HEHE Process and Impact Evaluation

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Executive Summary

Background and Methodology

GasNetworks™ is a collaborative of Berkshire Gas, Columbia Gas of Massachusetts, New England Gas, NSTAR, National Grid and Unitil that was established in 1997 to promote energy efficiency and high-efficiency natural gas technologies in Massachusetts, Rhode Island, New Hampshire, and Maine. This report provides summaries of findings from an impact and process evaluation of the Gas Networks' Residential High Efficiency Heating and Water Heating Equipment Program (HEHE). HEHE is a residential program that provides education and training to heating and plumbing contractors on high-efficiency heating equipment, including boilers, furnaces, and water heaters. Program rebates are directed to customers to help offset the cost of investments in high-efficiency heating and water heating equipment. The program is managed collaboratively by staff members at the six sponsor utilities. The program implementer is ICF, whose staff includes an overall project manager as well as account managers/project coordinators. One of the account managers' functions is to be a circuit rider who regularly visits supply houses to provide program marketing and support. ICF has also contracted with Lockheed Martin for the services of one additional circuit rider. Rebate processing for the HEHE program is provided by Energy Federation, Inc. (EFI) and the Center for Ecological Technology (CET, used in Berkshire Gas territory only).

The impact evaluation for this study included billing analysis models of 2007-08 HEHE participants from all the sponsor utilities in the GasNetworks collaborative. Additionally, the impact evaluation developed billing analysis models of 2007-08 customers who installed gas equipment through National Grid's oil-to-gas conversion program (OTG), including those who installed high-efficiency equipment (HEHE participants) and those who installed standard-efficiency equipment (nonparticipants). Note that although the HEHE program has been in existence for over a decade, this is the first impact evaluation of the program in at least the past decade.

The process evaluation focused on understanding the program: (1) from program implementation and delivery perspectives including program staff, implementation contractors, circuit riders, supply houses, rebate processors, and participating and nonparticipating heating and plumbing contractors; and (2) from end use customer perspectives including program participants and nonparticipants. The process evaluation also focused on contractor experience with the Fall 2009 HEHE Annual Conference.[1] Accordingly, data collection activities for the process evaluation included in-depth interviews with program staff, program implementer staff, program contractors, rebate processing contractors, circuit riders, and supply houses / big box stores; and telephone surveys of HEHE program participants from the 2007-08 and 2009 program years, oil-to-gas conversion customers including HEHE participants and nonparticipants, general

[1] The HEHE program conducts an annual conference that offers seminars, continuing education training, and exhibitor booths. The fall 2009 conference was held at the Lantana in Randolph, MA.

population program nonparticipants, participating and nonparticipating contractors, and contractors attending the Fall 2009 HEHE Annual Conference.

Key findings, conclusions and recommendations from this evaluation are described below.

Gross Program Savings

The impact evaluation of the HEHE program focused on the 2007-08 program year. The impact evaluation used six billing analysis models to estimate savings for each of the program measures. Each model had notable advantages and disadvantages. Accordingly, the savings results from the models were averaged to obtain the final per-unit gross savings estimate.[2] The final average estimated overall program per-unit gross savings are shown in Table ES-1. The program-level savings estimates are based on the weighted average of the relative proportions of installations of each measure. The gross per-unit savings for the 2007-08 program year are estimated to range from 72 therms for boilers with 85% to 89% AFUE to 137 therms for boilers with 90% or greater AFUE; estimated furnace savings are estimated to be 118 therms for furnaces with 92% or greater AFUE and 127 therms for ECM furnaces with 92% or greater AFUE; estimated water heater savings are estimated to be 80 therms for indirect water heaters and 97 therms for on-demand tankless water heaters.

Table ES-1: 2007-08 Program Savings Summary

	Average Program Model Savings per Unit (Therms)	**Model Savings Range**
Furnaces: AFUE 92% or greater	**118**	99-132
Furnaces: AFUE 92% or greater with ECM	**127**	102-147
Boilers: AFUE 90% or greater	**137**	105-182
Boilers: AFUE 85%-89%	**72**	64-87
Boilers Steam: AFUE 82% or greater	**109**	96-122
Indirect water heaters	**80**	70-89
Tankless water heaters: EF>0.82	**97**	82-111
Overall Program	**105**	

[2] Model 1 calculated baseline energy consumption for each HEHE measure category and employed an engineering ratio formula to estimate savings. The savings model were not included in the average, and only models 2-6 were included in the final savings estimate.

Market Overview & Free Ridership

As Table ES-2 shows, all of the HEHE rebated measures have very high free ridership, and nonparticipating contractors are estimated to account for the large majority of sales of all of the high-efficiency boilers, furnaces and water heaters.

- Free Ridership for the HEHE measures is estimated to range between 50% and 73%
- High-efficiency equipment is estimated to account for three-quarters of all sales of boilers and furnaces in the GasNetworks service area
- Although high-efficiency water heaters also have high free ridership, they account for only about one-third of all water heater sales in GasNetworks service area

Table ES-2: Measure Free Ridership and Sales Data

	2007-08 Free Ridership	2009 Free Ridership	Rebated Equipment		% Sales by Nonparticipating Contractors	% Total Sales of Equipment Type
			% of Participating Contractor Sales	% of Total Sales of Equipment		
Furnaces						
AFUE 92%+	67%	66%	100% (2,236)	14%	86%	60% (16,200)
ECM Furnace	62%	55%	100% (1,612)	39%	61%	15% (4,100)
Boilers						
AFUE 85%-89%	69%	73%	36% (780)	5%	87%	45% (16,900)
AFUE 90%+	60%	61%	100% (3,700)	48%	52%	20% (7,700)
Steam Boilers	67%	68%	100% (500)	20%	86%	11% (4,200)
Water Heaters						
Indirect	66%	68%	100% (3,537)	18%	82%	16% (19,600)
On-demand tankless	63%	59%	68% (1,575)	12%	83%	11% (13,400)
Combo Units	50%	50%	56% (392)	8%	86%	4% (4,900)

