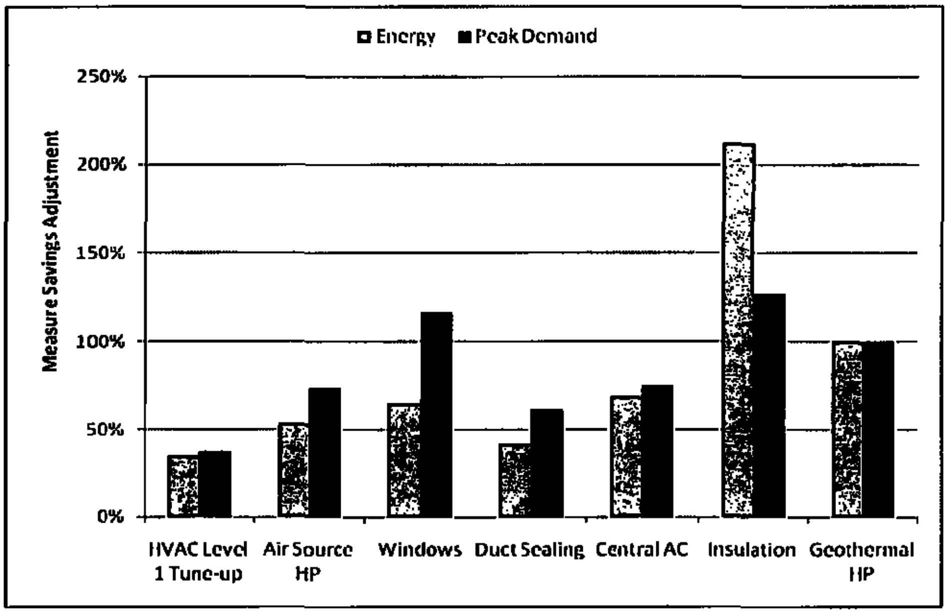
Source: Navigant analysis

The high field verification rates found are excellent for a first year program, which is indicative of HEIP being a well-run program with good quality control.

1.3.2 Measure Unit Savings Adjustment Factors

Updated unit savings values were compared to the original deemed savings values for each measure to derive **measure unit savings adjustment factors,** shown in Figure 1-2 below. Low values (large adjustments) for this parameter generally reflect inaccurate baseline assumptions in the original deemed savings estimates. The measure unit savings adjustments show that the updated unit savings values are lower than the deemed values almost across the board, with the exception of the attic insulation measure and the peak demand value for windows.

Figure 1-2: Measure Unit Savings Adjustment Factors[3]



Source: Navigant analysis

The primary drivers for the changes in unit savings from the deemed values are as follows:

1. **The deemed savings calculations assumed much higher baseline heating and cooling consumption than the billing data of actual participants showed.** Deemed values were based either on the North Carolina Measures Database, which assumed higher baseline consumption than HEIP participants showed, or on similar programs in Florida and California, where HVAC consumption is significantly different.
2. **For some measures, actual installs differed from what was assumed.** For duct sealing, windows, and attic insulation, the actual distributions of installation location, baseline efficiency and measure details were different from what was used in the deemed savings calculation.
3. **Level 1 HVAC tune-ups appeared to claim a higher percentage savings than what has been found in past studies of the measure.**[4]

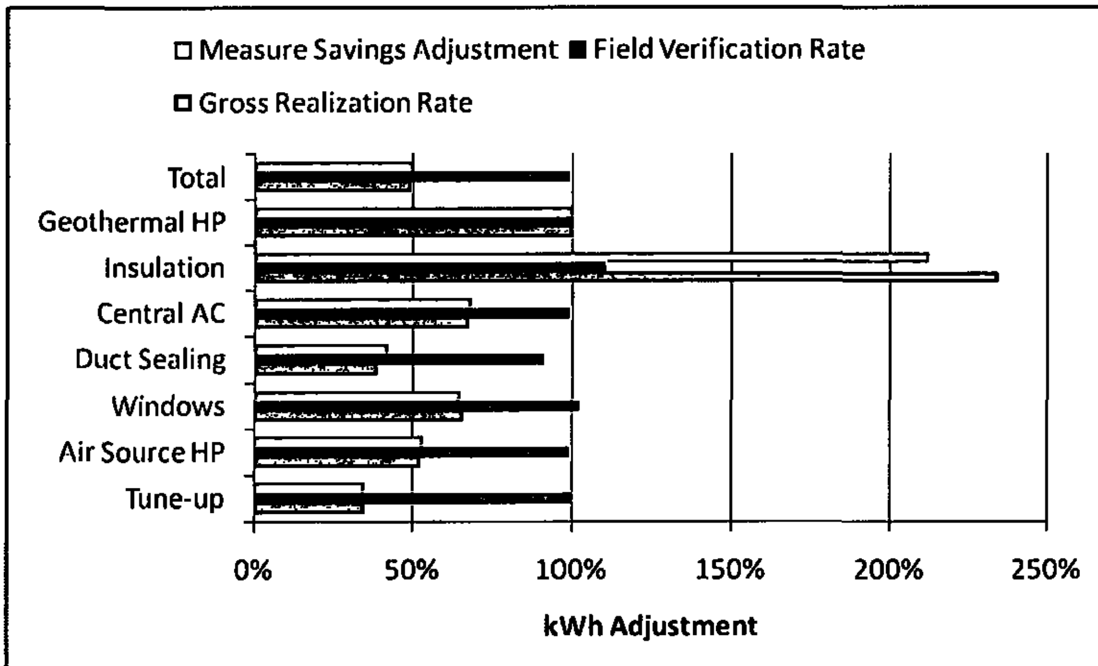
[3] Geothermal heat pumps were not modeled (and were thus assigned a measure savings adjustment of 100%) due to the uncertainty in modeling that measure and its relatively minor contribution to reported savings (~1%).

[4] Deemed savings documentation for this measure was minimal, so it was difficult to determine what was assumed.

1.3.3 Gross Realization Rates and Verified Gross Savings

Measure savings adjustments were multiplied by the corresponding field verification rate to derive the gross realization rate for each measure, shown in Figure 1-3 below. The measure savings adjustments drove the gross energy realization rates in all cases, showing that the program's low gross realization rates were not a result of poor implementation but rather of overly optimistic deemed savings values.

Figure 1-3: Energy Savings Adjustment Factors by Measure[5]



Source: Navigant analysis

The distribution of peak demand reductions adjustments is similar to those for energy savings. As with the energy savings adjustments, low measure savings adjustments drove the low gross realization rates for peak demand reductions. Overall, however, the realization rates for gross peak demand reductions (61% program-wide) are higher than for energy savings (50%).

[5] Because of the low participation and savings associated with geothermal heat pumps in 2009, the impacts of geothermal heat pumps were not explicitly evaluated and savings from that measure were only adjusted by the program average field verification rates.

1.4 Process Findings

The evaluation team found HEIP to be a well-run program, and its 2009 performance exceeded PEC's expectation. Customers were generally quite satisfied with the measures installed, and roughly three-quarters of contractors consider the program to be very important to their business and consider the training provided to be valuable. HEIP also compares well with similar programs across the country, as measured by similarities with a list of "best practices" for residential retrofit programs.

1.5 Recommendations

Overall, the HEIP is running well, with strong participation and good tracking of program activity in 2009, the first year of program operation. The foundation is in place for building on the program's first year performance to achieve increasing savings in future years.

The evaluation team recommends 11 discrete actions for improving the HEIP offering, based on insights gained through staff and contractor interviews, participant and prequalifed contractor surveys, analysis of program records and assumptions, and review of onsite verification data. These recommendations provide PEC with a roadmap to fine-tune HEIP for continued success, and are organized around three broad objectives:

1. improving average savings and increasing program participation,
2. improving program delivery, and
3. enhancing program tracking and evaluation efforts.

Table 1-3 summarizes these program recommendations.

Table 1-3: Summary of Recommendations

Improving Program Cost-Effectiveness	
1. Tighten eligibility requirements for measures that are not meeting average savings expectations.	a. Require electric heating for participation where a measure does not meet cost-effectiveness requirements.
	b. Limit eligibility for duct sealing to systems where at least half of the ducts are located in the attic
	c. Limit window rebates to customers replacing single pane windows, especially in the Western region.
2. Relax restrictions on participation for measures that are meeting savings expectations.	a. Expand eligibility for envelope measures to include customers with electric heat, even absent central cooling.
	b. Expand eligibility for envelope measures, as above, but limit eligibility for customers without central cooling to the Western region.
3. Add program elements and require bundled measures to increase customer and program return on investment.	a. Offer a rebate for HVAC quality installation (verified refrigerant charge and airflow).
	b. Offer a rebate for combining duct sealing and envelope measures with new downsized HVAC equipment.
	c. Offer additional rebate for more air sealing in conjunction with ceiling insulation and air sealing.
Improving Program Delivery	
4. Target underperforming areas of the service territory for additional marketing and/or contractor development.	a. Locate field staff outside of Raleigh area.
	b. Increase marketing to South Carolina.
	c. Target marketing to underperforming rural areas using local newspapers and community outreach.
5. Offer technical training and workshops for contractors, particularly for duct sealing and air sealing.	
6. Offer marketing training for contractors.	
7. Increase marketing in 2011 to fill the void left by the expiration of the ARRA tax credits.	
8. Make revisions to the Save the Watts webpage, such as directing PEC customers directly to the appropriate Progress territory.	
Enhancing Program Tracking and Evaluation Efforts	
9. Revise application forms to specify the type of measure data required to estimate energy savings.	As an example, the windows application should require each window size to be specified separately, with documentation of the total number of each size and the resulting square footage.
10. Modify program processes to integrate data collection activities required for EM&V.	a. Require the "ARI" number of the new equipment combination installed for HVAC system replacements.
	b. Invite participants to complete a customer satisfaction and free ridership survey at, or shortly after, the time of measure installation.
11. Track savings at a finer resolution using multiple, updated deemed savings values on the basis of measure size, quantity, location, or other characteristics that will provide for a more accurate estimate of energy and peak demand reductions.	

Section 2. Introduction

The Home Energy Improvement Program (HEIP) is part of the portfolio of energy efficiency programs initiated by Progress Energy Carolinas (PEC) beginning in late 2008. HEIP provides rebates for the retrofit and maintenance of equipment in existing homes, while other PEC offerings address efficiency opportunities in new homes and commercial buildings. This report covers evaluation, measurement, and verification (EM&V) activities for HEIP for Program Year 2009 (PY2009) projects, defined as those receiving rebates during the 2009 calendar year.[6] The Level II HVAC tune-up measure was not evaluated, because this measure had not been adopted as of the end of 2009 and there were no 2009 savings to evaluate for this measure.

EM&V is a term adopted by PEC and refers generally to the assessment and quantification of the **energy and peak demand impacts** of an energy efficiency program. EM&V uses a variety of analytic approaches including onsite verification of installed measures, analysis of customer billing records, and application of engineering and energy simulation models. EM&V also encompasses an evaluation of program processes and customer feedback, typically conducted through participant surveys. A glossary of evaluation terms is provided in Appendix A.

This report is intended for PEC's internal use to support program improvements as well as to support compliance with the North Carolina Utilities Commission order for "a description of, the results of, and the costs of all measurement and verification activities."[7]

2.1 *Objectives of the Evaluation*

The primary purpose of the EM&V assessment was to estimate **gross annual energy and peak demand impacts** associated with 2009 HEIP activity. Secondary objectives included:

- Estimating gross impacts by measure[8]
- Providing updated unit savings values for each measure.[9]

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[6] Residential new construction measures are addressed under the Home Advantage program, while commercial measures are addressed under the Energy Efficiency for Business program. In 2010, PEC added four new programs including Commercial, Industrial, and Governmental Demand Response, Appliance Recycling, Residential Lighting, and Neighborhood Energy Savings (targeted at low income customers). In addition, several other new programs are currently under consideration.

[7] See R8-69, "Cost recovery for demand-side management and energy efficiency measures of electric public utilities," North Carolina Utilities Commission Order Adopting Final Rules In the Matter of Rulemaking Proceeding to Implement Session Law 2007-397, February 29, 2008.

[8] The EM&V team did not evaluate Level II HVAC tune-up measure because this measure had not been adopted as of the end of 2009 and there were no 2009 savings to evaluate.

- Evaluating the strengths and weaknesses of current program processes and customer perceptions of the program offering and delivery
- Recommending improvements to program rules and processes that support greater savings, enhanced cost-effectiveness, and improved customer satisfaction.

Ultimately, Progress Energy Carolinas can use these results for reporting impacts to the North Carolina Utilities Commission and the Public Service Commission of South Carolina and as an input to system planning. In addition, this report describes strengths and weaknesses of the current program delivery, and recommendations for improving total program impacts. Specifically, this evaluation provides program staff with answers to the following key questions:

1. Which measures are performing the best?
2. Where should additional marketing efforts be focused?
3. What are the strategies available for redesigning measures to increase impacts?

The results of this evaluation should allow PEC staff to improve the design of HEIP to increase benefits delivered while remaining cost-effective, thus providing greater value to ratepayers.

2.2 *Reported Program Participation and Savings*

HEIP generates energy and peak demand reductions by offering rebates for the following residential measures and equipment, focused on heating and air conditioning savings:

1. HVAC Equipment Replacement (central AC, air-source and geothermal heat pumps)
2. HVAC Level 1 Tune-up (condenser coil cleaning and general maintenance)
3. Duct Sealing
4. Window Replacement
5. Attic Insulation

PEC maintains a program tracking database that identifies key characteristics of each project, including participant data, measures installed, and estimated energy and peak demand

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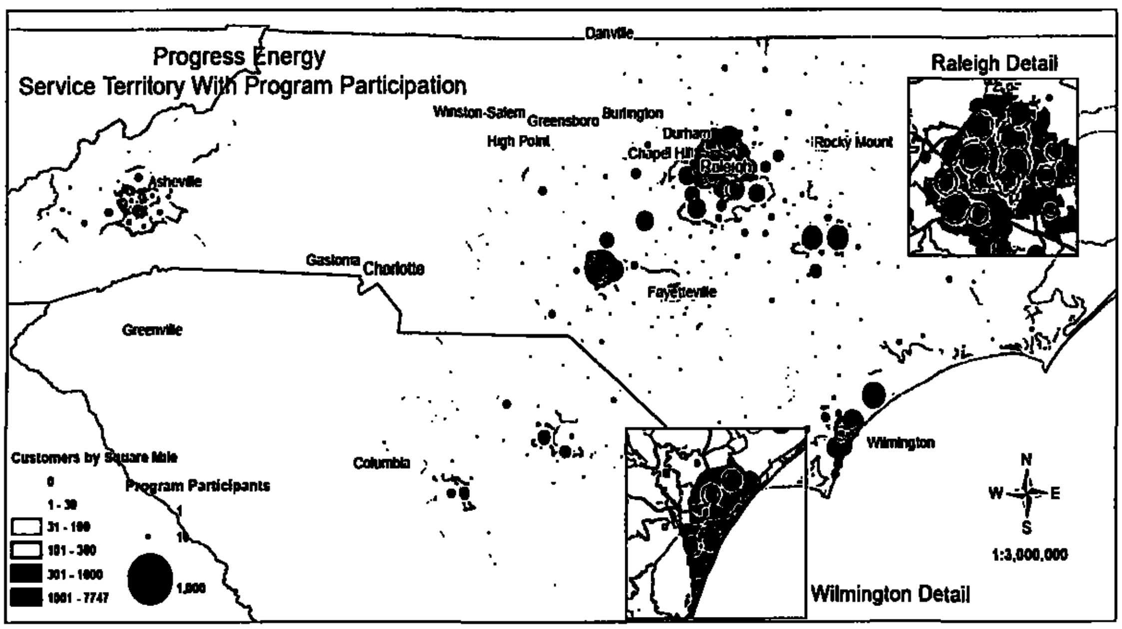
[9] Unit savings values are the savings assigned to each measure. These values may be in terms of kW and kWh per installed measure, or they may be scaled based on the size of the installation (e.g., per square foot of insulation, per ton of cooling capacity of an AC unit, etc.). PEC assumed a set of savings values in support of its original program filing, and the EM&V team assess whether changes in these values were appropriate based on data such as the geographic location of the measures, the energy consumption of the participants, and the characteristics of participant homes,

reductions[10] based on assumed ("deemed") savings values. During 2009, the program had participation across a variety of measures, spanning much of the service territory. The total number of measure installations was highest in the Raleigh area, as shown in Figure 2-1. The size of the solid circles in the figure represents the relative number of program participants by zip code, while the shaded areas represent the relative density of customers, with darker brown higher densities and lighter yellows lower densities. The clusters of participants in the Raleigh and Wilmington areas correspond with higher population densities in those regions. Additional maps of program participation are provided in Appendix C-2.

Figure 2-1: HEIP Measure Installations Map



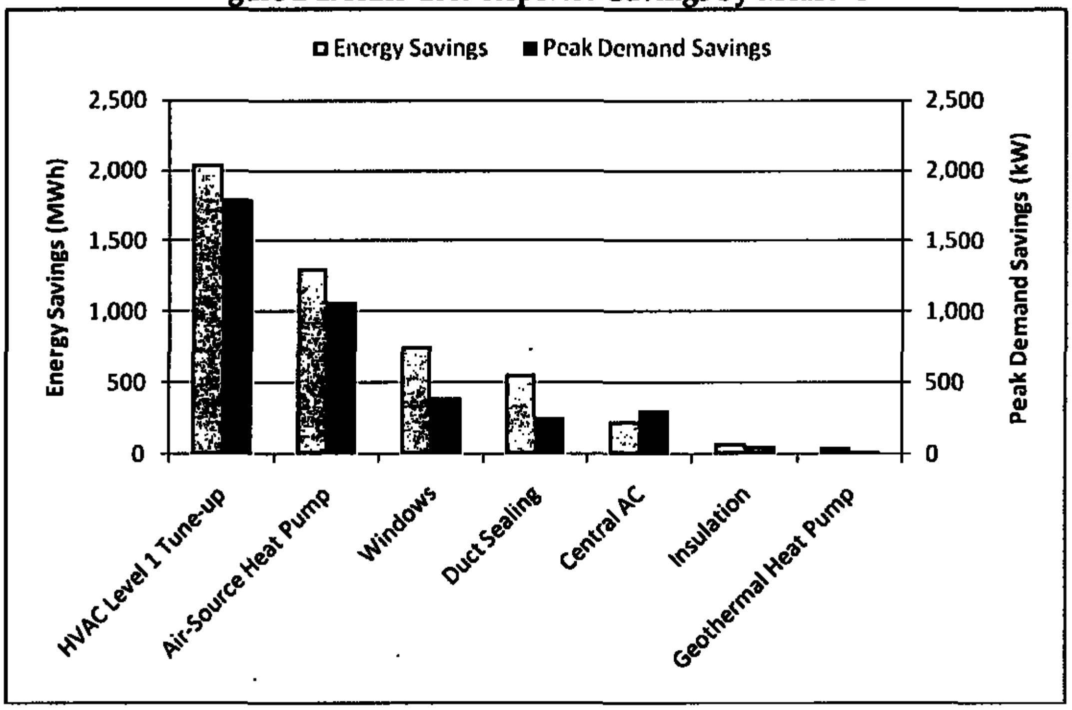
Source: Navigant analysis of HEIP tracking database

Reported savings from PY2009 measures was 5.0 GWh, with a peak demand reduction of 3.9 MW. The level 1 HVAC tune-up measure was the largest contributor to reported savings in 2009, making up approximately 40% of the total, followed by heat pump replacements, window replacements, and duct sealing. There was limited participation in the geothermal heat pump and attic insulation measures. The share of peak demand reductions by measure was roughly

[10] "Peak demand reductions" are defined as the reduction in peak power demand that is coincident with the utility system peak, which is synonymous with summer peak demand reductions in PEC territory.

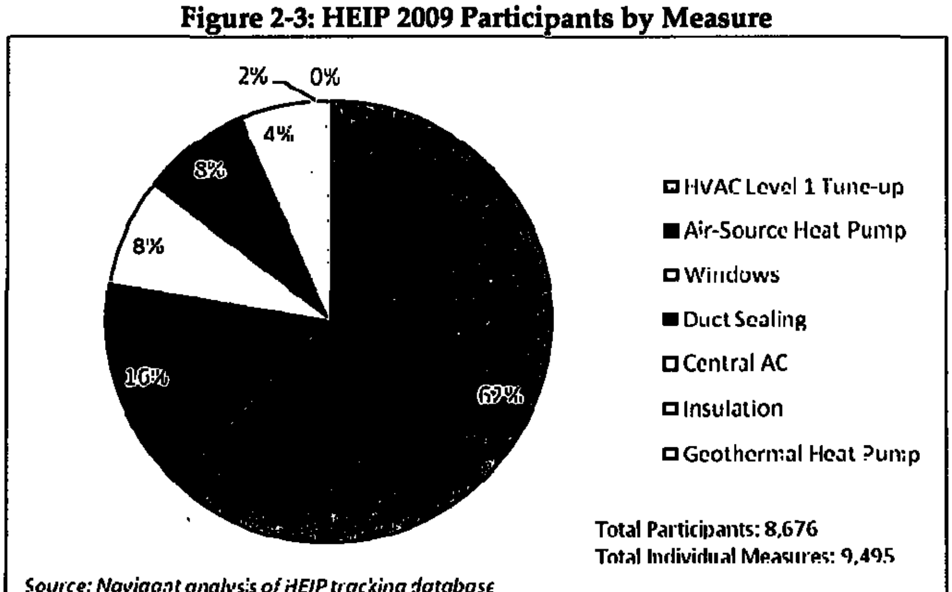
the same as it was for total energy savings. Figure 2-2 below shows reported savings by measures, and Figure 2-3 shows the breakdown of participation by measure.

Figure 2-2: HEIP 2009 Reported Savings by Measure



Source: Navigant analysis of HEIP tracking database

Figure 2-3: HEIP 2009 Participants by Measure



Source: Navigant analysis of HEIP tracking database

Table 2-1 below shows participation and gross savings reported by measure:

Table 2-1: HEIP 2009 Reported Gross Annual Energy and Peak Demand Savings by Measure

Measure	Participants	Annual Energy Savings (MWh)	Fraction of Annual Energy Savings	Coincident Demand Savings (kW)	Fraction of Coincident Demand Savings
Level 1 HVAC Tune-ups	5,210	2,044	41%	1,800	46%
Air Source Heat Pumps	1,769	1,302	26%	1,068	27%
Windows	928	751	15%	387	10%
Duct Sealing	860	561	11%	263	7%
Central AC	514	234	5%	312	8%
Insulation	191	75	1%	52	1%
Geothermal HP	25	50	1%	20	1%
Total	8,676	5,017	100%	3,902	100%

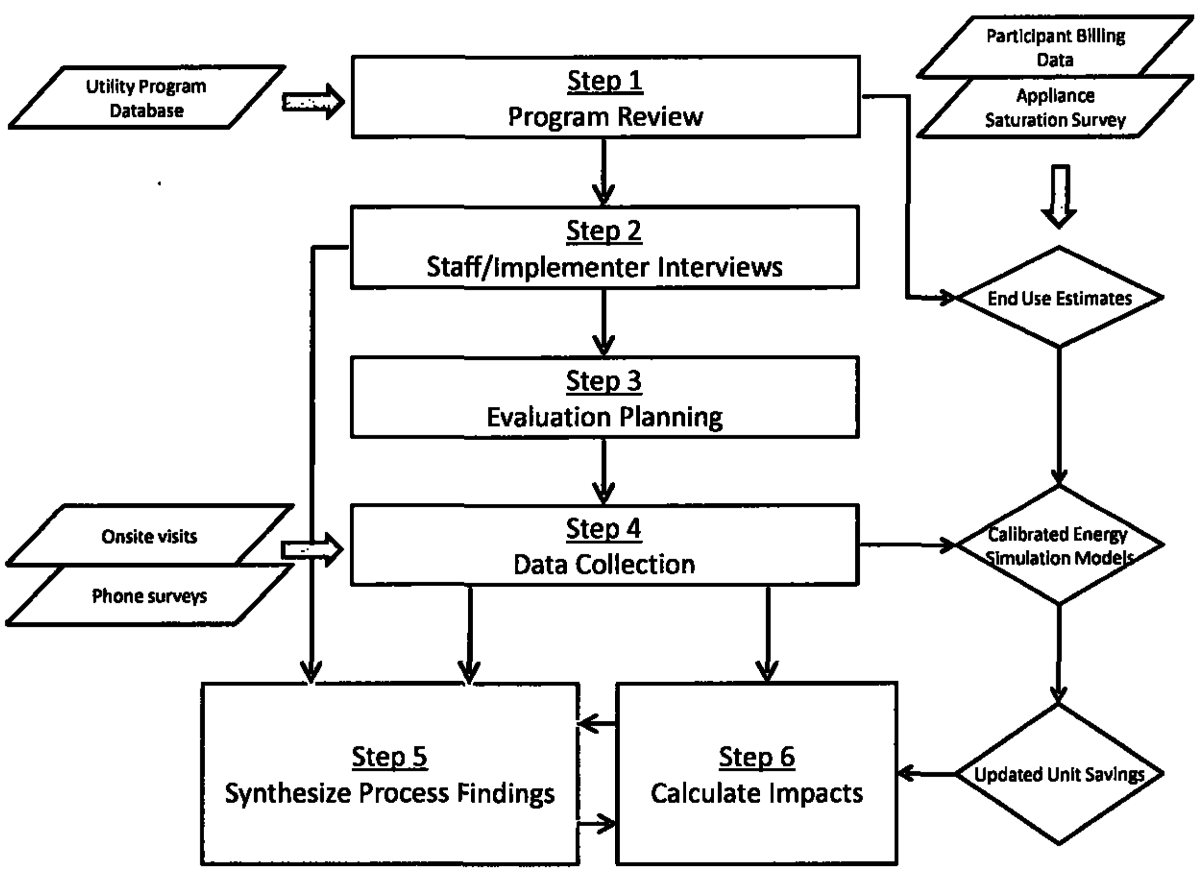
Source: Navigant analysis of HEIP tracking database

Overall, HEIP attracted participation in a broad suite of HVAC and building envelope measures in 2009.

Section 3. Evaluation Methods

The steps used in evaluating HEIP are similar to those used successfully by the EM&V team in evaluating other utility energy efficiency programs. The program database was the starting point for understanding the mix of measures. Details of the evaluation plan and analysis were determined after reviewing program documents and interviewing program and implementer staff. The team collected field data through onsite visits and telephone surveys to verify tracking data and to provide inputs into the energy models which drove the impact analysis. Finally, interview data was synthesized into process recommendations, and total program impacts were calculated using the results of the energy models and the field verification data. This general process is outlined in Figure 3-1.

Figure 3-1: Evaluation Process Flow Diagram



Source: Navigant

3.1 *Step 1: Program Review*

The evaluation began with informal conversations with PEC evaluation and program staff. Program documentation was requested and reviewed, including the following:

- Program tracking database (the Overture database provided to PEC by Paragon Consulting)
- Additional tracking data from Honeywell, PEC's implementation contractor
- Program applications
- Program guidance to contractors
- Spreadsheet documenting sources of deemed savings
- The North Carolina Measures Database
- Program filings with North Carolina Utility Commission

The program review generated a picture of which measures and regions were providing the largest savings, which helped guide the subsequent evaluation research.

3.2 *Step 2: Staff/Implementer Interviews*

The evaluation team conducted interviews with three PEC program staff and one member of the Honeywell contractor team in order to understand how the program was working and what program changes might already have been implemented since the program filing. The following topics were discussed during the interviews:

- How the program was designed to work
- How program data is tracked from the customer installation through to PEC's reporting system
- Data quality control procedures in place to ensure the integrity of application data
- Measures of particular interest to PEC staff
- Measures likely not to be included in future program years

3.3 *Step 3: Evaluation Planning*

The results of the program review and staff interviews were used to develop a detailed action plan that served to direct the evaluation. The evaluation team chose to analyze all measures except for geothermal heat pump installations; this measure was excluded due to its small contribution to program reported savings (~1%) and the high uncertainty associated with modeling it. For each of the selected measures, two major evaluation pathways were pursued:

1. **Field verification rates** were estimated, roughly indicating the share of measure installations verified as appropriately installed and functioning properly in the field, and

2. **Unit savings values** were updated based on secondary literature and on findings from energy models calibrated to the end-use consumption patterns of PEC participants.

In evaluating a first-year program, the effectiveness of data tracking and internal program quality controls are unknown; consequently, as noted above, the evaluation team focused field data collection on verifying measure installations across the different measures and regions.[11] Level II HVAC tune-ups were not evaluated, because this measure had not been adopted as of the end of 2009 and there were no 2009 savings to evaluate for this measure.

Because of the high degree of uncertainty in the deemed savings values, the evaluation team also made it a priority to determine more accurate unit savings by measure. Full on-site monitoring of end-uses, including data logging of HVAC system usage, was outside of the scope and budget of this evaluation, so the evaluation team developed updated unit savings values based on building energy simulation models calibrated to participant billing data (see Step 6: Impact Analysis, below). In future years, it may be desirable to instead use detailed monitoring to focus field efforts on updating unit savings values for certain measures that are identified as the highest contributors to the overall uncertainty of program savings.

3.4 *Step 4: Data Collection*

Data collection was conducted using a combination of telephone surveys and site visits. The **telephone surveys** were designed primarily to support the process evaluation and to inform the free-ridership analysis. However, at the end of the phone surveys, interviewers also recruited customers willing to allow a site visit.

The telephone sample was stratified primarily by measure and secondarily by region to give an accurate representation of measure-level results. As shown in Table 3-1, 138 participating customers responded to the telephone survey and each measure was represented by at least 24 respondents.[12]

[11] The EM&V team used field visits as the primary mode of verification because field verification is more reliable than phone verification, particularly for certain measures for which the customer would not be able to provide confirmation of proper installation and functioning (e.g., duct sealing).

[12] Customers installing geothermal heat pumps were not surveyed because the number of participants (25) and the reported savings were each less than 1% of reported totals.

Table 3-1: Sample Sizes for Participant Telephone Surveys

	# Respondents	# of Participants in 2009[b]
Heat Pump/AC	57	2,283
Level 1 HVAC Tune-up	30	5,210
Duct Sealing	34	860
Windows	24	928
Attic Insulation	24	191
Total[a]	**138**	**8,676**

a. The "total" category is smaller than the sum of participants for each measure because some participants implemented multiple measures. Customers installing geothermal heat pumps were not surveyed because the number of participants (25) and the reported savings were each less than 1% of reported totals for the program.

b. Participants include all those receiving rebates in calendar year 2009.

Source: Navigant

The telephone surveys were also used as a recruitment tool for **on-site verification**. As a result of this recruiting need, more telephone surveys were completed than would have been necessary to achieve 90/10 confidence and precision at the program level (for "yes/no" and similar questions). The onsite sample was stratified by measure and region, with the objective of getting a significant verification sample for each measure, spread across all regions, and 90/10 confidence and precision at the program level.[13]

In addition, the Western region was oversampled in order to get a significant sample of sites for the verification of Western-region peak demand reductions. The evaluation team concluded that on-site verification of level 1 HVAC tune-ups would be unreliable and potentially misleading without conducting expensive and difficult-to-achieve pre-post measurement of equipment performance; thus, the level 1 tune-up measure was not included in the on-site verification sample. The on-site verification sample is shown in Table 3-2. There were at least nine sites visited for each of the four measures being verified.

[13] Actual precision could not be determined with certainty until after the verification data were collected since the variability of the data are a significant determinant of the level of precision. In the end, the sample size was sufficient for a relative precision of +/- 6% for energy savings and +/- 7% for demand reductions at a 90% level of confidence (see Appendix F).

