PROCESS AND IMPACT EVALUATION OF THE 2007-2008 ENERGY TRUST OF OREGON HOME ENERGY SOLUTIONS PROGRAM

Volume 1: Summary Report

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STRUCTURE OF THE REPORT

This report is divided into two volumes. The information in this volume (Volume 1) is a summary of our more detailed findings found in Volume 2. This volume provides recommendations from the process evaluation of the PY2007-2008 program, as well as the findings from our impact analysis for PY2007. Note that a billing analysis for PY2008 will be conducted at a later date as part of a separate effort conducted by Energy Trust.

Volume 2 provides detailed chapters for each of Energy Trust of Oregon's major Home Energy Solutions program components, which include single family rebates, Home Performance with Energy Star, Home Energy Review, multi-family homes, manufactured homes, and Energy Saver Kits, as well as a chapter presenting our findings from depth interviews with trade allies. This volume was designed for interested parties to review detailed findings from a specific program component that contributed to the key findings and recommendations presented in Volume 1.

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1. EXECUTIVE SUMMARY

Energy Trust of Oregon's Home Energy Solutions (HES) program provides cash incentives to Oregon households to encourage the adoption of energy efficiency measures. The program covers a range of efficient options that provide electricity and gas savings to customers living in single-family, multi-family, and manufactured home sectors.

In 2007-2008, the Home Energy Solutions program provided services to over 45,000 sites. The table below shows the breakdown of participation by sector.

Table 1. Total Participation in the Program

	2007	2008	Total
Single Family	**13,955**	**16,931**	**30,886**
Cash Incentives	8,581	10,811	19,392
Home Energy Review (HER)	5,191	5,964	11,155
Home Performance with ENERGY STAR (HP)	183	156	339
Multi-family	**127**	**182**	**309**
Manufactured Homes	**1,112**	**557**	**1,669**
Energy Saver Kits	**NA**	**12,812**	**12,812**
Total	**15,234**	**30,482**	**45,716**

Note: This table removes duplicates within the single family program; HER or HP participants who also received rebates are only counted once in this table. However, all relevant measures are counted in the next section and table.
HER participants who also received HP are counted in this table as HP. This totals 207 participants, or approximately 2% of total HER participation.

Impacts

For 2007, the evaluation found that the Home Energy Solutions (HES) program gross savings reached 89% of program goals for electricity and 137% for natural gas. Net savings reached 61% of program goals for electricity and 66% for natural gas.[1]

[1] Due to the timing of our evaluation efforts, Energy Trust will conduct the 2008 impact analysis under a separate evaluation effort.

Table 2. 2007 HES Program Energy Impacts

	Gross Impacts		Free Ridership Rate		Net Impacts	
	kWh	Therm	kWh	Therm	kWh	Therms
Ex Ante	16,555,777	800,564	0	0	16,555,777	800,564
Ex Post	14,792,298	1,098,922	0.31	0.52	10,165,209	526,782
Realization Rate	0.89	1.37			0.61	0.66

We also found that 7% of the surveyed population installed measures they considered energy efficient outside of the HES program. Although no impacts are added to the overall program values from this spillover[2], rough calculations indicate that it is possible these measures could account for about 5% of the overall energy or therm program impacts.

Program Satisfaction

Overall program satisfaction is high across all program components. Residential and multi-family participants are generally pleased with the services provided by Energy Trust. Specifically, our examination of program satisfaction found the following:

- Satisfaction is highest among manufactured homes (who received free services) (92% rating 8 or above on a scale from 0 to 10), customers that received Home Performance with ENERGY STAR services (87% rating 8 or above), and Energy Saver Kit recipients (83% rating 8 or above).
- Satisfaction is lower for multi-family participants (56% rating 5 on a scale of 1 to 5). However, responding managers of participating buildings report that tenants are extremely pleased with the program and acknowledge significant savings on their energy bills.
- Satisfaction appeared to be slightly lower for HER participants, with mean ratings for all of the HER indicators of satisfaction ranging from 8.1 to 9.4 (67% to 93% rating 8 or above).
- Interestingly, satisfaction among single-family rebate participants appears to be the lowest (79% rating 8 or above).

Notably, across all efforts, the greatest needs are for a streamlined application process and improved quality control of contractors.

Market Assessment

The HES program provides incentives for 26 measures listed in the program database; however, gas furnaces, heat pumps, insulation, duct sealing, and windows are the key

[2] No impacts are included because of the uncertainty in knowing if a measure that a customer stated was energy efficient really met the requirements of the program as well as the difficulty in gathering sufficient information to calculate a good value via a phone call without undue respondent burden.

measures promoted by the program efforts. Our exploration of the effect of the HES program on these five markets found the following:

- Energy Trust should consider increasing the gas furnace incentive requirements to 95% efficiency, which may provide an opportunity to further increase the efficiency of the gas furnace market. Trade allies suggested that incentives for 90% efficient furnaces may not be necessary, because the percentage of gas furnaces rated 90% or more efficient may be larger than stated in Energy Trust's 2009 Trade Ally assessment, and several said they sell few furnaces below 90%.
- Energy Trust should consider either reducing efficiency requirements for heat pumps or increasing the incentive levels because several trade allies expressed concern that the current incentive level/efficiency requirement combination does not make the upgrade worth it for the customer.
- Energy Trust should retain the duct sealing incentive because trade allies believe that it drives the market by creating awareness. In fact, further marketing could result in more jobs for trade allies. Trade allies felt that altering the level or structure of the incentive could be effective without shrinking the market, but further exploration is required to verify feasibility.
- The insulation incentive is fine as is and provides a large portion of business for the trade allies. Some allies suggested providing different incentive levels based on existing insulation or types of insulation installed, but further exploration is required to verify feasibility.
- Energy Trust could consider removing the requirement for the windows incentive to have a second measure installed. However, trade allies did not have a uniform opinion of the effect of the HES program on the windows market.

Program Processes

The process evaluation effort assessed eight key program processes, which include trade ally training and communications, program applications and paperwork, marketing efforts, policies and program requirements, partner collaboration, internal communications, and databases. Our in-depth interviews and surveys with trade allies, program staff, and program participants found the following:

- Energy Trust should provide additional training to increase quality control and reduce participant dissatisfaction. Energy Trust may consider performing additional contractor screening to remove inadequate contractors from the list. Further, Energy Trust should ensure that program participants are aware of the list of contractors who are qualified to make installations.

- Energy Trust should streamline the application processes to reduce confusion and incomplete responses. Trade allies suggest moving toward web-based and universal forms. Energy Trust should strive to increase trade ally awareness of the online submission process and universal forms as well as routinely provide follow-up with customers and trade allies regarding the paperwork process.

- Energy Trust should increase customer awareness of the Home Energy Solutions program by promoting measure-specific marketing materials and distinguishing between programs (especially Home Performance with ENERGY STAR and Home

Energy Reviews). There remains significant potential to increase awareness of program offerings among multi-family property owners. We also recommend proactively increasing trade ally awareness of the available marketing support and materials.

- Energy Trust should improve communication with trade allies by proactively ensuring that they are receiving the assistance they require and are provided relevant information. Trade allies noted that it would be helpful if the most important information was communicated with some type of priority designation.
- Energy Trust should promote one on one communication with collaborators in the following areas: program design, contractor training, program status updates, and marketing efforts. Further, Energy Trust and CSG can strive to improve their collaborative process particularly in the early stages of marketing efforts.

Additional recommendations are provided in this summary report, while a more descriptive write-up of findings is provided in Volume 2.

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MEMO

Date: January 20, 2010
To: Board of Directors
From: Sarah Castor, Evaluation Project Manager
Diane Ferington, Residential Sector Lead
Subject: Staff Response to the Home Energy Solutions 2007-2008 Process and 2007 Impact Evaluation

Based on the evaluation report, the Home Energy Solutions program worked well during the 2007-2008 program years and into 2009. Program activity and savings goals have increased steadily over the past several years, while participant satisfaction with the program has remained high, particularly for Home Performance and manufactured home participants.

Since the evaluator provided draft process evaluation results and feedback to the program early on, many of the recommended changes have been completed or are underway. These include a redesign of the Home Energy Review leave-behind material and changes to the tracking of marketing efforts.

Still, the evaluator made several additional recommendations that we would like to address:

- *Provide additional contractor training to increase quality control and reduce participant dissatisfaction*

  Energy Trust will continue to offer as much training in as many locations as possible to encourage quality work. This year, the HES program will also be instituting a tiered trade ally network to elevate trade allies who consistently display quality work and excellent customer service.

- *Streamline the application processes to reduce confusion and incomplete responses*

  Energy Trust constantly reviews and improved its forms and application processes. In the last year, the program has introduced a universal form for HES incentives and an online form for HVAC measures. We have also dropped the requirement for collecting residential utility account numbers on program forms. The program also encourages trade allies to complete forms on behalf of customers to reduce missing information and improve customer experience; part of the new tiered structure will be based on whether the trade ally regularly completes forms for participants.

Beginning this spring, the program will begin regularly surveying participants from the previous month about satisfaction with program elements, including paperwork. This real-time feedback should provide information on how improvements are impacting participants.

- *Improve communication with trade allies by proactively ensuring that they are receiving the assistance they require and are provided relevant information*

  E-mails, newsletters, and the Energy Trust website will remain the preferred method of communication with trade allies. As Energy Trust program activity has increased over the past few years, it is important for us to be nimble in making changes to manage budgets efficiently. As a result, we feel the recommended 90 days notice before program and incentive changes go into effect will not be practical in all cases; however, we will provide at least 30 days notice before program changes go into effect in all cases. We will also ensure that important communications about changes and opportunities for comment are clearly identified as such.

- *Consider increasing the gas furnace incentive requirements to 95% efficiency and consider either reducing efficiency requirements for heat pumps or increasing the incentive levels*

  Due to transformation of the gas furnace market toward 90% efficiency, the program will be discontinuing the incentive at the end of May (except for customers eligible for the Savings Within Reach track). An incentive for 95% efficient furnaces is not cost-effective based on the small incremental savings over 90% units, so Energy Trust is not able to offer an incentive for this level. However, these units are eligible for state and federal tax credits.

  Current heat pump requirements and incentives will remain in effect. The premium incentive HSPF requirement of 9.0 is in line with the Oregon Residential Energy Tax Credit. In addition, our recent market transformation study of the heat pump market showed that already in 2009 44% of units installed had an HSPF of 8.5 or above.[1]

The results of the 2007 impact analysis were less satisfying than we had hoped. In particular, we are skeptical of the results showing that wall insulation saved less than floor insulation, HERs saved 49 therms in gas heated homes, and replacement heat pumps saved only 153 kWh on average. While the pooled fixed effects models used in this evaluation were more stable than those used in the 2005-2006 evaluation, the puzzling results lend more support to moving away from these types of models. Consequently, the results from this report will not be used to true-up savings for the 2007 program year or to predict future savings.

[1] http://energytrust.org/library/reports/091229_Heat_Pump_Report.pdf

The 2008 impact evaluation will be performed using weather-normalized annual consumption using a PRISM-like approach. In-house Evaluation staff will conduct the analysis with review by two outside experts in the field of utility billing analysis.

2. INTRODUCTION

This report presents the results of the 2007-2008 Home Energy Solutions (HES) process and impact evaluation. The HES program is a complex program, covering multiple sectors, multiple measures, and varied and changing offerings in order to meet the changing needs of the market. In this section we describe and present a brief history of the program including the changes that occurred during the 2007-2008 program cycle.

2.1 Program Overview

Energy Trust of Oregon's Home Energy Solutions (HES) program provides cash incentives to Oregon households to encourage the adoption of energy efficiency measures. The program covers a range of efficient options that provide electricity and gas savings to customers living in single-family, multi-family, and manufactured home sectors. Below we provide a brief overview of the offerings to each of the three targeted sectors: single-family, multi-family and manufactured homes. We also discuss the new Energy Saver Kit offering.

For **single-family homes**, there were three key initiatives in 2007-2008: (1) cash incentives or rebates, (2) Home Energy Review, and (3) Home Performance with ENERGY STAR.

Cash incentives are available to customers for certain measures that meet energy efficiency qualifications established by Energy Trust. Participants must hire contractors to install most of these measures for them.

Home Energy Review is a free in-home audit program in which a trained auditor visually inspects the home for leaks, presence of insulation, efficiency of appliances, and other issues that could affect energy use. The auditor then makes recommendations for changes the homeowner could make to improve the energy efficiency of their home (some of which are eligible for rebates). The auditor also provides free CFLs, low-flow showerheads, and aerators. Participants are also able to receive rebates through the HES program if they install eligible measures.

The Home Performance with ENERGY STAR (HP) component of the program is a more advanced and technical in-home audit service that costs approximately $400 (but varies by contractor). While the Home Energy Review only takes about an hour, the HP program takes three to four hours and is performed by a Building Performance Institute Certified contractor who employs diagnostic testing to find out exactly where the home is leaking, if there are any safety issues, and examines the HVAC equipment. HP also results in recommendations for changes the homeowner could make, and the program is designed to provide whole house solutions for energy efficiency. Many HP participants also receive rebates through the HES program.

Multi-family buildings can also participate in the HES program. For multi-family homes, property owners or management companies can receive a building assessment in which an auditor evaluates the building and makes recommendations for energy efficiency. The auditor may also provide CFLs, showerheads, and aerators for the tenants. In addition, participating buildings can install measures eligible for cash incentives, primarily insulation

and windows.

From 2002 to 2008, Energy Trust funded contractors to provide free duct testing, duct sealing, and air sealing services to participants living in **manufactured homes**. The contractors may also provide CFLs. This program is unique in that frequently the participant does not have any direct contact with Energy Trust, as they can schedule directly through the contractor and they do not have to submit paperwork themselves.

In 2008, another effort, **Energy Saver Kits**, was added to the HES program. These kits were provided to Pacific Power customers upon request and included a variety of free measures depending on water heater type. Those with an electric water heater received four CFLs, a showerhead, and aerators, while those with a gas water heater received six CFLs. The kits also came with a checklist of low-cost actions that could be taken around the house to save energy.

The Home Energy Solutions program also includes smaller initiatives or pilot programs that were not covered by this evaluation effort.

2.2 Program History

Energy Trust introduced the Home Energy Solutions program (formerly called Home Energy Savings) in 2002, serving PGE and PacifiCorp customers (electric only). In 2003, the program added Northwest Natural territory, and thus included gas efficiency measures, and in 2006 Cascade Natural Gas was added.[3] Conservation Services Group has managed the program since mid-2005, taking over from Ecos Consulting. CSG instituted the Home Performance with ENERGY STAR program.

While this program is a continuing program effort for Energy Trust, key changes for the 2007-2008 program cycle included:

- Expanding the program in Eastern and Southern Oregon
- New pilot initiatives such as The Corvallis Energy Challenge
- Expanding the multifamily and mobile homes programs
- Technological upgrades (new incentive form, new FastTrack system, new Home Check system, redesigning website)
- Developing and distributing Energy Saver Kits (started in 2008)
- Growth of Home Performance with ENERGY STAR effort
- Increases in HES installations (all sectors) from 2007 to 2008, driven by lighting, air sealing and duct testing, and HVAC

In addition to these changes, additional changes occurred in 2009 (during the evaluation period) and many of our respondents, particularly trade allies, mentioned some of these changes. Specifically, the following program changes occurred during the course of our evaluation effort:

- Heat pump requirements (HPSF) increased in May 2009
- Duct sealing incentive structure changed in May 2009

[3] As of January 1, 2009, Energy Trust no longer serves Avista customers.

- Gas furnace incentive level decreased in May 2009
- A universal application form was created
- Online submission of application forms were made available to trade allies
- The revised website launched in September 2009

We describe these changes made after the period covered by the evaluation because some of these changes, particularly the website and the application, address issues documented through our evaluation effort.

3. METHODOLOGY

Our evaluation drew on information collected from eight distinct data collection efforts. Three of these were qualitative efforts: in depth interviews with program staff and collaborators, observations of meetings, and in-depth interviews with trade allies. Under this evaluation effort, our team also conducted a general population survey (in support of a segmentation study conducted outside of this program scope) as well as four quantitative survey efforts with the following participant populations: single-family participants, multi-family participants, manufactured home participants and participants that received Energy Saver Kits.

Table 3. Summary of Data Collection Efforts

Data Collection Effort	Total Completed Interviews/ Observations
Qualitative Survey Efforts	
In depth staff and collaborator interviews	20
Observation of meetings	2 meetings
Trade Ally in depth interviews	28
Quantitative Survey Efforts	
General population survey	903
Single-family participants	800
Energy Saver Kit recipients	252
Manufactured home participants	70
Multi-family home participants	58

Below we describe each of these data collection efforts, as well as our analysis efforts for the impact evaluations.

3.1 Data Collection Efforts

In-Depth Staff and Collaborator Interviews

Opinion Dynamics began this effort by conducting interviews with program staff from Energy Trust and CSG. We conducted 20 interviews with staff members, either in coordination with the kick-off meeting or at another time in January 2009. We also interviewed six program collaborators in February and March 2009. These interviews provided an understanding of the program, allowed us to document internal program processes and concerns, and helped us to develop questions for the phone surveys and other in-depth interviews.

Monthly/Quarterly Meetings Heard or Observed

Opinion Dynamics observed two monthly meetings held between Energy Trust and the implementation staff of Conservation Services Group in the first half of 2009. These

observations allowed us to understand the dynamics of the key players, document program efforts, and provide recommendations on program processes.

Trade Ally In In-Depth Interviews

Opinion Dynamics conducted in-depth interviews with 28 active trade allies in July and August 2009. These interviews focused on five market areas: insulation (6), windows (5), gas furnace (5), heat pump (5), and duct work (4), as well as Home Performance with ENERGY STAR (3). These interviews allowed us to provide market assessments for these areas as well as programmatic insights related to the relationship between trade allies and Energy Trust, with a focus on communication. (Note that these in-depth interviews were conducted as a follow-up effort to Energy Trust's annual Trade Ally survey effort, conducted in early 2009).

Single Family Home Participant Phone Survey

Opinion Dynamics fielded the single family home participant survey, including the Home Energy Review (HER) and Home Performance with ENERGY STAR (HP) modules, in July and August 2009. Starting with a usable sample of 29,211 unique participants, we obtained 800 completed interviews. This survey collected data relevant to the impact analysis (measure retention, free ridership, spillover, etc.) as well as satisfaction and process issues. A breakdown of completed survey efforts and response rates are shown in the table below.