These data for the GasNetworks program are corroborated by similar information from other states and programs showing high free ridership and high market shares for energy-efficient equipment. According to GAMA/AHRI sales shipment data, two-thirds (67%) of the furnaces sold in 2007 in Connecticut were high-efficiency models.[3]An evaluation for the California Public Utilities Commission found free ridership in the California Investor Owned Utility programs to be to be 81% for high-efficiency (90%+ AFUE) natural gas furnaces and 78% for high-efficiency

[3] Data from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

natural gas tank storage water heaters.[4] A market transformation model for high-efficiency gas furnaces in Oregon indicated that 2009 free ridership levels ranged between 60% and 68%.[5]

Program Awareness & Participation

Both the general population of end users (49%) as well as nonparticipating contractors (85%) exhibit high awareness levels of the HEHE Program. Mailings from GasNetworks or the program sponsors were a notable source of program awareness among the general population (36%) and among nonparticipating contractors (22%). However, these data also suggest that the role of market actors in the equipment supply chain may be more important to promoting actual program participation: HEHE participants (50%) reported that they most often heard about the HEHE program from their contractors.

Motivations for Program Participation & Equipment Purchases

Although about one-half of HEHE participants (54%) participated in the program to obtain the rebate, their most important criterion when deciding what equipment to purchase was energy efficiency (41%), followed by contractor recommendation (24%). Both participating and nonparticipating contractors most frequently cited saving money on operating costs when promoting high-efficiency heating and water heating equipment to customers. Some also mentioned saving energy.

Nonparticipating contractors who were familiar with the HEHE program were asked what would motivate them to participate in the program. Two general motivators emerged: generating more business and financial benefits. Sixteen percent of nonparticipating contractors said that increased customer demand would motivate them to participate and ten percent noted that they would like more business leads. The financial motivations cited focused on more money or reduced cost of participating in the program (11%), rebates (11%), and rebates to contractors (7%).

Barriers to Participation

The financial barrier of customer unwillingness to pay for the upfront costs of high-efficiency equipment is a common theme that runs through the barriers mentioned by contractors, customers, and program staff. Note, however, that the high market shares for energy-efficient equipment and the high free ridership levels described previously suggest that the financial barrier is not much of an obstacle as survey results would lead one to believe.

Participating contractors mentioned barriers such as paperwork hassle, an incorrect HEHE list of contractors from which their names were missing, and rebate issues. Interviews with supply house staff revealed that an indirect hurdle to contractor participation in the program may be the physical barriers presented in the venting and installation required for some high-efficiency

[4] The Cadmus Group. 2010. *Residential Retrofit High Impact Measure Evaluation Report*, conducted for the California Public Utilities Commission.
[5] Summit Blue Consulting. 2009. *Gas Furnace Market Transformation Model Development and Market Research*, conducted for the Energy Trust of Oregon.

equipment[6] Supply house staff also noted that lack of contractor knowledge of the high-efficiency equipment may be another barrier to their participation in the program. Program staff observed that contractors who have become accustomed to installing specific types of standard-efficiency equipment may be disinclined to change their practices.

Post-Participation Actions

Since participating in the HEHE program or converting from oil to gas, about three in ten HEHE participants reported installing energy-efficient appliances (31%), insulation (30%), and new windows (27%). Similarly, about three in ten oil-to-gas conversion (high efficiency) participants installed more efficient appliances (29%), and nearly two in ten installed new windows (18%) and/or insulation (17%). Overall, both the HEHE and oil-to-gas conversion participants indicated that the program had at best a moderate influence on their decision to install these energy-efficient measures.

Program Marketing

The HEHE program has been promoted through a variety of marketing methods, including customer mailings, contractor trainings, home shows, and building conferences. Relationship building with vendors, suppliers, and contractors also has been a large part of marketing the program. Circuit riders or account manager visits to supply houses have been effective in educating contractors. Implementation contractors reported that they have promoted the HEHE program through regular visits to supply houses by circuit riders and account managers.

About one-third (34%) of participating contractors said they do not do any advertising at all. Among those who do, more than four out of five (85%) said that their advertising promotes the fact that they install energy-efficient heating or water heating equipment.

Influence of Rebates

Although, as noted previously, the HEHE rebates are a primary motivator of the customer decision to participate in the HEHE *program*, they are not perceived to be very strong influencers of the decision to purchase the energy-efficient *equipment*. Most HEHE program participants indicated a strong likelihood of purchasing the energy-efficient equipment in the absence of the rebates.

- Free ridership ranges from 50% to 73%, depending upon the program measure.
- About four out of five HEHE program participants (82%) and nearly three out of five OTG participants (57%) said they would have been likely to install the equipment at the same time without a rebate or discount from GasNetworks.
- About three out of five HEHE participants (62%) disagreed that the rebate was a critical factor and about one in five (19%) strongly disagreed. In contrast, only about one in five (19%) of the OTG participants disagreed with the statement.

[6] A venting or drainage system upgrade is often required when replacing an old furnace or boiler with higher efficiency, condensing furnaces or boilers. Condensing furnaces and boilers can create corrosive condensate that requires special venting strategies for furnaces and drainage strategies for boilers.

- More than two out of three out HEHE participants (69%) agreed that they would have paid the full price for the equipment and nearly two out of five (38%) strongly agreed. One-half (50%) of the OTG participants also agreed with the statement and one in five (20%) strongly agreed.