Table 3-2: On-site verification sample

	# Measures	# of Participants in 2009[b]
Heat Pump/AC	32	2,283
Level 1 HVAC Tune-up	0	5,210
Duct Sealing	13	860
Windows	9	928
Attic Insulation	10	191
Total[a]	**64**	**8,676**

a. The "total" number of sites visited was 45, but many sites had multiple measures.

b. Participants include all those receiving rebates in calendar year 2009.

Source: Navigant

3.5 *Step 5: Process Evaluation*

The Year One process evaluation focused on describing the program's processes and procedures, as well as assessing how well the program is running from several key perspectives: those involved in the program's day-too-day management; the program prequalified contractors who deliver program services; and the customers who received those services. The evaluation team interviewed internal PEC staff, as well as implementation contractor (Honeywell) staff. The evaluation team conducted surveys with program participants, and also with prequalified contractors that participated in the program in 2009.

After collecting the data, the evaluation team then reviewed the findings, and developed the program logic model presented in Chapter 5. The evaluation team analyzed survey results to determine what portions of the program are working well, and where PEC might be able to make improvements. The evaluation team also assessed the program relative to similar programs in other jurisdictions, to consider how it compares against industry best practices.

3.6 *Step 6: Impact Analysis*

The impact analysis consisted of three parts, 1) updating **measure unit savings** with energy simulation models and secondary literature, 2) deriving **field verification rates** from on-site visits, and 3) calculating **verified gross savings** for the program. Appendix A provides brief definitions of commonly used EM&V terms, and Appendix B provides a comprehensive description of the impact analysis methodology.

The impact analysis was comprised of the following detailed steps:

3.6.1 Step 6.1: Update Unit Savings Values

Building energy simulation models were created for each combination of measure and region and then used to generate updated assumptions for **unit energy savings and unit peak demand reductions.**[14] First, billing data from nearly 8,700 HEIP program participants were combined with appliance saturation data to create monthly end use consumption estimates for each combination of measure and region. The corresponding building energy simulation models were calibrated to this end use data. Unit savings for each measure were then calculated on the basis of model outputs and secondary literature review. These evaluation team then compiled unit savings values by measure, region, heating type, and installation location into an updated unit savings database.

3.6.2 Step 6.2: Derive Field Verification Rates

In order to determine field verification rates, the results of the field data collection activity were compared with the reported installations to check for both *quantitative* and *qualitative* differences. The findings were aggregated across each measure in order to determine two field verification rate components:

1. **Quantity Verification Rate:** this was calculated as the total quantity/size found at all sites in the sample divided by the sum of what was reported in the tracking data for the same sites. For example, at a home with attic insulation, the ceiling area insulated was measured at 1100 square feet, while the tracking database gave 1000 square feet. The resulting quantity verification rate for that site was 110%.

2. **Measure Characteristic Verification Rate:** for each site in the sample, the efficiency, installation location, and installation quality of what was installed was compared to the value reported in the program database. Where there was a discrepancy, a new unit savings value was mapped in from the updated savings database (described above). The measure characteristic verification rate was then calculated as the updated savings of the measures found in the field divided by the updated savings of what was reported in the tracking database, using the quantity reported in the tracking data (to avoid double counting).

The final **field verification rate** for each measure was calculated as the product of the **quantity verification rate** and the **measure characteristic verification rate.** For level 1 HVAC tune-ups

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[14] "Unit energy savings" refers to the assumed savings for installation or performance of one measure (e.g., central air conditioning system or duct sealing) at a single participant's residence.

and geothermal heat pumps, which were not verified on-site, the program average verification rates were applied.

3.6.3 Step 6.3: Calculate Program Impacts

Once the simulation model runs were completed (see Step 6.1 above), the evaluation team applied updated **unit savings** values to the tracking data to determine program-level results. Each line item in the tracking database (corresponding to one type of measure installation at a unique customer site) was mapped to a new savings value based on the region, heating type, and best available match of base- and efficient-case measure characteristics. These new unit savings values were then multiplied by the measure quantity to derive an updated savings estimate for each line item. Finally, total savings values were summed by measure over the whole program.

The updated total savings by measure were combined with the measure-level verification rates to estimate **verified gross savings** impacts for each measure. Measure-level verified savings were then summed to determine verified gross savings at the program level. **Realization rates** were then calculated as the ratio of verified savings to reported savings, both by measure and for the program as a whole.

The results of the participant survey were used to estimate free-ridership for each measure. Program participants indicated whether, in the absence of the program, they would have installed the same measure of similar efficiency, and whether they had previously installed the same type of measure. Air-source heat pumps and central air conditioners were combined for the purposes of this analysis.

Section 4. Program Impacts

PEC's program tracking database provided savings values for energy and peak demand ("**reported gross savings**") based on program participation data and assumed unit savings, or "**deemed savings**", values. As discussed in Section 3.6, the EM&V team verified the accuracy of these reported savings values for each measure category using 1) on-site data collection to conduct field verification of measure installations, and 2) program participant characteristics, billing data, appliance saturation data, and energy simulation modeling to assess the most appropriate unit savings values. The result was a set of **verified gross savings** by measure and for the program as a whole.

The glossary in Appendix A provides brief definitions of commonly used EM&V terms.

The term "**gross savings**" refers to reductions in energy consumption and peak demand based on engineering estimates for known quantities and types of measure installations. Gross savings do not account for whether the measures were installed as a result of the program.[15] Table 4-1 compares the **verified gross savings** to the **reported savings.** The relationship between these two values is the "gross realization rate," shown here to be 50% for energy savings and 61% for peak demand reductions.[16]

Table 4-1: 2009 Annual Energy and Demand Reductions

	Annual Energy Savings (MWh)	Coincident Demand Reductions (MW)
Reported Gross Savings	5,017	3.90
Gross Realization Rate	50%	61%
Verified Gross Savings	2,494	2.37

Source: Navigant analysis

[15] Savings attributable to the program can be adjusted for free ridership and spillover/market effects. Free ridership is addressed at the end of this chapter; an assessment of spillover and market effects was not conducted for this analysis.

[16] HEIP's gross realization rates are not atypical for a first year residential retrofit program, due to the high degree of uncertainty around the initial savings values chosen during program design. The relatively low realization rates are more than offset by higher-than-projected participation, which resulted in realized savings exceeding projected savings by more than 50% (see Table 6-1 in chapter 6). The high participation reflects a successful first year program rollout and may also be attributable to the temporary availability of federal tax credits and state appliance rebates.

The remainder of this chapter presents the detailed impact findings broken down into the component parts:

1. **Field verification rate:** ratio of savings from equipment and measures verified on site versus that reported in the program database
2. **Measure unit savings adjustment factor:** ratio of updated unit savings values to the original deemed savings values used in the program tracking database
3. **Gross realization rate:** ratio of verified gross savings to reported savings, and **verified gross savings:** gross reductions in energy and consumption and peak demand verified through EM&V activities.

4.1 Field Verification Rates

Field verification rates reflect differences between the equipment installed on site and the equipment reported in the program tracking database. The EM&V team estimated field verification rates for each measure category using on-site verification of size, quantity and efficiency characteristics, identifying both quantitative and qualitative differences:

1. **Quantity verification rate** reflects disparities in *quantity and size* between the program database and actual, on-site conditions verified by the EM&V team (e.g., *total square footage of windows, or the size of a new air conditioner, measured in tons of cooling capacity).*

2. **Measure characteristic verification rate** reflects discrepancies between reported and verified *characteristics related to the efficiency* of the equipment installed or the *way it was installed* (e.g., *U-value and solar heat gain coefficient of new windows, SEER rating of a new air conditioner, or the location of newly sealed ducts).*

The final **field verification rate** for each measure category combines the effects of these two types of differences to determine a percentage adjustment on the reported savings *based on what the evaluation team identified as installed in the field.*

4.1.1 "Quantity" Verification Rates

The **quantity verification rates** varied from a low of 86% for duct sealing to a high of 113% for attic insulation. The low value for duct sealing reflects some sites not being sealed properly, while the high insulation value reflects a greater area being insulated than was reported at some sites. The window quantity verification number reflects the fact that some houses had more windows installed than were reported. Most measures were near 100% and the average was 100%, as shown in Table 4-2.

Table 4-2: Quantity Verification Rate by Measure

Measure	Quantity Verification Rate
HVAC Level 1Tune-up[a]	100%
Air-Source Heat Pump	100%
Windows	103%
Duct Sealing	86%
Central AC	100%
Insulation	113%
Geothermal Heat Pump[a]	100%
Program Average[b]	**100%**

a. Onsite verification was not performed for level 1 tune-ups, because after-the-fact verification of impacts would be highly uncertain for the effects of coil cleaning, or for geothermal heat pumps, due to the relatively small number of available sites (25) and the fact that geothermal heat pumps accounted for less than 1% of reported savings. Each of these measures was assigned a quantify verification rate of 100%, equivalent to the weighted average rate across all other measures.

b. Program Average represents the weighted average quantity verification rates based on the energy savings of the five measure types verified during the site visits.

Source: Navigant analysis

4.1.2 "Measure Characteristic" Verification Rates

The **measure characteristic verification rates** reflect differences between the reported measure characteristics and the measure characteristics observed on-site. Most measure characteristic verification rates are at or near 100% for both energy savings and demand reduction, although there are a few notable exceptions. The measure characteristic verification rate for demand reductions from windows is 90% (implying lower savings than reported) because some of the windows had lower efficiency than recorded in program records. Conversely, the measure characteristic verification rates for duct sealing are higher than 100% (greater savings than reported) due to duct sealing occurring in a part of the home with higher savings than the part of the home reported (see Table 4-3).

Table 4-3: Measure Characteristic Verification Rates

Measure	Annual Energy Savings	Peak Demand Reductions[b]
HVAC Level 1Tune-up[a]	100%	98%
Air-Source Heat Pump	99%	100%
Windows	99%	90%
Duct Sealing	107%	110%
Central AC	99%	100%
Insulation	97%	97%
Geothermal Heat Pump[a]	100%	98%
Program Average[c]	**100%**	**98%**

a. Field verification was not performed for level 1 tune-ups, because after-the-fact verification of impacts would be highly uncertain for the effects of coil cleaning, or for geothermal heat pumps, due to the relatively small number of available sites (25) and the fact that geothermal heat pumps accounted for less than 1% of reported savings. These measures were each assigned measure characteristic verification rates of 100% and 98% for energy and peak demand, respectively, equivalent to the weighted average rates across all other measures.

b. The energy and demand measure characteristic verification rates can be different because some differences in measure characteristics have a larger or smaller impact at peak times than they do on average. For example, a lower window solar heat gain coefficient causes smaller solar gains, which result in peak demand being reduced, but winter heating consumption going up.

c. Program Average represents the weighted average measure characteristic verification rates based on the relative energy savings and peak demand reductions.

Source: Navigant analysis

4.1.3 Final Field Verification Rates

The **quantity verification rates** and **measure characteristic verification rates** combined to give **final field verification rates** close to 100%, reflecting the fact that nearly all measures inspected in the onsite sample were found to be of the same quantity, size, and quality as that reported in the program tracking database. Notable exceptions to the near-perfect field verification rates include the following:

- **Duct sealing** field verification rates for both energy savings and peak demand reductions are closer to 90%, which reflects some field sites not being properly sealed (and thus the evaluation team conservatively assigned a zero savings value to these installations);

- **Attic insulation** field verification rates are approximately 110% due to the actual area insulated being larger than what the tracking database reported; and

- For **windows**, the actual windows installed had lower efficiency than was reported.[17]

Energy and peak demand field verification rates are shown in Table 4-4 below:

Table 4-4: Final Field Verification Rates by Measure

Measure	Annual Energy Savings	Peak Demand Reductions[b]
HVAC Level 1 Tune-up[a]	100%	98%
Air-Source Heat Pump	99%	100%
Windows	102%	93%
Duct Sealing	92%	95%
Central AC	99%	100%
Insulation	110%	110%
Geothermal Heat Pump[a]	100%	98%
Program Average[c]	**100%**	**98%**

a. Onsite verification was not performed for level 1 tune-ups, because after-the-fact verification of impacts would be highly uncertain for the effects of coil cleaning, or for geothermal heat pumps, due to the small number of available sites (25) and the fact that geothermal heat pumps accounted for less than 1% of reported savings. These measures were assigned the program average field verification rates, 100% and 98% for energy and peak demand, respectively.

b. The energy and demand field verification rates can be different because some differences in measure characteristics have a larger or smaller impact at peak times than they do on average.

c. Program Average represent the weighted average field verification rates based on the relative energy and peak demand reductions reported in the database.

d. The confidence and relative precision for final field verification rates for energy savings and peak demand reductions are each 90/5. See Appendix C-1 for discussion of confidence and precision.

Source: Navigant analysis

Overall, the field verification rates were close to 100%, which is excellent for a first year program, reflecting good data tracking and quality control.

[17] There were also several windows found on site that had lower efficiency than reported, which had a moderate impact on peak demand reductions but a negligible impact on energy savings. This, combined with the finding of slightly greater installed quantities than reported, led to the result of an energy savings verification rate of greater than 100% with a demand savings rate that was closer to 90%.

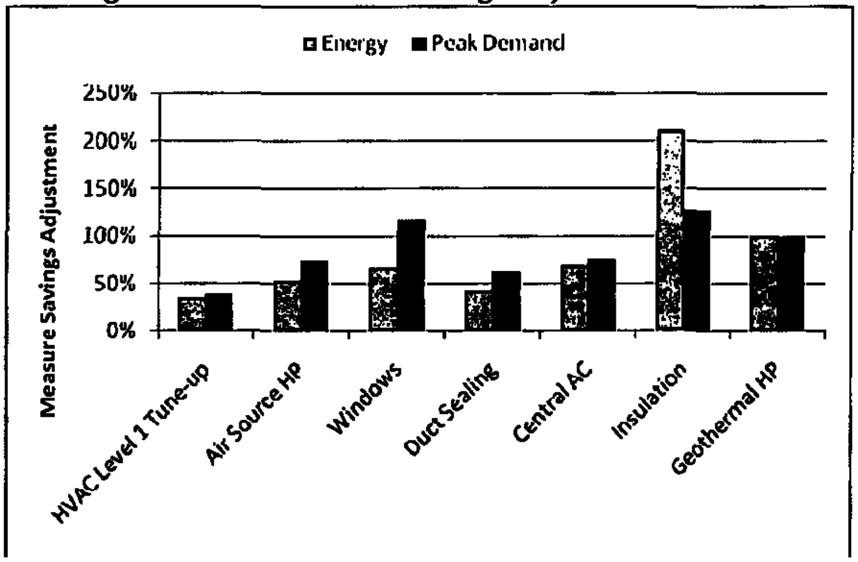
4.2 *Measure Unit Savings Adjustment Factors*

As noted above, the evaluation team determined the most appropriate **unit-savings values** for each measure through energy simulation modeling and consideration of relevant data on program participants and appliance saturations. The updated measure unit-savings values (one per measure) reflect the average savings across participants, weighted for the true participant mix across geographies, appliance types, home types, energy consumption levels, and other relevant characteristics.

The team then estimated **measure-specific unit savings adjustment factors** by comparing these updated unit savings values with the original deemed savings values for each measure A value of 100% indicates that the evaluation resulted in no change to the unit-savings value used by PEC. Values less than 100% indicate a reduction in unit savings, and values in excess of 100% indicate an increase in unit savings.

Figure 4-1 presents the **unit savings adjustment factors** and shows that the updated unit savings values are lower than the deemed values across most measure categories, with the Level 1 tune-up measure the most extreme at a 35% adjustment factor for energy savings and a 38% factor for demand reductions. Adjustment factors for most other measures are generally between 50% and 70% for energy savings and between 60% and 80% for demand reductions. Notable exceptions are the significant increase in unit savings for the attic insulation measure (*more than double for energy and a 27% increase for demand) and for demand reduction for* windows. Unit savings adjustments generally reflect inaccurate baseline assumptions in the original deemed savings estimates, as described below.

Figure 4-1: Measure Unit Savings Adjustment Factors[18]



Source: Navigant analysis

The measure savings adjustment values, discussed above and expressed as a percentage of deemed savings values, illustrate the direction and magnitude of the EM&V changes to unit savings values. The actual deemed savings values and the verified unit savings values are presented in Table 4-5 for both energy savings and demand reductions. More detailed verified unit savings values are provided in Appendix D.

[18] Geothermal heat pumps were not modeled (and were thus assigned a measure savings adjustment equal to the average of the other measures) due to the uncertainty in modeling that measure and its relatively minor contribution to reported savings (~1%).

Table 4-5: Updated Unit Energy Savings and Peak Demand Reductions

Measure (units)	Unit Energy Savings		Measure Unit Savings Adjustment	Unit Peak Demand Reductions		Measure Unit Savings Adjustment
	Deemed	Verified		Deemed	Verified	
Level 1 HVAC tune-ups *(kWh/system)*	277	96	35%	0.244	0.092	38%
Air Source Heat Pumps *(kWh/system)*	697	371	53%	0.572	0.424	74%
Central Air Conditioners *(kWh/system)*	429	293	68%	0.572	0.429	75%
Ground Source Heat Pumps *(kWh/system)*	1,725	1,725	100%	0.690	0.690	100%
Duct Sealing *(kWh/system)*	579	244	42%	0.271	0.167	61%
Windows *(kWh/home)*	796	516	65%	0.410	0.480	117%
Attic Insulation *(kWh/home)*	391	830	212%	0.270	0.344	127%

Note: Unit savings are given in terms of the deemed savings units used in the program. Navigant advises changing the units for future iterations of the program (see Recommendation 11 in Section 6.2.3). The values in this table do not include the quantity and measure characteristic verification rates. The field verification rates are applied separately from the unit savings values presented here.

Source: Navigant analysis.

- There is a large disparity between the **deemed savings and updated unit savings.** This is not uncommon for first year programs, as there is usually high uncertainty in savings values chosen during program design. PEC generally assumed a single savings value for each measure type (e.g., 796 kWh per home installing efficient windows). These values were either borrowed from other sources or based on an assumed mix of participants across geographies and with various heating and cooling system types and fuels. In the latter case, these program-planning assumptions could not possibly have accurately reflected the true (then-unknown) mix of participants and thus the evaluation team expected that adjustments would be necessary.

The primary reasons for the discrepancies in unit savings are as follows:

1. **Deemed savings values assumed higher baseline heating and cooling consumption than the billing data of actual participants showed.** The implication is that efficiency improvements from HVAC-related measures have a smaller baseline consumption level from which to produce energy and demand savings. This was examined explicitly for the *central AC, air-source heat pump, and duct sealing* measures, which sourced deemed savings values from the North Carolina Measures Database (NCMDB). Base heating and cooling consumption from the NCMDB models were compared to that of Navigant's models, which were calibrated to the billing data of the actual participant group.

   The comparison showed the EM&V team's base heating and cooling consumption to be dramatically lower than what was assumed in the deemed savings values for air-source heat pumps, and somewhat lower for central AC and duct sealing. Differences in base consumption values for these measures for homes in Raleigh[19] are shown in Table 4-6, which indicates that consumption among participants is between 15% and 45% less than originally assumed by PEC, depending on the equipment/measure and on whether the consumption is for heating or cooling. This suggests measure savings adjustment factors of between 55% and 85% accounting for the apparent overestimate in the NCMDB of consumption estimates,[20] before adjustments are made for other differences, as described below.

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[19] The specific regional weightings used in the deemed savings values were not available for this comparison, so Raleigh was chosen as a proxy for the program as a whole.

[20] Uncalibrated residential energy simulation models like the ones used in developing the NCMDB frequently overestimate heating and cooling energy consumption. This may be due to inaccuracies in the simulation engines themselves or due to unexpected occupant behavior, like people turning their heating or cooling off on a regular basis. Calibrating residential energy simulation models corrects for most of these problems by ensuring that the model heating and cooling energy reflect the actual heating and cooling energy consumed by participants.

Table 4-6: Base Heating and Cooling Energy Consumption Comparison

Measure (units)	Deemed Cooling	Verified Cooling	Cooling Difference	Deemed Heating	Verified Heating	Heating Difference
Central AC (kWh/ton)	892	680	-24%	NA	NA	NA
Air Source Heat Pump (kWh/ton)	921	505	-45%	1,423	851	-40%
Duct Sealing (kWh/sf)[a]	1.77	1.51	-15%	2.73	1.84	-33%

a. Duct sealing comparison based on the case with heat pump heating and ducts in the attic.

Source: Navigant analysis and NC Measures Database simulation files, obtained from Architectural Energy Corporation.

Deemed savings values for the window and attic insulation measures were based on programs in Florida, with very different baseline heating and cooling consumption than North Carolina, and level 1 HVAC tune-ups were based on savings from a similar climate in California. In each of these cases, there was not sufficient information on baseline consumption values to draw out an explicit comparison.

2. For some measures, **actual installations were significantly different than what was assumed** for the deemed savings.

    a) In the case of **duct sealing**, deemed savings were based on ducts located in the attic, whereas field visits revealed that 64% of ducts actually sealed were in the crawlspace, where savings from duct sealing are significantly lower. The reduced savings are due to the fact that crawlspaces stay at moderate conditions throughout the year, which means that return leaks in crawlspaces draw ambient air that is only moderately warmer (in summer) or colder (in winter) than the primary airflow in the ducts. Thus, the efficiency gains from duct sealing are modest. Conversely, attics typically experience extreme temperatures in the summer and winter, resulting in significant heat loss or gain in leaky ducts and a commensurate deterioration of efficiency that duct sealing can address.

    b) For **windows**, the deemed savings were based on a window upgrade which did not reduce solar heat gains. Most of the actual installed windows *did*, on average, reduce solar gains, resulting in higher cooling savings but lower (and sometimes negative) heating savings.[21]

c) The deemed savings calculation for **attic insulation** assumed a baseline of R-19, while the actual installations, based on contractor reports in program records, showed a high prevalence of lower R-values in the baseline, which drove higher savings.

3. **The deemed savings value for level 1 HVAC tune-ups appear to be based on a higher percentage savings** than other studies of the measure typically indicate.[22] The best data available in the literature show a 7% instantaneous improvement in system efficiency with a level 1 tune-up, primarily due to condenser coil cleaning.[23] However, this measure degrades fairly quickly as the coil becomes dirty again. The evaluation team's professional judgment is that performance will degrade roughly linearly back to the baseline over a period of three years. As a result, an appropriate average annual savings value would be 3.5%, compared to the 7-10% implicit in the deemed savings value.[24]

4.3 *Gross Realization Rates and Verified Gross Savings*

The evaluation team estimated **verified gross savings** for each measure by multiplying the measure-specific **field verification rate** from Section 4.1 by the **measure unit savings adjustment factors** from Section 4.2. The result is an estimated **gross realization rate** for each measure, representing the percentage of reported savings verified through the EM&V activities.

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[21] The deemed savings calculation assumed a baseline double clear window with 0.65 U-value and 0.41 solar heat gain coefficient (SHGC) being improved to a low-e window with 0.4 U-value and 0.4 SHGC. The actual SHGC of double clear windows is about 0.6; the actual windows installed had an average U-value of 0.3 and an average SHGC of 0.3.

[22] Deemed savings documentation for this measure was minimal, so it was difficult to determine what was assumed.

[23] The Energy Center of Wisconsin did a comprehensive study of residential air conditioner performance in Wisconsin, published in 2008. Their small sample of 12 showed a mean of 6.8% EER improvement, with a range of -4% to 26% EER improvement. An analysis of coil cleaning EER improvement results from KEMA's 2009 study of HVAC tune-up savings in California shows a similar mean savings and range. Both of these studies had small sample sizes and a large range of results, so there is still significant uncertainty around these estimates. It is clear that there are large savings opportunities available for correcting completely fouled condensers. However, coil cleaning programs generally include condenser coils with varying degrees of fouling from completely clean to completely fouled. In addition, field measurements of EER after a condenser coil cleaning are prone to error, with evaporative cooling frequently created as a result of the washing process. As a result, caution must be taken in applying the results of these studies directly.

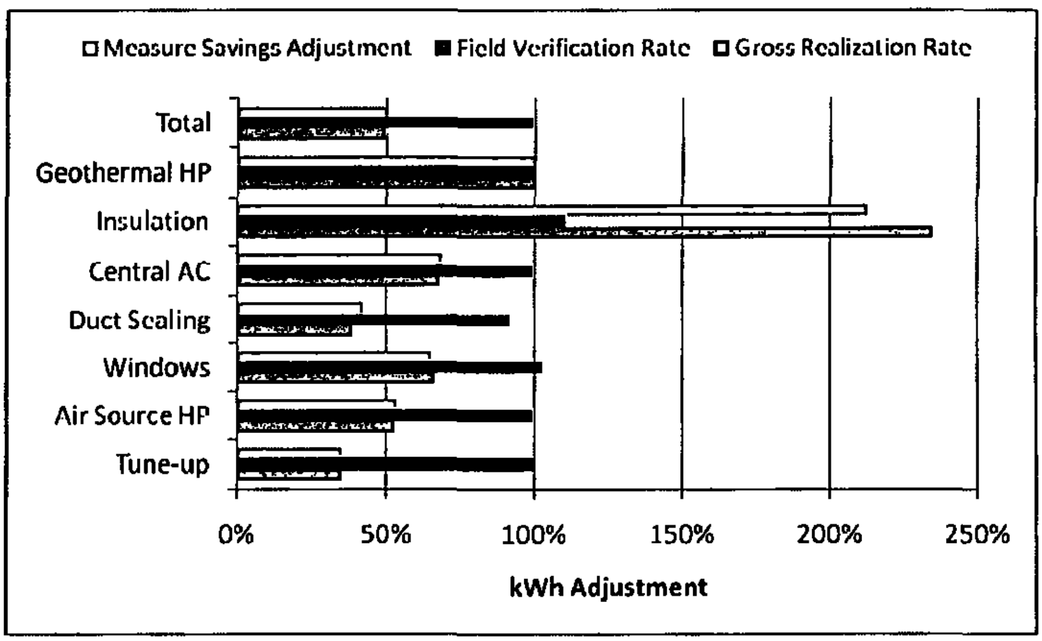
[24] For purposes of cost-benefit analysis, it is important to note that the savings are higher in year 1 and lower in year 3. Overall yearly average savings values are 5.8%, 3.5%, and 1.2% for years 1, 2 and 3, respectively.

4.3.1 Energy (MWh) Savings

Gross realization rates for energy savings range from 35% for level 1 tune-ups to as high as 234% for insulation (Figure 4-2). This means that the evaluation found tune-up savings to be little more than one-third of what PEC reported, while savings from insulation measures were more than double the reported savings. Realization rates for most measures were between approximately 40% and 70%.

The measure savings adjustments, discussed above in 4.2 drove the gross energy realization rates in all cases, showing that the program's low overall gross realization rates were not a result of poor implementation but rather of overly optimistic deemed savings values. This is illustrated in Figure 4-2 by the similar size of the green (top) and blue (bottom) bars, representing the measure savings adjustments and gross realization rates, respectively. As discussed earlier, field verification rates were generally at or near 100%. It is not uncommon for evaluation of first-year programs to find significant adjustments to deemed savings values and correspondingly low realization rates, as there is usually high uncertainty in the initial savings values used in program design.

Figure 4-2: Energy Savings Adjustment Factors by Measure[25]



Source: Navigant analysis

[25] Because of the low participation and savings associated with geothermal heat pumps in 2009, the impacts of geothermal heat pumps were not explicitly evaluated and savings from that measure were not adjusted.

Table 4-7 presents gross realization rates for all measure categories. By applying these realization rates to PEC's reported energy savings, the evaluation team estimated *verified gross savings* for each measure. Total savings across all measures is roughly 2.5 GWh, compared to reported savings of about 5.0 GWh, resulting in a weighted average gross realization rate of 50%.

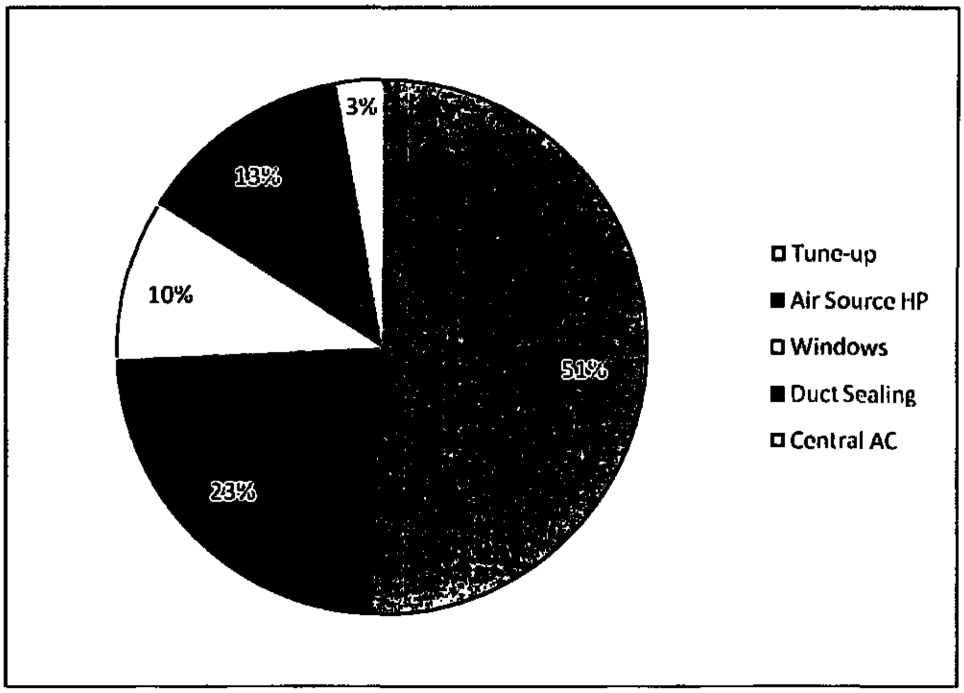
Table 4-7: Verified Gross Energy Savings by Measure

Measure	Reported Energy Savings (MWh)	Gross Realization Rate	Verified Gross Energy Savings (MWh)
Level 1 HVAC tune-ups	2,044	35%	710
Air Source Heat Pumps	1,302	53%	686
Central Air Conditioners	234	68%	158
Ground Source Heat Pumps	50	100%	50
Duct Sealing	561	39%	217
Windows	751	66%	497
Insulation	75	234%	175
Total	**5,017**	**50%**	**2,494**

Source: Navigant analysis

The verified gross energy savings of nearly 2.5 GWh is approximately 2.5 GWh less than reported in the PEC program database. Each measure represents a potential source of reduction in the total reported savings, and the contribution of each measure to this reduction in total gross savings is shown graphically in Figure 4-3. HVAC tune-ups provided the greatest downward adjustment in savings, followed by air-source heat pumps, duct sealing, and windows. The contribution of each measure to the reduction in savings is a function of both the magnitude of reported savings and the gross realization rates. Level 1 tune-ups have both high savings and a low realization rate; duct sealing is a relatively small contributor to savings, but its low realization rate resulted in a larger-than-proportional reduction to reported reduction.