Table 4. Breakdown of Completes

Category	n
Total	800
By Year	
2007	379
2008	421
By Sector	
HER	145
HP	70
Cash incentive	585
By Measure	
Duct sealing/insulation	181
Insulation	180
Air sealing	152
Gas furnace	138
Heat pump	132
Water heater	128
Windows	101
Solar water heaters	57

Table 5. Attrition for Single Family Home Participant Survey

Survey Info	Total
Usable Sample	29,211

Attempted to Contact	5,995
Completed	800
Response Rate	17%

Manufactured Home Participant Interviews

Opinion Dynamics conducted interviews with 70 participants who live in manufactured homes. Notably, we attempted to field a manufactured home telephone survey in August 2009 but found that the respondents were not familiar with the terminology of duct sealing and air sealing. We made a few follow-up calls to participants and found that the description of the program required more nuance and interaction with the participants. As a result, we switched to a format that allowed for more extensive interaction and comments from participants (rather than a close-ended survey format). We completed 70 interviews in August and September 2009 from a sample of 532. This survey allowed us to assess satisfaction with the program, free ridership, and spillover.

Multifamily Home Participant Phone Survey

Opinion Dynamics completed 58 telephone surveys with 2007 and 2008 multifamily participants in September and October 2009. For this effort, we started with a sample of 309 sites and 181 usable unique participants. Like the other participant surveys, this survey focused on data relevant to the impact analysis (specifically net-to-gross issues) and programmatic issues. We also obtained process-related information regarding the relationship between the participants and their tenants.

Table 6. Attrition for Multifamily Home Participant Survey

Survey Info	Total
Usable Sample	181
Attempted to Contact	181
Completed	58
Response Rate	42%

Energy Saver Kit Participant Phone Survey

Opinion Dynamics also fielded an Energy Saver Kit participant survey in August 2009. We completed 252 interviews from a usable sample of 6,329 unique participants. This survey allowed us to determine installation rates of measures in the kits, measure retention, free ridership, and energy savings. Because these kits were available in 2008 only, they were not included in the impact analysis, which was only for 2007.

Table 7. Attrition for Energy Saver Kit Participant Survey

Survey Info	Total
Sample	6,329
Attempted to Contact	1,952
Completed	252
Response Rate	18%

General Population/Nonparticipant Phone Survey

Finally, Opinion Dynamics conducted a general population survey in May 2009. We completed 903 interviews. The data collected from this effort was used in a segmentation analysis conducted by Research Into Action. We present some of this data in our report, but the majority of the data is presented under a separate research report written by Research Into Action.

3.2 Analysis Efforts

Market Assessment of Five Key Markets

In Energy Trust's 2009 Trade Ally Survey report, Energy Trust described the state of each of the primary markets touched by the program (e.g., gas furnaces, heat pumps, insulation, duct sealing and windows) as reported by responding trade allies. The Opinion Dynamics evaluation team built on this information by specifically asking trade allies to comment on Energy Trust's initial assessment of five different markets. The initial assessment was faxed to trade allies and trade allies were asked for feedback and comments. Through this iterative process, we gathered insights on the influence of the program, and recommendations for changes to incentive levels and program requirements. For context, this assessment also included information from the assessment of free-ridership (discussed below). This analysis is presented in Section 5, Assessment Of Key Markets.

Review of Engineering Estimates

The Opinion Dynamics evaluation team completed a review of the existing engineering-based saving estimates for each individual program measure. This review allowed us to make recommendations for improvements to the program assumptions, as well as areas in need of additional research. The results of this analysis were provided to Energy Trust in a memo submitted on July 21, 2009 and are also provided in Volume 2, Appendix C.

Billing Analysis

The Opinion Dynamics evaluation team (under the guidance of the Heschong-Mahone Group) conducted a billing analysis for 2007 participants based on weather data, residential end-use load shapes, program data for participants, and billing data for participants. The details of this analysis are described in Section 8, Impact Analysis.

The billing analysis was conducted for the single-family and manufactured homes sectors. Our team did not conduct a billing analysis for multi-family participants since Energy Trust had performed billing analysis multiple times previously with poor results (i.e., difficulty with the models). Additionally, Energy Trust is now performing analysis using normalized annual data on 14 multi-family buildings with another 30 planned.

Notably, due to the timing of the effort, this billing analysis was only conducted for 2007 participants. The 2008 impacts will be assessed through a separate study being conducted by Energy Trust.

Net to Gross Analysis

The Opinion Dynamics team calculated net to gross ratios for each measure using a self-reported approach. Data was gathered through the quantitative survey efforts listed above using a standard approach outlined by Energy Trust. The results of our net-to-gross analysis by measure are shown in Section 0, Free Rider Values and NTG Calculation.

4. OVERVIEW OF PARTICIPATION

This section describes overall participation in the 2007-2008 program by providing participation numbers and a breakdown of program installations by measure and sector.

4.1 Participation

In PY2007-2008, the HES program reached 45,716 participants.[4] Overall, participation in this program appears to have increased from the 2005-2006 program cycle.

- Participation among single-family homes increased from 26,212 sites in 2005-2006, to 30,886 sites in 2007-2008.
- Participation among multi-family homes was 309 participating sites in 2007-2008, likely similar to 2005-2006 numbers.[5]
- The number of manufactured homes increased from 940 in 2005-2006 to 1,669 in 2007-2008.

The table below shows the breakout of participation by sector for 2007-2008.

Table 8. Total Participation in the Program

	2007	2008	Total
Single Family	**13,955**	**16,931**	**30,886**
Cash Incentives	8,581	10,811	19,392
Home Energy Review	5,191	5,964	11,155
Home Performance with ENERGY STAR	183	156	339
Multi-family	**127**	**182**	**309**
Manufactured Homes	**1,112**	**557**	**1,669**
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Total	**15,234**	**30,482**	**45,716**

Note: This table removes duplicates within the single family program; HER or HP participants who also received rebates are only counted once in this table. However, all relevant measures are counted in the next section and table.
HER participants who also received HP are counted in this table as HP. This totals 207 participants, or approximately 2% of total HER participation.

4.2 Breakdown of Program Installations by Measure and Sector

[4] Note that there could be some overlap between program components, but this provides a general sense of program growth. For multi-family, we reported unique sites rather than unique participants because so many participants are property management companies.

[5] Note that the prior MF study did not present the number of sites, only savings estimates.

The Home Energy Solutions Program provided cash incentives for a large number of measures. The database reports 26 different measure groups. While we note that some of these are overlapping efforts (duct sealing, duct test/seal, duct seal), we have left them as distinct categories in the table below since they are recorded as such in the program databases.[6] The total number of measures installed for each sector, as reported by the program database, is shown in the table below.

Three measures account for the largest number of single-family participants: Home Energy Review (HER), insulation, and gas furnaces. Duct sealing and heat pump also account for a large number of single-family participants.

Among multi-family homes, windows and insulation account for the majority of the program efforts, although lighting, aerators, and showerheads are also installed in tenant units through the multi-family effort, and thus are shown in large numbers in the table below.

For manufactured homes, the major program efforts are duct testing and sealing/air sealing. CFLs are also installed in many of the manufactured homes served by the program.

Table 9. Home Energy Solution Measures

Measure Groups	Number of Measures		
	Single Family	Multi Family	Manufactured Homes
Ceiling insulation	3,919,093/3855[a]	97	-
Floor insulation	2,297,405/2387	100	-
Wall insulation	1,168,843/1389	12	-
Lighting	70,496	50,388	1,754
Other insulation	17,346	-	-
Gas furnace	14,100	15	-
Home Energy Review (includes lighting and water measures)	11,375	-	-
Aerators	8,907	10,713	-
Showerheads	4,641	4,812	-
Duct sealing	3,359	-	1,362
Heat pump	3,131	-	-
Duct test/seal	2,405	-	1,668
Air sealing	2,349	-	772
Duct insulation	2,226	-	-
Water heater	1,973	165	-
Windows	1,158	24,978	-

[6] Database issues are discussed in a later section.

Measure Groups	Number of Measures		
	Single Family	Multi Family	Manufactured Homes
Solar hot water	355	-	-
Duct air	-	-	332
Heat pump Tune-up	283	-	-
HEM	196	-	-
Duct seal	-	-	108
Boiler	80	-	-
Solar Energy Review	74	-	-
Commissioning	37	-	-
Gas fire	28	-	-
Other	22	-	-
Total	**7,529,881/152,171**	**91,280**	**5,996**

[a] Note: Shell insulation quantity is reported in square feet, while the rest are per unit. Therefore we also included the number of participants for each measure.

Note that many of the lighting, aerator, and showerheads shown in the table above were provided by the Energy Saver Kits effort in 2008, although the program database does not break these measures out as a separate measure group.

5. ASSESSMENT OF KEY MARKETS

As part of our effort, we explored program effects on five key markets affected by the HES program efforts:

- Gas furnaces
- Insulation
- Duct sealing
- Heat pumps
- Windows

Our assessment of these five markets built upon the initial description of the markets provided in the Energy Trusts' 2009 Trade Ally Survey Report. In this section we describe Trade Ally comments regarding the markets, as well as examine free-ridership rates among participants who had these measures installed by the program, to better understand overall effects of the HES program and provide recommendations for changes in incentive levels and/or program requirements.[7] (Note that a table of free-ridership by measure is also provided in Section 0 of this report.)

Key findings by market are described below and a more detailed write-up can be found in Volume 2 Appendix B. In these sections, we present feedback received by trade allies including their suggestions for changes to the program. We realize that all suggestions may not be warranted but have included them here simply to inform Energy Trust about the perceptions of trade allies. We present our program recommendations in the final section of this chapter.

5.1 Gas Furnaces

The HES gas furnace incentive is seen as valuable by trade allies, but has a high level of free ridership among single-family participants (58%).

Specifically, in addition to the small monetary value, trade allies believe that the Energy Trust rebate provides a non-monetary benefit of validating (or reinforcing) the contractor's claims that the efficient unit is worth the initial investment. Trade allies also believe that the incentives increase demand for high efficiency products; however, there is some evidence that the financial incentives might only be needed for furnaces that are at least 95% efficient: there were several comments that would indicate that the percentage of gas furnaces 90% or more efficient may be larger than stated in Energy Trust's 2009 assessment. Energy Trust should consider increasing the gas furnace incentive requirements to 95% efficiency, which may provide an opportunity to further enlarge the gas furnace market. One trade ally also specifically suggested incenting at the 95% efficiency level.

[7] Although not all incentives are under consideration for change, we asked trade allies the hypothetical question of what would happened if the incentives were decreased or removed.

Overall, trade allies that deal with gas furnaces say the program and the incentives are very influential in the market; and the program has changed what is currently being installed. In the absence of the Energy Trust of Oregon incentive, the trade allies with whom we spoke felt that the market would shrink. (Note that these comments were specific to Energy Trust incentives):

> *You'd see people less willing to do a 90% furnace.*
>
> *They would buy less efficient products.*
>
> *That rebate is the big thing to the consumer.*
>
> *You know I think people would revert back to putting in a lower efficient model… the knowledge of the incentive program out there has certainly spurred things. I just feel very strongly that without some of these incentives that are available we would certainly have a decrease in the efficiency of the equipment that we are installing.*

In fact, one trade ally said that the reduction of the incentive to the $100 amount (May 2009) "*has reduced the sales of higher efficiency products*." Another said that "*…some of the decreases in the incentives…certainly have had customers taking a second look to see whether or not it's worth doing the upgrades for them…"*[8]

Our calculations from the single family participant survey indicate that Energy Trust is having an effect on the market, but that many of the high efficiency installations would have occurred in the absence of the program. The gas furnace free ridership rate is 58%. This large rate may suggest that trade allies are ascribing a larger influence to the incentive than may exist. However, trade allies perceive that the incentive helps move participants up the ladder of efficiency.

5.2 Heat Pump

While trade allies noted both the monetary and non-monetary benefits of heat pump incentives, several trade allies (including one interviewed for ducts) expressed concern that the heat pump efficiency requirements are too high, making the incentive not cost-effective for the customer in the current market:

> *…. the big incentives have more to do with the overall efficiency and the special motor requirements …..they should take a closer look at the air conditioning side and heat pumps because people aren't willing to pay in Oregon what you need to meet the high end equipment requirement. It doesn't pencil out mathematically….*[9]

Most of the contractors said the market would not change much if the incentives were removed, but contractors noted that this is partially because of the recent decrease in incentive levels (May 2009).[10] In their opinion, the incentive is not enough to get customers

[8] There is a $1,500 tax credit that is only good for 95% efficient furnaces. In addition, the RETC is unchanged.

[9] Note that in Energy Trust territory, cooling is a minor load compared to heating.

[10] One trade ally, however, said the market would change a lot without the incentive.

to the highest efficiency. The contractors recommended that Energy Trust consider decreasing the efficiency requirements. However, increasing incentive levels for the required efficiencies could also have the same effect.

Our calculations from the single family participant survey indicate that in 2007-2008, there was a high level of free-ridership in the heat pump market (63%). However, these participants fell under the old incentive levels and requirements, and therefore cannot be directly compared to the input given by the trade allies. Three trade allies indicated that free ridership would be even higher under the new incentive levels. We recommend interviewing participants in the 2009 program to more accurately determine the effects on this market.

As a final note, one heat pump contractor expressed concern that Energy Trust focused too much on new homes and that existing homes were not getting the right level of attention from the program.[11]

5.3 Duct Sealing

Trade allies felt that Energy Trust's duct sealing incentive has increased overall awareness of this service, and that removing the incentive would likely have a large impact on the market. However, according to trade allies, decreasing the incentive may or may not have a big impact. Altering the level or structure of the incentive may be feasible without shrinking the market.

Overall, trade allies felt that there is a lot of opportunity to increase market share in the duct sealing market if awareness can be raised. The trade allies believe that the duct sealing incentive really drives the market. Taking away the incentive would likely decrease the number of duct sealing jobs done, as many would not even know about the option otherwise.

Overall, trade allies report varying levels of effects on their business as a result of the recent incentive changes (May 2009). One mentioned that the recent change was a huge hit to the company. But another said the recent decrease in incentive level did not change the number of jobs.

Our calculations from the single family participant survey indicate the free ridership rate for duct sealing is 31%. Again, this fits with the trade ally belief that the rebates drive the market. This is the lowest free ridership rate among the five measures, and also the rebate that trade allies felt most strongly about.

One contractor suggested that cleaning duct systems and furnaces should be recognized by Energy Trust as an efficiency improvement, and another suggested that the rebates should be performance-based, rather than cost based. A trade ally interviewed for insulation suggested paying more for air sealing and duct sealing testing:

> *Again, going into the air sealing and duct sealing I think they could pay more for the testing. For instance, the duct sealing testing they only paid thirty-five*

[11] Energy Trust's new homes program focuses on builders rather than contractors.

> *dollars when it's realistically anywhere from three to five hundred dollars to do the test itself and they pay thirty-five dollars…*

Energy Trust should also be aware that according to trade allies, barriers to offering duct sealing include cost-effectiveness and safety.

5.4 Insulation

Trade allies believe the insulation incentive is very important to the market. According to trade allies, taking away the incentive could decrease business by up to 40 to 70%. On the other hand, marketing would help increase the number of jobs.

Overall, the trade allies believe the incentive levels are satisfactory. Our calculations from the single family participant survey indicate that free ridership for insulation is 38%. This is in line with the trade allies' perception that the incentive is important to the market and that removing it could decrease business by 40 to 70%.

One trade ally also mentioned that the insulation market is different in Bend from that presented in the 2009 Trade Ally Survey.

5.5 Windows

Trade allies had mixed opinions about the value of the window incentive. However, three of the trade allies thought removal of the incentive would decrease the efficient window market.

One trade ally expressed the high importance of the incentive:

> *I think it's making people more aware of energy efficiencies, especially with the new federal tax credit. People are really starting to dig into [it] and seeing the benefits of having a high efficiency product.*

Two others felt it was important but did not clearly explain why. A fourth mentioned that it only affects about 10 to 15 percent of jobs. Another mentioned that it drives prices down. Still another trade ally thought the effect would only be significant in multifamily, not single family units.

Trade allies suggested various changes to the incentives, including removal of the requirement for other measures, expanding the square footage, and increasing the efficiency requirement.

Our calculations from the single family participant survey indicate that the free ridership rate for windows is 48%. This indicates that about half of customers would have installed efficient windows anyway, and may explain why trade allies had mixed opinions about the value of the incentive. It is clearly valuable to many people, but not to an overwhelming majority. Perhaps some of the measure suggestions given by the trade allies to customers could increase the value of the rebate by enticing more customers to upgrade to efficient

windows.

One of the trade allies thought the incentives should be marketed better to rental properties. In addition, two trade allies suggested that doors should also qualify for rebates.

5.6 Recommendations

Based on our exploration of the effect of the HES program on these five markets, we recommend the following:

- Energy Trust should consider increasing the gas furnace incentive requirements to 95% efficiency, which may provide an opportunity to further increase the efficiency of the gas furnace market. Trade allies suggested that incentives for 90% efficient furnaces may not be necessary, because the percentage of gas furnaces rated 90% or more efficient may be larger than stated in Energy Trust's 2009 Trade Ally assessment, and several said they sell few furnaces below 90%.
- Energy Trust should consider either reducing efficiency requirements for heat pumps or increasing the incentive levels because several trade allies expressed concern that the current incentive level/efficiency requirement combination does not make the upgrade worth it for the customer.
- Energy Trust should retain the duct sealing incentive because trade allies believe that it drives the market by creating awareness. In fact, further marketing could result in more jobs for trade allies. Trade allies felt that altering the level or structure of the incentive could be effective without shrinking the market, but further exploration is required to verify feasibility.
- The insulation incentive is fine as is and provides a large portion of business for the trade allies. Some allies suggested providing different incentive levels based on existing insulation or types of insulation installed, but further exploration is required to verify feasibility.
- Energy Trust could consider removing the requirement for the windows incentive to have a second measure installed. However, trade allies did not have a uniform opinion of the effect of the HES program on the windows market.

6. ASSESSMENT OF PROGRAM EFFORTS

Below we briefly describe the six program efforts covered by our evaluation, including:

1. Single-family Rebates
2. Home Energy Review
3. Home Performance with ENERGY STAR
4. Multi-family Rebates
5. Manufactured Home Services
6. Energy Saver Kits

Note that these brief descriptions of the program efforts and key recommendations, build upon detailed results provided in Volume 2 of this report.