OTG participants also exhibited a notable, but not as strong, likelihood of purchasing the equipment had it not been available at a discounted price from National Grid.[7]

HEHE Rebate Processing

About one-quarter (24%) of participating contractors said that they had experienced some problems in processing the rebate. The problems were mainly that it took too long to receive the rebate (35%) or that there were issues with the paperwork (27%). The rebate processing contractors, EFI and CET, indicated that 80% of the time they processed HEHE participant rebates within four weeks. Reasons that some rebates took longer than four weeks to process included incomplete data entry on the form, program changes, and invoicing cutoff dates.

Internal reporting of rebate processing was another area highlighted for improvement. The circuit rider reported difficulty getting feedback from EFI concerning the number of rebate forms supplied by circuit riders that were resulting in rebates. A similar concern was expressed by implementation contractors who requested information about where processed applications had originated. Aside from meeting that need, implementers described the data tracking process as complete and updated frequently. Program staff noted that the rebate processors had been responsive to their data requests and that they had worked with EFI to establish better reporting guidelines, such as extracting equipment pricing information from the rebate forms that they process. However, they believe there is opportunity for further optimization of EFI's reporting system by eliminating manual reporting and having EFI enter all information directly into the data processing systems of program sponsors.

Key Role of Contractors

The role of market actors in the equipment supply chain appears to be crucial to promoting actual program participation: HEHE participants most often heard about the HEHE program from their contractors. Contractors, in particular, are the linchpin for effective delivery of the HEHE program as strong influencers of the customer decision to install high-efficiency equipment. They are the primary point of contact with customers and are critical to informing customers about the HEHE program, influencing them to make the decision to purchase high-efficiency equipment, and following proper installation practices so that the equipment savings are fully realized.

- One-half of the respondents to the HEHE participant survey (50%) said that they first learned about the program rebates from their contractor.

[7] It is important to note that the discounted price provided to these participants incorporated both the HEHE rebate and the National Grid fuel conversion rebate and this may account for these ratings by the oil-to-gas participants.

- Contractors had recommended the specific models of heating systems that were installed for about one-half of HEHE program participants (49%) and three out of five (58%) general population respondents.

In light of the key role of contractors, it is important to understand the steps that the HEHE program could take to make it easier and more attractive for contractors to participate. In addition to a lack of customer interest, participating contractors mentioned barriers such as paperwork hassle, an incorrect HEHE list of contractors from which their names were missing, and rebate issues. A notable percentage of participating contractors reported that they do not do any advertising at all. Nonparticipating contractors reported that they would be motivated to participate in the program by the prospect of more business.

Contractor Installation Practices

The survey of participating contractors revealed installation practices that are sub-standard, which can reduce or negate the savings from the installations of the rebated equipment. The HEHE program has had little or no influence on these installation practices. Specifically, most participating contractors are not using Manual J for equipment sizing, using mastic for duct sealing, or giving the correct instructions to customers on using an ECM furnace fan.

Program Satisfaction

The 2007-09 HEHE program participants have been very satisfied with the program overall, with an average satisfaction rating of 9.1 out of 10. From their perspective, the process of participating in the program works well and as a whole they are satisfied with the rebates and the equipment they installed.

Participant Profile

HEHE participants are more likely than the rest of the population to live in single-family detached homes they own. HEHE participants also have higher household incomes: 11% of HEHE participants had an annual household income under $50,000 as compared to 29% of the general population. The participants also tend to be older: 19% of HEHE participants were under 45 years old as compared to 27% of the general population.

Recommendations

The GasNetworks HEHE program has been active for well over a decade. In that period, the market for high-efficiency equipment has changed to a point where today there is strong awareness of and substantial interest in such equipment. Indeed, all of the HEHE rebated measures have very high free ridership and nonparticipating contractors are estimated to account for the large majority of sales of all of the high-efficiency boilers, furnaces and water heaters.

1. NMR therefore recommends that the HEHE program drop all current rebates for furnaces, forced hot water boilers, steam boilers, and water heaters.

2. NMR recommends that the HEHE program should assess the feasibility of working to effect a change in the state standards for forced hot water boilers to 90% AFUE.
3. NMR further recommends that the HEHE program consider a new program for early replacement of newer, less efficient boilers.
4. NMR also recommends that the HEHE program continue to nurture its relationship with contractors because of the key role they play in customer education and energy-efficient equipment purchase and installation.
    i. The program should evaluate the potential savings from offering an installation incentive to contractors for adhering to energy-efficient criteria for equipment sizing, duct testing, and duct sealing. Note that if the HEHE program decides to drop rebates for some or all equipment models, in addition to ensuring proper installation, offering installation incentives would also provide continued motivation to contractors to promote installations of high-efficiency equipment.
    ii. The program should educate contractors and participants on correct usage of ECM furnace fans, and check settings during verification visits.
    iii. The HEHE program can further increase its value to contractors by helping them grow their businesses through energy-efficient installations. Examples of approaches that would be attractive to them include offering co-op advertising and providing referrals.
    iv. Make greater efforts to reach out to nonparticipating contractors. Approaches to doing so could include:
        - Facilitating program participation by older contractors. Examples of approaches might be to have exhibits at trade shows that demonstrate installations of high-efficiency systems, and if possible, demonstrate how the installation practices are simply an extension of what techniques they are already familiar with.
        - Increasing the number and frequency of educational offerings.
5. Finally, NMR recommends that the HEHE program conduct a survey of distributors in HEHE states and elsewhere to get a better estimate of market-level sales by efficiency level, and the possible long-term spillover both within and outside the HEHE states.

1 Study Background

GasNetworks™ is a collaborative of Berkshire Gas, Columbia Gas of Massachusetts, New England Gas Company, NSTAR, National Grid and Unitil that was established in 1997 to promote energy efficiency and high-efficiency natural gas technologies in Massachusetts, Rhode Island, New Hampshire, and Maine. The GasNetworks' High Efficiency and Water Heating Equipment Program (HEHE) is a residential program that provides education and training to heating and plumbing contractors on high-efficiency heating equipment, including boilers, furnaces, and water heaters. Program rebates are directed to customers to help offset the cost of investments in high-efficiency heating and water heating equipment. The program database shows that from May 2007 through December 2009 approximately 11,984 boilers, 10,185 furnaces, 11,291 water heaters, and 418 combo units were purchased through the program.