Figure 4-3: Sources of EM&V Reductions to Reported Energy Savings

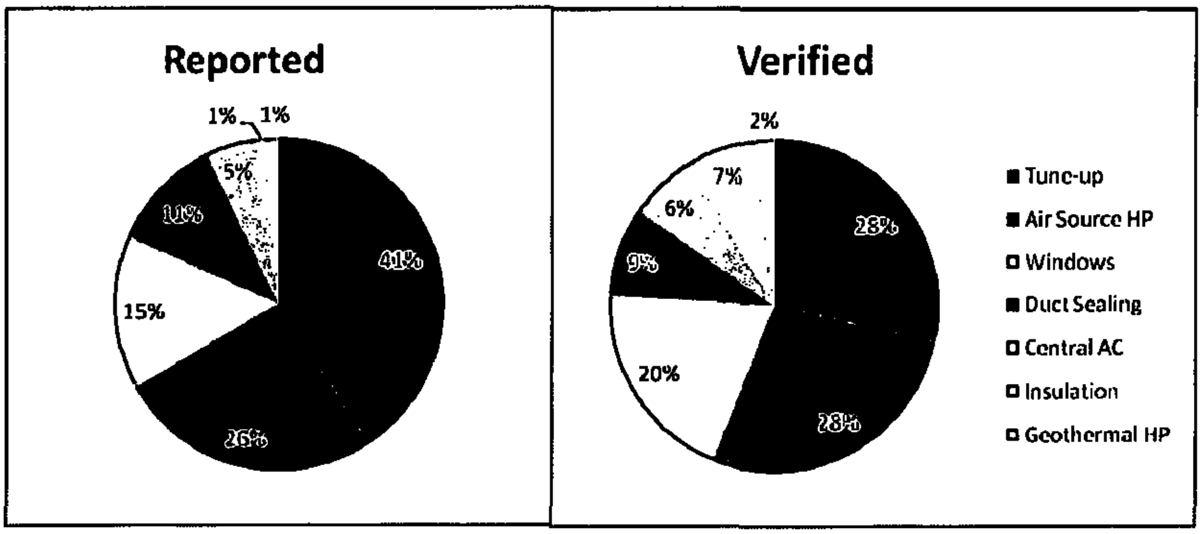


Source: Navigant analysis

Note: The insulation measure category did not contribute to any reduction in reported savings. Values presented here are based on total reductions from the five measures shown.

The relative contribution of each measure to gross program savings shifted significantly as a result of the evaluation effort. Figure 4-4 presents a comparison of the proportion of total savings by measure in the reported and verified cases. The portion of total verified energy savings attributed to HVAC tune-ups is significantly smaller than what was reported (28% vs. 41%). In contrast, insulation is a negligible part of reported energy savings but accounts for almost 10% of verified savings. The windows category also increased significantly, from 15% of reported savings to 20% of verified savings.

Figure 4-4: Distribution of 2009 Reported and Verified Gross Energy Savings



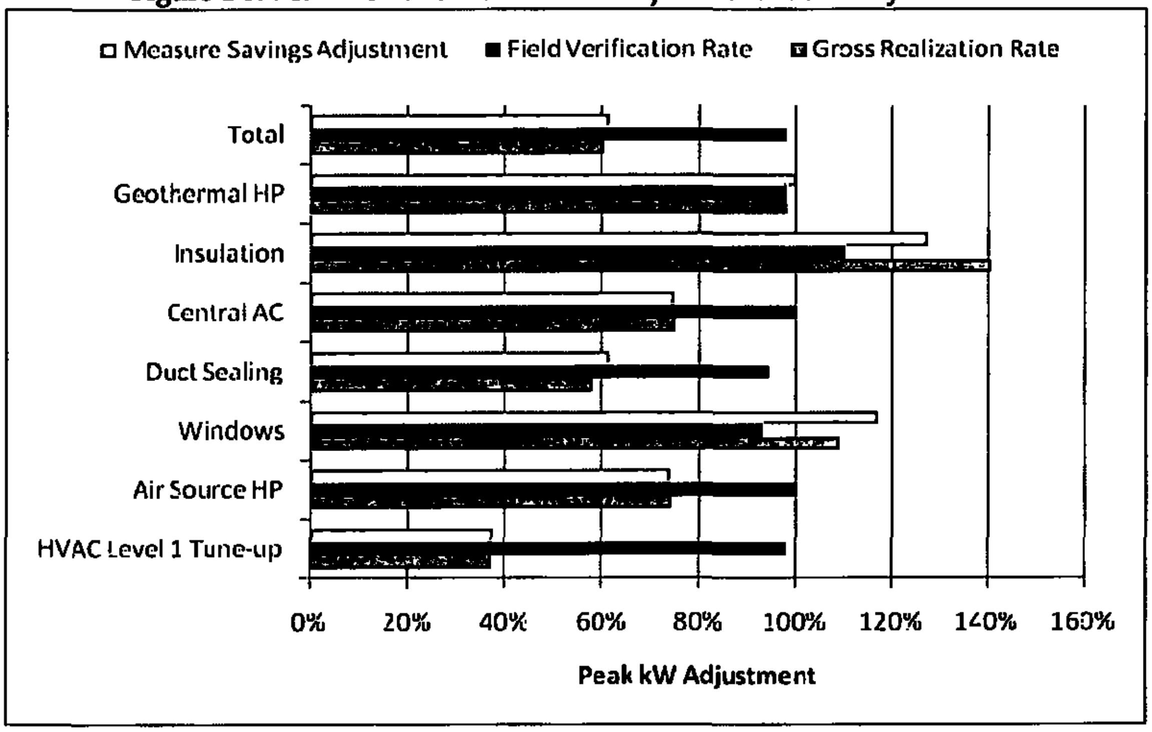
Source: Navigant analysis

4.3.2 Peak Demand Reductions

The distribution of peak demand reductions adjustments is similar those for energy savings. As with the energy savings adjustments, low measure savings adjustments drove the low gross realization rates for peak demand reductions. Overall, however, the gross peak demand realization rates are higher. This is true for the windows measure in particular, where the demand savings realization rate is above 100%, while the energy savings realization rate was near 60%.[26] Demand savings adjustment factors are shown in Figure 4-5.

[26] This reflects a change in the assumptions about solar heat gain coefficients which reduced heating energy savings, but increased summer peak demand reductions because of the large reduction in solar heat gain.

Figure 4-5: Peak Demand Reductions Adjustment Factors by Measure



Source: Navigant analysis

The total verified gross peak demand reductions were 61% of what was reported, compared to the 50% gross realization rate for energy savings reported above. Excluding the level 1 HVAC tune-ups, which had a realization rate of just 37%, the gross peak demand realization rate would be 81%. The peak demand reductions realization rates are higher than the energy realization rates because the disparity in base consumption, which drove down energy savings (see Section 4.2, page 29), was much lower for cooling than for heating. Since peak demand reductions are driven by cooling, they were less affected by the adjustment in base consumption.

Table 4-8 presents gross realization rates and peak demand reductions by measure. Total savings across all measures is roughly 2.4 MW, compared to reported savings of about 3.9 MW.

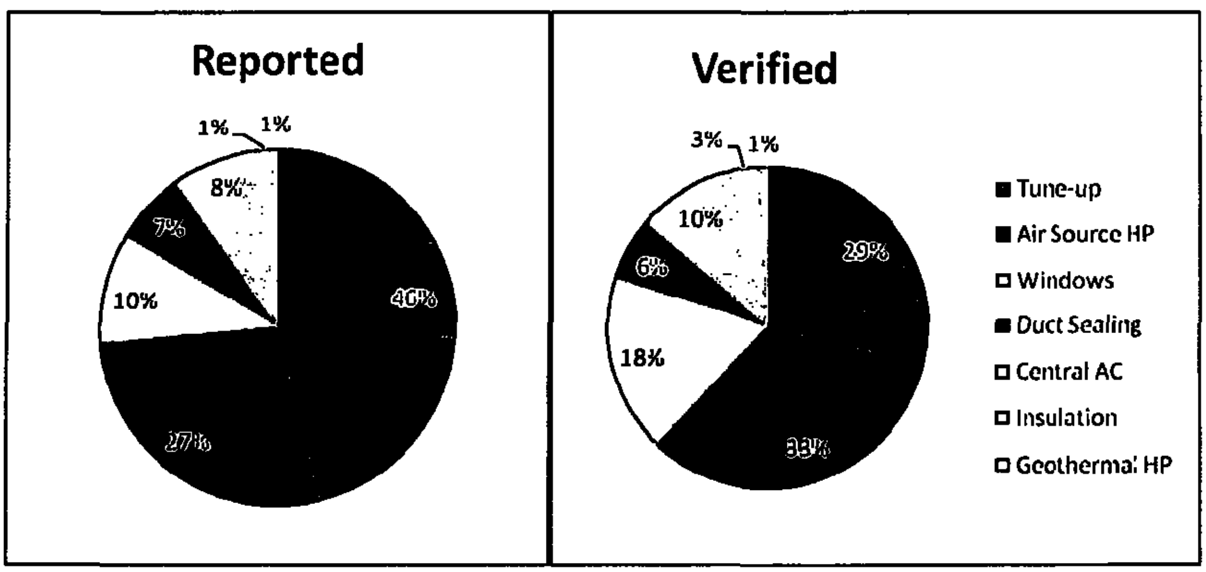
Table 4-8: Verified Gross Peak Demand Reductions by Measure

Measure	Reported Gross Demand Reduction (kW)	Gross Realization Rate	Verified Gross Demand Reduction(kW)
Level 1 HVAC tune-ups	1,800	37%	670
Air Source Heat Pumps	1,068	74%	794
Central Air Conditioners	312	75%	235
Ground Source Heat Pumps	20	98%	20
Duct Sealing	263	58%	153
Windows	387	109%	421
Insulation	52	141%	72
Total	**3,902**	**61%**	**2,365**

Source: Navigant analysis.

While level 1 HVAC tune-ups made up almost half of reported peak demand reductions, they make up only about 30% of verified peak demand reductions. In contrast, the share of gross peak demand reductions attributable to window replacements almost doubled as a result of this evaluation, from 10% to 18%. Figure 4-6 provides a comparison of the relative contributions of each measure to total peak demand reductions.

Figure 4-6: Distribution of 2009 Reported and Verified Gross Peak Demand Reductions



Source: Navigant analysis

Winter peak demand reductions are primarily important in the Western region, where there is a more localized transmission constraint in the winter, while the overall summer peak demand affects the system peak for the entire service area. Verified gross winter peak demand reductions are lower than reported, due largely to the influence of HVAC tune-ups and air source heat pumps which generate almost zero winter demand savings. This is because heat pump units are operating primarily using supplemental heat in the extremely cold temperatures that occur during the winter system peak. Winter peak demand reductions are summarized in Table 4-9.

Table 4-9: Verified Gross Winter Peak Demand Reductions by Measure

Measure	Reported Gross Demand Reduction (kW)	Gross Realization Rate	Verified Gross Demand Reduction (kW)
Level 1 HVAC tune-ups	2,088	14%	286
Air Source Heat Pumps	1,192	6%	70
Central Air Conditioners	0	N/A	180[a]
Ground Source Heat Pumps	0	N/A	0
Duct Sealing	291	121%	351
Windows	432	42%	252
Insulation	62	294%	183
Total	**4,063**	**27%**	**1,091**

a. High efficiency air conditioners generate winter demand savings because they include high efficiency furnace fans that consume less energy during heating operation.

Source: Navigant analysis.

4.4 *Free Ridership*

The discussion of gross savings above refers to reductions in energy consumption and peak demand based on engineering estimates for known quantities and types of measure installations. Gross savings do not account for whether the measures were installed as a result of the program. Net savings, on the other hand, are adjusted for free-ridership (program-reported savings that would have occurred even in the absence of the program) and spillover (savings not reported by the program that occur as a result of the program). Net savings, therefore, reflect savings attributable to the program, which is the more appropriate metric for use in cost-effectiveness analysis.

For the PY2009 analysis, the focus of the EM&V assessment was on gross impacts, and thus EM&V activities included a limited free-ridership analysis based on self-reporting via a participant phone survey and no quantifiable spillover assessment. Free ridership findings are presented below primarily for purposes of assessing the relative effectiveness of and need for incentives for the various measures. Free-ridership for most measures was estimated to be between 20% and 30%, with Level 1 HVAC tune-ups a notable exception at 45% (Table 4-10).

Table 4-10: Estimated Free Ridership by Measure

Measure	Free-Ridership
Level 1 HVAC Tune-ups	45%
Duct Sealing	20%[a]
Air Source Heat Pumps and Central AC	29%
Other (Attic Insulation and Geothermal HPs)	23%
Windows	26%

a. The free ridership value for duct sealing is based on secondary research. See footnote 28 below.

Source: Navigant analysis of phone survey results.

The relatively high free ridership for level 1 HVAC tune-ups can be explained by the large number of customers who already had an annual maintenance contract that includes the equivalent of a level 1 tune-up.[27] Free ridership levels for the other measures are similar to those found in other residential retrofit programs. Sixty-nine percent of duct sealing participants received duct sealing in conjunction with the installation of a new HVAC system, so this measure was difficult to survey independently. Other evaluations of stand-alone duct sealing have shown lower free ridership ranging from less than 10% to as much as 36%. A duct sealing free ridership value of 20% is appropriate to use until a new survey can be fielded to evaluate the influence of the program on sealing ducts separately from the influence of the program on installing new HVAC equipment.[28]

[27] The level 1 HVAC tune-up measure was considered by PEC to be a strategic vehicle to attract a critical mass of participating contractors.

[28] The free ridership estimated for the duct sealing measure in the 2009 participant survey was 32%. In the 2006-2008 statewide evaluation in California, five programs had duct sealing free ridership values of 4%, 15%, 20%, 21%, and 36% (KEMA et al, *Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs*, 2010). An evaluation of an Arizona duct sealing program found 8% free ridership (Summit Blue Consulting, confidential).

Section 5. Process Findings

The process evaluation describes HEIP's processes and procedures, as well as assesses how well the program is running from several key perspectives: those involved in the program's day-to-day management; the program prequalified contractors who deliver program services; and the customers who received those services. The findings draw on the interviews and surveys conducted, as well as a thorough review of program documents.

PEC's HEIP program provides incentives for the company's residential customers to install new HVAC systems, tune up their existing HVAC systems, and tighten their home's envelope. PEC rolled out the program in early 2009 to both customers *and* contractors since the program's services are usually performed by a contractor rather than by the homeowner. Once a contractor has been through one of the PEC training sessions, the contractor is considered "pre-qualified" and appears on a list on PEC's website. Customers tend to enter the program after learning about it either directly from PEC, or from a pre-qualified contractor. Honeywell, PEC's implementation contractor, inspects 5% of all incented activities, including the Level 1 tune-ups, which accounted for most of the program's savings in 2009.

The sections below present process findings organized as follows:

1. **The logic model,** which describes the functioning of the program from program staffing and activities to program outputs and ultimately indicators of performance, and
2. **Key findings** for program staffing, program goals, marketing and outreach, the network of pre-qualified contractors, the customer experience, and PEC's website. Comprehensive survey results are provided in Appendix E.

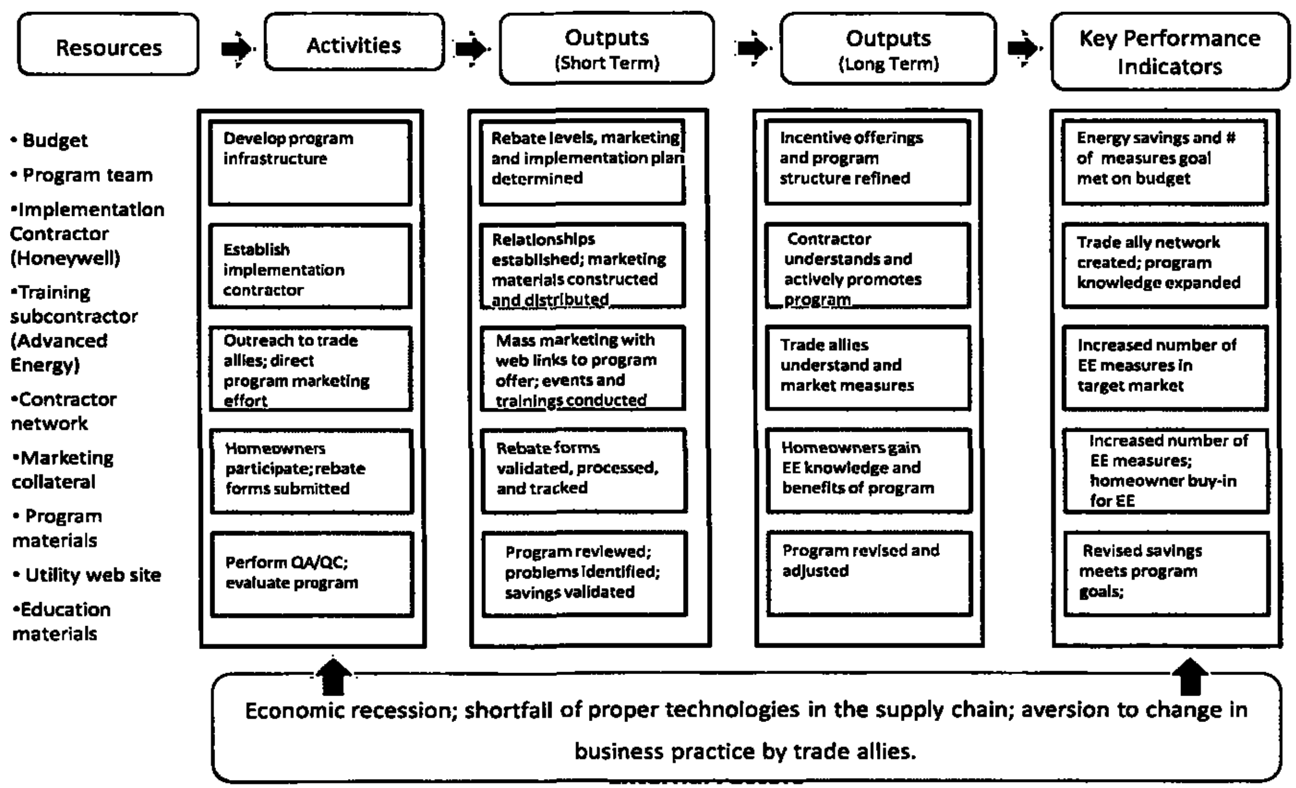
5.1 *Program Logic Model*

Evaluators drafted a program logic model following program documentation review and initial program staff interviews. During the in-depth program staff interviews, evaluators reviewed the program logic model with the program manager and staff and finalized the logic model as presented below in Figure 5-1.

The logic model can be linked to key performance indicators to provide ongoing feedback to program management. The model flows from top to bottom, and is organized according to five basic categories: program resources; program activities; outputs; short-term and long-term outputs, and key performance indicators. Stepping across the activities enumerated in the logic model indicates an approximate "flow" in the sequence of activities. For example, this logic model starts with the program infrastructure and ends with the activity that results in direct energy savings. In each column, resources needed for each activity are specified above that activity, followed by the activity's outputs. The program theory links outcomes causally to the various outputs in each column.

Figure 5-1: Program Logic Model

Progress Energy – Home Energy Improvement Program



5.2 *Key Findings*

The evaluation team found HEIP to be a well-run program, and its 2009 performance exceeded PEC's expectation. One example of its success is that, when the program began in July with contractor training, PEC had hoped to sign up several hundred contractors during the first few months. The program had more than 500 pre-qualified contractors by the end of 2009 and had set a new goal of 1,000 by the end of 2010.

HEIP compares well with similar programs across the country, as measured by similarities with a list of "best practices" for residential retrofit programs, compiled through a joint project of the California Public Utility Commission and the California Energy Commission. Table 5-1 shows best practices that the evaluation team considers to be part of the HEIP offering.

Table 5-1: Residential Program Best Practices

Program Component	Best Practices
1. Theory and Design	Plan thoroughly using collaborative approach; clearly articulate program theory
	Build feedback loops into program design
	Understand market conditions/ Stay abreast of future standards
	Maintain program design flexibility
	Offer financial incentives to as appropriate to increase participation
	Involve multiple stakeholders
	Target supply side actors where appropriate
	Offer a stable and consistent program to customers
2. Project Management	Develop strong relationships with trade allies
	Set clear expectations and provide adequate support for all contractors
	Keep management teams small
	Provide staff and trade allies with good training
	Clear lines of responsibility; decision-making authority matches level of responsibility
	Maintain clear and active lines of communication with stakeholders & implementers
	Clarify participation requirements through application & contracting processes
3. Reporting and Tracking	Integrate all program data, including measure-level data, into a single database
	Clearly define data needs and articulate data requirements needed to track progress and measure success (progress indicators)
	Use comprehensive, logical and easy to use tracking systems that support evaluators as well as program staff
	Conduct regular checks of tracking reports to assess how program is working
	Carefully document tracking system, provide manuals for all users
	Use internet to facilitate data entry and reporting ; build in rigorous quality control screens for data entry, real time data validation systems that perform routine data quality functions
	Automate routine functions such as monthly reports
	Fully integrate or link with cross- program databases, CIS, CRM
	Track trade ally activity
4. Quality Control and Verification	Make sure project inspectors are equipped and experienced for the task
	Use verification method capable of confirming measure and installation quality
	Develop inspection and verification procedures during program design phase

Program Component	Best Practices
	Always inspect first job submitted by new vendor
	Write clear specifications for measures installations using "contractor-friendly" language
	Select appropriate percentage of properties for inspection and verification; build in statistical features to the sampling protocol to allow reduction in required inspection based on observed performance and demonstrated quality of work
	Conduct independent on-site post-installation inspections and/or follow up telephone calls to estimate number of measures installed
	Create processes for tracking complaints and failure by measure and by contractor
	Provide quick and timely feedback to applicants
	Implement a contractor screening or certification or training process
5. Participation Process	Provide technical assistance, manuals to help applicants & market actors with participation process
	Make customer eligibility easy for contractors to determine
	Use an easy, simplified participation process for both trade allies and customers; minimize documentation requirements, but do not over-simplify
	Provide training to trade allies as appropriate on proper installation practices
	Try to maintain some availability of program funds throughout most of program year
	HVAC: Understand product availability before establishing product eligibility; Use incentives to prompt upstream market actors as appropriate to promote EE equipment and strategies; use internet to facilitate program participation; provide easy to use load software for running the Manual J calculations if these are required; Avoid being the middleman
	Audits: Provide a range of options; use rebates to support market transformation strategies; make audit flow seamlessly into adoption of recommended strategies
	Make program participation part of existing, routine transaction
	Use internet to facilitate program participation, publicize program docs, application docs, procedures for reporting etc
6. Marketing and Outreach	Communicate with customers through multiple media (for programs focused on broad end use customer market)
	Promote messages that equate efficiency improvement with home improvement
	Cooperate with trade allies & leverage partnership with cities and community organizations as appropriate to get message out
	Assemble and use information about the target consumer demographics to tailor message to target audiences
	Leverage marketing dollars through cooperative marketing efforts with other programs, sponsorship by manufacturers and through coordination with national or regional efforts to promote similar products
	Use the program's Web site to broadly inform the market and attract participation; and prominently feature links to program specifics
	Keep energy efficiency service providers well informed about program features and changes through seminars, training sessions, trade show and annual meeting of key groups; provide materials to help them market the program

Some of the best practices that PEC may be performing but that the evaluation team did not verify include always inspecting the first project completed by a new contractor and taking advantage of external factors, like heat waves and seasonal changes to enhance marketing effectiveness.

5.2.1 Program staffing

PEC's project manager oversees the program, but Honeywell manages all implementation, which includes maintaining the contractor network and inspecting completed contractor work. Honeywell has added staff as the program has grown; by early 2010 the company had three field coordinators to work with pre-approved contractors and perform inspections throughout North and South Carolina, and anticipated hiring more as the number of pre-approved contractors – and thus the number of customers whom they bring in to the program – grew.

Both PEC and Honeywell staff speak positively about their working relationship. One Honeywell staff member commented that, compared to their work with other utilities in the region, their management is "just blown away by how good the relationship is with PEC." PEC staff confirmed that Honeywell has done a good job with the program and keeps it running smoothly.

5.2.2 Program Goals

HEIP exceeded its targeted savings goals by more than 50% for energy savings and nearly double for peak demand reductions, as discussed in Chapter 4. The individual measure that contributed most to those savings was the HVAC Level 1 tune-up. Program staff, while pleased with the overall response to the Level 1 tune-up, expressed some concern that the high participation might mean that some customers who applied for incentives would have had the tune up without the program. However, the program began during an economic downturn, when consumers were looking for ways to save on their monthly bills, and the majority of the program participants surveyed (89%) reported that they would they would have been very unlikely to have taken action or installed energy efficiency measures without participating in the program.

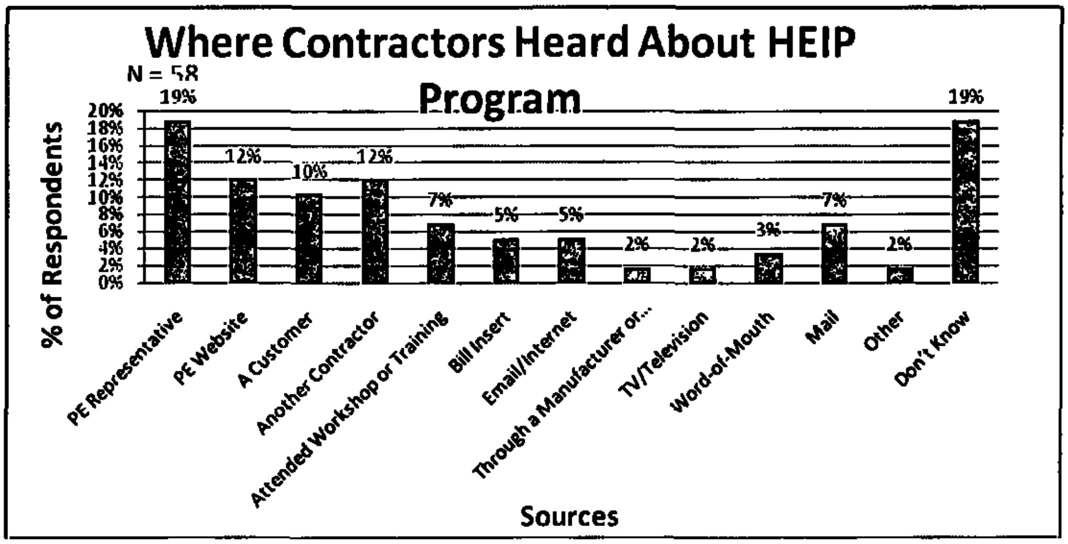
5.2.3 Overall Marketing and Outreach

PEC markets the program primarily through bill stuffers, bill envelopes, e-mail blasts, and through the contractor network. Honeywell helps recruit contractors into the program, and the contractors then market to customers.

Our surveys asked contractors how they learned about the program. Contractors reported learning about it in a variety of ways: 19% learned about it from a Progress Energy representative and 12% from the Progress Energy website. Another 12% heard about the program from another contractor, while 10% of respondents named a customer as their source. Figure 5-2: Where Contractors Heard About Progress Energy's HEIP Program shows the full range of responses.

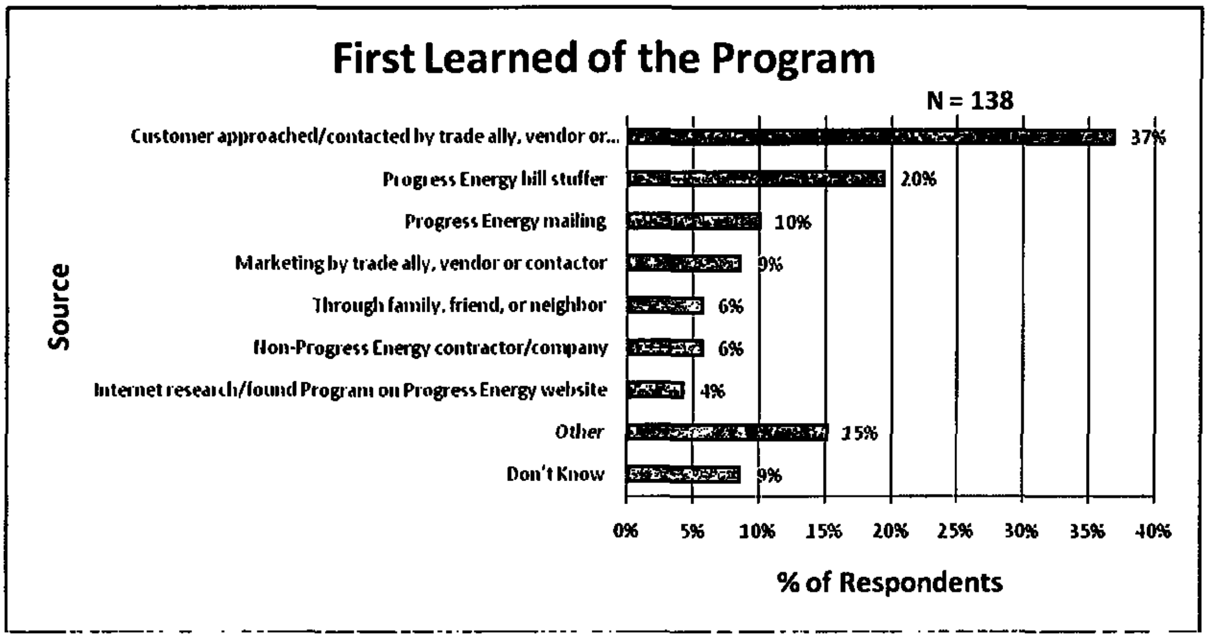
NAVIGANT

Figure 5-2: Where Contractors Heard About Progress Energy's HEIP Program



Customer survey results indicate that the program is working as designed, e.g. that contractors play a very important role in the program process. Participants were asked to indicate all the sources through which they learned about the program; 37% learned about the program through direct contact from a contractor, while 9% learned about it through contractor marketing. Figure 5-3 shows the range of ways in which customers found out about the program.

Figure 5-3: Where Program Participants First Learned about the Program



When asked to rank the importance of the information sources from which they learned of the program, 30% of program participants cited a PEC source (bill stuffer, direct mailing, or website), while 46% cited contractors. The survey results suggest that, while PEC's marketing materials are effective, contractor communications are even more so.

5.2.4 The Contractor Network

The contractor network is the core of HEIP. After its initial recruitment and training efforts, contractor recruitment has come from customers who ask their contractors about the program, from calls to Honeywell, and from PEC's website. Contractors do not receive any incentive for participating in the program, but many seem to see it as a competitive edge in a tight market.

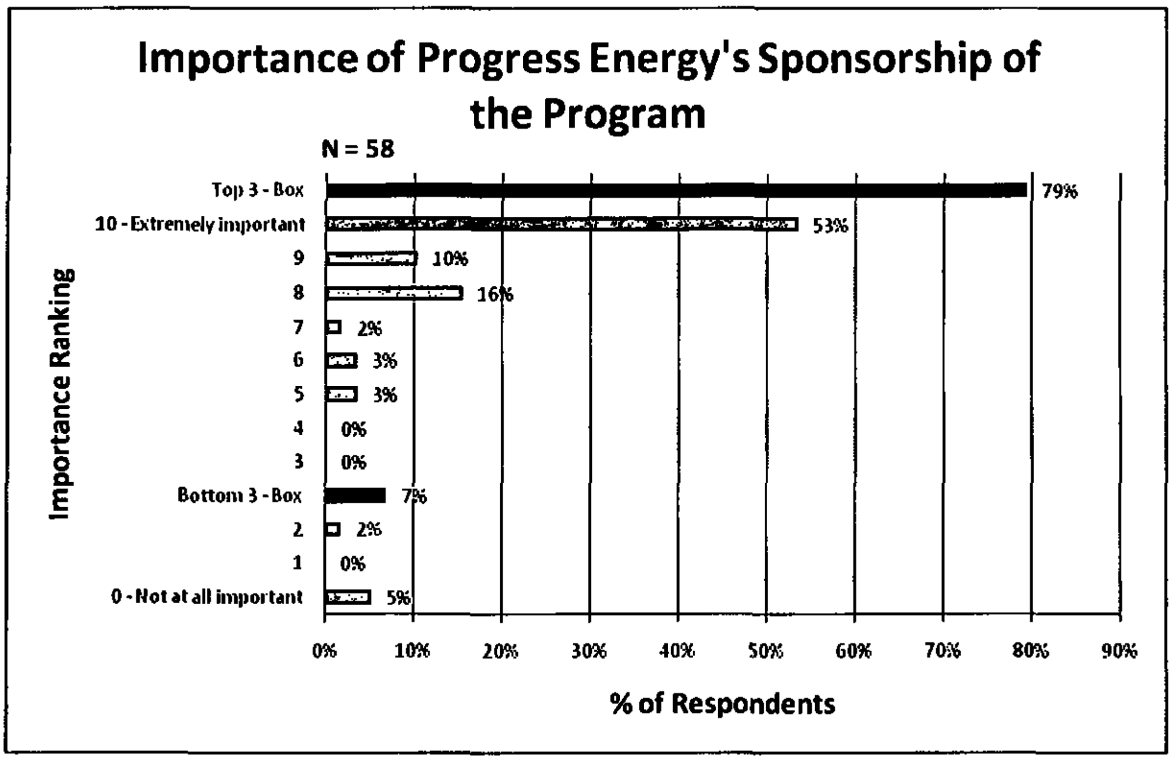
Contractors receive several benefits for program participation, including: initial training, marketing support, and a web tile (message block/image button on their website). At the end of 2009, PEC was working on a program logo for contractors to use, as well as on some cooperative advertising.