6.1 Single Family Rebates In-Brief

Overall, 19,392 people participated in the single family homes Home Energy Solutions program in 2007 and 2008, not including Home Energy Review participants. Single family rebates account for a small portion of the electric energy saved by this program, but a much larger portion of the gas savings. (In 2007, these participants account for 16% of the gross kWh and 77% of the gross therm savings from the overall portfolio, as described in Volume 2, Chapter 3.)

Most notably for these participants, satisfaction with the program appears to have declined since 2006. However, 79% of participants still rated their satisfaction with the program as 8 or above on a scale from 0 to 10. Based on comments from survey respondents, the greatest needs that, if met, could increase satisfaction with the Home Energy Solutions program appear to be a streamlined application process and more advertisement and quality control of contractors. In addition, marketing of the program could be increased. Specifically, we recommend that:

- Rebate instructions should be made clear and paperwork streamlined as much as possible (if this has not been done already); Energy Trust could also encourage contractors to do the paperwork for their customers.
- For overall program satisfaction, experience finding and working with contractors can make the difference between a rating of 8 (on a scale of 0 to 10) and 10; Energy Trust should strive to provide easy access to qualified contractors, potentially through raising awareness of the Energy Trust contractor list and ensuring that contractors on the list have been properly screened.
- Energy Trust's list of contractors is more important for some measures than others, and could be made more prominent or advertised in locations where people search for contractors on an emergency basis, such as the yellow pages or online searches.
- Energy Trust could leverage external tax credits for both awareness of their program and motivation for potential participants to take energy saving actions; this may be addressed by the new incentive grid that clearly portrays all the rebates and tax credits

available.

- Contractors frequently inform customers of the Home Energy Solutions (HES) program but seldom recommend additional energy saving measures. Package solutions should be encouraged, possibly through incentives for trade allies who install multiple measures.

Additional details from the interviews with participants who received rebates from this program effort are provided in Volume 2, Chapter 3.

6.2 Home Energy Review In-Brief

The Home Energy Review makes up a large percentage of the overall savings of the Home Energy Solutions Program (approximately 20% in 2007). The per unit savings from HER are among the highest, and this, combined with the large number of households served, leads to a large portion of total savings.

Overall, 11,155 people participated in a Home Energy Review in 2007 and 2008. Of these, we estimate that 55% have taken some action as a result of this effort—with about one third of all HER recipients channeled into the Home Energy Solution rebates.[12]

Satisfaction with HER is also relatively high, with mean ratings for all of the HER indicators of satisfaction ranging from 8.1 to 9.4 (67% to 93% rating 8 or above).[13] However, the two greatest needs for Home Energy Review appear to be revamped training of HER auditors and additional leave-behind information for home owners. Specifically, we recommend that:

- Energy Trust and CSG review the HER training to ensure that all auditors are adequately trained to provide accurate household-specific information to participants.[14]
- Energy Trust and CSG review the current HER materials to make sure they are meeting participants' needs. While overall satisfaction with the program is high, HER recipients are not as satisfied with the quality of information they receive during the HER. In Q1 2009, the program made some changes to the materials but Energy Trust and CSG should review the new materials based on comments below to make sure they are meeting participants' needs. This will likely help increase the number of actions taken as a result of the HER. Specific recommendations are presented below and include requests for:
  - Prioritized recommendations
  - Accurate tables of cost estimates, rebate values, tax credits, and tax write-offs
  - Step-by-step instructions of how to qualify for rebates
  - Specific information about different products

[12] Note that the number of HER participants is based on the database, but the percent taking action is based on survey responses.

[13] There may be geographic differences in the data that account for some of these problems associated with the HER. However, we have not examined these differences.

[14] Neither participants nor trade allies provided specifics regarding the training needed. Comments included that services are recommended that are not needed, such as duct sealing in houses without duct work.

- Information on how to choose a product
- Clear contact info
- Lists of additional resources

One of the largest challenges that HER faces is the precarious balance between providing individuals with valuable information to help understand the costs and priorities in their home, and the need for this program to be perceived as neutral (so as not to favor some fuels, contractors or trades over others). Homeowners are asking for information about costs and priorities, so finding a way to help provide some of this information in a way that does not favor any individual contractors or trades will enhance the value of this program component.

Additional details on our analysis of the HER effort are provided in Volume 2, Chapter 5.

6.3 Home Performance In-Brief

Between 2007 and 2008, 36 contractors completed Home Performance jobs at 340 sites (339 unique participants), with an average of 6.1 measures per site. Of these, 5%, or 17 sites, did not have multiple measures installed. The most frequent measures installed as part of Home Performance jobs were duct work, air sealing, ceiling insulation, and floor insulation. These measures produce a moderate amount of energy savings per unit in comparison to other measures rebated through the program.

Overall, both customers and contractors value HP dbecause it relies on building science and a whole house approach to provide sound technical expertise of measures to take in your home, and customers are very happy with this service. However, we recommend some changes Energy Trust could make to improve this component of the program:

- Work to distinguish Home Performance with ENERGY STAR from the free audit provided by the HES program (through marketing efforts).
  - Use the terms “building science”, “technical expertise” and “whole house approach”-- to set it apart from the free HER audit. These terms appear to be the valuable and distinguishing trait of this program component to customers and contractors alike.
  - Ensure that HER auditors, and possibly non-HP trade allies, are properly trained to be able to explain the difference between HER and HP to potential participants.

- Improve marketing of the HP program:
  - Leverage customer feedback and testimonials to promote the HP program to others; this may help overcome potential cost barriers. (Testimonials may also help to distinguish between HP and HER.)
  - Continue to employ multiple forms of advertising for HP, as participants come in from a variety of sources including internet, utility, mass media, and Energy Trust in general.
  - Expand marketing of the HP program to increase awareness levels commensurate to

those of the HER program.

- Explore whether the Home Energy Analyzer can be used to further pull participants into the HP program.
- Expand HP information on the website to include more detail and specificity, not only of the comprehensive home assessment, but of the entire process for assessment, installation, and close-out.

- Consider providing incentives for diagnostic testing or other HP-only incentives (perhaps while decreasing incentives for other measures) in order to increase participation in HP and overall installation of energy efficient measures.
- Consider moving to different software besides Home Check, or allow a choice of software that provides the necessary information to the customer and the program.
- Consider extending first year contractor incentives based upon number of jobs performed into the second year or moving some of the first year incentives into the second year to allow for a longer start-up time for contractors.

Additional details on our analysis of the HP effort are provided in Volume 2, Chapter 4.

6.4 Multi-Family Program In Brief

Overall, 309 sites participated in the Energy Trust Multi-Family program in 2007 and 2008. These 309 sites account for the large majority of HES program kWh savings. In 2007, we estimate that the multi-family program makes up approximately 61% of the gross kWh savings of the Home Energy Solutions Program and 4% of the gross therm savings, but this may be overestimated since it was based on adjusted ex ante impacts rather than a billing analysis effort.

Responding managers of participating buildings report that tenants are extremely pleased with the program and acknowledge significant savings on their energy bills. About three quarters of the participating building managers also share information with tenants. However, managers' or owners' dissatisfaction with paperwork and contractors seems to be keeping overall satisfaction with the program at a rather low level (56% reporting a 5 on a scale of 1 to 5, mean of 4.3). Energy Trust could make some changes to raise satisfaction levels as well as increase awareness of the program. Specifically, we have the following recommendations:

Building Assessment. Satisfaction with the building assessment is very high overall. However, Energy Trust should strive to make sure that the assessors are well trained and qualified and the recommendations are written, clear, and detailed. There were several comments made about the professionalism, training, and timing of the assessor.

Paperwork. The negative experiences with the paperwork and submittal process are decreasing satisfaction levels across the board. Energy Trust should attempt to streamline the paperwork process or make sure that all participants are receiving help with as much of their paperwork as possible. (Specific recommendations provided in Volume 2.)

Contractors. Even though very few participants used Energy Trust to help select a contractor, participants still project their experiences with their contractors onto Energy Trust. We recommend that:

- Although Energy Trust cannot guarantee the quality of contractors, they should attempt some amount of contractor screening and or training to eliminate bad ones from the list.
- Energy Trust should make sure that participants know that there is a list of contractors available who are qualified to make the installations that qualify for incentives.
- Institute a higher level of QC for new contractors with little or no track record. Inform owners that a higher level of QC will be required of contractors that are not in the trade ally network (or require that contractors come from the trade ally network).

Marketing. Very few participants hear about the multi-family program through Energy Trust; most hear about it through their contractor or word-of-mouth.

- If Energy Trust wishes to increase participation in this part of the program, we recommend that Energy Trust increase marketing to multi-family buildings by raising awareness levels. Selling points for participation (besides the obvious money savings) could include:
  - Increased tenant comfort/decreased turnover as well as a selling point for new tenants
  - Increased resale value of property
  - Green/environmental benefits
- Energy Trust could also foster relationships and repeat participation with existing participants as most of the owners own multiple buildings.
- Consider coop marketing with the Oregon BETC program to help increase awareness of both programs in the multi-family industry.

Additional details on our analysis of the multi-family effort are provided in Volume 2, Chapter 6.

6.5 Manufactured Homes In-Brief

The manufactured homes component of the Home Energy Solutions program is providing verified energy savings to a market that would not be served in the absence of this program, and the manufactured homes served by this program greatly appreciate and value this service. This effort, however, is estimated to account for a very small percentage of savings.

In 2007 and 2008, 1,669 people participated in Energy Trust's manufactured home program through eight contracting companies and CSG.[15] For 2007, this part of the Home Energy Solutions program accounted for 2.5% of the total savings from the Home Energy

[15] The jobs per contractor ranged from 11 to 1612, with up to 3 jobs per house.

Solutions program with an estimated per unit savings of 796 kWh per home[16] from our billing analysis effort.

This service is perceived as being valuable to recipients: 94% of respondents, including some who only received testing, said the services were valuable, mentioning lower heating bills and less energy waste. In addition, satisfaction is extremely high: 75% of respondents rated their satisfaction as a 10, with 92% giving a rating of 8 or higher.[17] Respondents were very happy with the quality of work and the professionalism of the contractors.

In all, 87% of the respondents that we interviewed had their home tested and sealed. The remaining homes were tested but not sealed. Notably, among those who stated that their home was only tested, four homes were mis-categorized in the database (that is, the database indicated that both testing and sealing was performed).

This service is also leading to some additional savings—more than just what is accomplished through the duct and air sealing and direct installations. In all, several respondents mentioned that their contractors made additional recommendations, and 9% of respondents took additional energy saving actions that they attribute to the program.

The recommendations for this program component are limited due to the high levels of savings and satisfaction. However, based on our findings, Energy Trust and CSG should consider the following:

- Increase program savings from manufactured homes by:
  - Providing more homes with CFLs during the service.
  - Training contractors to continue recommending additional energy saving actions to these homes.
  - Finding ways to meet additional needs since a large percentage of respondents indicate that their home is in need of additional energy saving actions, such as new heating systems.
- Implement checks to ensure accuracy of the database so that the saving estimates are more reliable for reporting purposes.

Additional details from our interviews with participants in the manufactured home effort are provided in Volume 2, Chapter 7.

6.6 Energy Saver Kits In-Brief

In 2008, Energy Saver Kits were mailed to 12,812 homes.[18] There were two main types of kits sent out to Pacific Power customers based on the fuel type of the recipients' water

[16] The 796 kWh is from duct sealing and/or duct insulation. However, if other measures were installed at the same time as the duct measures, this value would capture that savings as well.

[17] This was on a 10 point scale where 10 was very satisfied.

[18] This is the number verified in the review of databases. The database indicates 11,633; however, there were multiple entries for some records.

heater. Homes with electric water heaters received four CFLs, one showerhead, and two faucet aerators. Homes with gas water heaters received six CFLs only. These kits also contained a checklist with energy saving tips.

While this program effort was not initiated until 2008, and thus was not examined as part of the 2007 billing analysis; due to the large number of participants it is estimated to make up a large percentage of savings for 2008.

Based on our analysis of the program database, engineering estimates for the measure contents, and survey data, it appears that in gross, the kits are providing 44% of the kWh savings expected based on kit type. Net savings (including free ridership and spillover) are 34% of expected savings. This shortfall from potential savings is due to the fact that not all program participants reported receiving complete or listed kit types[19], only 58% of items received in the kits were installed, some of the kit CFLs replaced older CFLs, and many people indicated they would have purchased the items in the absence of receiving the kit. The kits also provide unexpected therm savings as a result of those participants with gas water heaters who reported receiving water measures.

However, in addition to the savings estimates reported above, 25% of kit recipients have taken some type of action suggested by the accompanying checklist that may result in further energy savings attributable to the program.

Overall, respondents report a high level of satisfaction with the Energy Saver Kits. Even respondents who did not use the items were happy with receiving them. More than eight in ten respondents (83%) reported their level of satisfaction as an 8 or higher on a scale of 0 to 10. More than two-thirds (67%) rated their level of satisfaction as a 9 or 10.[20] Those that were not satisfied most frequently reported dissatisfaction with at least one of the items: CFLs were not bright enough or burned out[21], or aerators had problems or produced too little pressure. Some also reported installation problems.

Based on our review of the Energy Saver Kit data, we recommend the following:

- Given the large number of Energy Saver Kit recipients in 2008, Energy Trust should consider assessing impacts of this portion of the savings for the 2008 impact evaluation effort.
- Collect phone numbers for Energy Saver Kit recipients to facilitate follow-up.
- Consider evaluating the cost effectiveness of the kits given that recipients install only 58% of items that they recall receiving.
- Alternatively, consider altering kit contents based on recall, installation rates, and free ridership to include the measures with the greatest likelihood of producing savings.

Additional details on our analysis of Energy Saver Kits are provided in Volume 2, Chapter 8.

[19] This could be a result of recall problems or indicate that some participants are receiving kit types other than what was listed in the database.

[20] The mean score for all respondents was 8.8.

[21] No information on why bulbs burned out was collected.

7. ASSESSMENT OF PROGRAM PROCESSES

As part of the process evaluation effort, our evaluation also explored eight key areas:

1. Training
2. Applications and Paperwork
3. Marketing Efforts (and Website)
4. Policies and Program Requirements
5. Trade Ally Communications
6. Collaboration
7. Internal Communications
8. Databases

Below we provide a summary of findings and recommendations for each of these areas of exploration. This data was originally provided to Energy Trust as part of an early feedback memo on April 20, 2009, and a copy of this memo is provided in Volume 2 Appendix A.

Note that some of these findings overlap with the six program efforts described above.

7.1 Training

Training of those implementing program efforts was a recurring theme throughout our evaluation effort.

Among single-family participants, satisfaction with contractors (ratings of 9 or 10 on a scale from 0 to 10) ranged from 58% to 72% depending on the measure. When discussing reasons for overall rating of Energy Trust, some participants mentioned issues with contractors. Even respondents who gave high ratings (eight on a scale where 10 is very satisfied) provided feedback such as "*most of my problems were with the contractor*," and "*the contractor did a bad job sealing my home*." Even though very few participants used Energy Trust to help select a contractor, participants still project their experiences with their contractors onto Energy Trust.

There also is a clear need for additional training of the HER auditors based on interviews with participants and trade allies.[22] The perception among trade allies is that auditors are not adequately trained (perhaps because of the rate of turn-over within CSG) and that as a result, the recommendations that they provide to households are not always in line with the best interests of the homeowner. Trade ally comments were supported by the comments of HER participants, such as: "I *had a lot of questions and the guy did not have answers,"* and *"I wanted to know how to get a rebate or something like that and they couldn't tell me."*

[22] CSG directly employs most of the auditors who complete the HERs. In outlying areas (non-Willamette valley), community action agencies, hired by CSG, also provide them. Auditors typically have sales, customer service, or environmental backgrounds. Customer service skills are particularly valued because auditors are "in and out of customers' homes all day and [they] have to interact and engage with them for the time that [they're] there." It is thought that the field aspects can be taught.

Multi-family participants also mentioned contractor satisfaction as an issue. Although most multi-family participants indicated that they relied on past experience and recommendations from others to find their contractors; approximately a third of multi-family participants indicated that they used the Energy Trust list as a reference when asked directly. Comments from multi-family participants included*"…the contractors took us for an unexpected ride, In my opinion, they were inexperienced…[Energy Trust] need[s] to do a better job selecting and monitoring the contractors."*

Furthermore, multi-family participants also expressed similar concerns with their building assessments, offering suggestions to improve the professionalism and timing of the building assessment effort, including: "*They didn't know as much as I,"* and *"…the field people could have been more professional, they were not completely prepared."*

Manufactured home participants who received services for free did not express the same level of concern with the contractors, and were generally pleased with the services that were provided.

There is clearly a need for training of HER and Building Assessment auditors, and although Energy Trust cannot take direct responsibility for contractors, there does seem to be an opportunity for Energy Trust to improve contractor quality through training and screening.

Recommendations related to training include:

- Provide needed training. Based on our review of trade ally responses, trainings are seen as valuable, and contractors are asking for more trainings. There were requests for training sessions in outlying areas, for Energy Trust to provide more notice of training sessions, and to provide more training materials. Specific training topics suggested include sales and marketing, external tax credits related to Energy Trust incentives, and technical field training.
- Raise awareness of the list of contractors to make sure that participants know that there is a list of contractors available who are qualified to make the installations that qualify for incentives.
- Perform contractor screening and/or training as frequently as necessary to remove inadequate ones from the list.[23]
- Institute a higher level of QC for new contractors with little or no track record. Inform multi-family participants that a higher level of QC will be required of contractors that are not in TA network (or require that contractors come from trade ally network.)
- Institute higher training standards for HER Auditors and multi-family building assessors.

[23] Note that contractor screening is currently done once a year. Additional screening could be based on complaints from participants (or solicited feedback) on an as-needed basis.