The Gas Networks Oil-to-Gas conversion program (OTG) encourages customers to switch their heating systems from oil to gas by allowing customers to purchase heating equipment, including boilers, furnaces, and hot water heaters, at discounted prices. The High Efficiency and Water Heating Equipment Program (HEHE), provides additional discounts for OTG customers to purchase high-efficiency heating equipment—these additional discounts are reflected in the total discounted price offered to customers. The program database shows that from May 2007 through March 2009, over 12,000 boilers or furnaces were converted from oil to gas by National Grid customers.

This report provides summaries of findings from an impact and process evaluation of the HEHE Program that was conducted between mid-2009 and mid-2010 by NMR and its subcontractor, Cadmus Group. The impact evaluation was conducted using program participants who received rebates from May 2007 through December 2008. The process evaluation was conducted using participants who received rebates for the period of May 2007 through December 2009.

The impact evaluation for this study included billing analysis models of 2007-08 HEHE participants from all the sponsor utilities in the GasNetworks collaborative. Additionally, the impact evaluation developed billing analysis models of 2007-08 customers who installed gas equipment through National Grid's oil-to-gas conversion program, including those who installed high-efficiency equipment (HEHE participants) and those who installed standard-efficiency equipment (nonparticipants).

The process evaluation focused on understanding the program: (1) from program implementation and delivery perspectives including those of program staff, implementation contractors, circuit riders, supply houses, rebate processors, and participating and nonparticipating heating and plumbing contractors; and (2) from end use customer perspectives including those of program participants and nonparticipants. The process evaluation also focused on contractor experiences with the Fall 2009 HEHE Annual Conference. Accordingly, data collection activities for the process evaluation included in-depth interviews with program staff, program implementer staff, program contractors, rebate processing contractors, circuit riders, and supply houses / big box

stores; and telephone surveys of HEHE program participants from the 2007-08 and 2009 program years, oil-to-gas conversion customers including HEHE participants and nonparticipants, general population program nonparticipants, participating and nonparticipating contractors, and contractors attending the Fall 2009 HEHE Annual Conference.

Volume II of this report provides the findings from the survey of contractors who attended the HEHE Fall 2009 conference. Volume III includes additional tables including the survey responses by key respondent groups. The discussion guides and questionnaires are included in Volume IV of this report.

2 Impact Evaluation

2.1 Methodology

The NMR team performed a billing analysis to determine the savings for the following measure categories. Several model specifications were specified to determine the savings for the program. The details of each model specification and the corresponding results are found later in this section.

Table 2-1: 2007-08 Incentives for Residential High-Efficiency Heating and Water Heating Program

Measure Type	Rating	Incentive
Furnaces (forced hot air)	AFUE 92% or greater	$100
Furnaces (forced hot air with ECM)	AFUE 92% or greater	$400
Boilers (forced hot water)	AFUE 90% or greater	$1,000
Boilers (forced hot water)	AFUE 85% or greater	$500
Boilers (steam with electronic ignition)	AFUE 82% or greater	$200
Indirect water heaters (attached to Energy Star hot water boiler)		$300
On-demand tankless water heaters (with electronic ignition)	EF > 0.82	$300

2.1.1 Data Preparation

The NMR team received participant billing data for all the Gas Networks utilities, as well as for customers who participated in National Grid's oil-to-gas conversion program. We then matched the heating degree days (based on the NOAA-defined base of 65 degrees) for each billing period to the nearest weather station for each home.

Since the program evaluation period ranged from May 2007 through December 2008, the post-period year used in all the proposed savings analyses was defined as 2009. Data for 2009 was available for nearly all participants. The data for the pre-period was very limited—only two utilities were able to provide more than 24 months of billing data.

We looked up the square feet for each home by address with automated queries in public assessors' records. This allowed us to normalize the usage between participants and nonparticipants, and thus not to be limited to the small sample sizes from the survey respondents for modeling approaches that compared participants and nonparticipants. We were able to obtain square footage information for approximately 85% of the homes.

We also looked up the efficiency and size of the new equipment based on the model numbers from manufacturers' websites and other public available databases. This information was used to develop equipment run-time estimates and to account for differences in equipment heating capacity in the participant-nonparticipant models.

2.1.2 Overview of Models

The NMR team developed six billing analysis models to determine program savings. Model 1 used the Princeton Scorekeeping Method (PRISM)[8] methodology that calculated baseline energy consumption for each HEHE measure category and then employed an engineering ratio formula to estimate savings. The next two models were pre- post- models based on billing data for all HEHE program participants (including customers from National Grid's oil-to-gas conversion program who installed qualifying HEHE equipment). The remaining three models were participant/nonparticipant models based on billing data for all HEHE program participants and nonparticipants (the latter were identified as customers who installed standard-efficiency gas equipment through National Grid's oil-to-gas conversion program).

The goal of the impact evaluation was to develop gas savings estimates for the measures installed by participants in the High Efficiency Heating and Water Heating Equipment Program. We used six primary modeling approaches to triangulate the actual savings results by program measure category: a post- only PRISM-like census approach (Model 1),[9] a pre- post- PRISM-like census approach (Model 2), a monthly pre-post approach (Model 3); a PRISM participant and nonparticipant modeling approach (Model 4), a monthly participant and nonparticipant modeling approach (Model 5), and a monthly participant and nonparticipant model that utilized demographic characteristics from customer surveys (Model 6).