Because contractors do not receive any incentives, PEC does not require that they meet any minimum thresholds to participate in the program. However, they need to be trained on the program, and their work must pass quality assurance inspections. To obtain and maintain their status as pre-qualified, contractors have to sign an agreement (release and indemnity), and abide by program rules and conditions

Contractors use the marketing materials PEC provides them, and they actively market the program to their customers. Nearly three quarters of the contractors surveyed believe they have the tools from PEC that they need to market the program. Contractors use a variety of methods to market the program: 35% commonly use handouts, pamphlets, brochures, and flyers; 32% said that they make comments to customers about rebates and incentives for the various measures that are offered; 21% percent mentioned word-of-mouth marketing as one method used; and 13% rely on PEC's marketing.

The evaluation team asked contractors how important to program success, on a scale of 0 to 10, they consider PEC's program sponsorship to be. Seventy-nine percent of the contractors surveyed believe PEC's sponsorship to be very important or higher. Figure 5-4 shows the full results.

Figure 5-4: Importance of Progress Energy's Sponsorship of the HEIP Program



PEC provides training to the contractors in its network. The evaluation team asked contractors how valuable they considered the training to be. Three quarters of those who received training (76%) felt that the training was very valuable, and ranked it above an 8 on a scale of 0 to 10.

Contractors were then asked if they thought more training would be useful. Fifty-five percent responded positively, saying they would find more training useful. Those who responded positively were then asked to provide what additional program or technical training would benefit their businesses or employees the most. Of the many options, twenty-two percent mentioned training on duct sealing and testing, 13% listed continued education on new energy requirements that come out, and 9% mentioned training on how to approach customers. An additional 9% mentioned training on air flow, sealing, and safety courses.

Fifty percent of respondents cited other examples of training they would find useful, including:

- Diagnostics training (6%)
- Marketing training (6%)
- Attic insulation (3%)
- Online and phone training (3%)
- More audit training (3%)

While economic development is not an explicit HEIP program goal, most of the participating HEIP contractors are small businesses, and two thirds of those surveyed have seen an increase in business since joining the program. Eighty-six percent of contractors who participated in the program in 2009 are very satisfied with their participation, giving it a rating of 8 or higher out of 10.

5.2.5 Customer Experience

Customers who participated in the 2009 HEIP program also rate the program highly. On a scale of 1 to 10 where 10 is excellent, 86% of participants ranked their overall experience with the program as an 8, 9, or 10, with 60% responding that their experience was a "10," or that they were "extremely satisfied."

The survey asked participants about their satisfaction with several key program aspects, including satisfaction with the information provided, program costs, and with the specific program components. Customers were asked to rank their level of satisfaction with providing program information on a scale of 1 to 10, with 10 meaning "extremely satisfied." Most customers were highly satisfied, grading the program with an 8 or higher.

Customers also were satisfied with program costs. When aggregated by measure, at least 70% of the customers who installed each measure were satisfied or very satisfied with the measure's costs, again on a scale of 1 to 10. In fact, well over 50% for each measure gave the program costs a perfect "10" ranking, meaning that they were extremely satisfied.

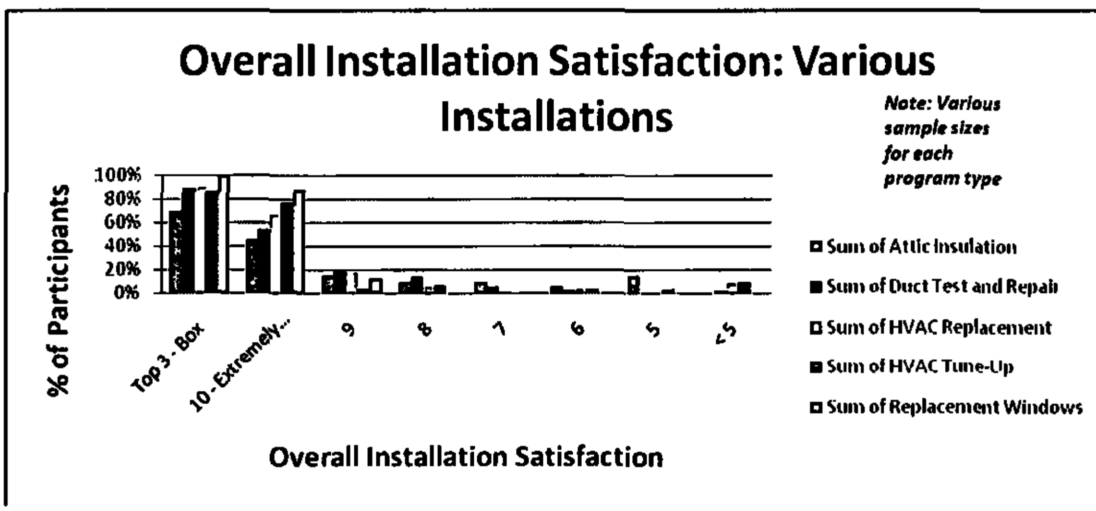
Not surprisingly, customers also are very satisfied with measure installation. Over 70% of the customers who installed each measure consider themselves to be very satisfied with the installation. Most notably, 100% of respondents reported overall satisfaction at 8 or higher with window replacement measures. And no participants indicated dissatisfaction with replacement window installations and attic insulation installations. Those measures with which customers indicated some level of dissatisfaction included HVAC tune-up and HVAC replacement. Customers offered two reasons for their dissatisfaction:

-*"Length of time (installation) took"*

-*"Issues with contractor"*

Figure 5-5 shows the range of customer responses on measure installation.

Figure 5-5: Overall Installation Satisfaction for Various Installations



Additional findings from the customer survey can be found Appendix E.

5.2.6 PEC's Website

The evaluation team reviewed PEC's online presence, educational materials, and marketing collateral. Our goal for this analysis included comprehensive assessment of online properties, using interactive best practices as our guide. Our review assumed each site could potentially be the initial entry point for program participants. These aggregate findings allowed us to identify both "bright spots" for replication and opportunities for improvement.

Since the time we made our initial review, PEC has worked to improve its website. As of the date of this report, PEC was nearing the roll-out of a new website on April 20, 2011, which will automatically direct customers to the appropriate landing page for their location, e.g. to Progress Energy Carolinas, rather than to a page that requires the customer to indicate either Progress Energy Florida or PEC.

Section 6. Conclusions and Recommendations

HEIP is running well, with strong participation and good tracking of program activity in 2009, the first year of program operation. The foundation is in place for building on the program's first year performance to achieve increasing savings in future years.

6.1 Conclusions

PEC concluded a successful first year administering HEIP, building a large network of qualified contractors and getting strong participation across the region. The EM&V effort verified 2009 gross savings of approximately 2.5 GWh of reduced energy consumption and 2.4 MW of coincident peak load reductions.

The verified gross savings exceed the 2009 program projections provided in the original program filing by more than 50% for participation and peak demand reductions and by more than 25% for energy savings, as shown in Table 6-1. Relatively low realization rates, due to the evaluation's finding of lower-than-assumed measure unit savings values, are more than offset by field verification of nearly 100% of measure installations and by a higher-than-projected participation rate, Participation was driven by an effective campaign to recruit participating contractors who attracted customers to the program.

Table 6-1: Verified Gross Savings Compared to 2009 Program Projections

	Participants	Annual Energy Savings (MWh)	Peak Demand Reduction (MW)
Program Filing (Projected)	5,005	1,965	1.50
EM&V Verified Gross (Actual)	8,676	2,494	2.37
Actual/Projected	173%	127%	158%

Sources: Navigant analysis, HEIP tracking database, and HEIP filings with the North Carolina Utilities Commission, Docket No. E-2, Sub 936, February 24, 2009 and with the Public Service Commission of South Carolina, Docket 2009-190-E, May 11, 2009. Projected gross savings were calculated from net savings values in the program filings using PEC's assumed net-to-gross ratio of 0.80.

Onsite field verification of equipment installations and measures reported in the program database was excellent, at near 100% verification of both quantity and measure characteristics, demonstrating that HEIP generally has good data tracking and quality control, both of which are necessary for the long-term success of the program. However, the evaluation identified several energy and peak demand savings assumptions that likely overstate savings from installed program measures. As a result, gross realization rates (i.e., the share of program reported savings verified through EM&V) were low, at approximately 50% for energy and 61% for demand, which reflects the uncertainty and optimism in the measure savings assumptions used by PEC in its initial program design. This is not uncommon in a first year program, and adjustments going forward can improve realization rates significantly.

There are pockets of low participation, especially in South Carolina and portions of the North and South regions in North Carolina outside of Raleigh and Southern Pines, which offer opportunities for program growth. At the same time, there are hot spots in Raleigh, Southern Pines, and Wilmington where the program has produced a lot of traction in the first year; merely staying the course and transitioning to more word-of-mouth marketing based on customer testimonials should result in strong program activity in these areas in coming years. PEC should be able to increase both participation and cost-effectiveness of HEIP in future years, contributing significant, cost-effective energy and peak demand reductions to PEC's portfolio.

6.2 *Recommendations*

The evaluation team recommends 11 discrete actions for improving the HEIP offering, based on insights gained through staff and contractor interviews, participant and prequalifed contractor surveys, analysis of program records and assumptions, and review of onsite verification data. These recommendations provide PEC with a roadmap to fine-tune HEIP for continued success, and are organized around three broad objectives:

1. Improving average savings and increasing program participation,
2. Improving program delivery, and
3. Enhancing program tracking and evaluation efforts.

Table 6-2 summarizes these program recommendations.

Table 6-2: Summary of Recommendations

Improving Program Cost Effectiveness	
1. Tighten eligibility requirements for measures that are not meeting average savings expectations.	a. Require electric heating for participation where a measure does not meet cost-effectiveness requirements.
	b. Limit eligibility for duct sealing to systems where at least half of the ducts are located in the attic
	c. Limit window rebates to customers replacing single pane windows, especially in the Western region.
2. Relax restrictions on participation for measures that are meeting savings expectations.	a. Expand eligibility for envelope measures to include customers with electric heat, even absent central cooling.
	b. Expand eligibility for envelope measures, as above, but limit eligibility to customer in the Western region.
3. Add program elements and incentivize bundled measures to increase customer and program return on investment.	a. Offer a rebate for HVAC quality installation (verified refrigerant charge and airflow).
	b. Offer a rebate for combining duct sealing and envelope measures with new downsized HVAC equipment.
	c. Offer additional rebate for more air sealing in conjunction with ceiling insulation and air sealing.
Improving Program Delivery	
4. Target underperforming areas of the service territory for additional marketing and/or contractor development.	a. Locate field staff outside of Raleigh area.
	b. Increase marketing to South Carolina.
	c. Target marketing to underperforming rural areas using local newspapers and community outreach.
5. Offer technical training and workshops for contractors, particularly for duct sealing and air sealing.	
6. Offer marketing training for contractors.	
7. Increase marketing in 2011 to fill the void left by the expiration of the ARRA tax credits.	
8. Make revisions to the Save the Watts webpage, such as directing PEC customers directly to the appropriate Progress territory.	
Enhancing Program Tracking and Evaluation Efforts	
9. Revise application forms to specify the type of measure data required to estimate energy savings.	As an example, the windows application should require each window size to be specified separately, with documentation of the total number of each size and the resulting square footage.
10. Modify program processes to integrate data collection activities required for EM&V.	a. Require the "ARI" number of the new equipment combination installed for HVAC system replacements. b. Invite participants to complete a customer satisfaction and free ridership survey at, or shortly after, the time of measure installation.
11. Track savings at a finer resolution using multiple, updated deemed savings values on the basis of measure size, quantity, location, or other characteristics that will provide for a more accurate estimate of energy and peak demand reductions.	

6.2.1 Recommendations for Improving Program Cost Effectiveness

In general, the dual objectives of maintaining high average savings and increasing program participation are difficult to reconcile. If average savings targets are not being met, options include limiting or expanding participation to high savings applications (e.g., efficiency measures in homes with electric heat or where the replacement baseline is low). Recommendations are as follows:

1. **Tighten eligibility requirements for measures that are not meeting average savings expectations.** If a measure is not cost-effective based on the 2009 verification results, there may be a subset of installations that *are* cost-effective. The updated unit savings values produced as part of this evaluation (found in Section 4.2) constitute a resource for determining the specific requirements for each measure that will produce the desired savings. Measure eligibility rules can be optimized to allow as many customers as possible to participate while still meeting cost-effectiveness requirements for the measure on the whole. If cost-effectiveness requirements for a given measure can be met without restricting participation, then there is no need to make changes.[29]

   Options include:

   a. Require electric heating for participation where a measure does not satisfy cost-effectiveness requirements.

   b. Limit eligibility for duct sealing to systems where at least half of the ducts are located in the attic.

   c. Limit window rebates to customers replacing single pane windows, especially in areas with low cooling loads, like the Western region.

2. **Relax restrictions on participation for measures that are meeting savings expectations.** Homes with electric heat offer opportunities for large energy savings, even if some may not have central air conditioning and therefore may provide relatively little peak demand savings. Options include:

   a) Relax the requirement that customers have central air conditioning in order to quality for envelope measures. In particular, expand eligibility to include customers with electric heat.

[29] The evaluation team did not review cost-effectiveness calculations or perform new calculations using revised measure savings assumption. Thus, the team cannot identify specific measures for which modifying eligibility requirements might be appropriate to increase cost-effectiveness. The list of options provided here represents a subset of the measures for which characteristics of the participants' homes are likely to create a significant disparity in realized savings.

b) Expand eligibility for envelope measures, as above, but limit eligibility for homes without central cooling to customers in the Western region, where winter peak reductions have been a strategic objective for PEC in the past.

3. **Add program elements in combination with providing incentives for bundled measures to increase customer and program return on investment.** Transaction costs are high for residential downstream rebate programs with small measures, and many measures may have borderline cost-effectiveness by themselves. When measures are bundled together, however, those transaction costs are spread over greater savings, and the resulting cost-effectiveness of the group of measures is likely to be greater than for individual measures. An example of this is combining new HVAC equipment with quality installation, which includes duct sealing, proper refrigerant charge, proper airflow, and proper sizing. This generates higher savings while costing less by encouraging contractors to install smaller equipment after they have upgraded the ducts. Similarly, HVAC equipment can be bundled with building envelope upgrades (attic insulation, efficient windows, etc.) to further reduce system size and increase savings.

6.2.2 Recommendations for Improving Program Delivery

4. **Target underperforming areas of the service territory for additional marketing and/or contractor development**, and consider locating field staff outside of Raleigh to support this effort. (See Appendix C-2 for a map illustrating relative participation by geographic regions). These areas include:
    a. South Carolina
    b. Western region
    c. Areas of the northern and southern regions outside of the Raleigh/Southern Pines areas – Henderson, Fayetteville, Asheboro, Rockingham, and more rural areas.

5. **Offer technical trainings and workshops for contractors**, particularly for duct sealing and air sealing. Air sealing is emerging as a large problem area due to the many insulation contractors with little experience in the area who signed up for the program. Honeywell is aware of the problem and is taking corrective action. Additionally, 50 percent of survey respondents indicated additional training would be useful and put forth duct sealing and testing as the number one topic.

6. **Offer marketing training for contractors.** Program marketing and promotion by contractors is a key component of PEC's marketing strategy, and as such, a continued

and greater focus on marketing tactics and program sell points is likely to increase participation. Survey results support the importance of contractors in promoting the program: 37% of homeowners learned of the program directly from a contractor, and an additional 9% learned of it through contractor marketing. More people ranked contractors as having been their most important information source (46%) than program marketing from PEC (30%).

7. **Increase marketing in 2011 to fill the void left by the expiration of the ARRA tax credits.** While both customers and prequalified contractors reported that the ARRA tax credits influenced customer decisions to participate in the program, both groups also cited PEC's sponsorship as another important factor. Since the ARRA tax credits ended in December 2010, PEC may need to increase its marketing effort to maintain the same overall participation levels – and maintaining the strong PEC brand will grow in importance for customers decide whether to invest in efficient products.

8. **Make revisions to the Save the Watts webpage.** The Save the Watts website is difficult to navigate both for customers interested in the HEIP program and for participating contractors. Making changes such as directing PEC customers directly to the appropriate Progress territory (rather than landing on a page that requires them to indicate whether they are in the Carolinas or in Florida) is one of several steps PEC should take to facilitate customers' access to information about the program.[30].

6.2.3 Recommendations for Enhancing Program Tracking and Evaluation Efforts

The following recommendations will aid the evaluation process and ensure that reported results track closely with verified savings and that the evaluation provides beneficial and actionable recommendations for program staff:

9. **Revise application forms to specify the type of measure data required to estimate energy savings.** Currently, the application forms for some measures allow contractors or customers to choose the units and level of detail for installation characteristics. Standardizing and specifying data fields will reduce or eliminate variability in the methods used to complete applications, which will allow for more accurate estimation of savings (especially in conjunction with Recommendation 11 below). For example, for windows measures, participants should be required to enter the number of windows of

[30] PEC is in the process of overhauling its website, with the new site expected to launch during the first quarter of 2011. Many of the issues raised regarding the Save the Watts website will be addressed in the new design.

each size installed, with the number of square feet per window of that size. Automatic checks can be used to verify that the square footage is not outside the typical range.

10. **Modify program processes to integrate data collection activities required for EM&V.** "Integrated data collection" (IDC) is a process by which data used in evaluation is collected during program delivery. This may include equipment specifications, engineering measurements, and customer feedback. PEC already has incorporated significant IDC for the impact analysis through collection of baseline data. Expansion of IDC would improve the evaluation, particularly with regard to process evaluation and assessment of free ridership.

    Specific recommendations include:

    a. Require the "ARI" number of the new equipment combination installed for HVAC system replacements.

    b. Invite participants to complete a customer satisfaction and free ridership survey at, or shortly after, the time of measure installation. Issuance of the incentive payment provides an additional opportunity for measures where customers receive rebates directly from PEC or its implementation contractor.

11. **Track savings at a finer resolution using multiple, updated deemed savings values** on the basis of measure size, quantity, location, or other characteristics that will provide for a more accurate estimate of energy and peak demand reductions. Recommended modifications include the following:

Table 6-3: Recommended Metrics for Tracking Savings

Measure	Savings Metric Savings per…
Windows	Square footage of window installed
Duct sealing	Square footage of served area; (possibly further disaggregated by attic vs. crawlspace)
Air-source heat pumps, central air conditioners, and HVAC tune-ups	Tons of cooling capacity (possibly also square footage of served area)
Insulation	Square footage of area insulated

NAVIGANT

2009 EM&V Report for the Home Energy Improvement Program

Appendices
(Final)

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Appendix A: Glossary of Terms

This glossary presents some of the common terms used throughout this report. The evaluation team has endeavored to define terms the first time they appear in the body of the report and to describe them in context where the authors deem that repeated explanation may warranted.

Deemed Savings: assumed unit savings values used in program design and tracking. See Unit Savings.

EM&V: short for Evaluation, Measurement and Verification - the assessment and quantification of the energy and peak demand impacts of an energy efficiency program.

Energy Savings: kWh savings over a given period of time, generally expressed in savings per year.

Field Verification Rate: the ratio of savings from equipment and measures verified on site versus that reported in the program database; calculated as the product of the quantity verification rate and the measure characteristic verification rate.

Gross Realization Rate: the ratio of verified gross savings to reported gross savings.

Gross Savings: reductions in energy consumption and peak demand based on engineering estimates for known quantities and types of measure installations; gross savings do not account for whether the measures were installed as a result of the program.

Measure characteristic verification rate: reflects discrepancies between reported and verified characteristics related to the efficiency of the equipment installed or the way it was installed. It is the ratio of savings generated by equipment with the characteristics actually installed on-site to the savings generated by equipment with the reported characteristics. This does not include size/quantity, but does include efficiency, installation location, and installation type.

Measure unit savings adjustment factor: the ratio of updated unit savings values to the original deemed savings values used in the program tracking database.

Net Savings: savings attributable to the program, after adjustments for free-ridership.

Peak Demand Reductions: the reduction in peak power demand that is coincident with the utility system peak. When the season is not specified, the implicit assumption is that peak demand reductions are summer peak demand reductions.

Quantity Verification Rate: reflects disparities in quantity and size between the program database and actual, on-site conditions verified by the EM&V team. It is the ratio of the quantity of a given measure verified on site to the quantity of a given measure that was reported, with adjustments for any differences in the equipment size.

Reported Gross Savings: the program savings as reported in the HEIP tracking database.

Unit Savings: the energy or peak demand reductions of a given measure *per unit* installed. Units differ by measure; for example, unit savings may be given as kWh per ton cooling capacity, or peak kW per square foot of window installed.

Verification Rate: See Field Verification Rate.

Verified Gross Savings: the gross savings verified by the EM&V team; these are the final third-party-verified gross savings for the program.

Appendix B: Detailed Impact Analysis Methodology

The impact analysis consisted of three parts:

1. First, the results of the on-site field data collection were used to **derive verification rates by measure.**

2. Next, **unit savings values were updated** by using participant billing data analysis and residential appliance saturations to calibrate energy simulation models for each major measure in each region. The team also used secondary research to derive percent savings estimates for HVAC level 1 tune-ups. An updated unit savings database was created from the model results for 2009 participants.

3. Finally, the team used verification rates and updated unit savings values to **calculate measure- and program-level gross savings.** The impact analysis was comprised of the following steps:

Step 6.1: Update Unit Savings Values

Analysis of Participant Billing Data

In order to determine energy consumption targets for energy model calibrations, Navigant analyzed billing data from ~8,700 HEIP program participants. Data from PEC was in the form of rows containing energy consumption for the past billing period and the billing date. Data was cleaned and converted to energy consumption for each calendar month by the following process:

1. Sum all consumption values for a particular month and year for each site to remove erroneous data[1].
2. Find the number of days in each billing period by subtracting the numeric value of the last date from the current date.
3. Determine the average consumption per day in each billing period by dividing total consumption by number of days.
4. Calculate consumption per day at the beginning and end of each billing period by assuming a constant slope between consumption per day of the previous period and that of the following period, and using that slope to adjust the average consumption per day of the current period.

[1] Erroneous data was stored as multiple lines for the same month: one for the erroneous value, one for the negative of the erroneous value (to cancel it out), and one for the correct value.

5. Assign consumption values to each day of the billing period by assuming that consumption per day linearly follows the slope calculated in (4).
6. Determine consumption for each calendar month by summing the consumption per day for the appropriate days of the two billing periods that contain part of that month. [2]

This data was averaged to produce monthly consumption for each site, using all months prior to the date of the measure installation (the "pre" case). Average monthly consumption was then calculated for each region, for each measure group, and for each measure within each region. These average values were plotted and examined, and it was determined that the participant groups split out by measure and region had large enough differences to merit creating individual models for each.

Average consumption was taken for each measure in each region except for those that had less than 30 sites' worth of billing data[3]; those latter were modeled using the average consumption for the entire region. In addition, the percent of participants with each of the four heating types (gas furnace, heat pump, dual-fuel heat pump, and electric resistance) was calculated for each measure group, to be used in the calibration process.

Disaggregate Billing Data into End-Uses

Once average monthly consumption was determined for each model group, those monthly total values were broken down by end-use using the Navigant billing data end-use disaggregation method. This method is Navigant's standard practice, and has been used in performing numerous residential evaluations nationwide. The basic steps are as follows:

1. **Determine average monthly consumption** for each model group by aggregating monthly participant billing data (described above).
2. **Estimate lighting and domestic hot water (DHW) usage** based on the U.S. DOE's Building America Research Benchmark and a study on lighting usage for the California IOUs (KEMA 2005), using average building size and electric hot water heater saturation for each region.

[2] This method, while more complex than simply determining the portion of each billing period in each month and assigning a proportional amount of the consumption to that month, is a more accurate way of dividing consumption. The alternative method will tend to reduce the (real) split between the highest and lowest consumption months by assuming that consumption in a given billing period is constant; it is important to get an accurate value for the lowest consumption month, since that drives the end-use disaggregation described below.

[3] Measures that did not have enough participants to be modeled explicitly included Eastern Central AC, Southern Central AC and Attic Insulation, and Western Central AC, Duct Sealing, and Windows.

3. **Calculate the remaining consumption,** which is attributable to HVAC and miscellaneous equipment (all uses other than lighting, DHW, and HVAC), by subtracting lighting and DHW consumption from the monthly average.
4. **Calculate miscellaneous equipment consumption** by:
    a. Identifying the base month, defined as the month with the lowest remaining consumption per day (April for the Northern, Southern and Eastern regions and May for the Western region); assume that heating and cooling (HVAC) consumption accounts for a small fraction of the total in the base month (usually ~10-15% in temperate climates with both heating and cooling).
    b. Subtracting the HVAC consumption in the base month from the remaining consumption; assume that this miscellaneous equipment consumption per day is constant throughout the year.
5. **Calculate HVAC consumption** by subtracting lighting, DHW and equipment consumption from the monthly average.
6. **Split HVAC consumption into heating and cooling** by assigning all winter season (Dec-Mar) HVAC consumption to heating and all summer season (Jun-Sep) HVAC consumption to cooling; split swing season HVAC consumption by assuming heating and cooling are proportional to the heating and cooling degree days in each month.4
7. ***Adjust the heating and cooling consumption*** *in each month by multiplying by the ratio* of average heating or cooling degree days for that month in the bill period to those of the same month in a typical year.

The first step in disaggregating monthly energy consumption into end-uses is to break out the uses that can be reliably calculated using engineering algorithms and primary research: lighting and domestic hot water (DHW).

Lighting. Annual lighting consumption per household was estimated using an equation from the US DOE's Building America Research Benchmark (BARB), which gives lighting consumption as a function of square footage of floor area:

$$\textit{Annual Lighting Consumption}\ (kWh) = 0.8 * \textit{Floor Area}\ (sf) + 805$$

To break the annual consumption into monthly values it is necessary to derive a seasonal load profile, due to the fact that lighting use increases during the winter months when there is less

[4] Heating and cooling degree days taken from www.degreedays.net, a website which aggregates data from the Weather Underground (www.wunderground.com)

daylight. The seasonal lighting variation profile was derived from a recent CFL monitoring study performed for the California investor-owned utilities (KEMA 2005). The basic steps are as follows:

1. **Determine the percent of total hours and weighted average hours per lamp** that are daylight-sensitive; assume family, kitchen/dining and living rooms are daylight sensitive. Input data and calculated result are shown in Table 2-1 and Table 2-2 below:

Table 2-1: Number of Fixtures and Average Daily Usage by Room Type

Room Type	Daylight Sensitivity	Number of Fixtures	Percent	Average Hours of Use
Bedroom	0	669	27%	1.6
Bathroom	0	400	16%	1.5
Family	1	194	8%	2.5
Garage	0	72	3%	2.5
Hallway	0	184	7%	1.6
Kitchen/dining	1	484	19%	3.5
Living	1	342	14%	3.3
Laundry/utility	0	68	3%	1.2
Other	0	94	4%	1.9

Source: KEMA 2005

Table 2-2: Percent of Total Hours and Weighted Average Daily Usage by Daylight Sensitivity

Type	% of Total Hours	Weighted Average Hours of Use
Daylight Sensitive	58%	3.24
Non Daylight Sensitive	42%	1.65

Source: Calculated from KEMA 2005

2. **Calculate an average percent "night adder"** by assuming an average adder of 0.75 hrs/day for daylight-sensitive lamps and 0.25 hrs/day for non-daylight sensitive; divide these values by the average hours per day and weight by the percent of total hours to get an average night adder (20%).
3. **Determine relative daily usage** by assuming that usage varies linearly from a minimum of (1-Night Adder) in June to a maximum of (1+Night Adder) in Dec; add an additional 20% to December to account for an observed spike in energy consumption in this month, assumed to be due to holiday lighting.
4. **Calculate relative monthly usage** by multiplying daily usage times the number of days in the month.

5. **Derive the monthly variation profile** by dividing each month's usage by the average monthly usage for the whole year. Steps 3, 4, and 5 are shown in Table 2-3:

Table 2-3: Daily Usage, Monthly Usage and Lighting Variation Profile

Month	Relative Daily Usage	Days/Month	Relative Monthly Usage	Lighting Variation Profile
Jan	113%	31	35.09	1.13
Feb	107%	28	29.85	0.96
Mar	100%	31	31.00	1.00
Apr	93%	30	28.02	0.91
May	87%	31	26.91	0.87
Jun	80%	30	24.06	0.78
Jul	87%	31	26.91	0.87
Aug	93%	31	28.95	0.94
Sep	100%	30	30.00	0.97
Oct	107%	31	33.05	1.07
Nov	113%	30	33.96	1.10
Dec	140%	31	43.40	1.40

Source: Calculated from KEMA 2005

The average monthly lighting electricity consumption for each model group was then calculated by multiplying the variation profile by the annual lighting consumption estimate.

Domestic Hot Water. The starting point for determining seasonal hot water end usage was the hot water end-use profiles from the 2008 Building America Research Benchmark. Average gallons per day of hot water are given for each month for dishwasher, clothes washer, baths, showers and sinks, along with the average temperature of the water mains. An example of this data (for Raleigh) is shown in Table 2-4 below:

Table 2-4: DHW Profile for Raleigh, NC

Month	Mains Temp (ºF)	Dishwasher DHW (gal/day)	Clothes Washer DHW (gal/day)	Bath DHW (gal/day)	Shower DHW (gal/day)	Sinks DHW (gal/day)	Total DHW (gal/day)
Jan	55.3	5.0	15	5.39	21.52	19.19	65.80
Feb	54.8	5.0	15	5.40	21.57	19.23	65.90
Mar	56.9	5.0	15	5.34	21.35	19.04	65.44
Apr	61.0	5.0	15	5.23	20.89	18.63	64.44
May	66.1	5.0	15	5.06	20.22	18.03	63.01
Jun	70.8	5.0	15	4.87	19.48	17.37	61.42
Jul	73.9	5.0	15	4.73	18.90	16.86	60.19
Aug	74.6	5.0	15	4.70	18.77	16.74	59.90
Sep	72.7	5.0	15	4.79	19.13	17.06	60.69
Oct	68.7	5.0	15	4.96	19.82	17.68	62.16
Nov	63.6	5.0	15	5.14	20.55	18.33	63.73
Dec	58.9	5.0	15	5.29	21.14	18.85	64.98

Source: 2008 DOE Building America Research Benchmark

To get total monthly DHW consumption, consumption each of the end-uses is multiplied by the saturations of that end use among participants in the region.[5]

Next, monthly electricity consumption for homes with electric domestic hot water was calculated using the monthly total gallons of hot water and the seasonally-adjusted mains water temperatures. This consumption was composed of two pieces: the water heating load and the UA load, which is the heat required to compensate for heat loss from the water heater tank. The equations used are as follows[6]:

[5] Dishwashers were assigned 100% saturation because it was assumed that households without a dishwasher use just as much hot water washing dishes by hand as they would with a dishwasher.