7.2 Applications and Paperwork Recommendations

Streamlining the incentive process was a program initiative during 2007 and 2008. In interviews, Energy Trust and CSG managers highlighted several issues around streamlining incentives including:

Converting to Web-Based Forms[24]: Staff expressed a long-held wish to convert the paper-based incentive application form to MS Word- or web- based forms. This conversion is believed to minimize staff effort for data entry and improve quality control, as well as reduce the number of incomplete forms. Incredibly, 50-75% of incentive forms are missing at least some information each month.[25] The interviewees specified that any new incentive form system would have to be secure from tampering and identity theft, and feature a method for receiving receipts or other proof of purchase, either via postal mail or via PDF. Due to this requirement, any new incentive form system would not be fully free of the conventional mail system, and additional staff time would be necessary to link the electronically-submitted information to the conventionally-submitted, scanned or emailed receipts. In addition, participants would experience an extra submittal step (step one: complete electronic form; step two: mail or scan in receipt). That said, requiring fields to be filled out before accepting the submission online could also help reduce incomplete information.

Removing the Need for Submitting Multiple Applications: For Home Performance with ENERGY STAR jobs, which often involve incentives for multiple measures, there are duplicative efforts for most of the items required on the incentive forms. Moreover, the incentive forms can require coordination between several contractors to ensure that all are submitted.

Trade allies are aware that the program has been working to streamline the process and many of the trade allies said that the forms were simple and straightforward now, but a few trade allies mentioned the process of submitting the paperwork as a drawback to the program, particularly the long lag time between bid and rebate, multiple phone calls to resolve problems, and phone calls required to fix paperwork errors when missing data is often available in another location in the paperwork.

Almost all of the interviewed trade allies indicated that they either completely fill out forms for their customers or at least provide support as they need it. However, participants still report experiencing difficulties, and an HES staff person estimated that at the end of 2008, 60% of the forms were completed by the participants, and the remaining 40% were more

[24] Based on our interviews with program staff, in the last full-year, 2008, over 18,000 incentive forms were submitted for the HES program. Of these, 99% arrived via standard mail with a paper copy of Form 300A; the remaining 1% arrived by fax.

[25] As of the close of 2008, non-residential (non Home Energy Solutions) incentive programs for efficient refrigerators, freezers and clothes washers at Energy Trust use an online incentive application form.

likely to be completed by trade allies or contractors—with smaller trade allies and contractors less likely to complete the forms and send them in.[26]

Program participants also expressed displeasure with the paperwork. When single-family rebate participants who were dissatisfied with the program or an aspect of it were asked the reasons for their dissatisfaction, a large number mentioned confusing, unclear, or difficult paperwork and processes.

In addition, while 55% of multi-family respondents received help with their paperwork from Energy Trust or their contractor, several respondents complained about the paperwork and general confusion over the process. Comments included, "*The paperwork was cumbersome," "I had to resubmit three times," and "There was a lot of phone calls, red tape, and a lot of paperwork."*

Several trade allies offered suggestions for improving the paperwork process including ensuring that there is some follow-up after the forms have been submitted, and having a person to contact with questions about the inspection process, etc. Several trade allies suggested than an online submittal would help (despite the fact that there is now an email form available). Of those trade allies who were aware and had actually used the email form, most said it helped the process. However, one trade ally mentioned that it was a slower process because they have to send a separate email for each application (rather than just putting a pile in the fax machine), and another trade ally said they have yet to find an email address to send in the form.

Nearly two-thirds (65%) of the single-family rebate participants indicated that they would have submitted the forms online if that option had been available, with the others indicating that they didn't have access to the Internet (26%), preferred paper (19%), or that the trade ally completed the forms for them (16%).

Recommendations about paperwork and application processes include:

- Ensure trade allies are aware of the online submission process.
- Ensure trade allies are aware of the universal forms and whether there is an option to still use individual forms for certain measures.
- Provide appropriate Energy Trust email addresses and contact information for those who are experiencing problems.
- Encourage trade allies to complete paperwork for customers.
- Consider a general follow-up process (for applications without problems) and improve the follow-ups for applications with problems so as not to alienate customers or trade allies.
    - For online submissions, consider an automatic reply that their forms were received and being processed and that average processing takes *x* days.
- Work towards providing an option of submitting forms online for all participants.

[26] In our interviews, we also heard from one respondent that the Contact Center prefers forms that were completed by the homeowners instead of contractors because homeowners are more likely to spell their names correctly.

7.3 Marketing Efforts

Awareness of Energy Trust is still relatively low. Among the general population, only 36% have heard of Energy Trust, and only about two-thirds of those who have heard of Energy Trust (approximately 22% of the total population) are aware of the programs that they offer.[27] The HER program seems to be most effectively marketed, as over two thirds (67%) of general population homeowners who had heard of Energy Trust are aware of this effort.[28] However, awareness of the Home Performance with ENERGY STAR effort is more limited at just 54%. Moreover, HP trade allies also report that few of their customers (across all jobs they do, not just Energy Trust-related) are aware of Home Performance with ENERGY STAR.

Furthermore, there is also a need for marketing efforts to help distinguish between the various facets of the program—and in particular, between HER and HP. According to both trade allies and participants, the distinction between HER and HP is not clear. When we asked non-HP contractors about Home Performance, they were also not able to distinguish between the efforts. Only one non-HP contractor had a really good idea of the difference between a Home Energy Review and Home Performance with ENERGY STAR. The majority of non-HP trade allies had absolutely no idea what the difference was or were wrong about the difference. Several of the trade allies expressed some basic understanding of the program, often noting that HER was less technical or free, while HP cost money and was more comprehensive. However, many of these respondents noted that they were guessing what the difference was, not that they had heard this information before.

In addition, multi-family participants expressed a concern that the program is not very well known within their sector.

Recommendations about marketing efforts include:

- Work to distinguish Home Performance with ENERGY STAR from the free audit provided by the HES program (through marketing efforts).
- Increase marketing of the HP program by leveraging customer feedback and testimonials to promote the HP program to others; this may help overcome the potential barrier of cost. (Testimonials may also help to distinguish between HP and HER.) Expand HP information on the website to include more detail and specificity. (Additional details provided under the HP write-up in Volume 2.)
- Raise awareness among multi-family property owners and managers. For multi-family homes, very few participants hear about the multi-family program through Energy Trust; most hear about it through their contractor or word-of-mouth. If Energy Trust wishes to increase participation in this part of the program, we recommend that Energy Trust

[27] Note that this data represents all survey respondents, not just those in Energy Trust's territory. The fields needed to break this data were not available to us.

[28] Our data did not demonstrate any differences between regions as the sample size for Eastern Oregon was only 11 and Southern Oregon only 6. However, 9 out of 11 respondents in Eastern Oregon were aware of HER, which is the highest overall percentage (but not significant at that sample size).

increase marketing to multi-family buildings by raising awareness levels. Selling points are described under the multi-family write-up (see 6.4 Multi-Family Program In Brief).[29]

- Create marketing materials for customers for specific measures such as insulation or windows.
- Proactively make trade allies aware of the range of marketing materials and marketing support available, and particularly access to online materials.
- Consider increasing positive advertising of Energy Trust and Energy Trust programs when budget is available for more offerings or participants.
- Track and report outcomes from Energy Trust marketing efforts to better understand where program collateral was disbursed, and to what extent specific pieces influenced customers to take action. Adding promotional codes to program collateral, asking callers to the Contact Center to identify where they heard about the program (and which promotional pieces they had), and placing a higher effort on monitoring collateral distribution and circulation could help provide feedback.

7.4 Policies and Program Requirements

Interviewed trade allies continue to be confused by some of the policies and requirements of the program. Several mentioned the complex nature of the program, the various rebate incentives, and the difficulties tracking the program requirements. In addition, it is clear that many trade allies are not familiar with the requirements for Home Performance with ENERGY STAR (and could not define what the program effort offers).

Trade allies perceive the HES program requirements as constantly in flux and not always open to trade ally input. Instructors and training schedulers, who interact regularly with trade allies and act as "the face" of the HES program, feel as though they bear the brunt of the criticisms from frustrated trade allies. They feel that trade allies lose a little bit of trust in the program, and in its representatives, each time that a policy shifts in a way that is unexpected. In addition, based on our initial review of the 2009 Trade Ally Survey administered by Energy Trust, some trade allies are frustrated by the staff turnover within CSG, and are interested in being heard and helping provide insights on the market. It is important to build trust with trade allies through consistent program policies and communications.

In addition, our interviews showed that trade allies reported that their status as a trade ally should set them apart from other contractors. For this reason, many allies felt that there should be requirements that weed out inadequate contractors. However, many felt that the current minimum requirement of five projects should not be raised because that would weed out smaller shops. Some larger companies were in favor of raising the minimum requirements.

[29] Note that PGE currently writes articles and places advertisements in rental market trade journals and magazines.

Recommendations about program and policy requirements include:

- Make trade ally requirements a standard for the industry, primarily by requiring appropriate certification.
- Do not change the minimum of five projects.
- Keep ongoing trade ally requirements as streamlined as possible and as consistent as possible between programs.
- Involve trade allies in policy changes from an early point in the process and poll them on proposed changes.
- Provide two weeks for comment and at least 90 days before policy or incentive changes go into effect.
- Communicate policy changes primarily through email, mail, or roundtables[30].
- Ensure that input is gathered from areas beyond Portland.
- Consider providing incentives for diagnostic testing (perhaps when homes go on to install measures) in order to increase participation in HP and overall installation of energy efficient measures.
- Evaluate whether different HP software besides Home Check would be useful, and if so, consider switching to software that provides the necessary information to the customer and the program.
- Consider extending the first year HP incentives into the second year or moving some of the first year incentives into the second year to allow for a longer start-up time for the contractors.

7.5 Trade Ally Communications

The HES program interacts with trade allies in a number of different ways – via incentive forms, training sessions, the Weatherization manual, Home Check, the Conservation Advisory Council, the Energy Trust website, marketing efforts, the Insider newsletter, and quarterly Round Table Trade Ally meetings, to name a few.

Despite the fact that when asked about their satisfaction with the program many trade allies discussed the helpfulness of Energy Trust representatives on the phone, many others also mentioned difficulties with communication: *Well I think…basically some of the telephone conversations we have…just were not what I would consider real customer service oriented.* Some also indicated that contractors had to be proactive to receive program information. And others indicated difficulty finding appropriate people in the organization to talk to, especially higher up: *It's a very complex organization from my point of view, and … I have trouble finding the answers to some of my questions.*

Several trade allies also mentioned that they felt overwhelmed at times with the information they received and suggested that when something was really important, that it be distinguished from other mail.

[30] Most changes are made on an annual basis; this schedule could be communicated to trade allies as well.

In addition, many contractors were not aware of marketing or coop advertising availability, new guidelines, and email forms. Trade allies could be glossing over this information if it has been communicated to them. If so, the program should ensure that this information is communicated effectively to increase awareness.

Recommendations on trade ally communications include:

- Ensure that trade allies are getting the assistance they are looking for, whether over the phone or in person, or clearly explain to them if such assistance is not available.
- Be more proactive in communication efforts; do not rely on the trade allies coming to you.
- Ease access to higher level managers in the organization, especially when a decision needs to be made.
- Track communication preferences - primarily contact trade allies through email but allow them to opt into a different communication preference.
- Make sure that the most important information stands out from the rest – consider two-day, marked or priority mail for key pieces of information. For email, consider priority status or wording in the subject line such as "Action Required" or "Opportunity for Comment".

7.6 Collaboration

Energy Trust coordinates and partners with several utilities, governments, and quasi-government organizations in Oregon and the Pacific Northwest on numerous energy efficiency programs and initiatives. We interviewed representatives from seven of these organizations to gauge the strength and frequency of communication between the HES program and these "collaborators."

Coordination with Energy Trust varied by organization and included efforts such as co-branding of marketing materials, call/contact center lead generation, and participation in Energy Trust pilots and programs. Some of the collaborators indicate that the level of communication and collaboration with Energy Trust is good across most programs, including the HES program. However, a few collaborators feel that while there are individual success stories, there *"could be a lot better relationship."*

Recommendations regarding collaboration include:

- Promote one-on-one communications between Energy Trust and collaborator program managers rather than "designated" individuals. Communication should be between the parties actually marketing and running the programs.
- Consider alternatives to "all-party" meetings for sharing marketing plans; it is felt by some that these are not the right venues - due to proprietary data concerns and difficulty in getting ideas out on the table.
- Discuss issues directly with collaborators rather than immediately referring collaborators to the implementation contractor. Respondents felt that since the contractors did not

report to them, they sometimes had little incentive to make changes and resolve issues.

- Encourage coordination and communication improvements in the following areas:
  - Program design - increase collaboration on the list of measures and incentives being promoted in their territories
  - Contractor training and retention
  - Program status updates and changes in scope and direction
  - Marketing efforts[31]
- Provide more lead time to utilities so that they can add HES program(s) into their own marketing calendars as they reported that they plan and book marketing 6 to 12 months in advance.
- Address all details of a program before launch in order to avoid unnecessary customer complaints to utilities. For example, ensure there is enough product on the shelves to meet demand.
- Address confusion over various incentive levels and federal tax credits.
  - Different incentive levels across the gas and electric utilities and Energy Trust can confuse customers and force them to "call around" trying to find the best deal. There may be a need for Energy Trust and collaborators to communicate more regularly to minimize potential overlap of offerings by the various parties. In interviews we heard that there is overlap between offerings and the challenge is to determine responsibilities and minimize current and future duplication of efforts.
  - According to our interviews, there may also be a problem with trade allies and vendors promoting both HES rebates and Oregon tax credits to the same customers, regardless of whether the customers qualify for both programs. When this happens, some consumers could be falsely led to believe that they can obtain both types of incentives. This leads to consumer dissatisfaction and distrust of all involved parties, and frustrated collaborator contact center personnel who must field angry calls.
- Provide better information by linking Utility and Energy Trust websites. One respondent suggested that all parties ensure that their web sites provide customers access to each other's sites. For example, a customer signing in to one utility's web site could click on a link to find out more about Energy Trust's programs and offerings.
- Improve coordination between the HES Contact Center and the Utility Call Centers to ensure no one falls through the cracks. Some interviewees indicated that there should be more coordination between Energy Trust and utility contact/call centers because they feel that the current arrangement occasionally drops callers who do not neatly fit into pre-defined categories. Based on interviews, contact/call center staff on both sides need to be better trained to know when and how to forward questions to the appropriate organization.

[31] We note that co-branding can work, but not if the customer is confused about who is doing what and where to go for information.

7.7 Internal Communications

Both CSG and Energy Trust have large staffs of people involved in this effort. Based on our depth interviews, the relationship between the Energy Trust team and CSG has continued to improve, and the two groups are constantly striving to improve program processes. Staff from Energy Trust and CSG meet frequently to facilitate communications. Moreover, due to recent hires within CSG, and the reorganization of some of the roles within Energy Trust staff, internal communications are improving. However, many of the program staff (both Energy Trust and CSG) acknowledged that there is still room for internal improvements. One specific area frequently mentioned was the marketing process and marketing review cycle. Many of these problems related to marketing efforts appear to stem from more fundamental problems with internal communications.

Recommendations specific to internal communications include:

- Better define the roles of each group (specifically, groups within Energy Trust and groups within CSG). There appears to be a significant amount of overlap in efforts between Energy Trust and CSG. For example, when asking individuals about the roles of the staff within each organization's marketing teams, there appear to be two groups that develop marketing collateral, two groups that "design" materials, and multiple groups that coordinate with trade allies and collaborators. One example of duplication occurred with the initiation of two parallel-path pilot efforts for Heat Pumps. The efforts were started by two different groups who were unaware of the other effort, and who only became aware of the other's efforts when they got to the point of developing marketing materials. Better defining roles will help streamline the process.
- Develop a better "Start Up" process. Within the HES program, there are several pilot efforts, communication materials, and other initiatives that attempt to expand participation and look for additional ways to get energy savings. Our initial interviews indicate that there is need for a more formal (and collaborative) process to initiate new efforts or changes in the program.
- Create a more collaborative process between the Program Staff and the Marketing Staff within CSG (and facilitate the marketing review process). In delivering HES, field staff bring technical expertise to the program, while the marketing team brings expertise crucial to delivering messages to customers. Bringing these two groups together is important (especially in developing marketing materials). Other suggestions for facilitating the marketing review process include:
  - Find time for the two groups to sit down at the beginning of the process and work together on the language in the materials.
  - Ensure that the targets and goals of each marketing piece are explicitly laid out. As mentioned above, marketing has recently initiated a "job start" process for each marketing piece. This is a form that is intended to help ensure that the targets and goals for each marketing piece are explicitly laid out prior to initiating the marketing effort. This is an important effort that will help facilitate the creation of new marketing pieces.
  - Shorten the review cycle. While the suggestions above will help facilitate the

marketing review process, the program may also want to directly address the marketing review cycle by shortening the timeframe and the number of reviewers. This may be accomplished in part by training HES staff to be able to understand all of the needs of the marketing materials (e.g., copy-editing, branding, target).

- Create a more pro-active marketing effort. According to interviews the majority of the marketing collateral is created by the HES program team, filtered through the CSG marketing team, and then sent to Energy Trust. The process within the marketing teams becomes reactive (rather than pro-active) and the timing is driven by "the project start date" rather than by a marketing plan. As a result of this reactionary process, some pieces may not be needed—or at least not as needed as other marketing efforts. Create a more actionable marketing plan that is explicit in who is initiating the marketing efforts and what roles they play.

7.8 Databases

The HES program uses two databases, Goldmine and FastTrack, to manage customer information, count installations, calculate energy savings, and track and manage incentive applications and payments. Goldmine is the relational customer database and the Contact Center uses it to track every call and incentive application form that comes in. Energy Trust and CSG staff use it to catalogue complaints from customers and contractors, and the results of marketing efforts. FastTrack is used to monitor program goals and verify and manage incentive payments. Most staff use FastTrack on a daily basis to look up specific records.

In addition to the databases, by the tenth of each month CSG submits to Energy Trust a monthly report that records the program's progress and activities and includes sections on goals and forecasting and detailed department-by-department updates. The reports grew incrementally lengthier over time: In early 2007 the monthly reports were around 30 pages in length, and at the end of 2008, they were well over 60 pages in length. One interviewee called these reports the program's "historical record."

Through our evaluation, we encountered several problems with the program database including incorrect labeling of program data, duplicate entries of data, and missing data. It was also difficult to use and interpret the program database since several measures (such as duct sealing) are entered under a variety of fields, and the differences between these fields are not explicitly laid out (e.g., duct test/seal, duct sealing, duct seal, etc.) Moreover, through survey efforts, we also found apparent discrepancies in the database which could be corrected to make program tracking and impact evaluation more accurate.