Model 1 yields a good proxy of what the savings would have been had all the participants achieved their savings based on only post- usage and an engineering formula. This method uses only post- period billing data and does not employ a nonparticipant group, but instead uses a simple engineering ratio method to obtain a proxy of savings. This savings estimate makes an assumption that each participant will save energy, and does not account for any pre-post adjustment; nor does it take into account a nonparticipant group. This method (Model 1) is not included for obtaining the final average gross savings estimate across the various models.

Models 2 and 3 allowed for developing usage and savings estimates for each of the seven program measure categories. Moreover, both modeling approaches accounted for differences in heating degree days across the utilities, and allowed for determining savings for normalized weather conditions, and not necessarily just the actual weather that may be milder or more extreme than the thirty year normal weather 1971-2000 averages from the National Climatic Data Center (NCDC).

Models 4 and 5 used both participant and nonparticipant data. Model 6 was an enhanced monthly participant and nonparticipant model that additionally incorporated survey household characteristics and behaviors to control for differences between participants and nonparticipants.

[8] The Princeton Scorekeeping Method (PRISM) is a program that uses statistical modeling to obtain the weather normalized usage from billing data, actual weather data, and weather normals. Our SAS modeling method is equivalent to running PRISM with a heating degree base 65.

[9] Since Model 1 was a post-only model with an engineering correction, it was not used to determining the final average savings estimate.

Each of models 4, 5 and 6 yielded reliable savings estimates for some but not all of the seven measure categories.

The savings estimates are based on going from a baseline of a new standard-efficiency unit to the new high-efficiency unit. The originally proposed post-only PRISM Model 1 used a formula for obtaining the savings estimate based on manufacturer-rated capacities and annual full load equivalent hours, and the delta between the new standard-efficiency baseline and the new higher efficiency. The full load equivalent hours were obtained directly from the post- period weather-normalized consumption (NAC).

We estimated savings using this post-only methodology. However, in addition to the proposed approach, we utilized an alternate approach for estimating the savings with pre- and post- billing data (Models 2 and 3). Our alternate approach first estimated the savings from replacing an existing system with a new, high-efficiency system. We then adjusted the savings estimates based on the new standard-efficiency baseline instead of the actual replaced efficiency using a similar formula. The results from this alternate method then were compared to the base method.

The alternate method first estimated the efficiencies and sizes for the replaced equipment and the savings were directly proportional to the delta of the efficiency and size of the replaced units. This alternate approach allowed for a more robust savings analysis and triangulation of the savings estimates. However, this method required more than two years of billing data since one year pre- and one year post-installation were desirable for each participant. This is discussed further below.

Since the tracking system did not contain the efficiency of the replaced unit, this was estimated from contractor surveys. Questions in the installation contractor surveys for each measure group obtained estimates of the age and efficiencies of replaced systems for each measure group. We used this information to estimate the average age and efficiencies of the replaced equipment for each measure group.

The six models that were run are summarized and described below:

Table 2-2: Summary Overview of Models and Data Sources

	Model Type		Description	HEHE PARTICIPANTS (includes HEHE participants and Oil-to-Gas conversion customers installing high-efficiency equipment)		NON-PARTICIPANTS (only Oil-to-Gas conversion customers installing standard-efficiency equipment)	
				Billing Data	**Survey Data**	**Billing Data**	**Survey Data**
Model 1	**Post- Only**	PRISM	Post-Only annual PRISM Model with engineering ratio adjustment	**Yes**	*No*	**Yes**	*No*
Model 2	**Pre- Post-**	PRISM	Pre-Post annual PRISM usage difference model	**Yes**	*No*		
Model 3		Fixed Effects	Pre-Post monthly weather normalization difference model	**Yes**	*No*		
Model 4	**Participant vs. Non-participant**	PRISM	Post-Only participant-nonparticipant PRISM based differences in annual usage	**Yes**	*No*	**Yes**	*No*
Model 5		CSA	Post-Only participant-nonparticipant pooled conditional savings (CSA) model based on differences in monthly usage	**Yes**	*No*	**Yes**	*No*
Model 6		Enhanced CSA l	Model 5 enhanced with survey data on house and behavioral characteristics	**Yes**	**Yes**	**Yes**	**Yes**

1. **Post- Only PRISM Model**. Total weather-normalized annual consumption (NAC) for all customers for the post- period only. This method did not have a pre/post component, nor did it employ a nonparticipant group, but instead used a simple ratio method to obtain a proxy of savings. This savings estimate made an assumption that each participant will save energy, and did not account for any behavioral or pre-post adjustment. This method (Model 1) was not included in obtaining the final average gross savings estimate.
2. **Pre- Post- PRISM Model**. Total weather-normalized annual consumption (NAC) for all customers for the pre- and post- periods.
3. **Pre- Post- Fixed Effects Model**. A fixed effects model based on weather normalized pre- and post- differences in monthly usage by measure category.

4. **HEHE Participant vs. Nonparticipant PRISM Model**. Total weather-normalized annual consumption (NAC) based on differences between HEHE participants and oil-to-gas conversion nonparticipants who installed standard-efficiency heating systems, by measure category.
5. **HEHE Participant vs. Nonparticipant CSA Model**. A pooled conditional savings (CSA) model based on weather normalized differences in monthly usage by measure category between HEHE participants and oil-to-gas conversion nonparticipants who installed standard-efficiency heating systems.
6. **HEHE Participant vs. Nonparticipant CSA Model with Survey Data**. A pooled conditional savings (CSA) model based on weather normalized differences in monthly usage between HEHE participants and oil-to-gas conversion nonparticipants who installed standard-efficiency heating systems by measure category enhanced with survey data information.

In all models that are run, the savings that are derived are not net savings and they do not take free ridership into account. The free ridership estimate must be applied to the savings estimates to provide the net savings.