[6] The following is assumed for calculation: Hot Water Temp = 125, Heating Efficiency = 1, Tank UA = 5, Ambient Temp = 70

$$Heating\ Load\ \left(\frac{kWh}{day}\right) =$$
$$Consumption\ \left(\frac{gal}{day}\right) * 8.31\ \left(\frac{Btu}{gal\ ^{\circ}F}\right) *$$
$$(Water\ Temp - Mains\ Temp)(^{\circ}F)/(Heating\ Efficiency * 3412\ \left(\frac{Btu}{kWh}\right))$$

$$UA\ Load\ \left(\frac{kWh}{day}\right) = Tank\ UA\ \left(\frac{Btu}{hr\ ^{\circ}F}\right) * (Water\ Temp - Ambient\ Temp)(^{\circ}F) * 24\ \left(\frac{hr}{day}\right) /$$
$$(Heating\ Efficiency * 3412\ \left(\frac{Btu}{kWh}\right))$$

The DHW variation profile was then calculated by finding average consumption for each month, and dividing by the average for all months. Table 2-5 shows these calculations for Raleigh:

Table 2-5: DHW Electricity Consumption and Variation Profile for Raleigh

Month	Gal/Day	Mains Temp	Heating Load (kWh/day)	UA Load (kWh/day)	Days/ Month	Total kWh/ month	DHW Variation Profile
Jan	69.1	55.3	11.73	1.93	31	423.5	1.19
Feb	69.2	54.8	11.82	1.93	28	385.3	1.08
Mar	68.7	56.9	11.39	1.93	31	413.1	1.16
Apr	67.6	61.0	10.54	1.93	30	374.2	1.05
May	66.1	66.1	9.49	1.93	31	354.2	1.00
Jun	64.5	70.8	8.51	1.93	30	313.5	0.88
Jul	63.2	73.9	7.87	1.93	31	303.9	0.86
Aug	62.9	74.6	7.72	1.93	31	299.4	0.84
Sep	63.7	72.7	8.12	1.93	30	301.6	0.85
Oct	65.2	68.7	8.95	1.93	31	337.4	0.95
Nov	66.9	63.6	9.99	1.93	30	357.9	1.01
Dec	68.2	58.9	10.98	1.93	31	400.4	1.13

Source: Calculated from the 2008 DOE Building America Research Benchmark

Monthly domestic hot water electricity consumption was then multiplied by the electric hot water saturation to derive average household monthly DHW electric consumption by model group.

Miscellaneous Equipment. After subtracting the hot water and lighting end uses from the monthly household electricity consumption, the remaining consumption is composed of HVAC and miscellaneous equipment, which includes appliances and plug loads. To find the portion of the remaining consumption that is from miscellaneous equipment, remaining consumption per day is calculated for each month, and the month with the minimum daily remaining consumption is identified. This month (April for the Northern, Southern and Eastern regions and May for the Western region) is generally in the spring or the fall, and corresponds to the time of lowest HVAC use. Next, it was assumed that during this minimum consumption month, HVAC accounted for 10% of total consumption (past experience has shown this to be a reasonable assumption). Daily equipment consumption for this minimum month was then calculated as the total consumption per day minus the consumption of lighting, DHW and HVAC. This equipment consumption per day is assumed to remain constant throughout the year.

It was assumed that during the minimum consumption month (May), heating and cooling each make up 5% of the total electricity consumed for that month. The base, non-seasonal monthly electricity consumption was then calculated as the total consumption for May minus the seasonal end uses for May. This includes all appliances, plug loads, and other non-seasonal end uses.

Heating and Cooling. Navigant's experience has shown that heating and cooling energy still makes up 10% of total electricity consumption in typical homes in the minimum consumption. After assuming that the minimum consumption month included 5% heating and 5% cooling, the monthly heating and cooling electricity was calculated by subtracting the hot water, lighting, and base end uses from the total for each month. For June to September, all of the heating and cooling electricity is assumed to be cooling. For December to March, all of the heating and cooling electricity is assumed to be heating. For the last month, November, it is assumed that half the heating and cooling electricity is used for cooling and half is used for heating. The annual heating and cooling end uses were then calculated by summing the monthly heating and cooling end uses.

Create Energy Simulation Models

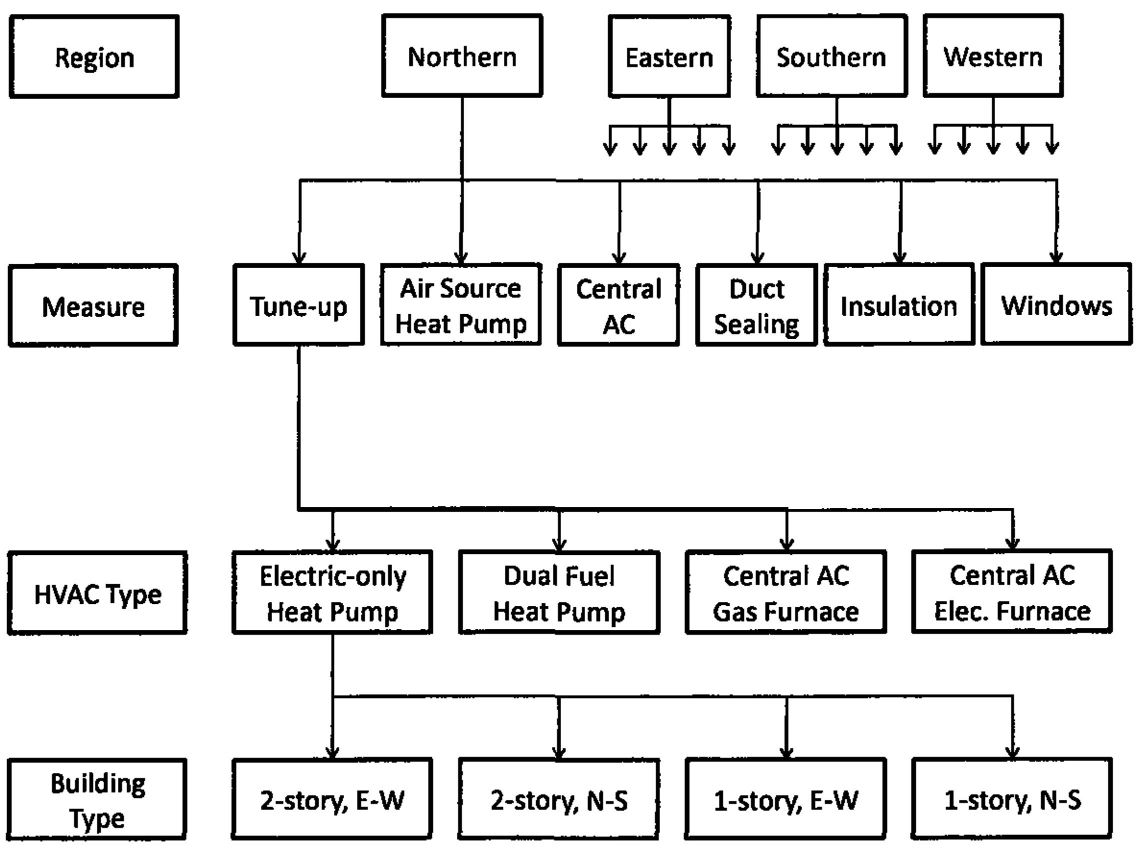
The energy models used in this evaluation were built using the DOE2.2 engine, and were based on the models used in the creation of the North Carolina Measures Database (which were in turn based on the models used in creating the California Database of Energy Efficiency Resources). Each of the models consists of four buildings: two each of single- and two-story homes, oriented N-S and E-W. Four base models were created for each model group, with differing HVAC types:

1. Air-source heat pump with electric resistance supplemental
2. Air-source heat pump with gas supplemental (dual-fuel heat pump)
3. Central AC with gas furnace, and

4. Central AC with electric furnace.[7]

These models were altered to match the participants in each model group by changing the average building size and other characteristics where participant data was available. The model hierarchy is depicted in Figure 2-1 below:

Figure 2-1 Building Energy Simulation Models



Source: Navigant

Calibrate Energy Simulation Models

Calibration was performed on each model group in order to match model energy consumption to the end-use targets for that group. Some model groups did not have a large enough group of participants to give a high degree of confidence in the billing data results; these groups were

[7] For HVAC equipment measures, not all of the base models were needed.

calibrated to the average billing data for the region.[8] Within each model group, all building envelope characteristics were kept the same across the models of different heating types. Calibration was an iterative process, involving the following steps:

1. **Derive modeled end use consumption for each model group** by weighting the eight sets of results (single- and two-story for each of the four heating types) from each simulation run by the percent of homes that were two-story (73%, from field data) and the heating type saturation of the participant group.
2. **Compare the modeled end-use consumption to the calculated participant end-use consumption.**
3. **Adjust calibration parameters and re-run the models.**

This process was repeated until the monthly error and total annual error in each end-use was reduced to no more than 1% of the annual end use target. Calibration parameters were adjusted within pre-determined reasonable ranges, in order to avoid getting unrealistic building characteristics.

Derive Unit Savings

Secondary research was conducted to determine reasonable baseline and efficient cases for each measure. For certain measures (windows, attic insulation) the range of possible scenarios was narrowed to a few base- and efficient-case options, based on the groupings of measure specifics in the program tracking data. Next, parametric model runs were performed for each model group by altering the measure parameters in the calibrated models while leaving all other parameters constant. Finally, unit savings were calculated for all combinations of base and efficient cases by taking the difference between energy consumption and peak demand of the corresponding base and efficient model runs.[9] The final results were compiled into a new database of savings values specific to HEIP, broken down by region, heating type, and several base- and efficient-case options for each measure.

Step 6.2: Derive Verification Rates

In order to determine field verification rates, the results of the field data collection activity were compared with the claimed installations to check for both *quantitative* and *qualitative* differences. For each measure-site combination in the field sample, the field data was first checked for

[8] The central AC measure in the East, central AC and attic insulation measures in the South, and central AC, duct sealing and windows measures in the West were all modeled using the average participant data for their respective regions.

[9] The one exception to this method was the HVAC level 1 tune-up measure; for this measure savings were calculated by taking a percent savings of heating and cooling energy consumption and applying it to the baseline consumption of the calibrated energy models.

completeness and accuracy, then compared to the tracking data. The findings were aggregated across each measure in order to determine two adjustment factors:

1. **Quantity Verification Rate:** this was calculated as the total quantity/size found at all sites in the sample divided by the sum of what was reported in the tracking data for the same sites. For example, at a home with attic insulation, the ceiling area insulated was measured at 1100 square feet, while the tracking database gave 1000 square feet. The resulting quantity verification rate for that site was 110%.

2. **Measure Characteristic Verification Rate:** for each site in the sample, the efficiency, installation location, and installation quality of what was installed was compared to the value reported in the program database. Where there was a discrepancy, a new unit savings value was mapped in from the updated savings database (described below). The measure characteristic verification rate was then calculated as the updated savings of the measures found in the field divided by the updated savings of what was reported in the tracking database, using the quantity reported in the tracking data (to avoid double counting).

The final **verification rate** for each measure was calculated as the product of the **quantity verification rate** and the **measure characteristic verification rate**. In this fashion, energy and peak demand verification rates were calculated for each measure except level 1 tune-ups and geothermal heat pumps, which were assigned average verification rates. Level 1 tune-ups were considered too difficult to verify with any degree of accuracy and geothermal heat pumps were too few in number to have a significant impact on the total program savings. Air-source heat pumps and central air conditioners were lumped together for this analysis, because they are installed by the same contractors, with the same general process and opportunities for mistakes.

Step 6.3: Calculate Program Impacts

Map Updated Savings to Program Tracking Database. Once updated unit savings values were derived from the model runs, they were applied to the tracking data to determine program-level results. Each line item in the tracking database was mapped to a new savings value, based on the region, heating type, and best available match of base- and efficient-case measure characteristics. These new unit savings values were then multiplied by the measure quantity to derive total savings for each line item. Finally, total gross savings values were summed by measure over the whole program.

Appendix C: Supplemental Findings

Appendix C provides supplemental findings on the following topics:

1. Statistical significance of impact findings
2. Participation mapping across the PEC service territory

APPENDIX C-1: Statistical Significance of Impact Findings

Sampling precision for the field verification was determined for each sample stratum's verification rate using a 90% confidence interval. The analysis was conducted for the five measures for which onsite verification was performed (AC, heat pump, duct sealing, windows, and attic insulation), and AC and heat pumps were combined into one stratum, as presented in the body of this EM&V report. Precision values were calculated using stratified ratio estimation, in which the stratum verification rate (i.e., the weighted average ratio between verified and reported savings for sample measures of a given type) was multiplied by the adjusted gross savings (i.e, reported gross savings adjusted for the measure unit savings adjustment factors) for each sampled site measure in the stratum to yield a set of predicted savings values for each sampled measure.[10] The difference between each verified savings value and the same site's predicted value was then the basis for determining a variance for the stratum that was used for purposes of statistical precision calculations.

The precision calculation was based on the final field verification rates for each measure, which combine both the "quantity verification rates" and the "measure characteristic verification rates." However, for six of the sixty-four sampled sites, the EM&V team was not able to verify one or the other of these verification rates; therefore, for purposes of the statistical calculations, the analysis included only the fifty-eight sites for which a complete verification rate could be calculated.[11]

The verification rates by measure are presented in Table 3-1 The overall confidence and precision of the energy and peak demand verification rates each 90/5, indicating a 5% relative precision at a 90% level of confidence. Results for individual strata are generally less precise,

[10] The evaluation team stratified the sample by measure type. Ratio estimation refers to the method of assessing the statistical significance of reported savings. Rather than merely analyzing the verified savings values for each project in the sample, the evaluation analyzed the ratio of verified savings to reported savings (adjusted for changes in measure unit savings values), which generally reduces the variability of data across sampled sites, and thus lowers the coefficient of variation.

[11] Reducing the number of sites used in the analysis can be expected to lower the precision of the findings unless there is a correlation between the quantity and the measure characteristic verification rates for a given site.

with the exception of the heat pump and AC stratum, which was approximately 90/1 (i.e., virtually all sampled installations were verified as properly installed to the same specifications as indicated in the program records). This suggests that some of the individual measure verification rates have relatively high uncertainty and should be interpreted with caution, while the overall program verification rates have relatively low uncertainty and can be viewed as reliable indicators of program performance.

Table 3-1: Uncertainty of Field Verification Rates for Energy Savings and Peak Demand Reductions

	Relative Precision Based on 90% Confidence Interval (+/- %)	
	Energy Savings	Demand Reductions
Total[a]	**90/5**	**90/5**
Heat Pump/AC	90/1	90/0.2
Duct Sealing	90/18	90/18
Windows	90/4	90/9
Attic Insulation	90/25	90/30
Level 1 HVAC Tune-up	N/A	N/A
Geothermal Heat Pump	N/A	N/A

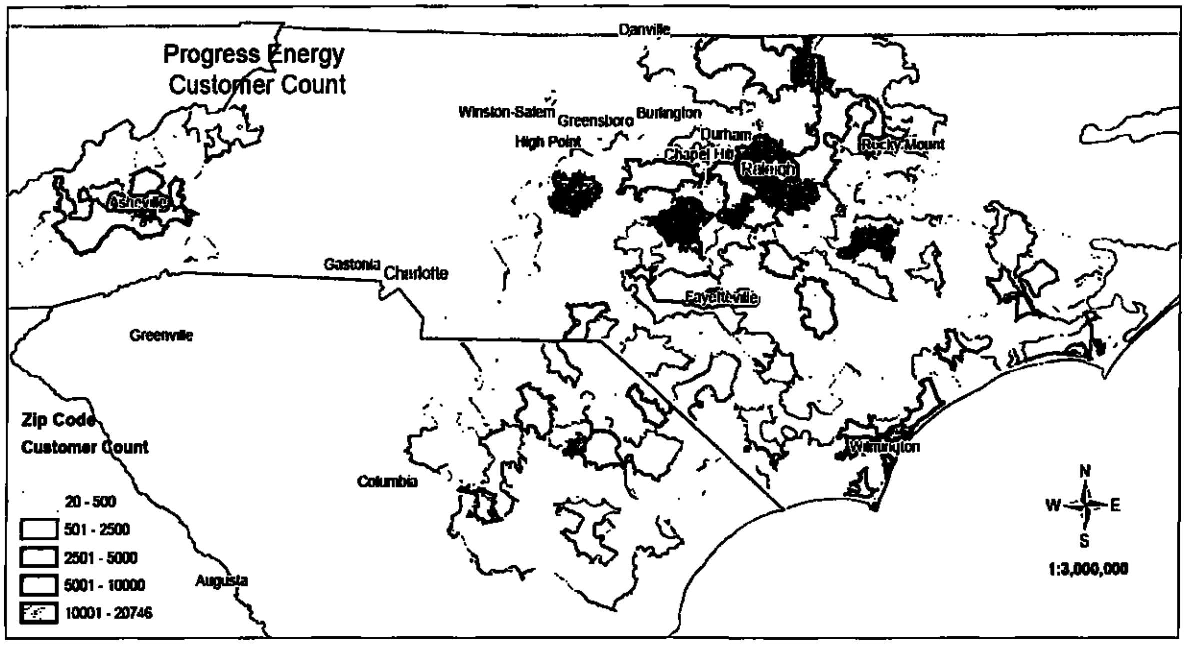
a. The "total" category precision values for energy savings and for demand reductions are a function of both the relative variability within each stratum and the relative energy savings (or peak demand reductions) across the individual strata. Since the relative savings are different for energy and demand, the relative precision levels for energy and demand do not necessarily have to be equal.

Source: Navigant analysis

APPENDIX C-2: Participation Mapping Across the PEC Service Territory

Navigant used Geographic Information Systems (GIS) to analyze the distribution of HEIP program participants and pull out trends that can inform future program design decisions. GIS is used to combine datasets at a geographical level to provide insights into spatial distributions and the reasons for those distributions. In the context of a utility energy efficiency program, GIS analysis can show program staff where participation rates are relatively high or low and where to concentrate future efforts. The first map, Figure 3-1 shows total PEC customers by zip code.

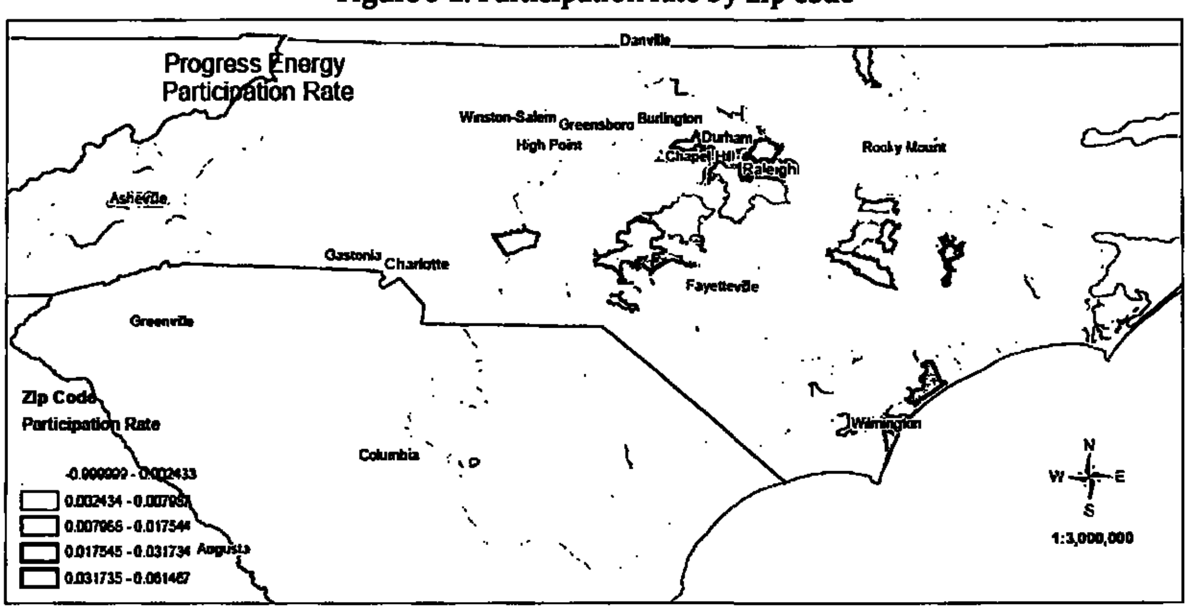
Figure 3-1: Total PEC Customers by Zip Code



Source: Navigant analysis

This map is primarily useful for drawing comparisons to maps of participation. Figure 3-2 shows the overall participation rate (participants per customer) by zip code.

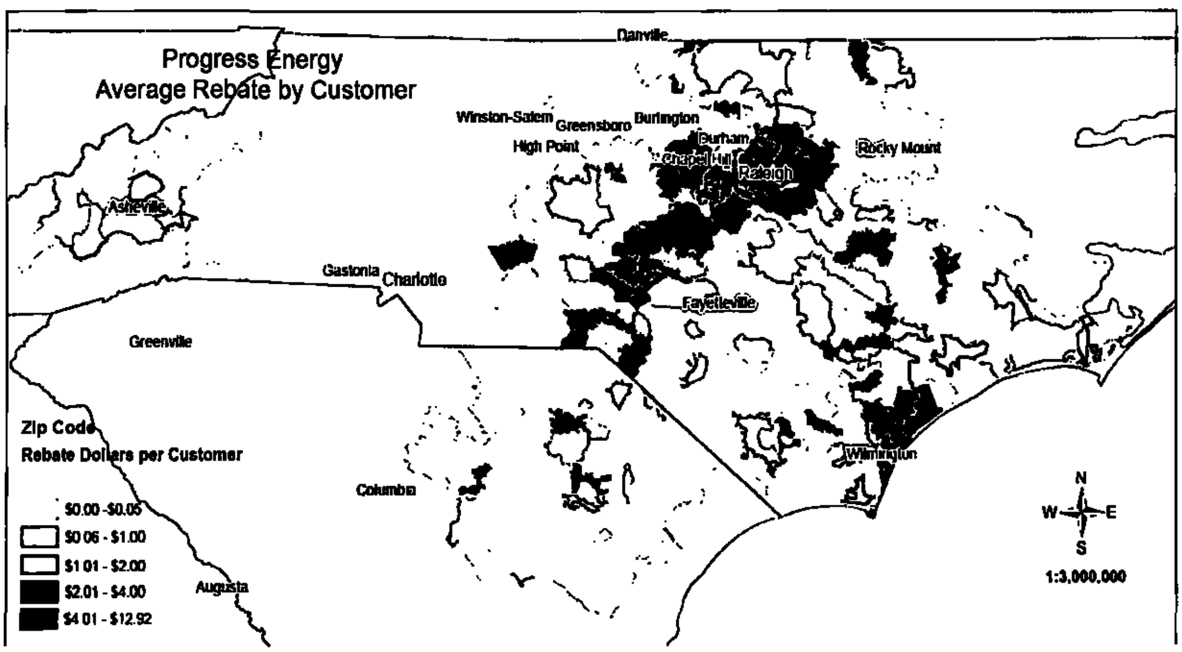
Figure 3-2: Participation rate by zip code



Source: Navigant analysis

The average participation rate is approximately 0.8%, so the two lightest colored regions have below average participation, and the lightest colored regions have extremely low participation. There are some populous areas that have low participation, according to this map. Cities in North Carolina in PEC territory with below average participation include Asheville, Fayetteville, Asheboro, Henderson, and Rockingham. Conversely, the Raleigh, Wilmington, and Southern Pines areas all have strong participation. As participation levels rise, it may be beneficial to target the lagging areas with additional marketing and contractor outreach so that incentive dollars flow evenly across the entire service area. Figure 3-3 shows the current incentive dollar spending per customer by zip code.

Figure 3-3: Rebate dollars per customer

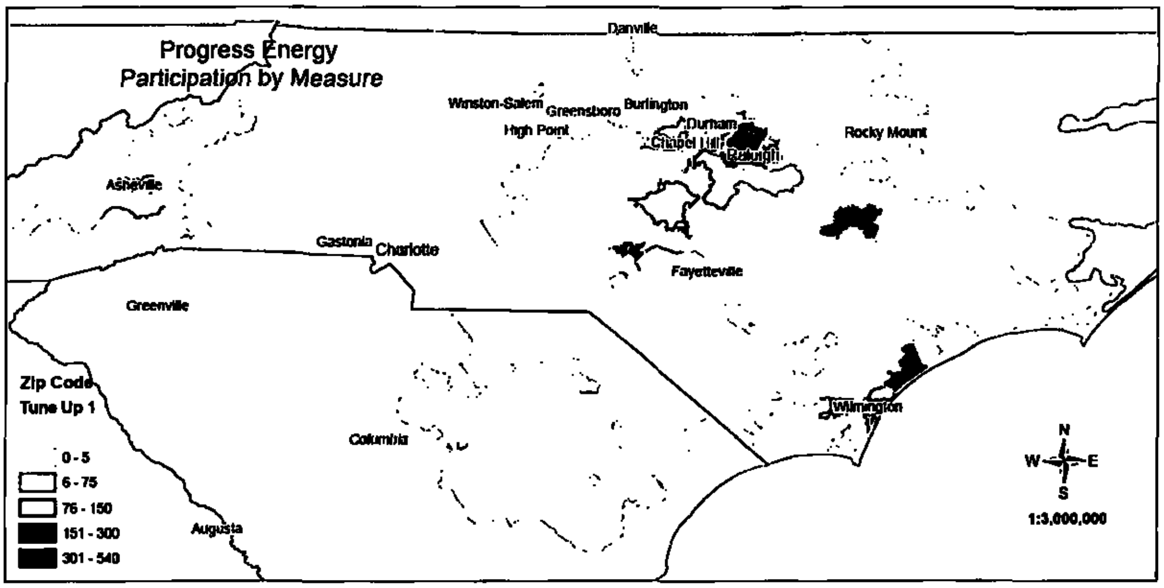


Source: Navigant analysis

The participation rate largely drives the distribution of rebate dollars.

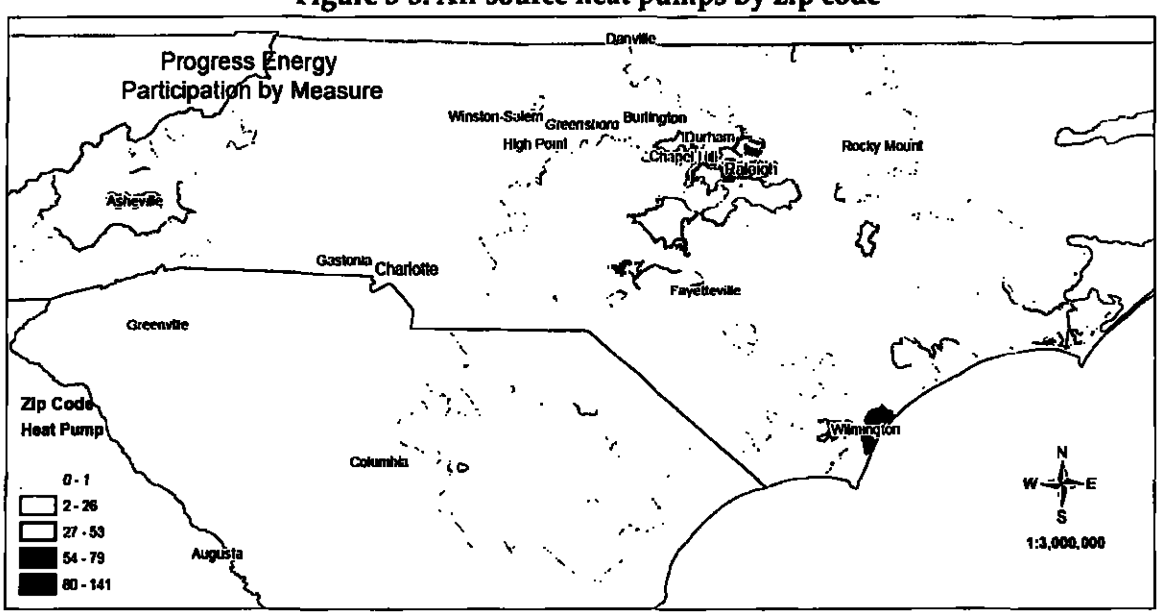
Level 1 tune-up and air-source heat pump installations, shown in Figure 3-4 and Figure 3-5, are concentrated in Raleigh, Wilmington, and Southern Pines, with a small amount of activity in other areas. This likely reflects where the largest contractors doing this work are located.

Figure 3-4: Level 1 Tune-ups by zip code



Source: Navigant analysis

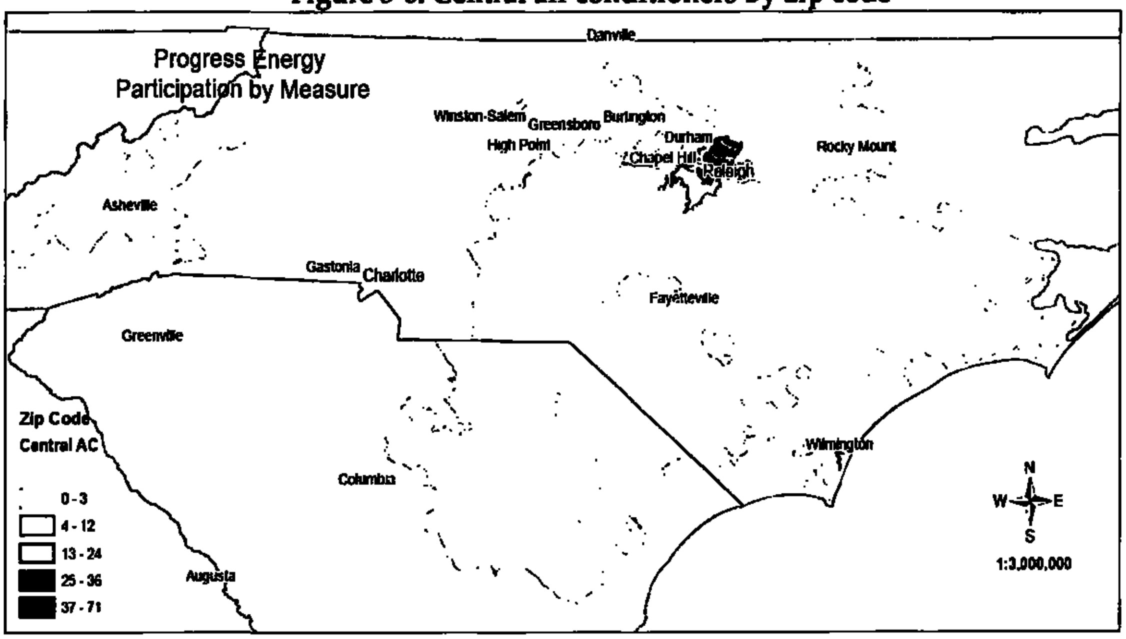
Figure 3-5: Air source heat pumps by zip code



Source: Navigant analysis

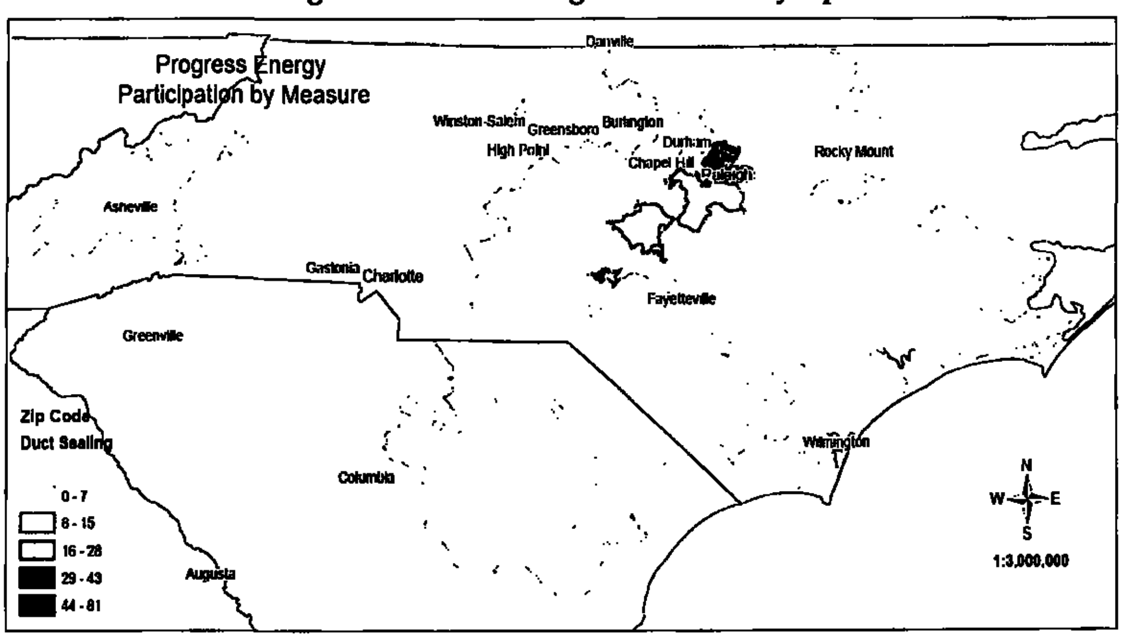
Central air conditioner installations were mostly limited to the Raleigh area, as shown in Figure 3-6. Duct sealing, shown in Figure 3-7, is concentrated in Raleigh and Southern Pines. Duct sealing was generally performed in conjunction with new equipment installations. The hot spots for duct sealing installations generally align with those of air-source heat pumps, with the exception of Wilmington, where duct sealing rates are notably lower.