Recommendations on database and reporting related efforts include:

- Ensure that FastTrack meets program needs. HES staff do not trust the accuracy of reports generated by FastTrack. Numbers of measures installed or processed are close, but often do not match reports generated by different people.
- Ensure that Goldmine still provides value to the program. Staff complain that Goldmine is old, difficult to use, and challenging to pull information from; many staff outside the Contact Center use it grudgingly, and only when pressed. Revisiting the time spent

maintaining Goldmine, and the value of this database, may be of interest to the program.

- Provide a data dictionary that provides the specifics about each measure. Currently in the database, the duct test measure sometimes has energy savings and sometimes does not, and this may lead to errors in how people account for actions in the database. During our initial investigation of the database, it was difficult to determine HER participants since this was listed as both a measure and a track. Notably, Energy Saver Kits are also included in HER. Details on how to interpret this part of the database will prove valuable for future evaluation efforts.
- Implement checks to ensure accuracy of the database so that the saving estimates are more reliable. Among our manufactured home respondents, four who stated that their home was only tested, (not sealed), were mis-categorized in the database, that is, the database indicated that both testing and sealing was performed. This represents about 6% of our sample.[32] Additionally, the number of individuals who stated they received CFLs did not match with the database entries: two people for whom we had a record of CFLs did not recall them; and, several people for whom we had no record mentioned that they received CFLs from the contractor.
- Collect telephone numbers for Energy Saver Kits, if possible, to aid in future phone surveys (rather than relying on look-ups).
- Streamline the monthly reports. The monthly report contains a lot of valuable and detailed information. The effort and resources invested in creating the report, however, is significant and likely excessive. Based on our interviews, it appears to take approximately one full working day to prepare each section, and one interviewee called it *"a tremendous undertaking."* Few staff at Energy Trust and CSG read the monthly report in full. While the monthly report demonstrates value as a historical record and a vehicle for inter-departmental coordination, it could be enhanced by changes such as highlighting new initiatives and bringing together information more succinctly and effectively.

[32] We note that in the sample it appears that "duct tests" for manufactured homes have working kWh attached to them. This is not the case for the single family program component.

8. IMPACT ANALYSIS

The evaluation team conducted an energy savings analysis for single-family and manufactured homes participating in Energy Trust of Oregon's Home Energy Solutions energy efficiency programs for 2007. The determination of energy impacts involved four distinct tasks:

1. Billing analysis provided per unit savings for about half (52%) of the measure descriptions[33] within the program.
2. Telephone surveys provided net-to-gross values for 63% of the measure descriptions which accounted for over 95% of the net savings estimates.
3. Spillover was calculated for the few measures that were installed outside of the program with a self-reported statement that the program influenced the installation. Spillover was around 5% of the total impacts.
4. Roll up of the above values to the program.

In the following section, we present the results of the savings analyses described above, including estimates of savings for each measure and for the overall portfolio as it was implemented in 2007.

8.1 Data and Methods

As part of the billing analysis of 2007 impacts, our team used regression modeling techniques to determine the energy impacts of efficiency measures on both electricity and gas usage in the homes. The regression models allowed correction for weather and customer-specific effects, while including non-participants as a baseline. The energy savings estimates are based on separate regression models for single-family vs. manufactured homes, and gas heating vs. electric heating.

The analysis was planned in two parts. The first part estimates gross impacts using data for 2007 participants, and data for 2008 participants as a comparison (non-participant) group. Each part is an iterative process that involves making increasingly detailed models until the models that best describe the data are found. The first step in this analysis was a pooled regression model, where the usage data from all customers was included in each regression model without corrections for individual households. This pooled model yielded results that were clearly inconsistent, so the analysis moved on to the second step, a customer-specific or fixed-effects model, where adjustments for each household are made. The fixed-effects models were much more successful in describing the data, so there was no need to proceed on to a multi-level model.[34]

[33] There were 121 measure descriptions from the program tracking database covering 24 measure categories. All billing analysis and net values were applied at the measure description level.

[34] The second part of the energy savings analysis was initially planned to be a determination of net impacts based on models similar to the models in part one, but with the addition of information from the participant and non-participant surveys. This part also optionally included the calculation of load shapes and peak savings

8.1.1 Data

The data used in these models is the 2005-2008 usage and measure installation data from 2007 and 2008 participants in the Energy Trust Oregon's Home Energy Saver program. The data are in the form of panel data,[35] with average daily electricity and natural gas usage based on monthly bills for each customer for 2005 through 2008.

There are 9,487 participants and 19 composite measures in the final 2007 participant dataset. A short description of the measures is shown in Table 10. A full table of the specific measures included in each of the composite measures used in the models is included as Table 17 in Appendix A.

Table 10: Measure descriptions

Measure	Description
Air Sealing	Seal air leakage in the home
Boiler	Replace Boiler
Ceiling Insulation	Install ceiling insulation
Duct	Test, seal and/or insulate ducts
Floor Insulation	Install floor insulation
Gas Furnace	Replace gas furnace
Heat Pump Install	Replace resistance heating with heat pump
Heat Pump Tune Up	Heat pump test and tune
Heat Pump Upgrade	Replace heat pump
Home Energy Review	Energy review of home
Lighting	Install CFLs
Other	Financial assistance
Other Insulation	Install other insulation
Solar Hot Water	Install solar domestic hot water system
Tank Water Heater	Replace tank hot water heater
Tankless Water Heater	Install tankless hot water heater
Wall Insulation	Install wall insulation
Water	Install water saving measures
Windows	Replace windows

There were initially 17,298 single-family and manufactured homes in the 2007 and 2008 participant databases; however, we removed 3,715 sites (21% of the total) due to any of the following problems:

- Conflicting main heating fuel types

for each of the measures. Part two is not included in the regression energy analysis at the request of Energy Trust.

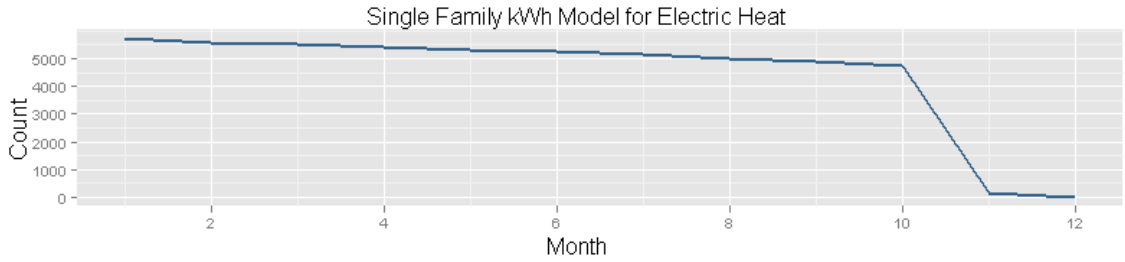
[35] Panel data is two-dimensional, containing observations on multiple phenomena observed over multiple time periods.

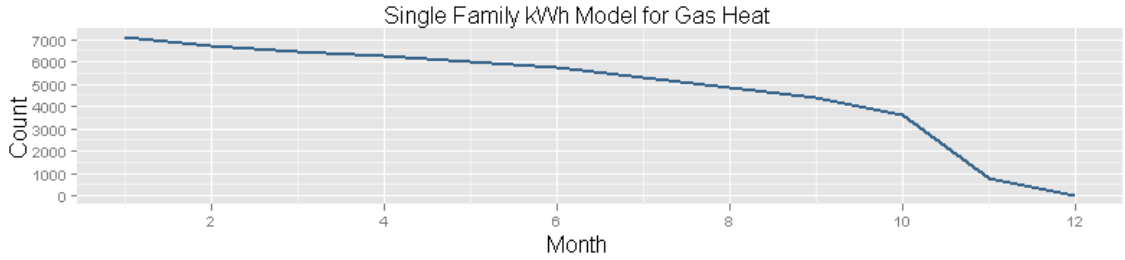
- Extremely high consumption (greater than 4 standard deviations from the mean)
- Multiple premise numbers within a utility
- Commercial rate class
- Installed measures from both single family and manufactured home programs
- Installed the same measure at several different times during 2007
- Conflicting main measure fuel and main heating system fuel for heating measures
- Both a heat pump and a gas furnace installed at the same site
- Change in consumption of a factor of two or more from 2006 to 2008

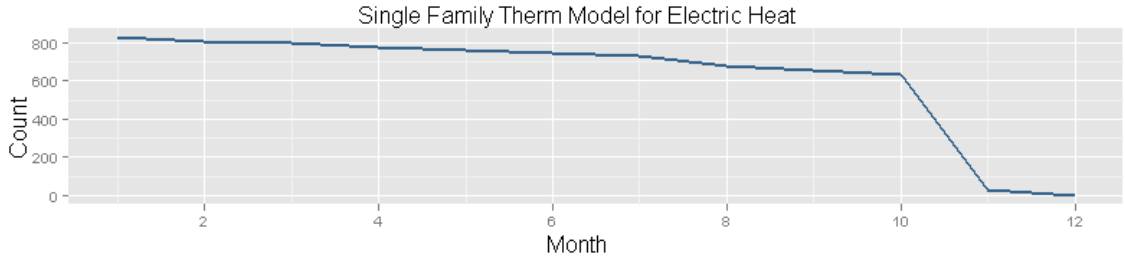
While we made every effort to identify problems based on the information available, this list of problems identified in the data is limited by the site information collected. Despite (or because of) the fact that we removed over 20% of the data due to these few tests, it is likely that other unidentified problems remain in the final data. While many problems were identified in this set of data, we believe that the remaining data is still suspect. A full review of the database where the original data reside and the queries used to pull the information should help alleviate future issues with the data. However, our models are stable and we feel they provide useful results.

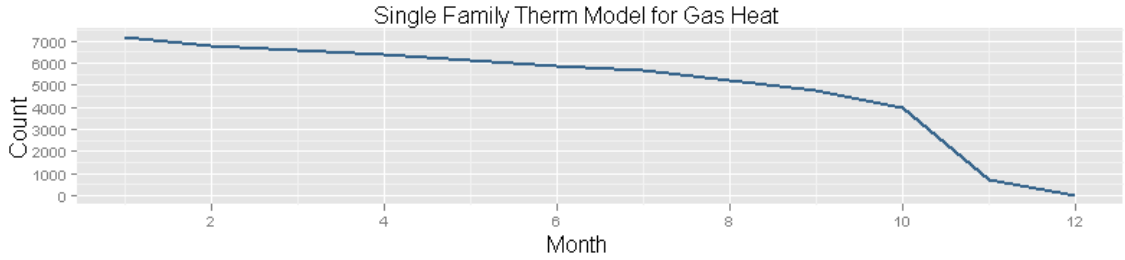
The 2008 participants are used as a "non-participant" comparison group to control for factors that affect usage in the population as a whole over the study period. Each 2008 participant was included as a control in the model until a measure was installed in the household. That household was then removed from the model to avoid including the effects of 2008 measures in the 2007 analysis. The number of non-participants drops to zero for December of 2008, but for the prior 47 months there are such a large number of non-participants that this should not affect the validity of the models. Plots of the number of customers in the non-participant group for each model are shown in Figure 1.

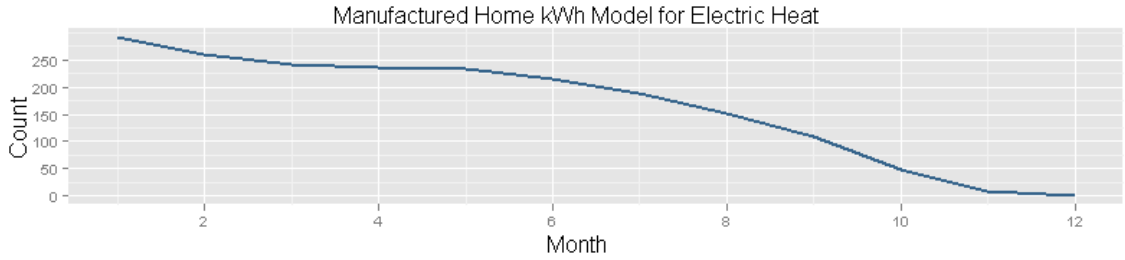
Figure 1: Number of non-participants for 2008 included in each of the five models





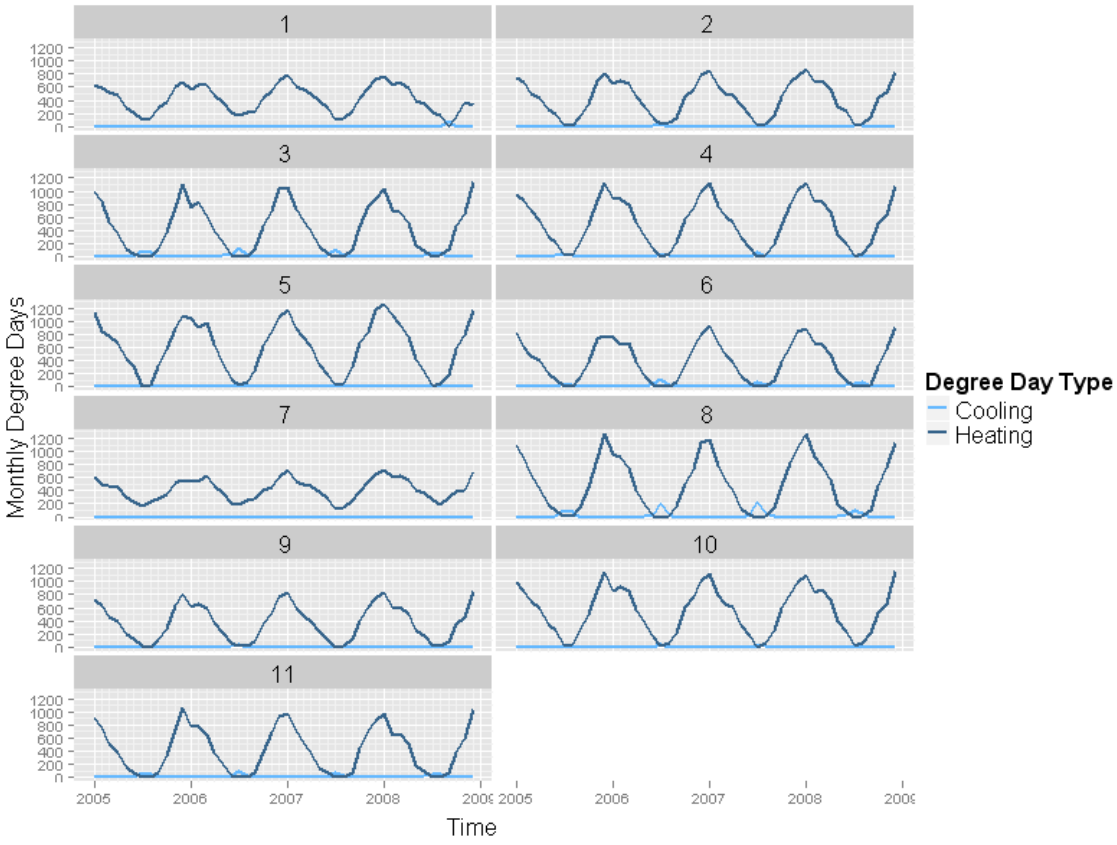






The weather datasets used in the models consist of daily temperatures for eleven weather stations. Using this data, we calculated heating degree days (base 65) and cooling degree days (base 75) for each month. Plots of these monthly totals are shown in Figure 2 for each weather station. There is one plot for each weather station (1-11), with the dark blue line showing monthly heating degree days and the light blue line showing cooling degree days. There are relatively few cooling degree days for most of the weather stations; only stations 3, 8, and 11 have enough cooling degree days to regularly appear on the plot in the summer months. Our analysis used site specific weather data.

Figure 2: 2005-2008 Monthly heating and cooling degree days
for all eleven weather stations



8.1.2 Model Specification

There are several models that could be used to analyze data in this format, with fixed-effects regression models as the best choice, once simpler models have been ruled out. Fixed-effects models correct for all time-invariant customer-specific effects by including the average usage for each customer as one of the parameters. This adjustment corrects for unmeasured (house size, occupancy) or un-measurable customer characteristics when those characteristics do not change during the measurement period.

The weather-corrected fixed-effects regression model that we used for each of the energy savings analyses is shown in Figure 3.

Figure 3: Fixed Effects Model

$$Usage = \beta_0 + \beta_1 CDD + \beta_2 HDD + \beta_3 HDD^2 + \beta_y Year_y + \beta_m Month_m +$$

$$\beta_e Measure_e + \beta_f Measure_e \cdot HDD + \beta_g Measure_e \cdot HDD^2 + \sum_{i=1}^{N} \gamma_i D_i + \varepsilon$$

Where:

- Usage = average daily usage in kWh or therms for the month

- CDD = total cooling degree days for the month (base 65)
- HDD = total heating degree days for the month (base 75)
- Year = set of dummy variables for year
- Month = set of dummy variables for month
- Measure = set of dummy variables for installed measures
- D = set of dummy variables for all customers included in the model
- ε = error term, corrected for autocorrelation

The models were chosen to be as simple as possible, while still including the variables and interactions that best explained the changes in usage over the study period. The data for the single-family and manufactured homes were each broken up into four separate models - because the models with interactions involving heating system fuel were extremely complicated and difficult to interpret. To reduce the possibility of multi-collinearity, which tends to cause instability in the estimates, the final models include only the terms that were statistically significant at the 0.1 significance level, and have n > 50 measure installed.

We used several statistical tests to assist in the selection of the model structure. In every case, the data show significant autocorrelation with lag one. The Durbin Watson statistics[36] ranged from 0.4 to 0.7 for the five different models before correction using the Yule-Walker method, and 1.6 to 2.3 after correction. These values are consistent with significant autocorrelation correction using the Yule-Walker method.

The second test, used to reduce the number of variables and interactions in the model, is a t-test of significance at a significance level of 0.1. Following best practices to create as parsimonious and stable a model as possible, variables with parameters that were not statistically significant were removed from the model in a backward stepwise selection until all of the parameters in the model were significant.

As the model converged towards a parsimonious final model, we screened for multi-collinearity by checking the variance inflation factor (VIF) for each variable, and also examined the proportion of the variance of the parameter estimate due to each principal component. Usually, variables with a VIF above 10 warrant further examination. In the final models, none of the measure-related variables have a VIF above 6, meaning that the test was not able to identify multi-collinearity in the model. We checked cross tabulations of each measure with the other measures in the model to determine whether simultaneous installation of measures was indicated. This was the case for the water measure and the lighting measure, which were always installed during a Home Energy Review.