2.2 Program Savings

2.2.1 PRISM Modeling Methodology Overview

We used the Princeton Scorekeeping Method (PRISM)[10] modeling methodology to weather normalize the usage for each HEHE participant and nonparticipants (oil-to-gas conversion customer who installed standard-efficiency equipment. From this model, we developed the total weather normalized annual consumption (NAC).

Weather normalization of gas usage, was accomplished by using a fixed reference temperature PRISM equivalent approach, with the fixed heating reference temperatures (tau) of 65 degrees Fahrenheit. In this modeling approach, we ran account-level models for the census of participants, and also the census of the oil-to-gas HEHE nonparticipants. This model had the following specification, which was analyzed for the post- period only in the base methodology, and for both pre- and post- periods in our alternate methodology. For each customer i and month t,

$$\mathbf{ADC_{it}} = \alpha_i + \beta_1 \mathbf{AVGHDD_{it}} + \varepsilon_{it}$$

Where,

- α_i is the intercept for each participant. This represents the daily base load (non-heating usage) in the pre- or post- period. For the standard methodology, only the post- usage was calculated.

[10] The Princeton Scorekeeping Method (PRISM) is a program that uses statistical modeling to obtains the weather normalized usage from billing data, actual weather data, and weather normals. Our SAS modeling method is equivalent to running PRISM with a heating degree base 65.

- β_1 is the heating slope in the pre- and post- period
- ADC_{it} is the average daily therm consumption during the pre- or post- program period
- $AVGHDD_{it}$, is average daily heating degree days (base 65) for the pre- or post- period based on home location
- ε_{it} is the error term

From the model above, the weather normalized annual consumption (NAC) for the pre- or post-period was computed as follows:

$$\mathbf{NAC_i = \alpha_i * 365.25 + \beta_1 * LRHDD_i}$$

Where, for each customer i,

- α_i is the base load for each participant (or nonparticipant). This represents the average daily therm base load (non-heating usage) from the model
- β_1 is the heating slope in the pre- or post- period from the model
- NAC_i is the pre- or post- period normalized annual therm consumption
- $LRHDD_i$, is the annual long run normal 1971-2000 heating degree days (base 65) based on home location
- $\beta_1 * LRHDD_i$, is the annual weather-sensitive component of NAC, also known as HEATNAC, this translates to the total non-base load, space heating or water heating component of usage

This method used only the post- period NAC, while our first proposed alternate method estimates unadjusted savings (DHEATNAC) as the difference between the pre- period heating consumption (HEATNAC) and the post- period HEATNAC.

We encountered difficulties in isolating the water heating baseload usage directly with PRISM. PRISM under-stated the true water heating usage, although it correctly specified the total normalized usage.[11] As a result, in order to obtain a more accurate proxy of the annual water heating baseload usage, we looked at the minimum average daily usage by month, and multiplied this by 365, assuming that this minimum usage month would be equivalent to a non-heating month. Next, the weather-normalized space heating usage was determined as the difference between the total normalized annual consumption (NAC) usage and the water heating usage. Although there is some seasonality to the water heating usage, this is not generally a problem. However, the water heating usage could not be disaggregated from the space heating usage. Thus, just using the minimum monthly usage as the proxy for the baseload ensured that the water heating usage was separated out. Without disaggregating the water heating usage from the space heating usage, it would be impossible to disaggregate the savings for boilers versus indirect water heaters.[12]

[11] The baseload from the modeling was, on average, around 87 Therms. However, the minimum average daily for the month yielded estimates around 178 Therms. The higher estimate also compared favorably to visual inspection of billing data accounts. This estimate was more in line with typical water heating UECs of approximately 150-200 Therms.

[12] We typically use base 65 heating degree days in the modeling, since the long run averages are commonly published by NOAA. Once the bases are changed, then the normals are not readily available. Based on past billing

Next, where the efficiencies and input capacities of space heating equipment and tankless water heaters were missing, we looked up or obtained this information from the manufacturer and model numbers. For indirect water heaters, the heating efficiency was used as the proxy for the water heating efficiency.

In order to determine the run-time of the space heating equipment, we obtained the input heating capacity of the heating equipment. This yields the therm usage of each furnace or boiler per hour. Based on the total heating usage, this can then be used to determine the run-time of the boiler and furnace.

As expected, the oil-to-gas conversion non-HEHE participant group furnaces and the base 80% efficiency equipment have higher run-times than the equipment used by participants. The actual input heating capacities are similar between the two groups and the difference in run-times.

For the space heating HEHE measures, we screened out homes with run-times below 500 hours and above 2500 hours. This corresponds to removing the top and bottom 1% of the run-times. These outliers of run-times may also indicate problems with the billing data, and the first methodology savings results below excluded the outliers.

2.2.2 Post- Only PRISM Model (Model 1)

Per the proposed PRISM methodology, using the post-period weather-normalized therms and the manufacturers' rated capacity (which were looked up by model number), the annual full load equivalent hours were calculated. The formula for determining equipment savings was:

$((AFUE_{ee}-AFUE_{b})/AFUE_{ee})$ x Capacity in therms/hour x [EFLH]

where $AFUE_{ee}$ is the efficiency of the energy-efficient equipment, $AFUE_{b}$ is the new standard-efficiency baseline, and EFLH is Equivalent Full Load Hours.

Note in the above formula that the term "Capacity in therms/hour x EFLH" is equivalent to the heating part of the normalized annual consumption NAC in the post- period. This is because the EFLH term can be calculated as the post- heating NAC (that is, temperature dependent NAC) divided by the input capacity in therms/hour. Thus, an equivalent specification for the formula above is:

$((AFUE_{ee}-AFUE_{b})/AFUE_{ee})$ x POST_HEATNAC

Table 2-3 summarizes some general characteristics and usage information for participants and nonparticipants. The nonparticipant and participant characteristics are generally quite similar.

analyses, the fixed tau method obtains similar NAC estimates with the variable tau method used in PRISM. We also examined models that used a base 60 heating degree days. These models were less robust than the base 65 models, and yielded savings estimates that were approximately 10% lower than the base 65 method. The NAC usage is very similar between the base 60 and base 65 models—there is an approximately 3% difference between the two set points. It should also be noted, that the baseload usage from the base 60 models is in line with the baseload derived from the minimum monthly usage method. Thus, in effect, the water heating usage that is used in the base 65 models is consistent with the higher estimates based on the base 60 models. It is very complex to run all the models for different bases.