Figure 3-6: Central air conditioners by zip code



Source: Navigant analysis

Figure 3-7: Duct sealing installations by zip code



Source: Navigant analysis

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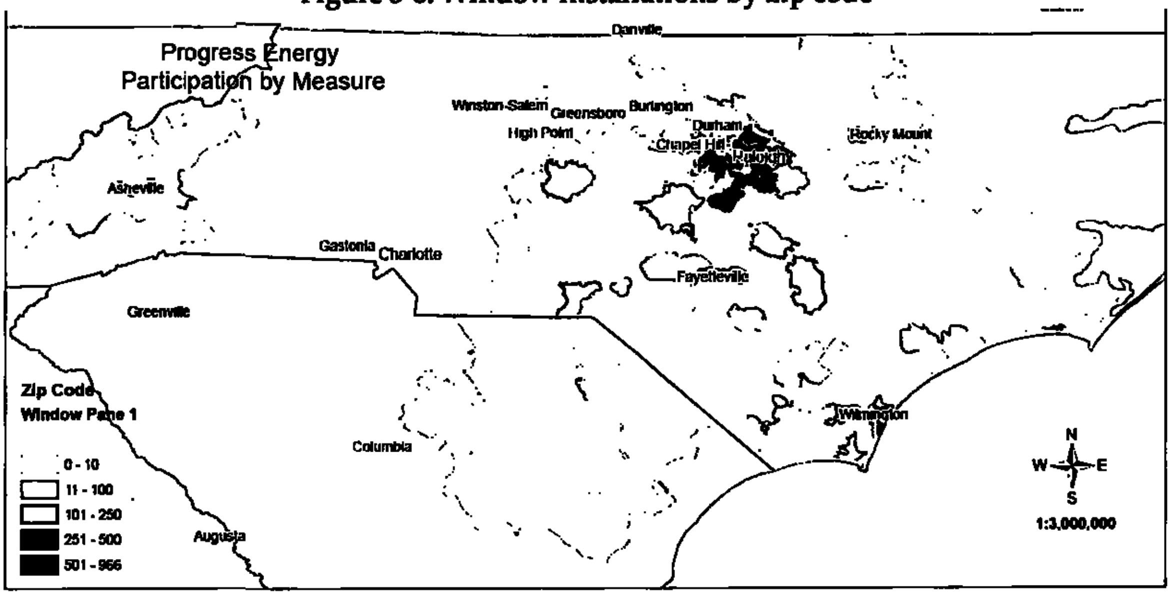
Figure 3-8 shows that window installations were more spread across the service territory, with some concentration in Raleigh. This is somewhat different than the HVAC measures, which had a notable hot spot in Southern Pines.

Figure 3-8: Window installations by zip code



Source: Navigant analysis

Overall, the GIS analysis shows that there are plenty of opportunities for program growth across PEC's service area.

Appendix D: Updated Unit Savings Values

Updated unit savings applicable to typical measure installations were presented in Chapter 4 of the report. These average unit savings values were based on 2009 participants' mix of measure efficiency, heating type, and region. Below are unit savings values broken out by these three characteristics. These unit savings do not include adjustments due to field verification rates from the EM&V sample; rather, they reflect anticipated savings if a measure were installed as recorded in the program database. Each of the values in the table reflect the weighted average across that particular group of 2009 participants.

Table 4-1 shows the measure unit savings by efficiency level.

Table 4-1: Measure Unit Savings by Efficiency Level

Measure	Base_Case	Efficient_Case	Units	kWh	Summer kW	Winter kW
Air-Source Heat Pump	SEER 13	SEER 15	Tons	108	0.144	0.003
Air-Source Heat Pump	SEER 13	SEER 16	Tons	162	0.172	0.026
Air-Source Heat Pump	SEER 13	SEER 17	Tons	186	0.158	0.038
Air-Source Heat Pump	SEER 13	SEER 18	Tons	228	0.201	0.035
Attic Insulation	R-03	R-30	SF Ceiling	1.34	0.00059	0.00129
Attic Insulation	R-03	R-38	SF Ceiling	1.39	0.00061	0.00134
Attic Insulation	R-03	R-49	SF Ceiling	1.42	0.00062	0.00138
Attic Insulation	R-08	R-30	SF Ceiling	0.83	0.00035	0.00082
Attic Insulation	R-08	R-38	SF Ceiling	0.87	0.00037	0.00086
Attic Insulation	R-08	R-49	SF Ceiling	0.91	0.00038	0.00090
Attic Insulation	R-12	R-30	SF Ceiling	0.64	0.00026	0.00064
Attic Insulation	R-12	R-38	SF Ceiling	0.68	0.00028	0.00069
Attic Insulation	R-12	R-49	SF Ceiling	0.72	0.00029	0.00073
Attic Insulation	R-19	R-30	SF Ceiling	0.47	0.00018	0.00048
Attic Insulation	R-19	R-38	SF Ceiling	0.52	0.00020	0.00053
Attic Insulation	R-19	R-49	SF Ceiling	0.55	0.00022	0.00057
Central AC	SEER 13	SEER 15	Tons	86	0.097	0.019
Central AC	SEER 13	SEER 16	Tons	98	0.171	0.010
Central AC	SEER 13	SEER 17	Tons	181	0.209	0.020
Central AC	SEER 13	SEER 18	Tons	186	0.230	0.020
Duct Sealing	Ducts in Attic	Ducts in Attic, Visually Inspected	Site	638	0.491	1.126
Duct Sealing	Ducts in Attic and Crawlspace/Basement	Ducts in Attic and Crawlspace/Basement, Visually Inspected	Site	430	0.305	0.725
Duct Sealing	Average Duct Location	Average Duct Location, Visually	Site	363	0.246	0.596

Measure	Base_Case	Efficient_Case	Units	kWh	Summer kW	Winter kW
		Inspected				
Duct Sealing	Ducts Half in Attic and Half in Conditioned Space	Ducts Half in Attic and Half in Conditioned Space, Visually Inspected	Site	319	0.246	0.563
Duct Sealing	Ducts in Crawlspace/Basement	Ducts in Crawlspace/Basement, Visually Inspected	Site	222	0.120	0.323
Duct Sealing	Ducts Half in Crawlspace/Basement and Half in Conditioned Space	Ducts Half in Crawlspace/Basement and Half in Conditioned Space, Visually Inspected	Site	111	0.060	0.162
Duct Sealing	Ducts in Conditioned Space	Ducts in Conditioned Space, Visually Inspected	Site	0	0.000	0.000
HVAC Level 1 Tune-up	No Tune-up	Level 1 Tune-up	Site	146	0.137	0.064
Windows	Double Pane	U-0.24, SHGC 0.23	SF Windows	1.84	0.00218	0.00023
Windows	Double Pane	U-0.25, SHGC 0.29	SF Windows	1.86	0.00199	0.00033
Windows	Double Pane	U-0.25, SHGC 0.40	SF Windows	2.03	0.00170	0.00070
Windows	Double Pane	U-0.30, SHGC 0.23	SF Windows	1.33	0.00202	0.00015
Windows	Double Pane	U-0.30, SHGC 0.30	SF Windows	1.46	0.00177	0.00018
Windows	Double Pane	U-0.30, SHGC 0.41	SF Windows	1.67	0.00156	0.00036
Windows	Double Pane	U-0.33, SHGC 0.24	SF Windows	1.11	0.00192	0.00011
Windows	Double Pane	U-0.35, SHGC 0.29	SF Windows	1.07	0.00175	0.00011
Windows	Double Pane	U-0.35, SHGC 0.38	SF Windows	1.20	0.00150	0.00015
Windows	Single Pane	U-0.24, SHGC 0.23	SF Windows	4.03	0.00321	0.00166
Windows	Single Pane	U-0.25, SHGC 0.29	SF Windows	4.04	0.00302	0.00196
Windows	Single Pane	U-0.25, SHGC 0.40	SF Windows	4.21	0.00273	0.00234
Windows	Single Pane	U-0.30, SHGC 0.23	SF Windows	3.51	0.00305	0.00131
Windows	Single Pane	U-0.30, SHGC 0.30	SF Windows	3.65	0.00279	0.00157
Windows	Single Pane	U-0.30, SHGC 0.41	SF Windows	3.85	0.00258	0.00199
Windows	Single Pane	U-0.33, SHGC 0.24	SF Windows	3.29	0.00295	0.00117
Windows	Single Pane	U-0.35, SHGC 0.29	SF Windows	3.26	0.00278	0.00127
Windows	Single Pane	U-0.35, SHGC 0.38	SF Windows	3.38	0.00253	0.00164

Table 4-2 shows unit savings by heating type.

Table 4-2: Measure Unit Savings by Heating Type

Measure	Heat_Type	Units	kWh	Summer _kW	Winter _kW
Air-Source Heat Pump	Average	Tons	136	0.156	0.012
Air-Source Heat Pump	Dual Fuel Heat Pump	Tons	156	0.156	0.065
Air-Source Heat Pump	Heat Pump	Tons	134	0.156	0.008
Attic Insulation	Average	SF Ceiling	0.56	0.00025	0.00058
Attic Insulation	Dual Fuel Heat Pump	SF Ceiling	0.56	0.00026	0.00015
Attic Insulation	Electric Resistance	SF Ceiling	1.25	0.00024	0.00120
Attic Insulation	Gas Furnace	SF Ceiling	0.18	0.00024	0.00002
Attic Insulation	Heat Pump	SF Ceiling	0.73	0.00026	0.00096
Central AC	Average	Tons	109	0.159	0.014
Central AC	Electric Resistance	Tons	100	0.160	0.000
Central AC	Gas Furnace	Tons	110	0.160	0.015
Duct Sealing	Average	Site	359	0.247	0.582
Duct Sealing	Dual Fuel Heat Pump	Site	339	0.253	0.103
Duct Sealing	Electric Resistance	Site	628	0.236	0.864
Duct Sealing	Gas Furnace	Site	161	0.236	0.017
Duct Sealing	Heat Pump	Site	468	0.253	0.974
HVAC Level 1 Tune-up	Average	Site	143	0.137	0.058
HVAC Level 1 Tune-up	Dual Fuel Heat Pump	Site	181	0.137	0.132
HVAC Level 1 Tune-up	Electric Resistance	Site	99	0.136	0.000
HVAC Level 1 Tune-up	Gas Furnace	Site	99	0.136	0.000
HVAC Level 1 Tune-up	Heat Pump	Site	181	0.137	0.113
Windows	Average	SF Windows	2.75	0.00256	0.00104
Windows	Dual Fuel Heat Pump	SF Windows	2.60	0.00258	0.00086
Windows	Electric Resistance	SF Windows	2.59	0.00255	0.00208
Windows	Gas Furnace	SF Windows	2.68	0.00255	0.00004
Windows	Heat Pump	SF Windows	2.94	0.00258	0.00141

Table 4-3 shows measure unit savings by region.

Table 4-3: Measure Unit Savings by Region

Measure	Region	Units	kWh	Summer _kW	Winter _kW
Air-Source Heat Pump	Eastern	Tons	178	0.162	0.035
Air-Source Heat Pump	Northern	Tons	120	0.155	0.004
Air-Source Heat Pump	Southern	Tons	132	0.161	0.007
Air-Source Heat Pump	Western	Tons	63	0.116	0.004
Attic Insulation	Eastern	SF Ceiling	0.500	0.00026	0.00050
Attic Insulation	Northern	SF Ceiling	0.681	0.00025	0.00069
Attic Insulation	Southern	SF Ceiling	0.664	0.00029	0.00077
Attic Insulation	Western	SF Ceiling	0.658	0.00022	0.00064
Central AC	Eastern	Tons	94	0.144	0.014
Central AC	Northern	Tons	112	0.162	0.014
Central AC	Southern	Tons	81	0.152	0.016
Central AC	Western	Tons	27	0.062	0.020
Duct Sealing	Eastern	Site	348	0.250	0.492
Duct Sealing	Northern	Site	367	0.238	0.611
Duct Sealing	Southern	Site	369	0.285	0.612
Duct Sealing	Western	Site	345	0.208	0.683
HVAC Level 1 Tune-up	Eastern	Site	153	0.136	0.091
HVAC Level 1 Tune-up	Northern	Site	143	0.135	0.061
HVAC Level 1 Tune-up	Southern	Site	152	0.146	0.043
HVAC Level 1 Tune-up	Western	Site	99	0.107	0.067
Windows	Eastern	SF Windows	3.40	0.00283	0.00148
Windows	Northern	SF Windows	2.60	0.00248	0.00076
Windows	Southern	SF Windows	2.46	0.00254	0.00098
Windows	Western	SF Windows	2.06	0.00276	0.00359

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Appendix E: Survey Results

The evaluation team conducted two surveys as part of the 2009 HEIP evaluation. The team surveyed 58 prequalified contractors from the list of those certified at the end of 2009, and also surveyed 138 program participants. For both surveys, the sampling approach was designed to ensure representation for all program measures, e.g. HVAC, duct sealing, and efficient windows. This Appendix provides detailed results from both surveys.

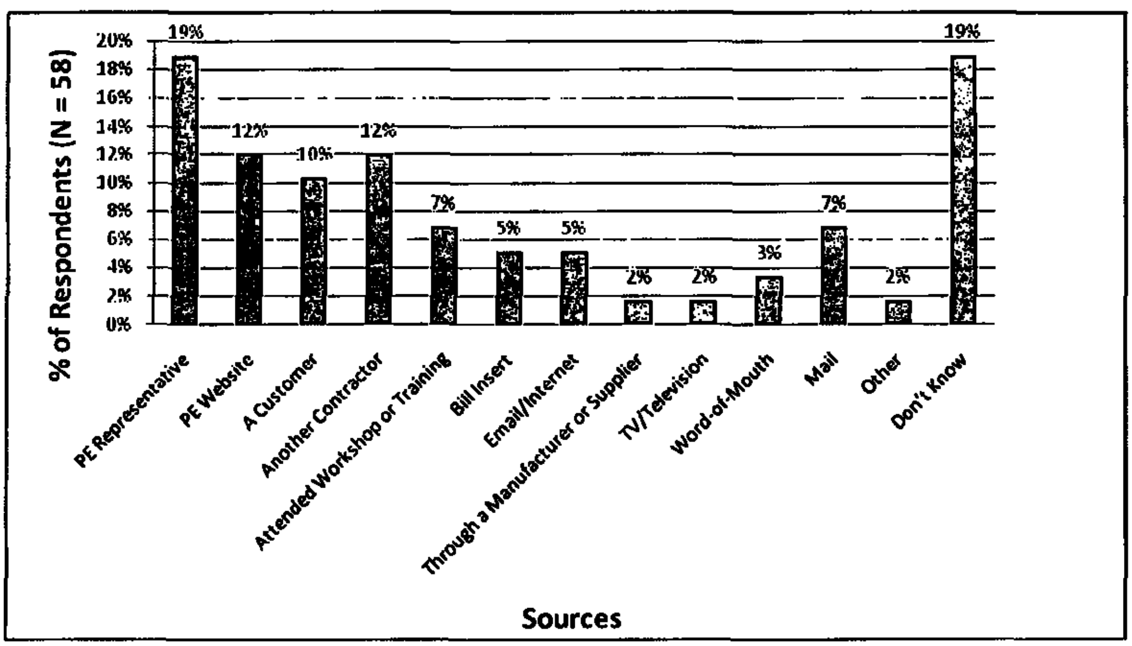
Prequalified Contractor Survey Results

The Contractor surveys were designed to assess multiple program aspects, including program marketing and outreach, program experience, awareness of state and federal tax incentives for high efficiency measures, participant knowledge and interest in energy efficiency, success of program-related training, and overall satisfaction with the program in general.

Program Awareness

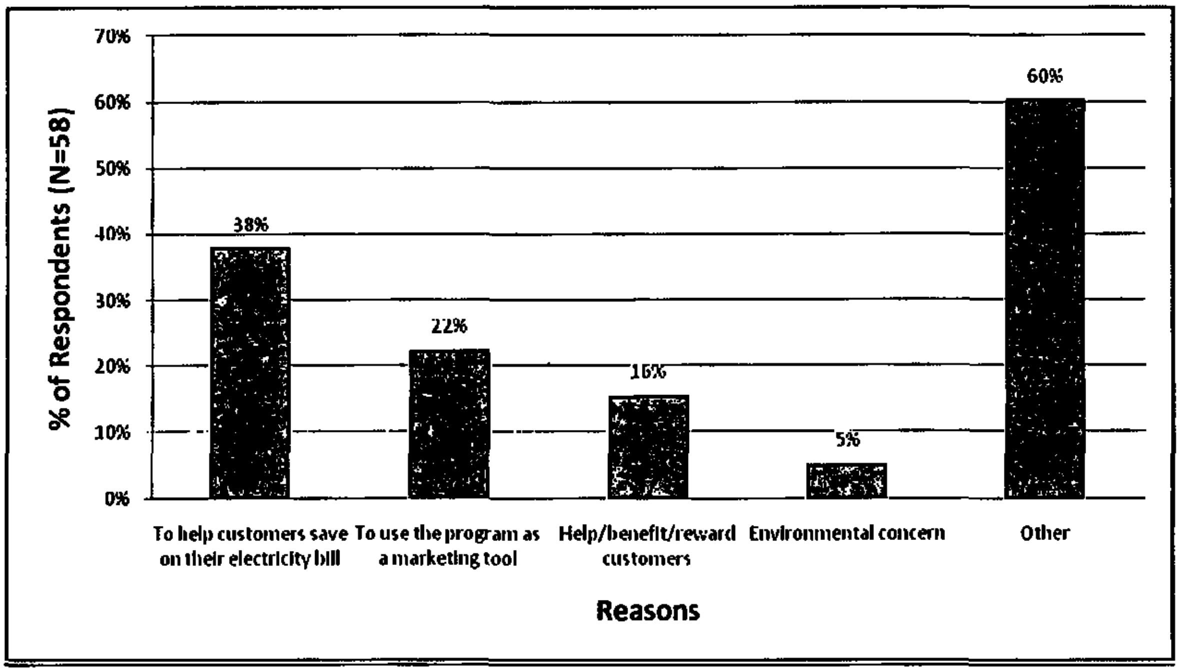
Prequalified contractors learned about the program in a variety of ways: 19% learned about it from a Progress Energy representative and 12% from the Progress Energy website. Another 12% heard about the program from another contractor, while 10% of respondents named a customer as their source. Figure 5-1 shows the full range of responses.

Figure 5-1: Where Contractors Heard About Progress Energy's HEIP Program



Thirty-eight percent of participants surveyed became Progress Energy pre-qualified contractors because they wanted to help customers save on their electricity bill. Twenty-two percent said they were motivated by the ability to use the program as a marketing tool. Only 5% joined out of environmental concerns. Figure 5-2 shows what motivated prequalified contractors to become involved with the program.

Figure 5-2: Why Contractors Decided to Become Progress Energy Prequalified Contractors



Marketing and Outreach

Survey results indicate that almost all prequalified contractors (97%) actively market the HEIP program to customers. Thirty-five percent of contractors commonly use handouts, pamphlets, brochures, and flyers to market the program. Thirty-two percent said that they make comments to customers about rebates and incentives for the various measures that are offered. Twenty-one percent mentioned word-of-mouth marketing as one method used, while 13% said that PEC mentions the program. Full results are shown in Figure 5-3.

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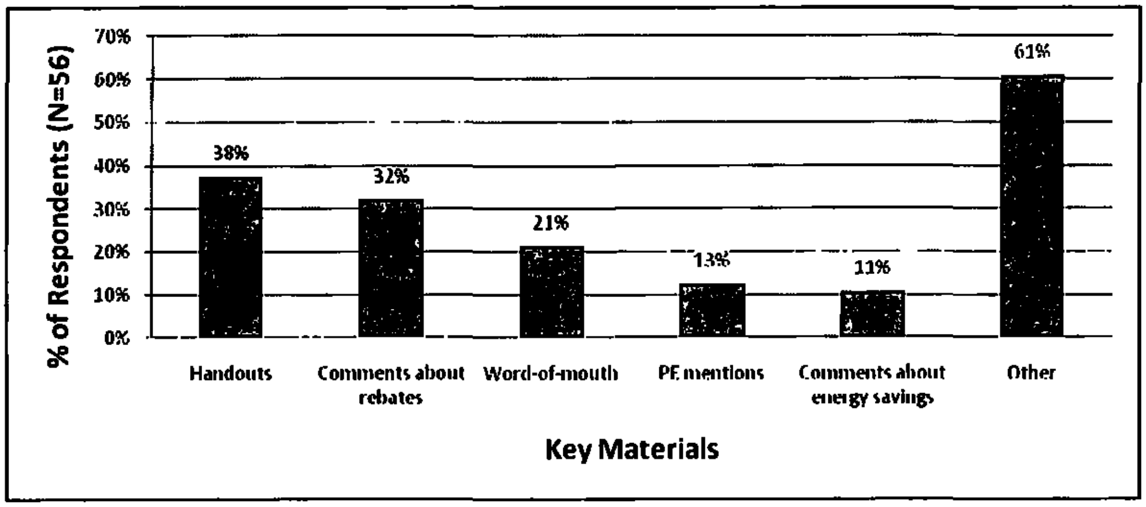
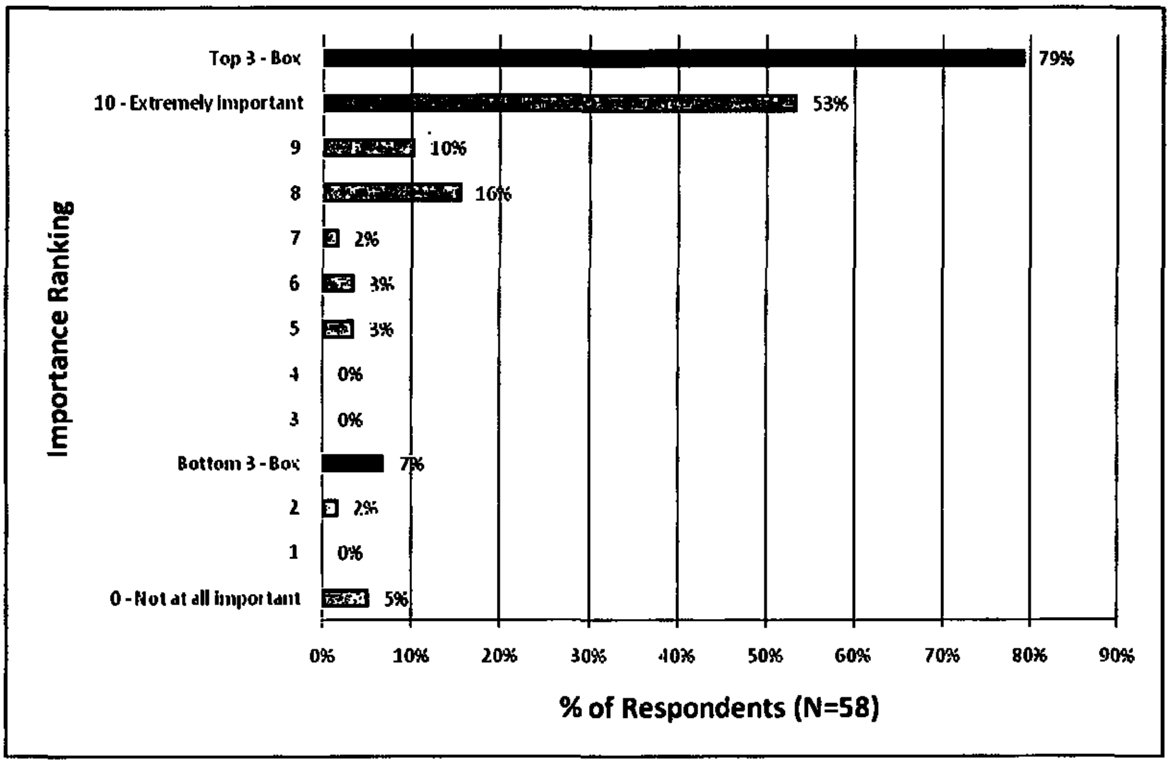
Contractors were asked whether PEC has provided them with the marketing materials they need; nearly three-quarters of the respondents believe they have the tools they need to market the program. The 3% of allies who do not actively market the HEIP program all mentioned that they do not do much marketing or advertising in general.

Figure 5-3: Key Materials and Messages Used to Market HEIP to Customers



NCI asked contractors how important to program success, on a scale of 0 to 10, they consider PEC's program sponsorship to be. Seventy-nine percent of the contractors surveyed believe PEC's sponsorship to be very important or higher. Figure 5-4 shows the full results.

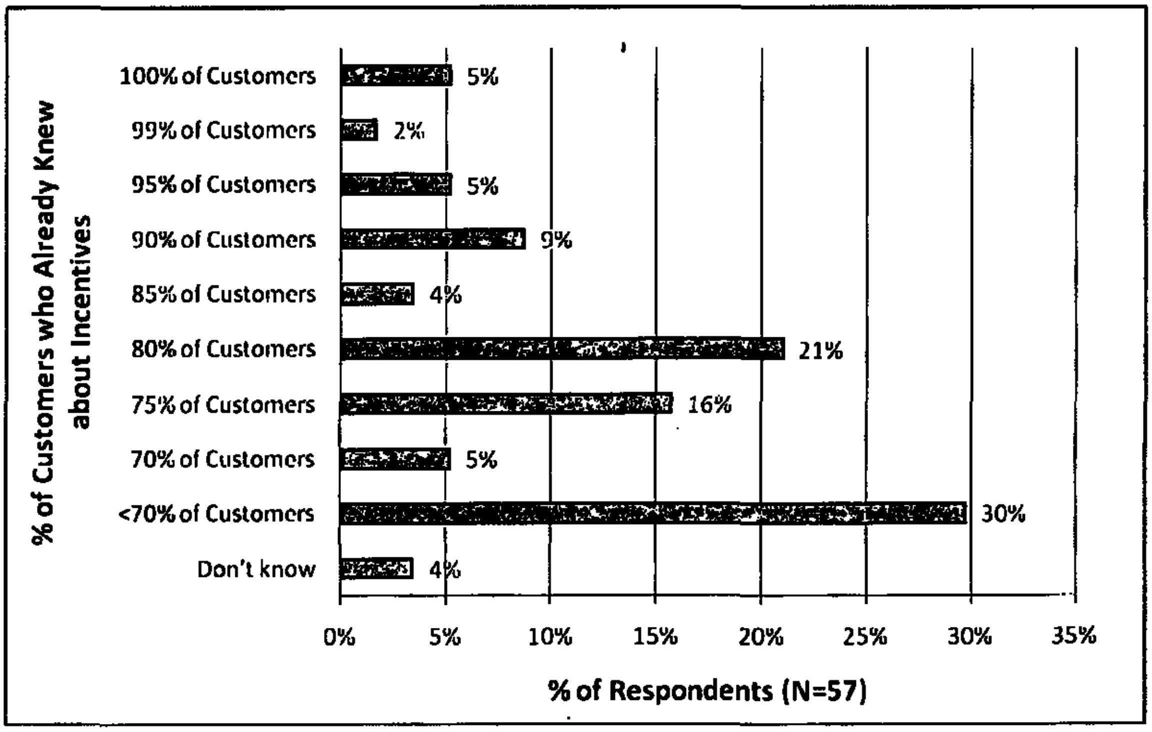
Figure 5-4: Importance of Progress Energy's Sponsorship of the HEIP Program



Awareness of State and Federal Tax Incentives

As part of the American Reinvestment and Recovery Act (ARRA), the Federal government offered tax credits, through the end of 2010, to homeowners who purchased energy efficient HVAC equipment. NCI has found that these programs have had a significant impact on utility rebate programs, and that contractors often combine the utility rebates, Federal tax credit, and sometimes manufacturer incentives into one attractive package for consumers. Our Contractor survey asked participating contractors about their knowledge and experiences with the Federal tax credit, as well as with state rebates. Consistent with national trends, an overwhelming majority of the contractors (98%) said that they were aware of the incentives, and the same percentage said that they always mention these incentives to customers in conversation. Only one Contractor reported only occasionally mentioning the incentives to customers. Contractors were then asked to gauge the percentage of their customers who already knew about the state and federal tax incentives before the contractors told them. Twenty-one percent replied that *90% or more of their customers already knew about the incentives, and 62% replied that 75% or* more of their customers already knew about the incentives. Figure 5-5 shows this breakout clearly.