8.1.3 Evaluative Discussion

What is the model estimating when it calculates savings? It is estimating the average daily reduction in usage that starts at the time the measure is installed, with corrections for weather, season, year, other program measures, and static household characteristics. For example, with heat pumps, the model calculates the average daily corrected difference in

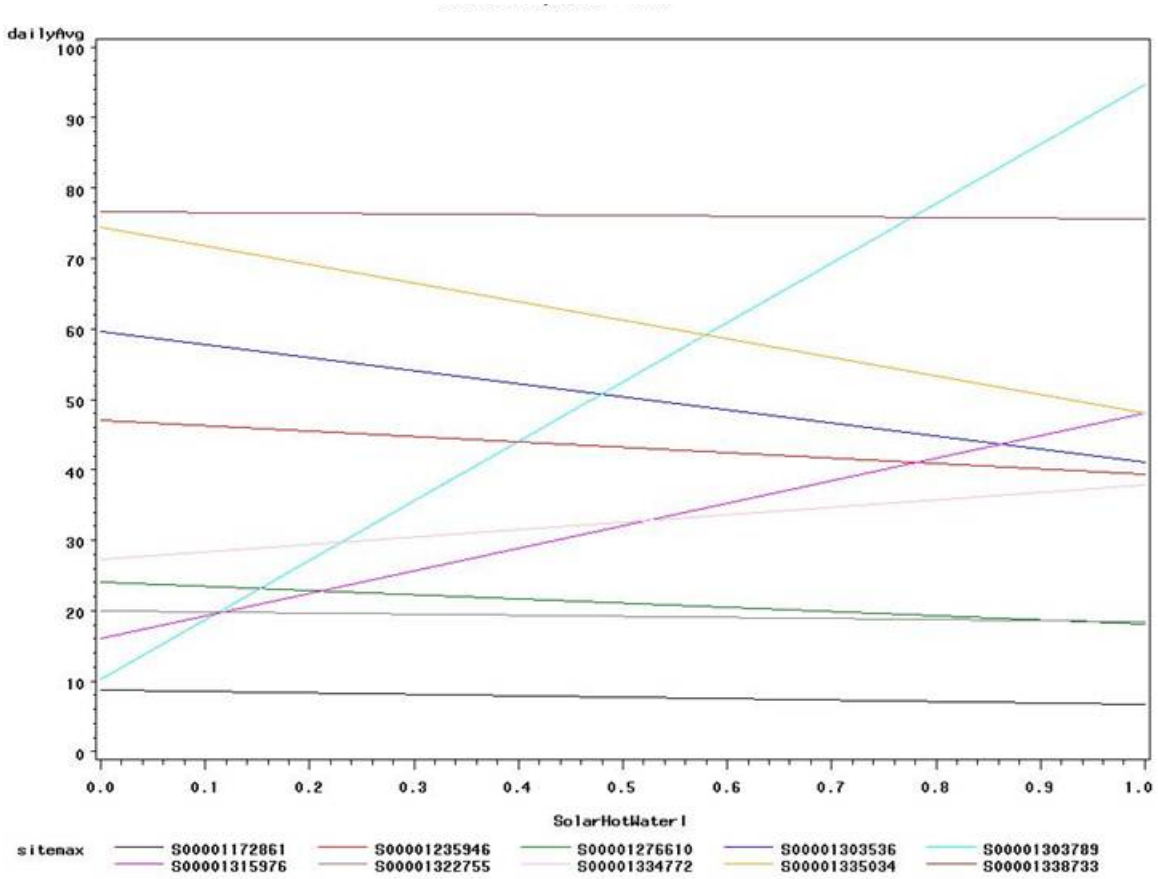
[36] Durbin-Watson Statistic is a diagnostic test for autocorrelation. When autocorrelation is present the results of a regression analysis are less reliable. This statistic becomes larger as the autocorrelation is reduced.

kWh consumption when a heat pump measure is installed. These are the gross savings estimates.

A problem that can arise is when a portion of the participants switch fuels or change their consumption considerably for some "exogenous" (other un-modeled) reason. In this case, the estimate of the effect is unlikely to be accurate. For example, the interaction plot in Figure 4 shows the uncorrected average daily kWh consumption for customers before and after they installed a solar hot water heater. Each line represents one customer. If the slope of the line is negative, the customer used less energy after the installation. Most of the customers used slightly less energy after the installation, but three, most notably the customer represented by the light blue line, used significantly more energy after the installation. These three (out of the ten customers with electric heat who installed solar hot water heaters) push the savings estimate far into the negative. This estimate is probably not giving a good approximation of the savings due to replacing an electric water heater with a solar hot water heater.

It is tempting to remove these three customers from the model because it appears that they have had changes in their households that have a large effect on their energy usage. However, we have no information about the participants that would justify this decision, since those participants who used less energy may have also had changes in their households that affected their energy usage the other way, and removing only those who increased their usage would introduce bias towards larger savings. A second possibility is to remove all customers whose usage changed, up or down, by a large amount over the analysis period. It is very unlikely that such a large change in consumption was actually caused by the measures, but rather by some change in the household or structure that is not recorded in our data. For this reason, the sites which experienced a change in average consumption of greater than a factor of two from 2006 to 2008 have been removed from the models.

Figure 4: Interaction plot of average daily kWh usage with solar hot water installation for participants with electric heating



What we are really interested in is the marginal energy savings given that the customer was replacing a hot water heater with a more efficient unit than otherwise would have chosen – because they were given a rebate on the more efficient unit. This can be buried in the estimates from the models (such as the ones in this analysis) when the change in usage caused by the installation of a measure coincides with a change in usage from some other cause. A large sample reduces the likelihood of this problem, so the reported sample sizes for each of the measures should be taken into consideration when the results are evaluated.

Small sample sizes also reduce the power of the model, so that parameter estimates are not statistically significant, even where there could be a real effect. So, when the sample size is small, the likelihood that the savings will be significant is also small, and the likelihood that the savings will have a significant relationship to weather is even smaller. For this reason, when the sample size is small, the measure savings estimate is usually reported as being constant (a straight line) across all months.

8.2 Billing Analysis Results for Participants in 2007

We created separate regression models to estimate the effects of the efficiency measures

on electric and gas usage. The parameter estimates for these regression models are shown in each of the following sections. For a complete explanation of the model specification, see section 8.1.2. After determining the best model for each case, we calculated the effects for each of the building and fuel types. The effects are presented as an estimate of the average daily and average annual savings for the installation of a measure in a single home for the 2008 weather year.

Table 11: Annual kWh savings for all modeled measures with number of participants (n)

Building Type	Single Family Homes		Manufactured Homes		Annual
Heating Fuel	Electric	Gas	Electric	Gas	Savings
Measure	(n)	(n)	(n)	(n)	(kWh)
Heat Pump Install	268				1861
Home Energy Review	678				1459
Ceiling Insulation	239				1324
Air and Duct Seal			276		796
Floor Insulation	158				442
Duct Test/Seal	88				407
Heat Pump Upgrade	500				153
Home Energy Review		3008			122
Gas Furnace		2721			-202

Table 12: Annual therm savings for all modeled measures with number of participants (n)

Building Type	Single Family Homes		Annual
Heating Fuel	Electric	Gas	Savings
Measure	(n)	(n)	(Therms)
Gas Furnace		2867	108
Ceiling Insulation		856	82
Tankless Water Heater		221	55
Home Energy Review		2921	49
Duct Test/Seal		502	47
Windows		180	35
Floor Insulation		519	26
Wall Insulation		342	14
Home Energy Review	74		7
Tank Water Heater		62	-5

The daily and annual single-family participant savings estimates for each measure are presented in arrays of plots in the Impact Appendix (See figures 6 – 10)

8.3 Free Rider Values and NTG Calculation

We queried both 2007 and 2008 participants about the reasons why they chose to install the measures. (See Savings Roll-Up: Free Rider Calculations in the Impact Appendix.) We provide both years of data here (Table 13 and Table 14), but applied those values from 2007 only if they were significantly different than 2008. Otherwise, the 2007-2008 free rider values were used.

Table 13. Free Ridership Values for Single Family Homes

Year	Value	Insulation	Duct Sealing	Air Sealing	Heat Pump	Gas Furnace[a]	Windows	Water Heaters	Solar Water Heaters
2007	n	99	77	57	62	62	51	48	30
	FR	0.38	0.37	0.29	0.62	0.64	0.45	0.51	0.21
	SE Mean	0.033	0.043	0.043	0.04	0.03	0.054	0.051	0.053
2008	n	80	95	90	69	62	50	78	28
	FR	0.38	0.26	0.19	0.64	0.51	0.5	0.4	0.22
	SE Mean	0.037	0.037	0.032	0.038	0.04	0.05	0.039	0.056
2007-2008	n	179	172	147	131	124	101	126	58
	FR	0.38	0.31	0.23	0.63	0.58	0.48	0.44	0.22
	SE Mean	0.024	0.028	0.026	0.028	0.026	0.037	0.031	0.038

[a] FR is statistically different between years.

Table 14. Free Ridership Values for Multi-family Participants

Year	Value	Windows	Insulation	CFL	Aerator	Showerhead[a]
2007	n	18	12	17	17	15
	FR	0.27	0.17	0.25	0.25	0.15
	SE Mean	0.069	0.081	0.085	0.077	0.072
2008	n	7	15	29	23	23
	FR	0.26	0.24	0.43	0.36	0.41
	SE Mean	0.117	0.072	0.065	0.071	0.068
2007-2008	n	25	27	46	40	38
	FR	0.27	0.21	0.37	0.32	0.31
	SE Mean	0.058	0.053	0.053	0.053	0.053

[a] FR is statistically different between years.

Measures not included in Table 13 (because we did not ask about the measure) were given a FR of 0. These measures accounted for 3.6% of the ex post net kWh and 5.7% of the ex post net therms.

To create a gross program level impact across all incented measures, we either multiplied the regression per unit value to the units in the program tracking database or simply passed through the ex ante impact. The net impact was calculated by multiplying one minus the FR (1-FR) values to each measure category shown in Table 13 and Table 14, even if the gross impact was a pass through. (see **Equation 1**).

Equation 1 Net Impact Equation

$$Net\_kWh\_Savings = \left(\sum_{m=1}^{n} NFR_m * Per\_Unit\_impact_m * n_{m,db} \right)$$

Where m=measure,
NFR=1-FR, and
db=database

Our final results are described below.

8.4 Roll-up of 2007 Savings

Overall, the evaluation found that the Home Energy Solutions (HES) program net savings were 61% of what the program expected for electrical energy and 66% for natural gas.

Table 15. 2007 HES Program Energy Impacts

	Gross Impacts		Free Ridership Rate		Net Impacts	
	kWh	Therm	kWh	Therm	kWh	Therms
Ex Ante	16,555,777	800,564	0	0	16,555,777	800,564
Ex Post	14,792,298	1,098,922	0.31	0.52	10,165,209	526,782
Realization Rate	0.89	1.37			0.61	0.66

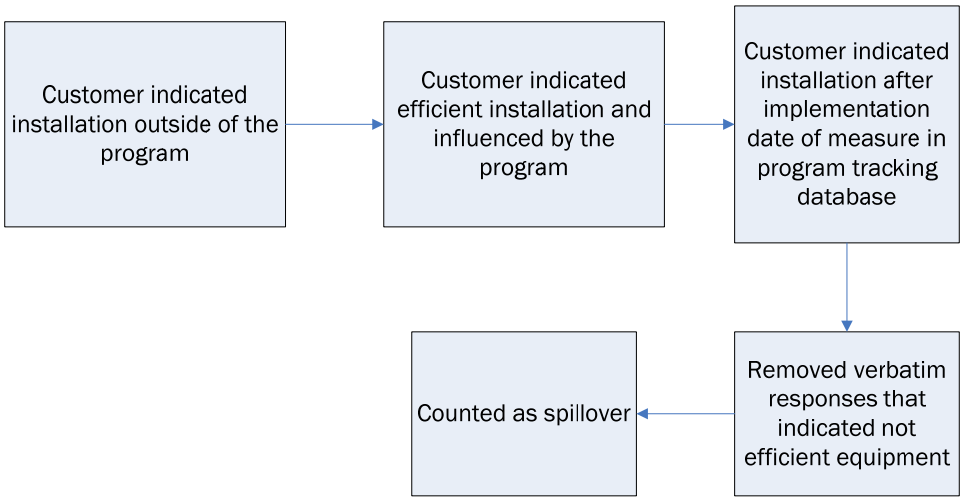
The previous evaluation found higher net realization rates for both kWh (at 73%) and therms (at 124%)[37], but used different methods. Previously, the billing analysis was considered to output net savings while this evaluation applied self-reported net values to the billing analysis results.

A Note on Spillover

We did not include spillover in our final results. In order to be included as spillover, responses from the survey needed to go through a series of steps as shown in Figure 5.

[37] Page iv of *Process and Impact Evaluations of the 2005-2006 Energy Trust Home Energy Solutions Program*. July 15, 2008. It is not clear how these values were determined when the tables in section 5.4 have low and high impact values

Figure 5. Path to Spillover



The actual numbers of measures that made it through the path and were counted as spillover are shown in Table 16.

Table 16. Spillover Measures

Measure	Original Values	Efficient and Influenced	Installed after Program Year	Final Spillover Values (removed verbatim)
Windows	80	22	14	14
Clothes Washer	22	11	11	11
Refrigerator	26	9	9	9
Wall Insulation	25	9	8	8
Ceiling Insulation	25	9	7	7
Dishwasher	26	7	7	7
Dryer	13	6	6	6
Gas Furnace	8	5	5	3
Gas Water Heater	20	8	8	4
Floor Insulation	15	5	3	3
HP Other (1 GF, 1 new house)	Included in other HP measure	3	3	2
Central AC	7	5	2	2
Elec Water Heater	15	3	2	1
HP replaced HP	9	1	1	1
Duct Insulation	7	1	0	0

Measure	Original Values	Efficient and Influenced	Installed after Program Year	Final Spillover Values (removed verbatim)
Elec Central heat	2	1	0	0
Room AC	1	0	0	0
Whole House Fan	1	0	0	0
			Total Measures Installed	78
			People Installing these Measures	53

These measures were installed by 53 people out of the 800 surveyed, or 7% of the population. Although no impacts are added to the overall program values from this spillover, it is possible that this could account for about 5% of the overall energy or therm program impacts. (See Savings Roll-Up: Spillover in the Impact Appendix).

8.5 Next Steps for Future Billing Analysis Efforts (2008 and Beyond)

Energy Trust will be conducting a cross-cutting billing analysis for future efforts using a different methodology than the one used for the 2007 research. The impact analysis for 2008, therefore, will be reported under a separate effort.

For future efforts, we recommend considering the best ways of accounting for impacts from efforts not evaluated in 2007 (e.g., multi-family impacts, etc.) Our billing analysis covered 41% of the ex ante kWh values for the HES program. Of the non-evaluated measures (which represent the remaining 59% of estimated ex ante kWh), the vast majority (over 91% of the kWh impacts) were from four multi-family measure groups – windows, insulation (floor and ceiling), lighting, and water measures. We note that Energy Trust had performed billing analysis multiple times previously with poor results (i.e., difficulty with the models) which is why it was not attempted here. Additionally, Energy Trust is now performing analysis using normalized annual data on 14 multi-family buildings with another 30 planned. An exploration of whether this research provides insights on the multi-family sector is important given the large proportion of savings from this sector.

Secondly, there were some unclear or mislabeled descriptions of measures within the program tracking database. The difference between “duct seal”, “duct sealing”, and “duct test/seal” were unclear throughout our evaluation. Some measures labeled “duct seal” had ex ante impacts and some did not, similarly with “duct test/seal”. We recommend that the next evaluation have a clear differentiation among these measures and assure that data entry into the database is identically performed. Additionally, the gas furnace measure category had, at times, heat pumps as the measure description and kWh impacts as the ex ante values. This was a difficulty throughout the analysis as it was unclear exactly what these measures included and was mislabeled for a time in the billing analysis. Mislabeled measures can cause unstable models. After cleaning the data extensively (although not

exhaustively) the billing analysis models were stable for our efforts.

A. IMPACT APPENDIX

This appendix provides detailed information from the impact analysis. In order, we provide:

1. Details regarding the regressions for single family programs
2. Details regarding the regressions for manufactured homes programs
3. Regression tables with parameter estimates and standard errors
4. Free rider algorithm
5. Spillover details

Single Family Programs

There are four single-family program models in total. Two of the models estimate natural gas (therm) savings, and two estimate electric (kWh) savings. The two models estimated for each fuel differentiate between participants whose main heating fuel is gas and participants whose main heating fuel is electricity.

The savings estimates are only presented for measures with statistically significant savings (α=0.10) and with at least 50 measures installed ($n \geq 50$). Estimates for measures with fewer than 50 participants were unreliable and tended to vary significantly when we checked the model by removing one participant at a time. This reduced the number of measures that are included in each model. Also, the lighting and water measures were combined with home energy review for all four models because the measures were always installed at the same time, making it impossible to separate the savings for the different measures. Therefore, the home energy review estimates include the effect of the lighting measure and the water measure.

Figures 6 through 10 present energy savings by measure. Each plot corresponds to one measure, with the measure named in the grey band at the top of the plot. The dark blue line shows average daily savings for the measure, with the lighter blue band representing the 90% confidence interval. When the 90% confidence interval intersects the horizontal axis, the savings estimate for that month is not statistically significant. The horizontal axis represents one year, with the months numbered one through twelve. The vertical axis is average daily savings, either in therms or kWh. There are also two numbers on each plot. The first, *n*, is the sample size, displaying the number of 2007 participants who had the measure installed in their homes. The second, *ann*, is the estimated annual savings in therms or kWh, as appropriate. This is calculated using the model results for each weather zone (corresponding to a weather station) weighted by the number of 2007 participants in each zone.

The savings shown in the plot is average daily savings for a single household. These savings are not constant across all months because of the interaction between heating degree days and the measure. For most measures, the savings is different in months with different weather. The most important weather variable in the model is heating degree days, so the heating degree days for each month were multiplied by the measure dummy variable, and an estimate was made for that interaction.