For the furnace group, the square footage of the nonparticipant homes is considerably higher than for participants. As expected the participant homes that installed furnaces had smaller homes than were found for those participant homes with newly installed boilers. On average, the heating capacity of participant furnaces is around 83,000 BTU/hr, while the heating capacity for participant water heater boilers is around 130,000 BTU/hr. All models with nonparticipants account for the square footage and heating capacity differences.

Table 2-3: Equipment Efficiencies, Capacities and Square Footage Summary

	n	Average Heating Efficiency	Average Input Heating Capacity BTU/hr	Average Square Footage of Home
PARTICIPANTS				
Furnaces: AFUE 92% or greater	2462	92%	82,521	1,914
Furnaces: AFUE 92% or greater with ECM	2790	95%	84,824	2,005
Boilers: AFUE 90% or greater	3421	93%	129,507	2,288
Boilers: AFUE 85%-89%	2128	85%	129,582	2,059
Boilers Steam: AFUE 82% or greater	1036	82%	141,514	2,086
Indirect water heaters	3632	91%	NA	2,236
Tankless water heaters: EF>0.82	1114	82%	NA	2,009
OIL TO GAS CONVERSION NONPARTICIPANTS				
Furnaces: Oil-to-gas Conversion non participants	199	80%	94,171	2,240
Boilers: Oil-to-gas Conversion non participants	1808	80%	129,459	2,114
Boilers Steam: Oil-to-gas Conversion non participants	974	80%	131,106	2,103

Table 2-4 compares the average total and heating post-usage with the input capacity of the equipment to determine the run-time of the equipment. From Table 2-4 we can see that the nonparticipant run-times generally are slightly higher. Thus, not only is the equipment using less energy, but the furnaces and boilers run-times are also lower. The exception to this is the steam boilers, for which participants have higher usage while the capacities and home square footage are similar between the two groups (see Table 2-3 above).

Table 2-4: Post-Usage and Run-time Summary

	n	Total Usage (Therms per Year)	Heating Usage (Therms per Year)	Input Heating Capacity (BTU/hr)	Input Heating Capacity (Therms/hr)	Heat Run-time (hours)
PARTICIPANTS						
Furnaces: AFUE 92% or greater	2462	924	776	82,521	0.825	955
Furnaces: AFUE 92% or greater with ECM	2790	988	824	84,824	0.848	982
Boilers: AFUE 90% or greater	3421	1273	1083	129,507	1.295	851
Boilers: AFUE 85%-89%	2128	1216	1031	129,582	1.296	809
Boilers Steam: AFUE 82% or greater	1036	1442	1276	141,514	1.415	915
Indirect water heaters	3632	1001	844	NA		
Tankless water heaters: EF>0.82	1114	1195	958	NA		
OIL TO GAS CONVERSION NONPARTICIPANTS						
Furnaces: Oil-to-gas Conversion nonparticipants	199	1090	956	94,171	0.942	1,036
Boilers: Oil-to-gas Conversion nonparticipants	1808	1298	1091	129,459	1.295	854
Boilers Steam: Oil-to-gas Conversion nonparticipants	974	1323	1132	131,106	1.311	874

Table 2-5 summarizes the estimated annual savings from the post-only PRISM Model 1 methodology for each of the HEHE and DHW program measure categories. The percent savings adjustment factor was developed as part of the base engineering ratio methodology that compared the efficiency of the equipment that qualified for the HEHE program to the efficiency of equipment that just satisfied code requirements. The savings adjustment factor part of the formula presented in the beginning of Section 4.1 is shown below:

$$(AFUE_{ee}-AFUE_{b})/AFUE_{ee}$$

where $AFUE_{ee}$ is the efficiency for the energy-efficient equipment, and $AFUE_{b}$ is the new standard-efficiency baseline.

This factor was multiplied by the weather-normalized end use (heating or water heating) equipment normalized annual (NAC) usage to obtain the post-only proposed engineering estimate of savings using the baseline methodology.

Table 2-5: Post-Only PRISM Ratio Model 1 Savings Results

Product	n	Annual Weather-Normalized Heating Post- Usage (Therms)	Average Percent Savings Adjustment Factor[13]	Annual Savings Therms
Furnaces: AFUE 92% or greater	2462	776	16%	134
Furnaces: AFUE 92% or greater with ECM	2790	824	18%	160
Boilers: AFUE 90% or greater	2128	1083	14%	168
Boilers: AFUE 85%-89%	1808	1031	6%	72
Boilers Steam: AFUE 82% or greater	1036	1091	9%	123
Indirect water heaters	3632	237	38%	82
Tankless water heaters: EF>0.82	1114	157	30%	47

2.2.3 Overview of HEHE Participant Only Pre-Post Models (Models 2 and 3)

The post-only model (Model 1, above) estimated annual measure savings based on participant usage only in the post period. We next ran a PRISM and fixed effects analysis for participants using both the pre- and post- periods. Unfortunately, pre-participation billing data was generally limited. Most utilities were only able to provide 24 months of billing data, and thus there was very little pre-period data available for the analysis. Most participants had billing data available from 1/08 to 12/09, and the program participation period ranged from 5/07 to 12/08.