Figure 5-5: Percentage of Customers who Already Knew about Tax Incentives

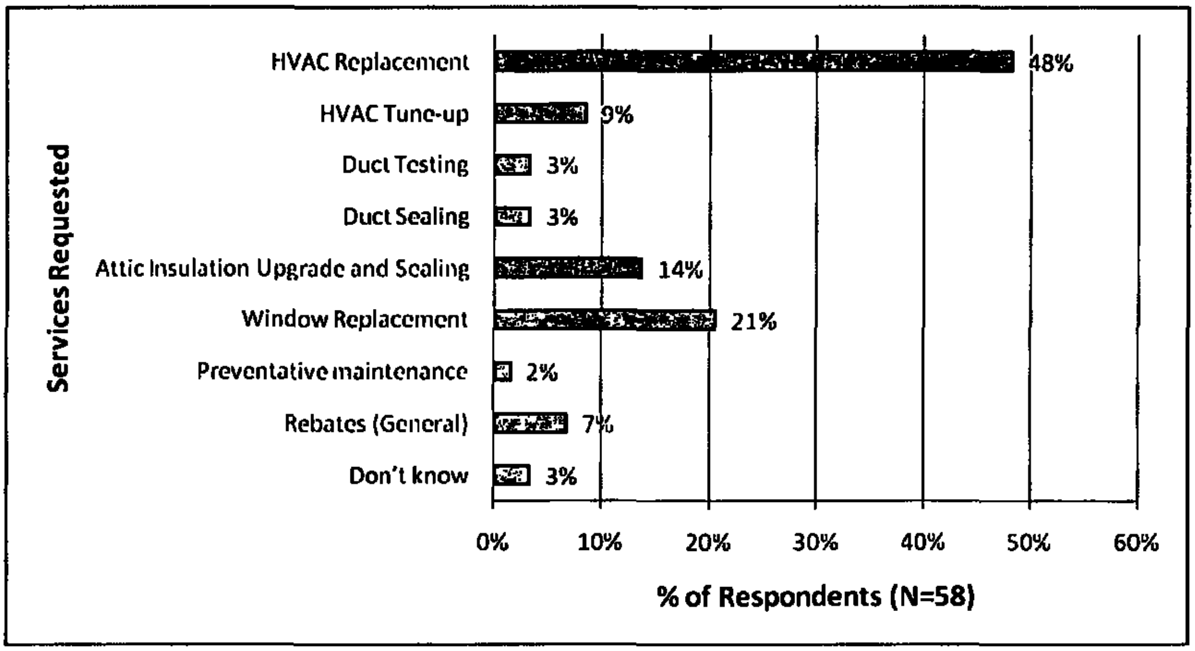


Customer Knowledge and Interest in Energy Efficiency

During 2009, HVAC Replacement and Window Replacement were the services most commonly requested by customers. Forty-eight percent requested HVAC Replacement services and 21% requested Window Replacement. (Figure 5-6)

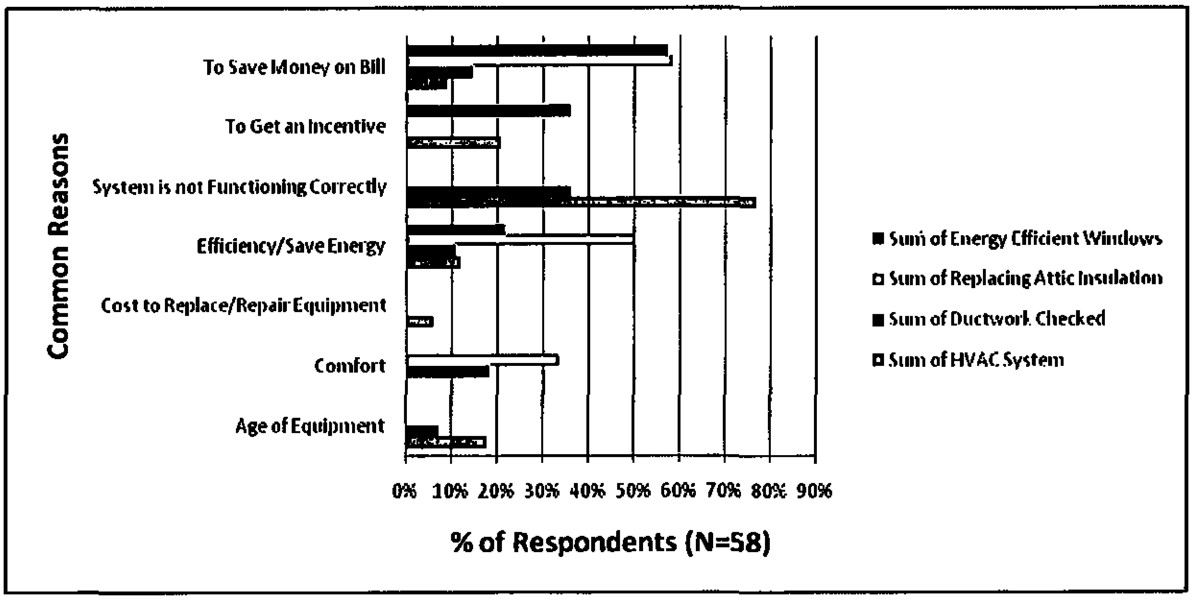
Participating contractors were asked if they had routinely marketed the same program-qualifying services to customers before they began to participate in the HEIP program. Ninety-one percent of the respondents responded that they did in fact market these services before joining the HEIP program, but 7% of respondents claimed that they did not routinely market these services until they began to participate in the HEIP program. Since joining the HEIP program, 50% of respondents say their inventory of high efficiency equipment has increased, and 36% say it has not changed.

Figure 5-6: HEIP Qualifying Services Most Often Requested by Customers



Contractors also were asked what reasons customers most commonly give for choosing various program measures. Customers offer different reasons for each of the four program measures: HVAC system replacement, duct work checking, attic insulation replacement, and energy efficient window installation. Allies said that 76% and 36% of customers had their HVAC system replaced and their duct work checked, respectively, due to the system not functioning correctly. The main motivation for customers to replace their attic insulation and install energy efficient windows is to save money on their energy bills. What all four of these reasons have in common is that customers are looking to save energy and they are looking to save money. (Figure 5-7)

Figure 5-7: Reasons Customers Most Commonly Give for Having Measures Repaired or Upgraded



Success of Program-Related Training

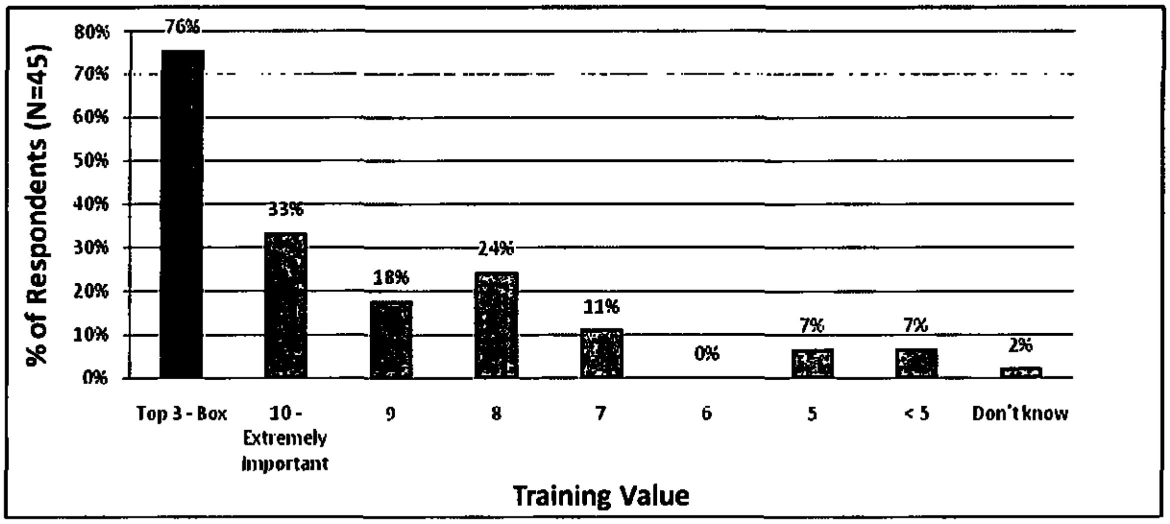
Forty-five of the 58 contractors (78%) participated in the PEC-sponsored program trainings. Of those 45, 76% felt that the training was very valuable, and ranked it above an 8 on a scale of 0 to 10. In fact, only 7% of respondents (4) ranked the program trainings below a 5 on a 10 point rating scale. The respondents who provided low rankings offered the following reasons for doing so:

-*"I use a different process for sealing the attic than conventional method."*

-*"Already know about efficiency of our windows."*

Figure 5-8 shows the full range of responses.

Figure 5-8: How Valuable was Training?



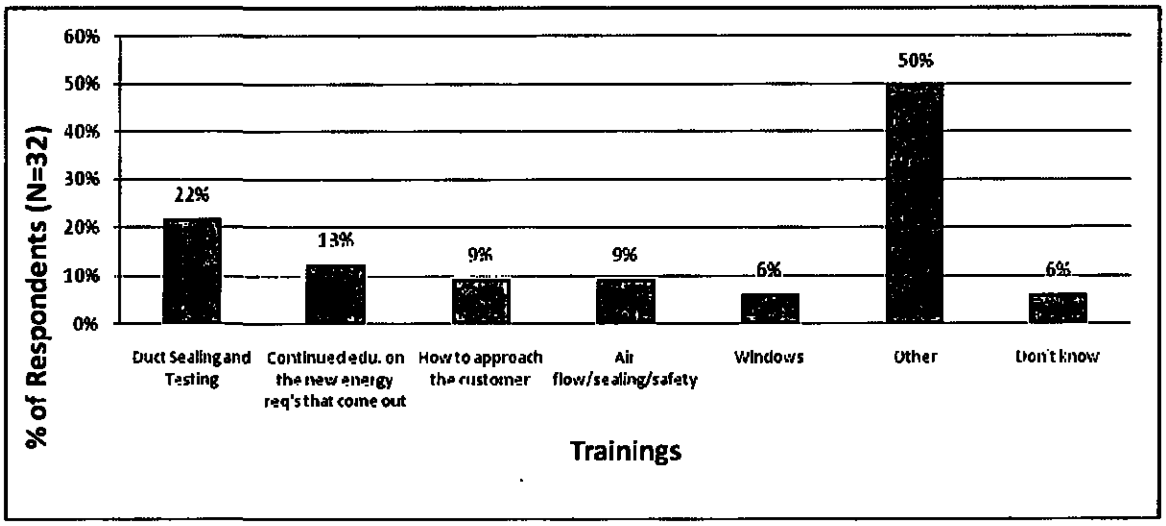
Contractors were then asked if they thought more training would be useful. Fifty-five percent (32 of 58) responded positively, saying they would find more training useful. Those who responded positively were then asked to provide what additional program or technical training would benefit their businesses or employees the most. Of the many options, twenty-two percent mentioned training on duct sealing and testing, 13% listed continued education on new energy requirements that come out, and 9% mentioned training on how to approach customers. An additional 9% mentioned training on air flow, sealing, and safety courses.

Fifty percent of respondents cited other examples of training they would find useful, including:

- Diagnostics training (6%)
- Marketing training (6%)
- Attic insulation (3%)
- Online and phone training (3%)
- More audit training (3%)

Figure 5-9 shows these results.

Figure 5-9: Additional Training that would be useful



Contractor Firmographics

Most of the contractors surveyed are small companies, with 20 or fewer employees (74%).

The following figures show the areas in which the surveyed contractors focus their work. Figure 5-10 shows how many contractors generate business through HVAC tune-ups; Figure 5-11, Figure 5-12, Figure 5-13, Figure 5-14 and Figure 5-15 show the same information for duct sealing, duct testing, HVAC replacement, window replacement, and insulation upgrade and sealing, respectively.

Figure 5-10: Proportion of Overall Business Revenue Generated Through HVAC Tune-up

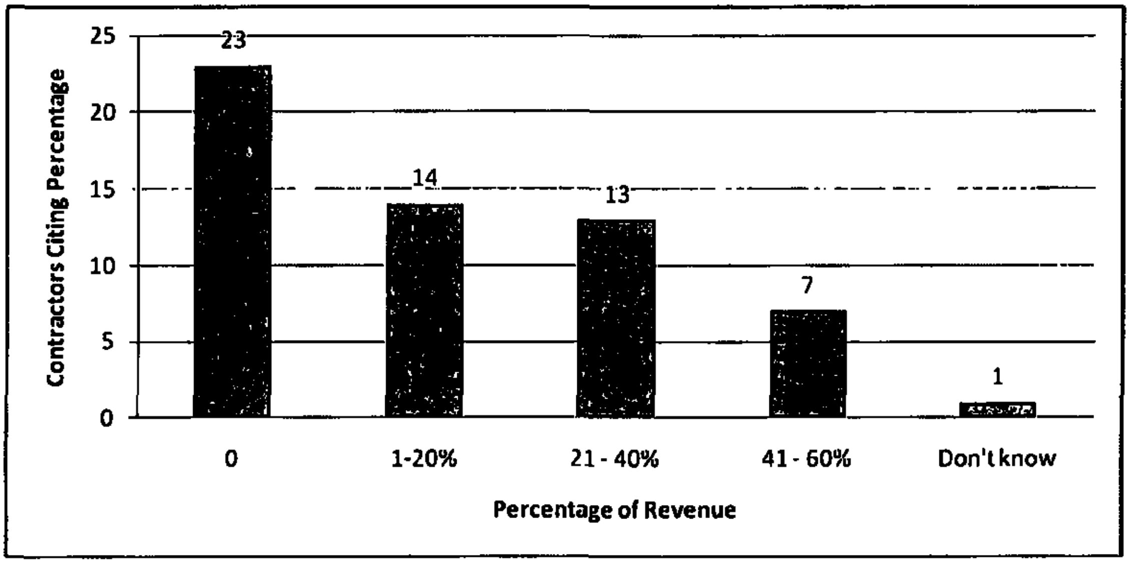


Figure 5-11: Proportion of Overall Business Revenue Generated Through Duct Testing

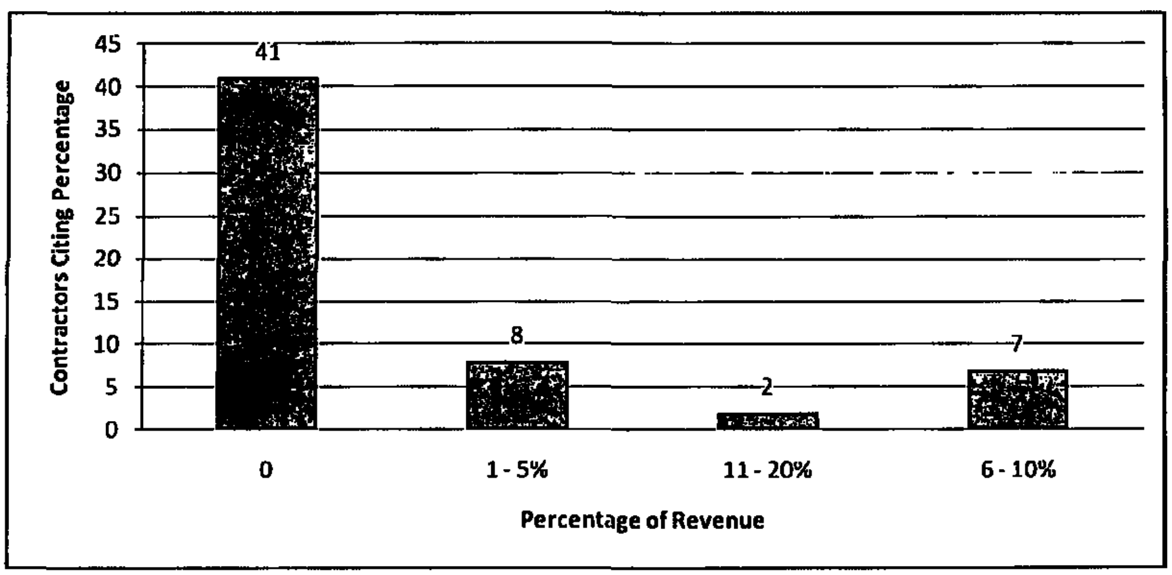


Figure 5-12: Proportion of Overall Business Revenue Generated Through Duct Sealing

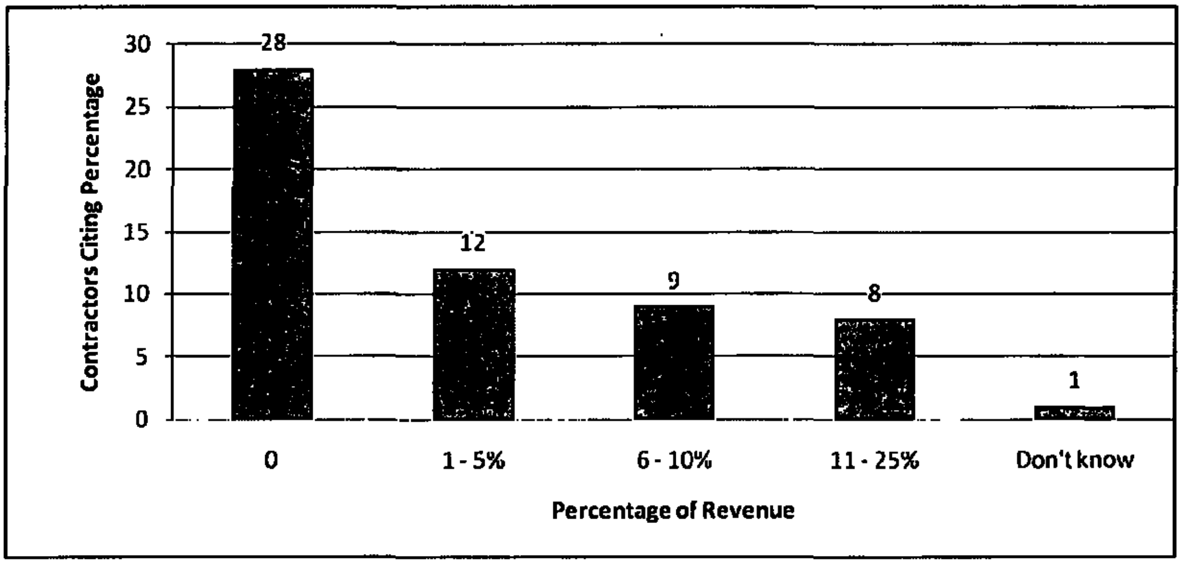


Figure 5-13: Proportion of Overall Business Revenue Generated Through HVAC Replacement

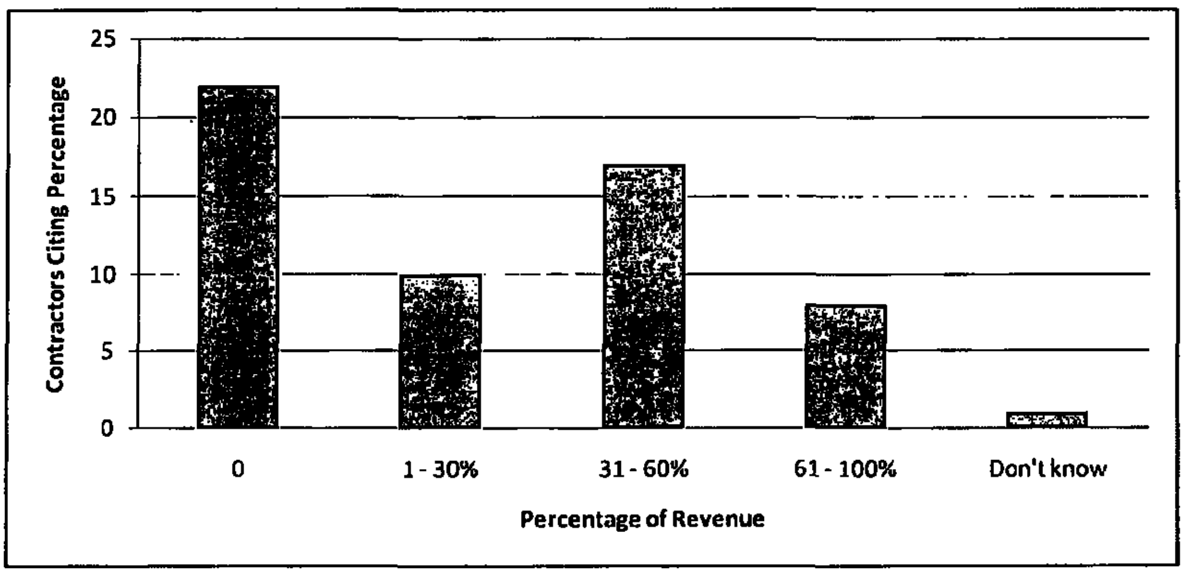


Figure 5-14: Proportion of Overall Business Revenue Generated Through Window Replacement

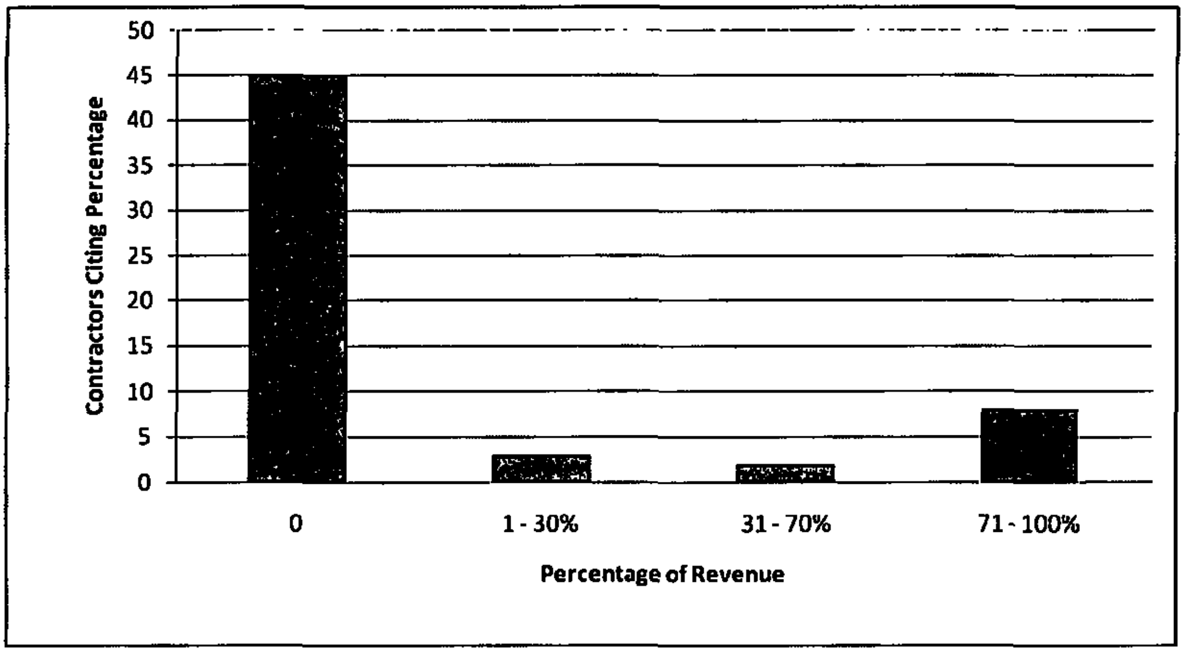
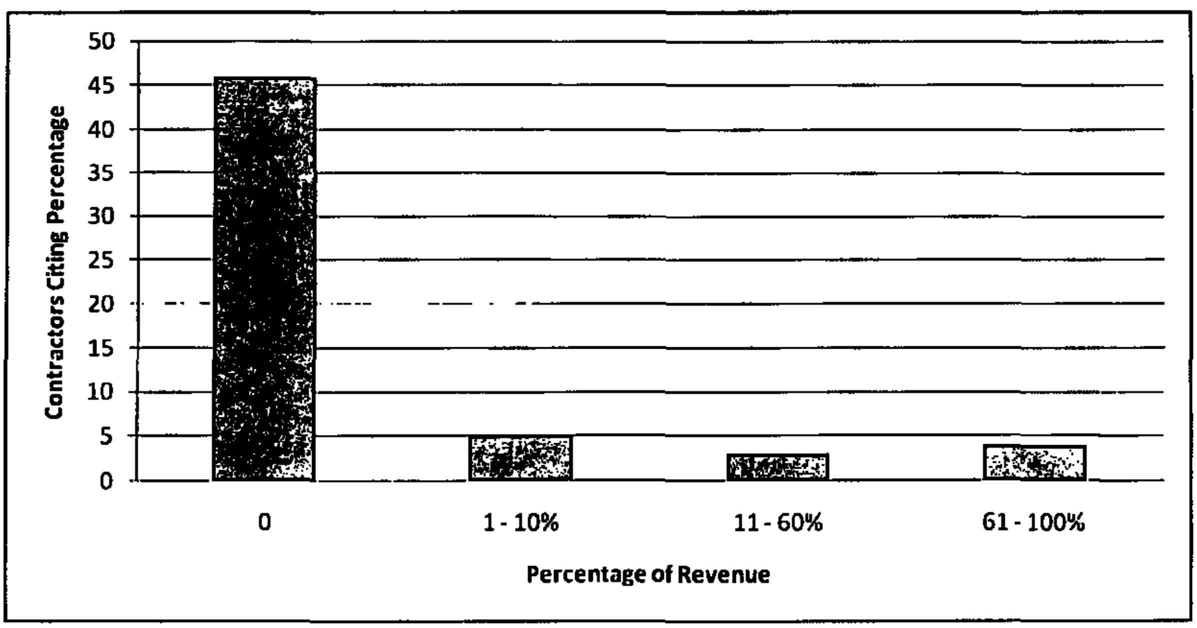


Figure 5-15: Proportion of Overall Business Revenue Generated Through Insulation Upgrade and Sealing



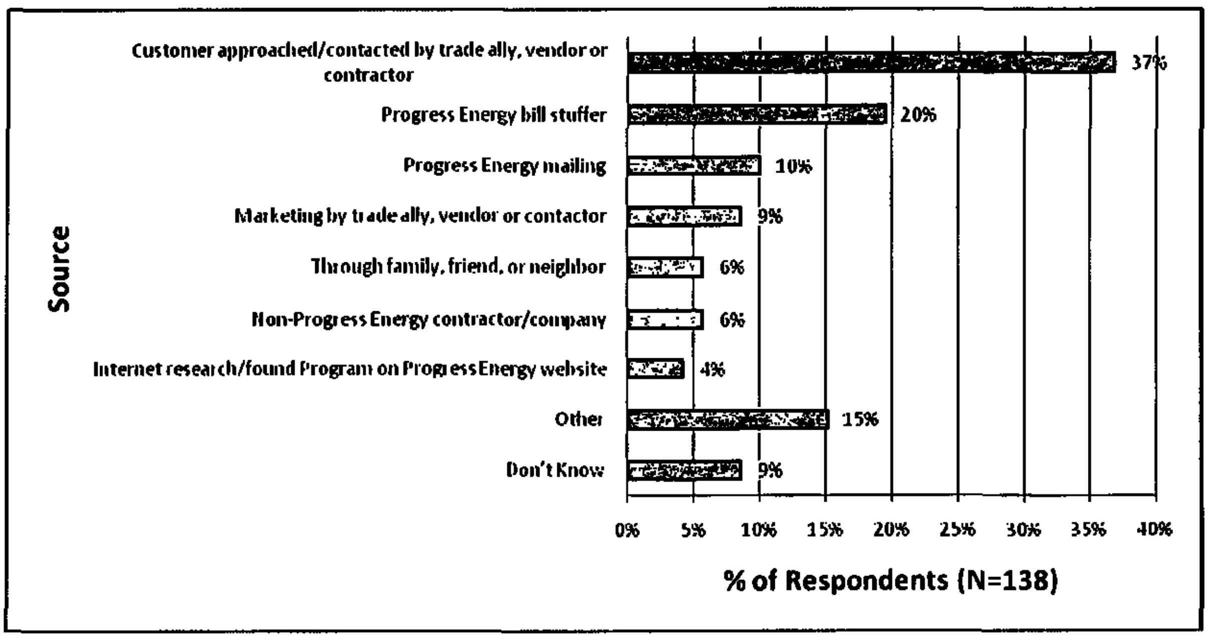
Program Participant Survey Results

NCI designed and implemented a telephone survey with 138 Progress Energy Home Energy Improvement Program participants. The surveys were designed to assess multiple program aspects, including program awareness and experience, sources of information about the program, satisfaction with key aspects of program delivery and the overall program, influence of the program on knowledge and behaviors, barriers to and benefits of participation, and suggestions for program improvements.

Program Awareness

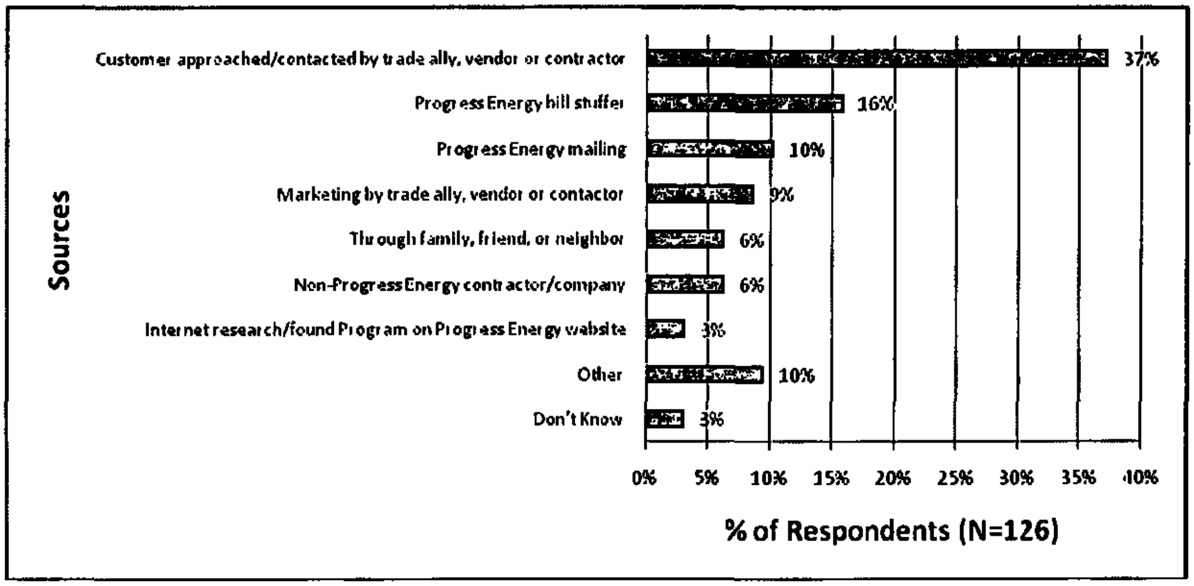
Survey results indicate that contractors play a very important role in the program process. Participants were asked to indicate all the sources through which they learned about the program; 37% learned about the program through direct contact from a contractor, while 9% learned about it through contractor marketing. Figure 5-16 shows the range of ways in which customers found out about the program.

Figure 5-16: Where Program Participants First Learned about the Program



When asked to rank the importance of the information sources from which they learned of the program, 30% of program participants cited a PEC source (bill stuffer, direct mailing, or website), while 46% cited contractors. The survey results suggest that, while PEC's marketing materials are effective, contractor communications are even more so. Figure 5-17 shows the full range of responses to this question.

Figure 5-17: Most Important Sources of Information



Customer Satisfaction

On a scale of 1 to 10 where 10 is excellent, 86% of participants ranked their overall experience with the program as an 8, 9, or 10, with 60% responding that their experience was a "10," or that they were "extremely satisfied." The only person who was dissatisfied with the program (a ranking less than 5) cited three reasons for dissatisfaction:

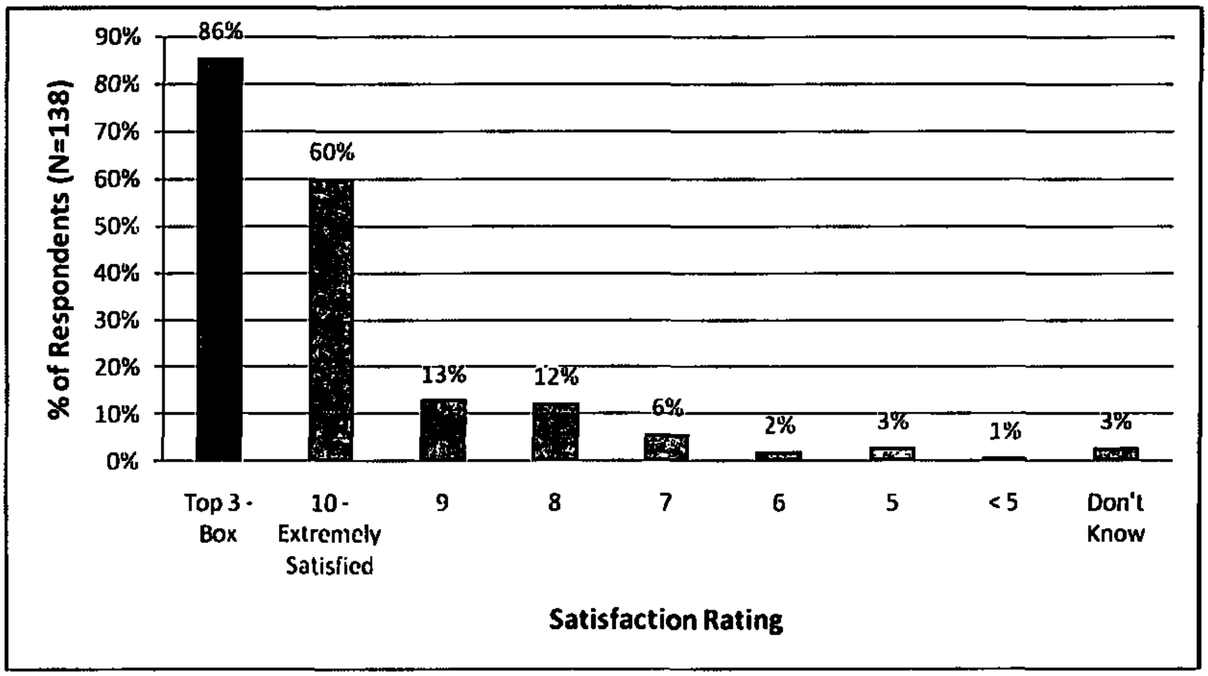
-*"Wouldn't allow us to select our own contractor/Contractors needed to be qualified."*

-*"Repairs were missed."*

-*"Repairs were not done properly."*

Figure 5-18 shows the breakout for customer satisfaction.