For example, the first plot in Figure 6 shows the model results as kWh saved in 2008 for the

average electrically-heated single-family home in which ceiling insulation was installed in 2007. There are 239 such households in the data set. The model estimates an average annual savings of 1,324 kWh for these households, with an average daily savings ranging from 2 kWh/day in the summer months to nearly 8 kWh/day in the winter. The shape of each of these plots is informative. If the plot is flat, there is no significant relationship between the weather and the measure. If the plot is U or V shaped, the savings is greater in winter than summer. If the plot looks like an upside down U or V, savings are greater in the summer. If the plot is W shaped, the savings are greater in summer and winter than in the spring and fall.

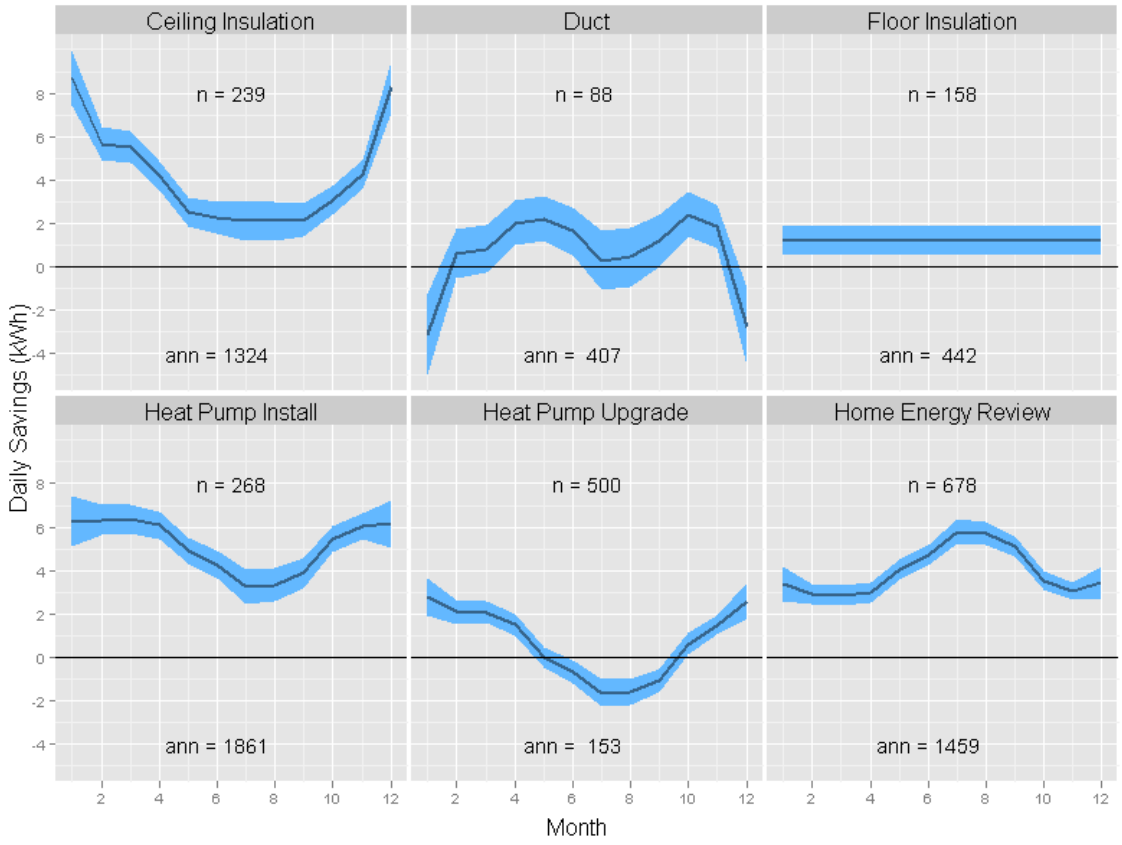
Electricity Savings

Homes with Electric Heat

The first kWh savings model is for single-family households using electricity as their primary heating fuel. The measure savings estimates are shown in Figure 6. Several of these estimates have features that may warrant future exploration. The duct measure, which includes duct testing, sealing, or insulation, shows negative savings for the winter months. The relatively small sample size and effect of the duct measure makes the daily savings estimates susceptible to small outliers. The negative winter savings may be the result of a few participants who installed the duct measure at the same time as they made another change that increased winter usage. The annual savings for the duct measure is a more stable number that should still be reliable.

The plot for the floor insulation measure shows that there is not a significant change in daily savings with changing temperature. While we expect insulation to save more when the temperature is colder, the savings from floor insulation do not change enough to detect using this model.

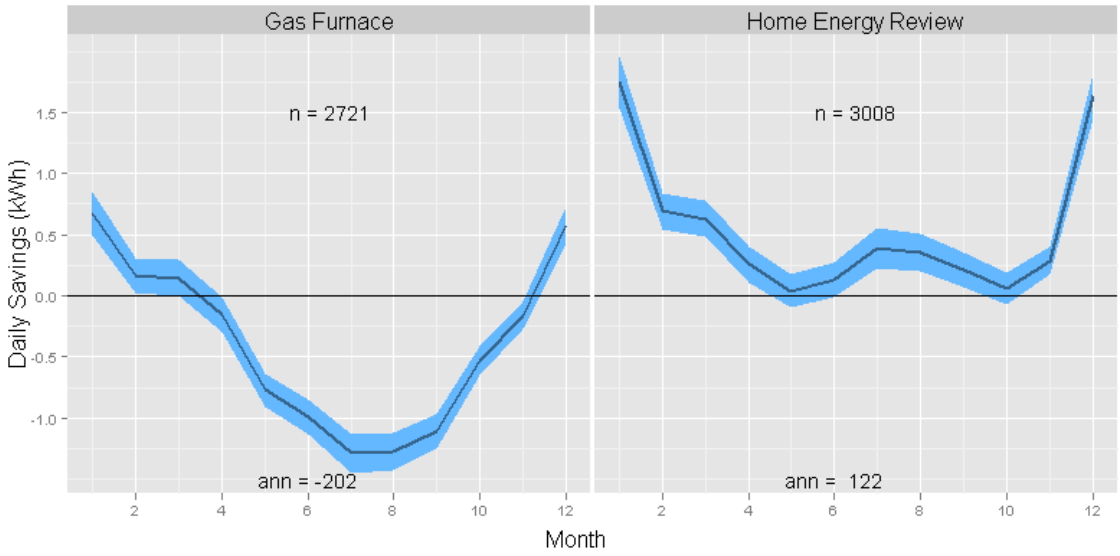
Figure 6: Average Daily kWh Savings for a Single Family Home using Electric Heat, with 90% Confidence Intervals, Sample Size (n) and Annual Savings Estimates (ann)



Homes with Gas Heat

The second kWh savings model is for single-family households using natural gas as their primary heating fuel. Figure 7 shows the savings estimates. The gas furnace measure shows increased usage annually, with savings in the winter and increased usage during the summer. The reason for this is not apparent: since the sample size is quite large, this shape is not the result of just one or two sites.

Figure 7: Average Daily kWh Savings for a Single Family Home using Gas Heat, with 90% Confidence Intervals, Sample Size (n) and Annual Savings Estimates (ann)

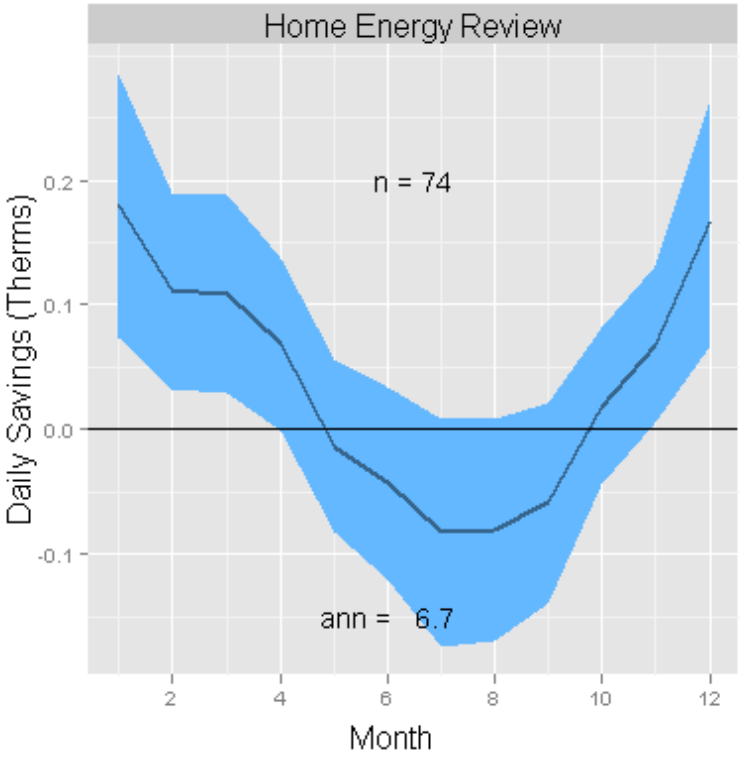


Natural Gas Savings

Homes with Electric Heat

The first therm savings model is for single-family households using electricity as their primary heating fuel. The results of this model are plotted in Figure 8. The home energy review measure is the only measure with a large enough sample size and significant savings.

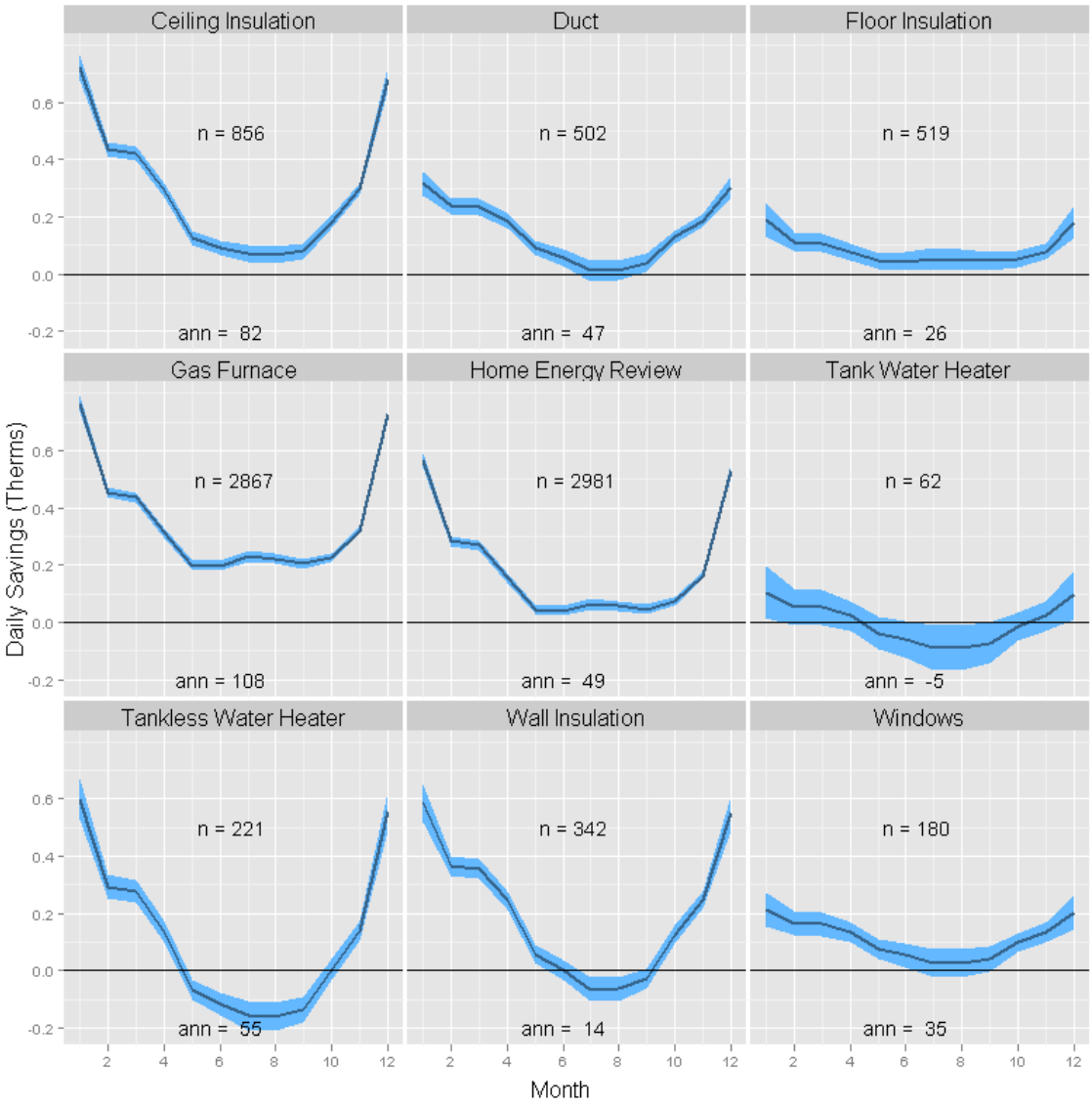
Figure 8: Average Daily Therm Savings for a Single Family Home using Electric Heat, with 90% Confidence Intervals, Sample Size (n) and Annual Savings Estimate (ann)



Homes with Gas Heat

The second therm savings model is for single-family households using gas as their primary heating fuel. This model is the most complex of all five models because of the large number of measures with significant savings estimates. Figure 9 shows the savings estimates for all of the measures in the model. The water heater measures in this model are limited to gas water heaters. The tank water heater measure shows a small increase in usage which might be due to the installation of larger water heaters or to other changes in the home that are not captured in the data.

Figure 9: Average Daily Therm Savings for a Single Family Home using Gas Heat, with 90% Confidence Intervals, Sample Size (n) and Annual Savings Estimates (ann)



Manufactured Home Programs

There is one manufactured home program model for kWh savings for those participants whose main heating fuel is electricity. The manufactured home program included only four measures: air sealing, duct sealing, gas furnace replacement, and heat pump replacement. The savings estimates are only presented for measures with statistically significant savings (α=0.10). This program included too few participants to make gas savings estimates, or electric savings estimates for homes with gas heat.

Electricity Savings

Manufactured Homes with Electric Heat

The results of the electricity savings model for manufactured homes using electricity as their primary heating fuel appear in Figure 10. This model is the only manufactured home program model with sufficient sample size to make reliable savings estimates. However, air sealing and dust testing/sealing were installed within 30 days of each other for all of the homes that had the air sealing or duct sealing measures installed, so it is not possible to make separate estimates for the two measures. The estimate for the combined measure, sealing, which includes air sealing, duct testing and duct sealing is shown below.

Figure 10: Average Daily kWh Savings for a Manufactured Home using Electric Heat, with 90% Confidence Intervals, Sample Size (n) and Annual Savings Estimate (ann)

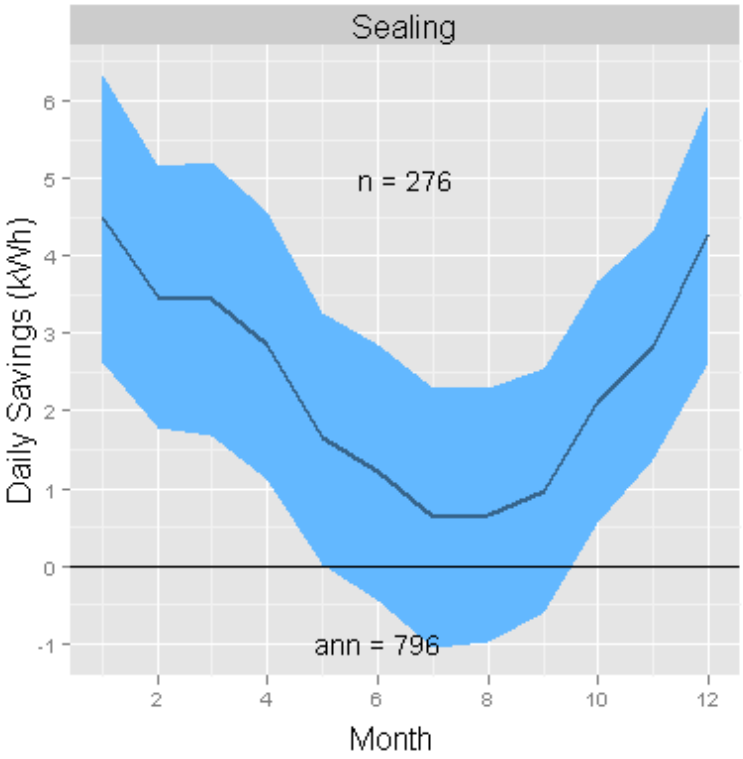


Table 17: Measures included in each modeled measure category

Measure	Measure Code	Measure Description
AirSealing	MHAIRSEALE	MH Air Sealing, Ele Heat
AirSealing	MHAIRSEALG	MH Air Sealing, Gas Heat
AirSealing	SFAIRSEALE	SF Air Sealing, Ele Heat
AirSealing	SFBDTE	Air Sealing: Blower door test
AirSealing	SFBDTG	Air Sealing: Blower door test
Boiler	HEGBLRINST	SF Gas Boiler
CeilingInsulation	HPFINSCEILE	HPF Ceiling/Attic Insulation/SQFT, Ele Heat
CeilingInsulation	HPFINSCEILG	HPF Ceiling/Attic Insulation/SQFT, Gas Heat
CeilingInsulation	INSCEILSFE	SF Ceiling/Attic Insulation, Ele Heat
CeilingInsulation	INSCEILSFG	Ceiling/Attic insulation SF Gas
CeilingInsulation	INSCEILSFG	SF Ceiling/Attic Insulation, Gas Heat
CeilingInsulation	SFINSCEILE	SF Ceiling/Attic Insulation/SQFT, Ele Heat

CeilingInsulation	SFINSCEILG	SF Ceiling/Attic Insulation/SQFT, Gas Heat
Duct	HPFINSDUCTG	HPF Duct Insulation, Gas Heat
Duct	INSDUCTE	SF Duct Insulation, Ele Heat
Duct	INSDUCTG	SF Duct Insulation, Gas Heat
Duct	SFINSDUCTE	SF Duct Insulation, Ele Heat
Duct	SFINSDUCTG	SF Duct Insulation, Gas Heat
Duct	MHCOMADE	MH Complex Add-On, Ele Heat
Duct	MHDUCTSEALE	MH Duct Sealing, Ele Heat
Duct	MHDUCTSEALG	MH Duct Sealing, Gas Heat
Duct	SFAIRSEALG	SF Air Sealing, Gas Heat
Duct	SFDUCTSEALE	SF Duct Sealing, Ele Heat
Duct	SFDUCTSEALG	SF Duct Sealing, Gas Heat
Duct	MHDLTSTE	MH Duct Leakage Test, Ele Heat
Duct	MHDLTSTG	MH Duct Leakage Test, Gas Heat
Duct	SFDLTE	SF Duct Leakage Test, Ele Heat
Duct	SFDLTG	SF Duct Leakage Test, Gas Heat
FloorInsulation	HPFINSFLOORG	HPF Floor Insulation/SQFT, Gas Heat
FloorInsulation	INSFLOORSFE	SF Floor Insulation, Ele Heat
FloorInsulation	INSFLOORSFG	SF Floor Insulation, Gas Heat
FloorInsulation	SFINSFLOORE	SF Floor Insulation/SQFT, Ele Heat
FloorInsulation	SFINSFLOORG	SF Floor Insulation/SQFT, Gas Heat
GasFurnace	HEGASFURN150	Gas Furnace $150 Incentive
GasFurnace	HEGASFURNB15	Gas Furnace w/ ECM Blower $150 Incentive
GasFurnace	HEGASFURND	Gas Furnace w/ ECM Blower $200 ALL GAS
GasFurnace	HEGASFURND15	Gas Furnace w/ ECM Blower $150 Incentive
GasFurnace	HEGASFURND15	Gas Furnace w/ ECM Blower $150 Incentive ALL GAS
GasFurnace	HEGASFURNDV	SF Direct Vent Gas Heater
GasFurnace	HPFGASFURNBA	HPF Gas Furnace Backup
GasFurnace	MHGASFURN150	MH Gas Furnace, $150 Incentive
GasFurnace	SFGASFURNBAC	SF Gas Furnace Backup
GasFurnace	SFGASFURNBAC	SF Gas Furnace Backup, Zone 1
GasFurnace	SFGASFURNBAC	SF Gas Furnace Backup, Zone 2
HeatPumpInstall	HPFHP82RPLC	HPF Heat Pump, Ele Furnace Replacement HSPF 8.2-8.49
HeatPumpInstall	HPHSPF87HPR	SF Heat Pump, Ele Furnace Replacement HSPF 8.1
HeatPumpInstall	SFHP82RPLC	SF Heat Pump, Ele Furnace Replacement HSPF 8.2-8.49
HeatPumpInstall	SFHP85RPLC	SF Heat Pump, Ele Furnace Replacement HSPF 8.5+
HeatPumpTuneUp	CHECKMER	CheckMe! Run
HeatPumpTuneUp	RFZ1WDS	Proper Refrig. Charge & Flow Z1 w Duct Sealing
HeatPumpTuneUp	RFZ1WODS	Proper Refrig. Charge & Flow Z1 w/o Duct Sealing
HeatPumpTuneUp	RFZ2WODS	Proper Refrig. Charge & Flow Z2 w/o Duct Sealing
HeatPumpTuneUp	TSZ1WDS	Cut-Out T-Stat & Rewiring Strip Heat Z1 w/ Duct Sealing
HeatPumpTuneUp	TSZ1WODS	Cut-Out & Rewiring Strip Heat Z1 w/o Duct Sealing
HeatPumpTuneUp	TSZ2WDS	Cut-Out T-Stat & Rewiring Strip Heat Z2 w/ Duct Sealing
HeatPumpUpgrade	HPFHP82UPG	HPF Heat Pump Upgrade HSPF 8.2-8.49
HeatPumpUpgrade	HPFHP85UPG	HPF Heat Pump Upgrade HSPF 8.5+
HeatPumpUpgrade	HPHSPF85HPHP	SF Heat Pump Upgrade HSPF 8.1
HeatPumpUpgrade	HPHSPF85HPHP	SF Heat Pump Upgrade HSPF 8.2
HeatPumpUpgrade	SFHP82UPG	SF Heat Pump Upgrade HSPF 8.2-8.49
HeatPumpUpgrade	SFHP85UPG	SF Heat Pump Upgrade HSPF 8.5+
HeatPumpUpgrade	SFNHPCXZ1ND	SF New Heat Pump Cx w/o Duct Sealing Z1

HeatPumpUpgrade	SFNHPCXZ1WD	SF New Heat Pump Cx w/Duct Sealing Z1
HeatPumpUpgrade	SFNHPCXZ2ND	SF New Heat Pump Cx w/o Duct Sealing Z2
HeatPumpUpgrade	SFNHPCXZ2WD	SF New Heat Pump Cx w/Duct Sealing Z2
HomeEnergyReview	HAUDIT	Home Energy Review
Lighting	CFLHERE	HER CFL, Ele Heat
Lighting	CFLHERG	HER CFL, Gas Heat
Other	BUYDOWN	Loan Buy-Down
Other	OFFSET	Loan Off-Set
Other	SWHCOUPON	Solar Water Heating Coupon
OtherInsulation	SFINSKWE	SF Knee Wall Insulation/SQFT, Ele Heat
OtherInsulation	SFINSKWG	SF Knee Wall Insulation/SQFT, Gas Heat
OtherInsulation	SFINSPIPE	SF Boiler Pipe Insulation/Linear FT
SolarHotWater	SOLHOTW	Solar Hot Water Measure
SolarHotWater	SOLHOTWPL	Solar Pool
TankWaterHeater	HECNGDHW	SF Water Heater, Cascade Natural Gas DHW
TankWaterHeater	HEGASDHW	SF Water Heater, Gas
TankWaterHeater	NEWTANKELE	SF Water Heater, Ele
TanklessWaterHeater	SFTANKLESSG	SF Tankless Water Heater, Gas
WallInsulation	HPFINSWALLG	HPF Wall Insulation/SQFT, Gas Heat
WallInsulation	INSWALLSFE	SF Wall Insulation, Ele Heat
WallInsulation	INSWALLSFG	SF Wall Insulation, Gas Heat
WallInsulation	SFINSWALLE	SF Wall Insulation/SQFT, Ele Heat
WallInsulation	SFINSWALLG	SF Wall Insulation/SQFT, Gas Heat
WaterMeasures	AERATORE	HER Faucet Aerator, Ele Hot Water
WaterMeasures	AERATORE2	HER Faucet Aerator, Ele Hot Water, CO Portland Pilot, Half Incnt
WaterMeasures	AERATORG	HER Faucet Aerator, Gas Hot Water
WaterMeasures	AERATORG2	HER Faucet Aerator, Gas Hot Water, CO Portland Pilot, Half incnt
WaterMeasures	SFSHOWERE	HER Showerhead, Ele Hot Water
WaterMeasures	SFSHOWERE2	HER Showerhead, Ele Hot Water, C.O. Portland Pilot, Half Incntve
WaterMeasures	SFSHOWERG	HER Showerhead, Gas Hot Water
WaterMeasures	SFSHOWERG2	HER Showerhead, Gas Hot Water, C.O. Portland Pilot, Half Incntve
Windows	WINDOWSFE	SF Windows, Ele Heat
Windows	WINDOWSFG	SF Windows, Gas Heat
Windows	WINDOWSFG	Windows SF Gas

Table 18: Counts of measures in final data

Building Type	Single Family Homes				Manufactured Homes			
Energy Type	Electric	Electric	Gas	Gas	Electric	Electric	Gas	Gas
Heating Fuel	Electric	Gas	Electric	Gas	Electric	Gas	Electric	Gas
Measure								
Air Sealing	43	200	11	196	276	8	8	6
Ceiling Insulation	239	865	35	856	-	-	-	-

Building Type	Single Family Homes				Manufactured Homes			
Energy Type	Electric	Electric	Gas	Gas	Electric	Electric	Gas	Gas
Heating Fuel	Electric	Gas	Electric	Gas	Electric	Gas	Electric	Gas
Duct Test/Seal	88	481	25	502	276	8	24	17
Floor Insulation	158	523	23	519	-	-	-	-
Gas Furnace	97	2721	98	2867	0	0	0	0
Heat Pump Install	268	0	26	0	0	0	0	0
Heat Pump Upgrade	500	2	175	2	0	0	0	0
Home Energy Review	678	3008	74	2981	-	-	-	-
Solar Hot Water	3	9	1	9	-	-	-	-
Wall Insulation	50	361	8	342	-	-	-	-
Tank Water Heater	3	1	8	62	-	-	-	-
Tankless Water Heater	1	0	47	221	-	-	-	-
Windows	45	165	6	180	-	-	-	-

Table 19: kWh Savings Model Parameter Estimates for Single Family Homes with Electric Heat

Variable	Estimate	Standard Error
Constant	14	0.16
Year 2005	-2	0.13
Year 2006	-2.7	0.12
Year 2007	-1.2	0.098
January	0.29	0.068
February	-2	0.09
March	-8.2	0.1
April	-13	0.12
May	-19	0.15
June	-21	0.17
July	-21	0.2
August	-21	0.2
September	-21	0.17
October	-17	0.12

Variable	Estimate	Standard Error
November	-6.1	0.077
HDD	0.0057	0.00046
HDD^2	1.1E-05	3.5E-07
CDD	0.053	0.0015
Ceiling Insulation	-2.1	0.66
Duct	0.22	1
Floor Insulation	-1.2	0.63
Heat Pump Install	-2.9	0.56
Heat Pump Upgrade	2	0.42
Home Energy Review	-6.2	0.37
HDD * Ceiling Insulation	0.001	0.002
HDD * Duct	-0.014	0.003
HDD * Heat Pump Installation	-0.0083	0.0018
HDD * Heat Pump Upgrade	-0.0075	0.0013
HDD * Home Energy Review	0.0093	0.0012
HDD^2 * Ceiling Insulation	-8E-06	1.9E-06
HDD^2 * Duct	1.6E-05	2.9E-06
HDD^2 * Heat Pump Install	4.8E-06	1.8E-06
HDD^2 * Heat Pump Upgrade	2.6E-06	1.3E-06
HDD^2 * Home Energy Review	-6E-06	1.2E-06

$R^2 = 0.76$ Durbin-Watson Statistic = 1.7

Table 20: kWh Savings Model Parameter Estimates for Single Family Homes with Gas Heat

Variable	Estimate	Standard Error
Constant	3.9	0.064
Year 2005	0.23	0.047
Year 2006	0.2	0.047
Year 2007	0.0018	0.037
January	-0.91	0.024
February	-2.3	0.034
March	-4	0.04
April	-5.3	0.048
May	-6.4	0.063

Variable	Estimate	Standard Error
June	-6.2	0.075
July	-4.5	0.091
August	-4.7	0.089
September	-6.1	0.075
October	-5.4	0.049
November	-2.4	0.03
HDD	-0.0019	0.00022
HDD^2	4.3E-06	1.7E-07
CDD	0.047	0.00066
Gas Furnace	1.4	0.087
Home Energy Review	-0.49	0.09
HDD * Gas Furnace	-0.0021	0.00011
HDD * Home Energy Review	0.0028	0.00028
HDD^2 * Home Energy Review	-4E-06	2.9E-07

$R^2 = 0.64$ Durbin-Watson Statistic = 1.7

Table 21: Therm Savings Model Parameter Estimates for Single Family Homes with Electric Heat

Variable	Estimate	Standard Error
Constant	0.4	0.025
Year 2005	0.36	0.018
Year 2006	0.14	0.018
Year 2007	0.064	0.014
January	0.17	0.0097
February	0.048	0.013
March	-0.36	0.016
April	-0.62	0.019
May	-0.87	0.024
June	-0.95	0.028
July	-0.9	0.031
August	-0.91	0.031
September	-0.9	0.027
October	-0.82	0.019
November	-0.27	0.012
HDD	0.0018	3.5E-05

Variable	Estimate	Standard Error
CDD	0.00051	0.00021
Home Energy Review	0.097	0.062
Tankless Water Heater	0.12	0.089
HDD * Home Energy Review	-0.0003	8.1E-05
HDD * Tankless Water Heater	-0.0013	0.0001

$R^2 = 0.82$ Durbin-Watson Statistic = 1.6

Table 22: Therm Savings Model Parameter Estimates for Single Family Homes with Gas Heat

Variable	Estimate	Standard Error
Constant	0.8	0.0072
Year 2005	0.042	0.0053
Year 2006	-0.058	0.0052
Year 2007	-0.04	0.0041
January	0.13	0.0028
February	-0.0093	0.004
March	-0.54	0.0047
April	-0.93	0.0056
May	-1.3	0.0075
June	-1.4	0.009
July	-1.4	0.011
August	-1.4	0.011
September	-1.4	0.0091
October	-1.2	0.0058
November	-0.37	0.0036
HDD	0.0025	2.7E-05
HDD^2	1.8E-07	2.1E-08
CDD	0.0011	7.9E-05
Ceiling Insulation	-0.066	0.021
Duct	0.0041	0.025
Floor Insulation	-0.055	0.027
Gas Furnace	-0.24	0.01
Home Energy Review	-0.074	0.01
Wall Insulation	0.089	0.03
Tank Water Heater	0.1	0.06

Variable	Estimate	Standard Error
Tankless Water Heater	0.17	0.036
Windows	-0.015	0.036
HDD * Ceiling Insulation	1.4E-05	6.7E-05
HDD * Duct	-0.0003	3.3E-05
HDD * Floor Insulation	0.00011	8.5E-05
HDD * Gas Furnace	0.00048	3.3E-05
HDD * Home Energy Review	0.00038	3.4E-05
HDD * Wall Insulation	-0.0004	0.0001
HDD * Tank Water Heater	-0.0002	7.4E-05
HDD * Tankless Water Heater	-0.0002	0.00012
HDD * Windows	-0.0002	4.9E-05
HDD^2 * Ceiling Insulation	-7E-07	6.8E-08
HDD^2 * Floor Insulation	-3E-07	8.6E-08
HDD^2 * Gas Furnace	-1E-06	3.4E-08
HDD^2 * Home Energy Review	-9E-07	3.4E-08
HDD^2 * Wall Insulation	-3E-07	1E-07
HDD^2 * Tankless Water Heater	-6E-07	1.1E-07

$R^2 = 0.88$ Durbin-Watson Statistic = 1.8

Table 23: Parameter Estimates for kWh Savings Model for Manufactured Homes with Electric Heat

Variable	Estimate	Standard Error
Constant	43	0.95
Year 2005	-1.5	0.37
Year 2006	-1.6	0.33
Year 2007	-1.4	0.28
January	0.31	0.28
February	-1.9	0.34
March	-8.7	0.39
April	-14	0.47
May	-18	0.63
June	-18	0.73
July	-15	0.85

Variable	Estimate	Standard Error
August	-15	0.82
September	-17	0.73
October	-15	0.51
November	-5.7	0.33
HDD	0.024	0.00099
CDD	0.04	0.007
Sealing	-0.42	0.42
HDD * Sealing	-0.0041	0.00063

R2 = 0.94 Durbin-Watson Statistic = 2.3

Savings Roll-Up: Free Rider Calculations

These free ridership values were calculated as such:

Equation 1. Free Ridership Scoring (FR)

FR=0.5*PI + 0.5*SI

Where PI = 1-(Max(XX6, XX10,XX11)/10)

SI = MEAN(XX8, XX8a, XX9)

The specific questions referenced in Equation 1 are as follows:

Program Influence Questions

XX6 - How influential was your contractor in your decision to purchase an energy efficient [MEASURE] where 0 means not at all influential and 10 means very influential?

XX10- How influential was the cash rebate in your decision to install an energy efficient [MEASURE], where 0 is not at all influential and 10 is very influential.

XX11 - How influential was the Home Energy Solutions program and information provided through the program in your decision to install an energy efficient [MEASURE], where 0 is not at all influential and 10 is very influential?

Stated Intent Questions

XX8 - Would you have installed a [MEASURE] without the Energy Trust program or its rebate?

XX8a - When would you have installed it?

1. At the same time or earlier
2 Within a year
3. More than 1 year later

XX9 - Would you have installed…

1. The exact same one
2. A less efficient one

Savings Roll-Up: Spillover

Because of the uncertainty in knowing if a measure that a customer stated was energy efficient really met the requirements of the program as well as the difficulty in gathering sufficient information to calculate a good value via a phone call without undue respondent burden, moving the spillover to an actual kWh value is not included in the overall impacts of the program. However, we did calculate spillover using secondary data for those few efficient measures which were stated to have been installed. The caveat from above still holds – we made no attempt to perform any sort of verification of the real efficiency of the measure.

Each of the measures that had at least one final spillover installation (i.e., all but the last four rows in Table 16) had values applied from either our current evaluation or other sources. These per unit values are shown in Table 24.

Table 24. Spillover Per-Unit Savings Values

Measure	Per Unit kWh	Per Unit Therm	Source
Windows	0	35	Regression
Clothes Washer	0	38.6	Energy Trust Engineering Estimates for MF - assuming MF clothes washer saving similar to SF and that SF using gas hot water heater
Refrigerator	1485	0	From Energy Star Calculator for top freezer with through the door water
Wall Insulation	0	14	Regression
Ceiling Insulation	1324	82	Regression
Dishwasher	118	0	From Energy Trust Calculator website - Dishwasher uses 472 kWh/yr and EE saves 25%
Dryer	0	0	No savings for dryer
Gas Furnace	-202	108	Regression
Gas Water Heater	0	-1.9	Regression
Floor Insulation	442	26	Regression
HP Other (1 GF, 1 new house)	1861	0	Regression
Central AC	0	0	Assume so little AC that impacts would be minimal. Difficult to figure out number and would make little difference in overall program number, so set to zero

Measure	Per Unit kWh	Per Unit Therm	Source
Elec Water Heater	126	0	Energy Trust engineering estimates for 0.93 efficient 50 gallon tank water heater
HP replaced HP	153	0	Regression

The per unit values were multiplied by the spillover numbers installed, summed, and divided by the total number of surveyed 2007 and 2008 participants (800). As this was only single family participants, we multiplied the spillover values by the total of 14,107 single family HES participants. This calculation is shown in Table 25.

Table 25. Total 2007 Spillover

	kWh	Therms
Total in Survey	25,734	1,494
Survey n	800	
Total/n	32.17	1.87
2007 N (program) - SF Only	14,107	
Spillover	***453,794***	***26,337***
Percent of Net Impacts	***4.6%***	***5.0%***