Figure 5-18: Overall Satisfaction with HEIP Program



Satisfaction with Key Aspects of Program Delivery and the Overall Program

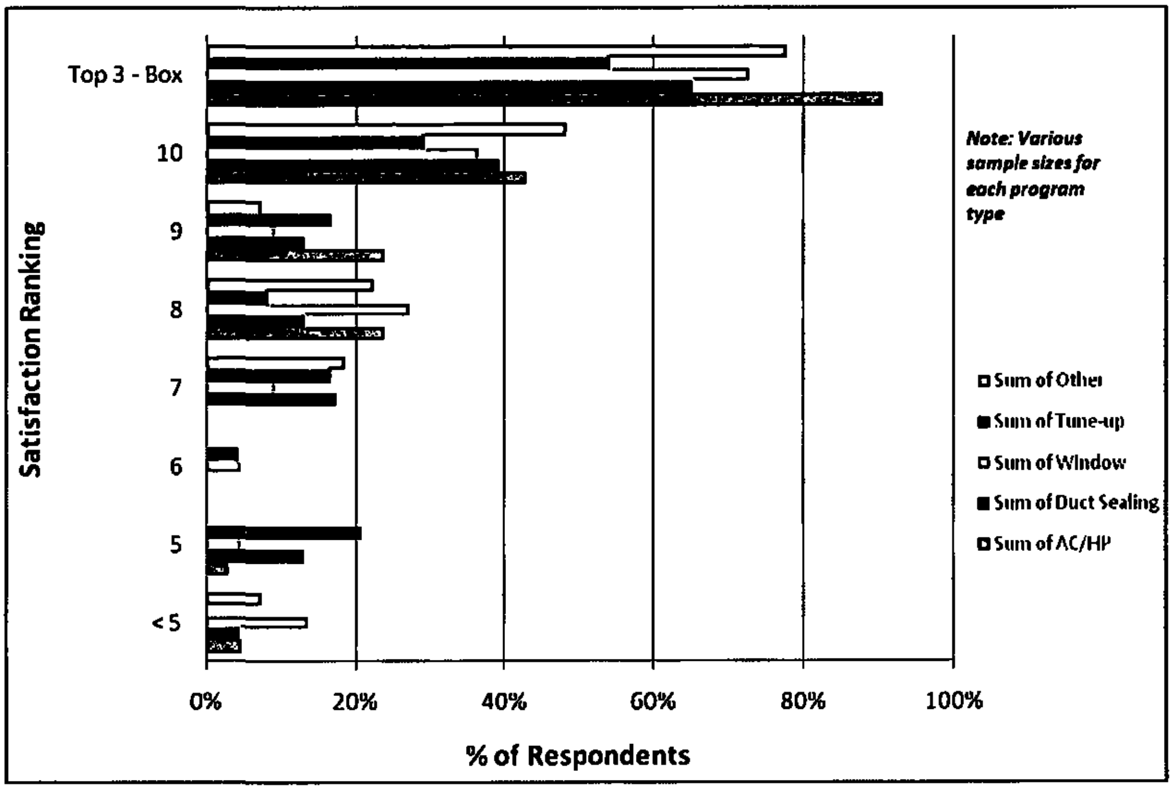
The survey asked participants about their satisfaction with several key program aspects, including satisfaction with the information provided, program costs, and with the specific program components. Customers were asked to rank their level of satisfaction with providing program information on a scale of 1 to 10, with 10 meaning "extremely satisfied." Most customers were highly satisfied, grading the program with an 8 or higher. Only five total customers graded the program below a 5; four offered the following reason:

-*"Lack of information/ didn't know much about the program."*

The remaining customer declined to comment on his or her low rating.

Figure 5-19 shows customer satisfaction with providing program information for the various program components.

Figure 5-19: Satisfaction with Program Information Provided



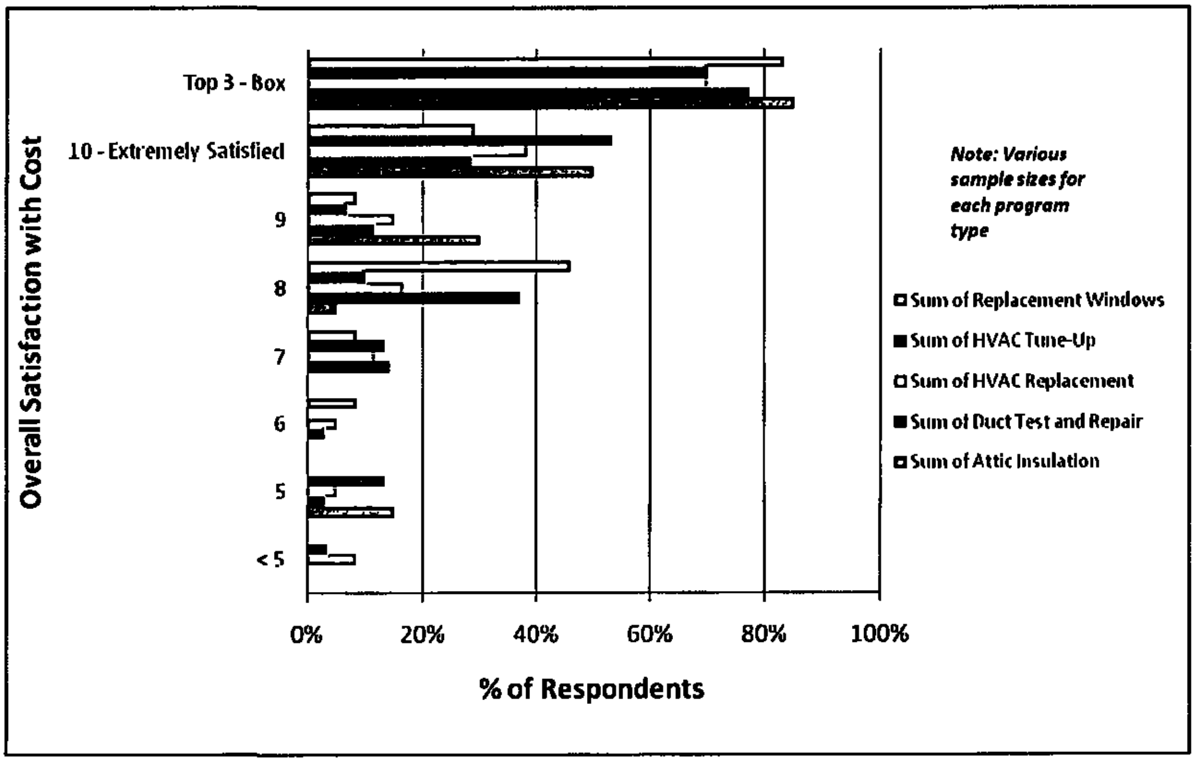
Most customers were satisfied with program costs. When aggregated by measure, at least 70% of the customers who installed each measure were satisfied or very satisfied with the measure's costs, on a scale of 1 to 10. In fact, well over 50% for each measure gave the program costs a perfect "10" ranking, meaning that they were extremely satisfied. Those who were not satisfied (<5) cited only one reason for their low rating:

-*"Can't get rebate from contractor."*

All other respondents who gave a rating below 5 declined to give specific reasons.

Figure 5-20 shows customer satisfaction with program costs.

Figure 5-20: Overall Satisfaction with Cost of the Various Installations



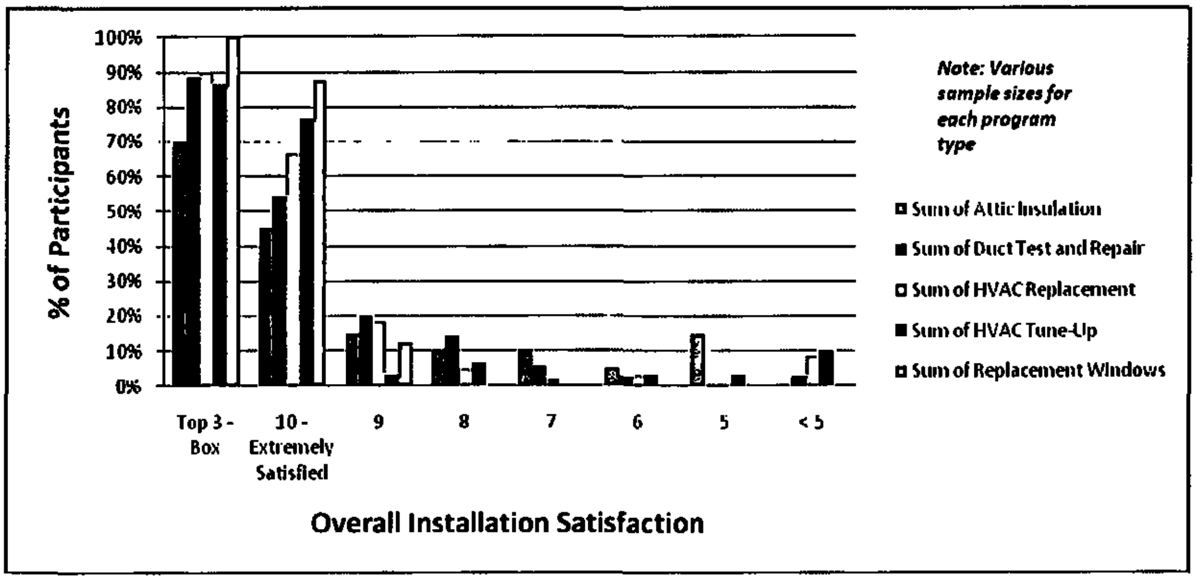
Not surprisingly, customers also are very satisfied with measure installation. Over 70% of the customers who installed each measure consider themselves to be very satisfied with the installation. Most notably, 100% of respondents reported overall satisfaction at 8 or higher with window replacement measures. And no participants indicated dissatisfaction with replacement window installations and attic insulation installations. Those measures with which customers indicated some level of dissatisfaction included HVAC tune-up and HVAC replacement. Customers offered two reasons for their dissatisfaction:

-*"Length of time (installation) took"*

-*"Issues with contractor"*

Figure 5-21 shows the range of customer responses on measure installation.

Figure 5-21: Overall Installation Satisfaction for Various Installations

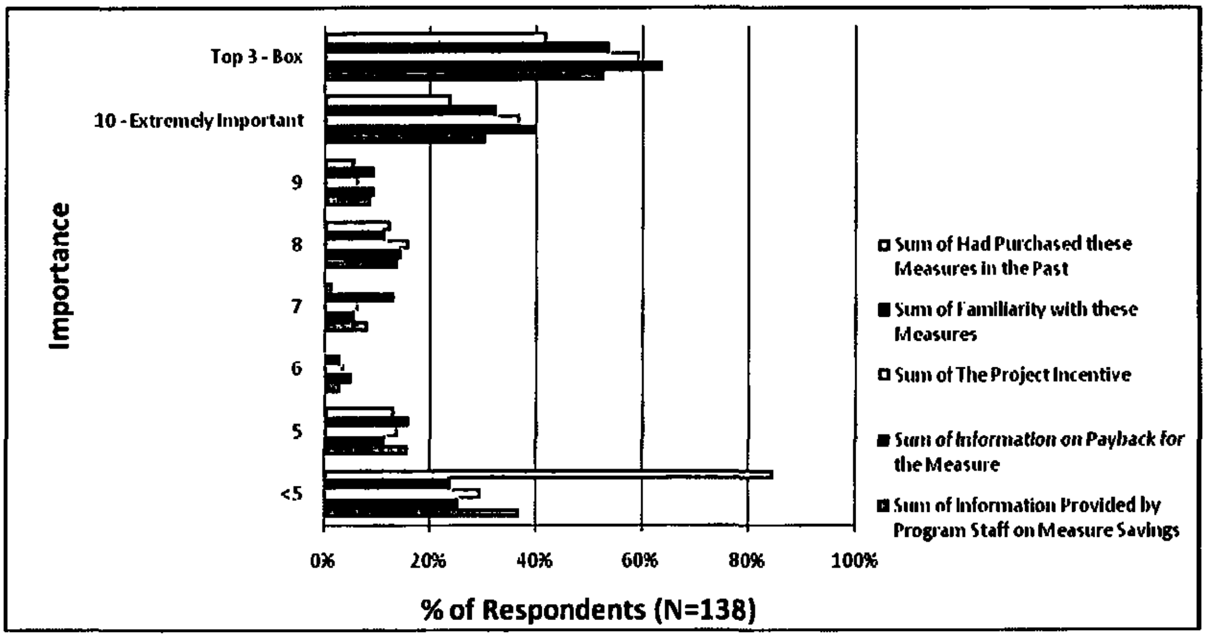


Program Influence on Customer Knowledge and Behaviors

The survey asked participants to rank the importance of various factors that led them to have work done on their homes. The most important factor, not surprisingly, was information about measure payback. Forty percent of those surveyed ranked it as the most important influence. The next most important factor was the project incentive, which 37% of participants ranked as "extremely important." The least important factor for having one of the HEIP measures completed was participants having purchased the measures in the past, which 85% of respondents ranked as "not important."

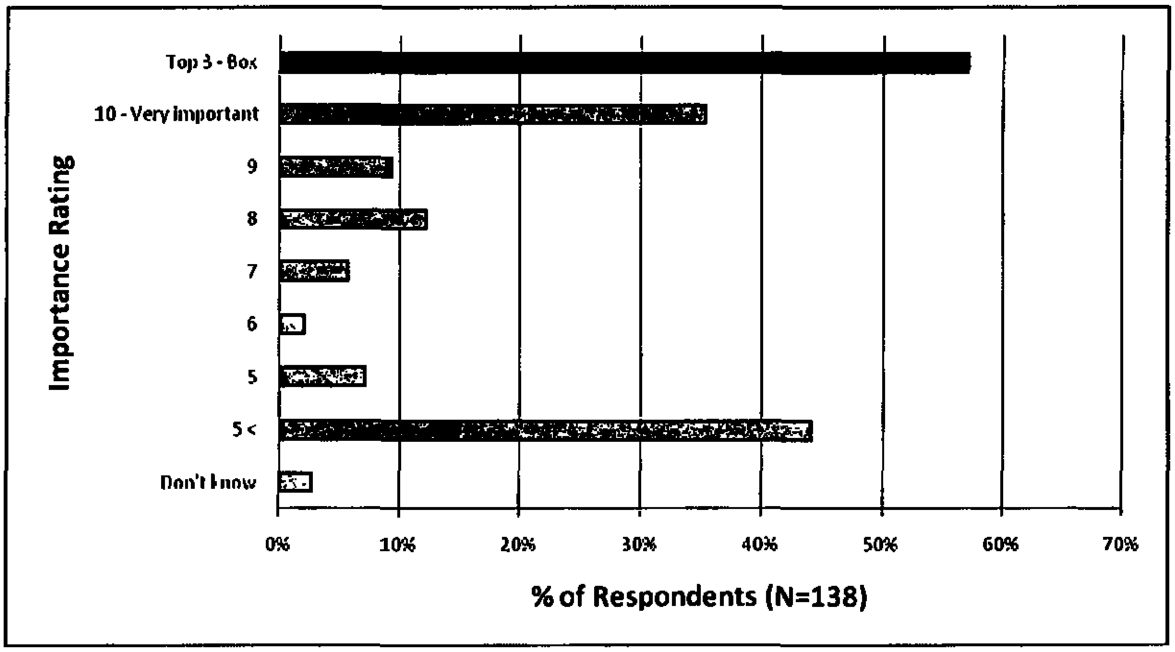
Figure 5-22 shows the various rankings.

Figure 5-22: Factor Importance: Comparison of Various Factors



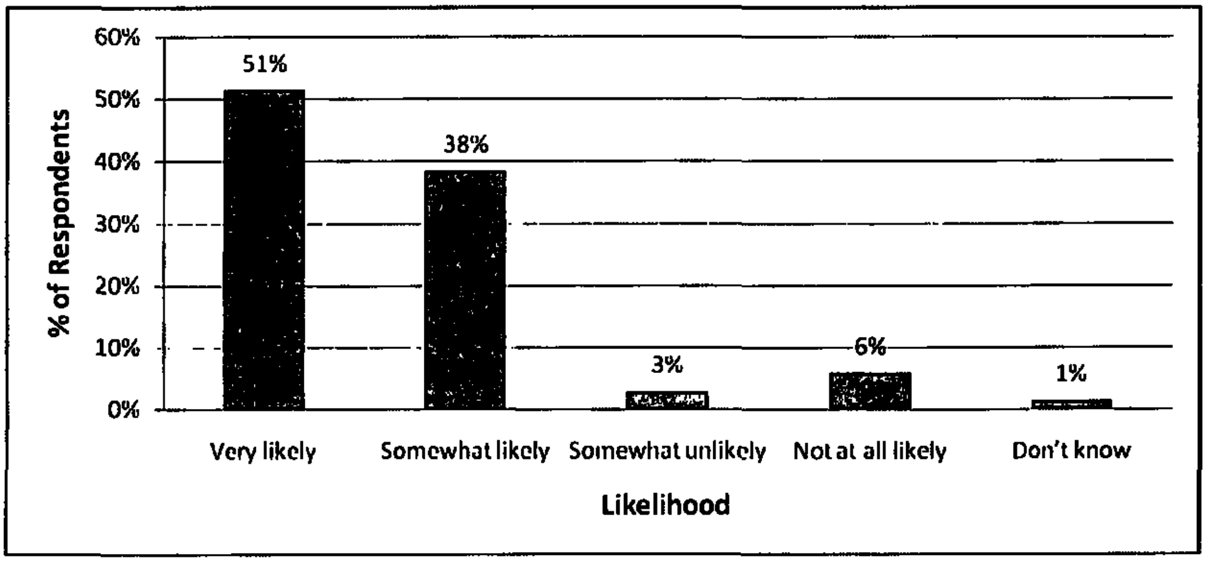
Participants were then asked how important the HEIP program was in influencing them to install additional energy efficiency measures. Participants split evenly on their responses: 57% said it was "very important" or higher, including 36% who ranked it as a 10, or "extremely important." However, 44% ranked it as less than 5, signifying a lack of influence. Figure 5-23 shows the various rankings.

Figure 5-23: Importance of HEIP in Influencing Additional Energy Efficiency Installations



Eighty-nine percent of participants said that they would have installed the measures without participating in the program, as shown in Figure 5-24.

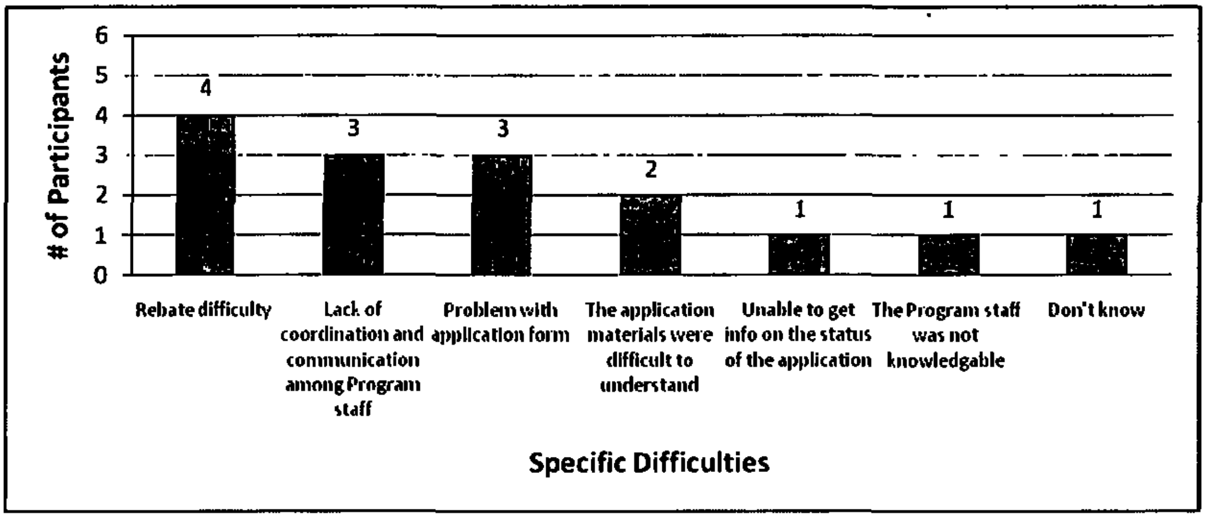
Figure 5-24: Likeliness to Install the Same Equipment if were Unable to Participate in HEIP Program



Suggestions for Program Improvements and Benefits of Participation

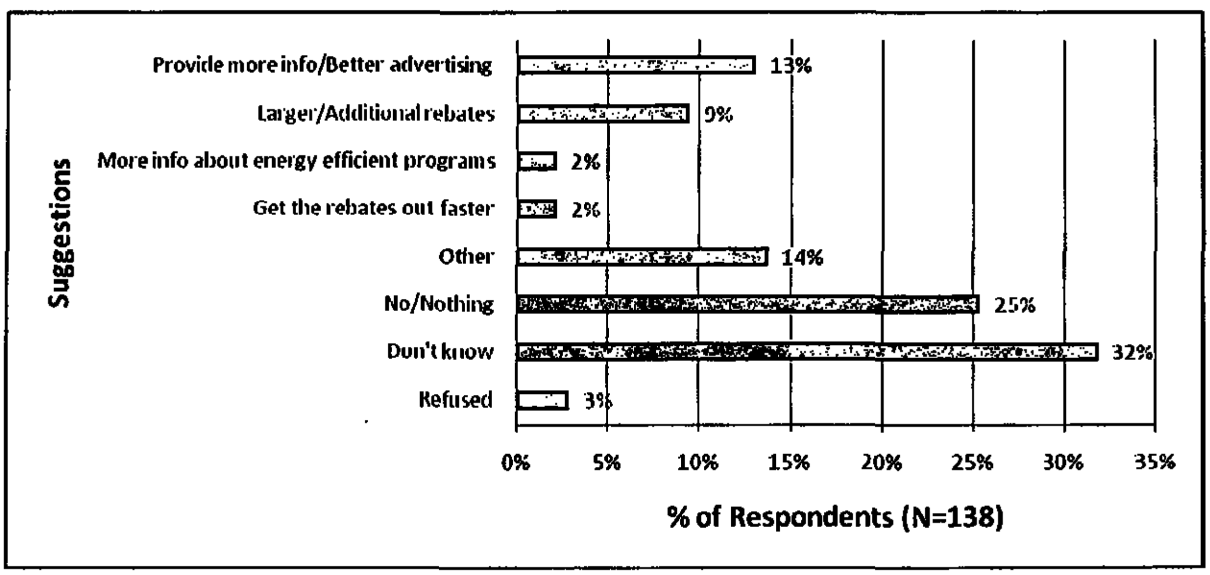
The survey asked participants if they had encountered any problems, delays or difficulties with the HEIP program. Eighty-six percent responded positively saying that they encountered no issues with the program, while 13%, or 18 participants, responded negatively saying that they did in fact encounter a problem, delay or difficulty. Of the 18 participants citing an issue, 15 cited specific difficulties, with the largest issue (four respondents) relating to rebates. Three other customers cited problems with the application form, and an additional three said they had trouble with a lack of coordination and communication among Program staff. (Figure 5-25)

Figure 5-25: Specific Issues that Cause the Most Difficulty



When asked if they had any recommendations to improve the program, 25% of participants said that they had no suggestions, with 32% saying that they simply did not know. The most popular suggestions listed were for the Program to provide more information / better advertising (13%), larger and/or additional rebates (9%), more info about the energy efficiency programs (2%), and getting the rebates out faster (2%). Figure 5-26 shows these results.

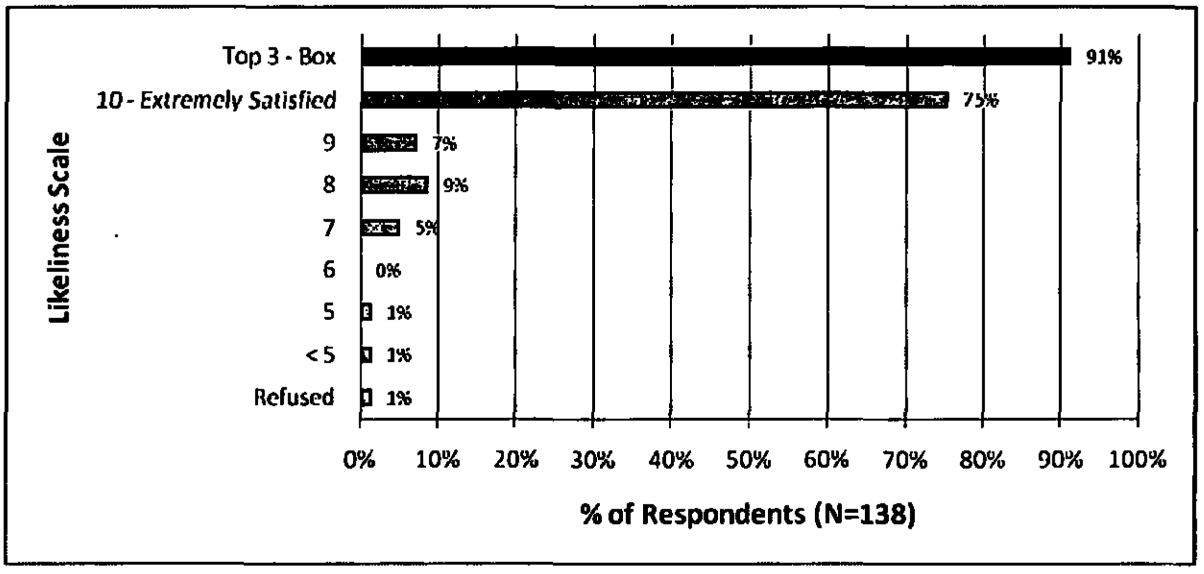
Figure 5-26: Program Changes and/or Suggestions



Ninety-one percent of the participants said they would definitely recommend the HEIP program to others. Figure 5-27 shows these results.

Only one program participant indicated that they would not recommend duct sealing specifically, and their reason was that there is *"No reason to do it / No incentive."*

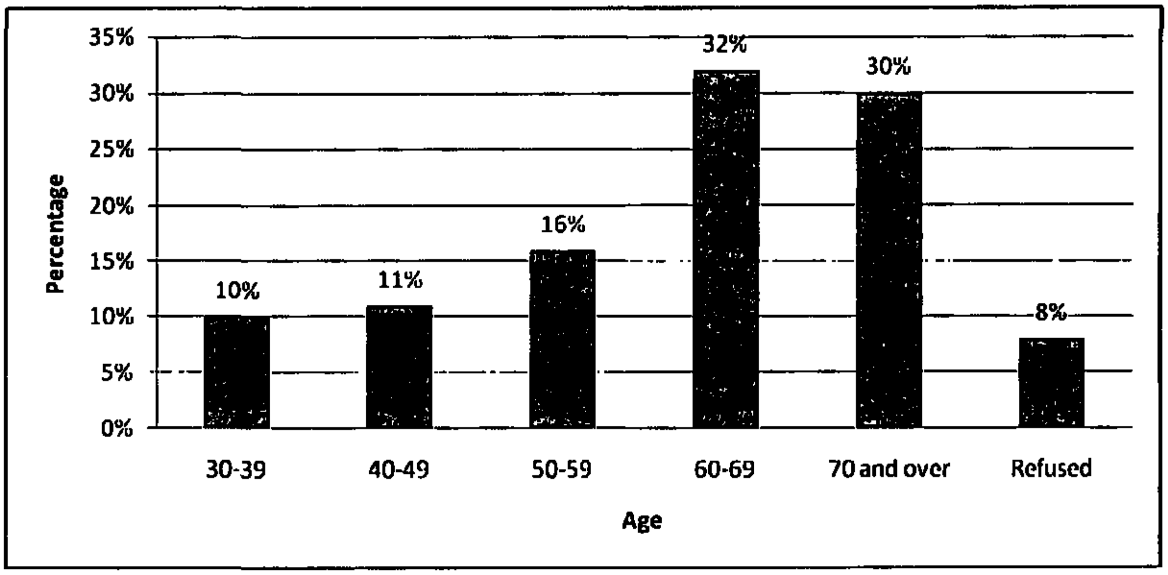
Figure 5-27: Likeliness to Recommend the HEIP Program to Others



Customer Demographics

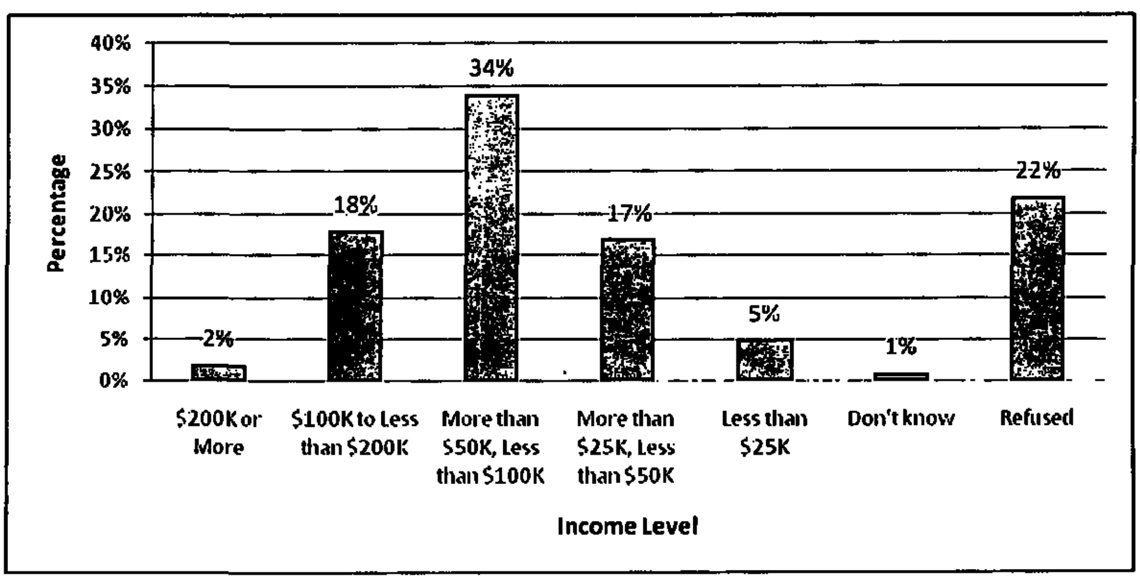
Most of the participants surveyed are near or in retirement, which may explain why they are motivated to make their energy dollars go farther. (Figure 5-28)

Figure 5-28: Age of Those Surveyed



The surveyed customers represent a range of household incomes, as shown in Figure 5-29.

Figure 5-29: Household Income



Program participants are, overall, well-educated; more than half have completed at least a bachelor's degree, and another 16% have at least some university education. (Figure 5-30)

Figure 5-30: Participant Education