In the subset of participant billing analysis where pre-data was available, the period from 4/07 through 3/08 was selected as having the best data quality. Thus, only the participants from 4/08 or later with sufficient pre- billing data could be used in the pre-post analysis, the remaining participants did not have sufficient billing data. Due to the limited pre-period billing data availability, only about 15% of the participant accounts could be used in the pre-post analysis. Most of pre-period data available was from National Grid; there also were a few NSTAR and Berkshire Gas accounts that had pre-data available.

[13] These are the averages of the adjustment factors for each measure categories. Since these factors are calculated for each participant, each with separate efficiencies, the average annual savings cannot be directly calculated from the average savings adjustment factor.

The following formula was used to obtain the adjusted savings above minimum AFUE standards for new equipment (code) for both Models 2 and 3.

Corrected Savings = (($AFUE_{ee}$-$AFUE_{b}$)/($AFUE_{ee}$ - $AFUE_{replaced}$) * (PRE_HEATNAC – POST_HEATNAC))

where Corrected Savings is the difference between pre- and post-NAC savings, $AFUE_{ee}$ is the efficiency of the energy-efficient equipment, and $AFUE_{b}$ is the new standard-efficiency baseline, $AFUE_{replaced}$ is efficiency of the replaced equipment, PRE_HEATNAC is pre-period heating NAC, and POST_HEATNAC is post-period heating NAC.

This adjustment formula discounts the savings based on the pre- post- difference because that difference is based on installing new equipment compared to the existing baseline that is always lower than the actual minimum efficiency standards. The lower the efficiency of the replaced equipment compared to the minimum efficiency standards, the more downward adjustment on the pre- post- savings is necessary to obtain the required estimates of savings above minimum efficiency standards.

Since the efficiency of the replaced equipment was not available from the tracking database it was estimated from the efficiency levels reported in the contractor survey. As part of the contractor survey, contractors were asked what the base efficiency was for equipment they had replaced. This provided a reasonable estimate of how much lower the existing equipment efficiency was compared to the code efficiency. The survey responses were averaged to obtain an estimate of the efficiency levels of the replaced equipment.

The water heating efficiencies reported in the surveys were unreasonably high, possibly because the respondents confused the efficiency rating of the water heaters with the AFUE for boilers. However, the contractor survey also collected information on the ages of the replaced water heaters and their average efficiency was estimated based on the code prevailing at the time of installation of the replaced equipment.

Table 2-6 summarizes the average age and the average pre- efficiency levels of the equipment from the contractor survey and the corresponding code prevailing at time of purchase. The average pre-level estimates were used in the formula above and applied to both models 2 and 3.

Table 2-6: Replaced Equipment Efficiency and Age

	Average Pre-Efficiency	Average Code Efficiency	Average Age of the Equipment
Furnaces: AFUE 92% or greater	72.5%	78%	22
Furnaces: AFUE 92% or greater with ECM	72.5%	78%	22
Boilers: AFUE 90% or greater	72.7%	80%	26
Boilers: AFUE 85% or greater	72.7%	80%	26
Boilers Steam: AFUE 82% or greater	68.6%	75%	36
Indirect water heaters	52.5%	57.5%	12
Tankless water heaters: EF>0.82	52.5%	57.5%	12

2.2.4 Pre- Post- PRISM Model (Model 2)

In this model, the PRISM methodology from Model 1 was applied where both pre- and post-period data were available.

Since we wanted to ensure that the participants used gas for heating their home even before installing the efficient equipment, in the pre- participation period, only those accounts that had pre- period heating usage over 100 Therms were retained for the analysis.[14]

Table 2-7 summarizes the pre- post- usage, square footage characteristics, and savings of the PRISM analyses.[15] Note the small sample sizes are due to the general unavailability of pre-data except for a few utilities that were able to provide sufficient billing data. The square footage is included only for comparison; the models do not normalize for square footage, since square footage is not likely to have changed between the pre- and post- periods. The unadjusted savings are simply the savings that are the weather adjusted pre- and post- differences in consumption. The savings above minimum AFUE standards for new equipment were calculated by applying the adjustment formula based on the average code efficiencies show in Table 2-6, above.

Table 2-7: PRISM Model Results (Model 2)

	n	Annual Pre-Usage (Therms)	Annual Post-Usage (Therms)	Unadj-usted Annual Savings (Therms)	Adjustment Factor	Annual Savings above Minimum Standards (Therms)	Average Square Feet of Home
Furnaces: AFUE 92% or greater	358	1,060	900	159	73%	116	1779
Furnaces: AFUE 92% or greater with ECM	686	1,056	883	173	75%	131	1959
Boilers: AFUE 90% or greater	729	1,339	1,107	232	66%	153	2194
Boilers: AFUE 85%-89%	162	1,185	1,035	150	43%	65	1864
Boilers Steam: AFUE 82% or greater	130	1,427	1,250	178	54%	96	2060
Indirect water heaters	426	1,451	1,371	80	88%	70	2207
Tankless water heaters: EF>0.82	320	1,072	973	99	83%	82	2319

[14] This was a conservative minimum for heating usage for a small home. When the minimum threshold was set at 300 therms that only removed an additional 3% of accounts, and that did not have any significant influence on the savings estimates that use the 100 therm minimum.

[15] The adjustment factor is **$((AFUE_{ee}-AFUE_b)/(AFUE_{ee} - AFUE_{replaced})$,** part of the formula for obtaining the corrected savings above minimum standards.

2.2.5 Fixed Effects Model (Model 3)

We also used a fixed effects model to estimate the difference between pre- and post- as unadjusted savings by measure category. In this modeling method, we employed pooled monthly time-series panel billing data, and attempted to correct for differences between the pre- and post-weather as well as differences between the usage magnitudes of the participants. The fixed effects component is characterized by normalization of the variation across the range of participants. While this can be accomplished by including separate intercepts for each customer, it can also be accomplished by simply including the annual pre- usage in the models, as was done in this case.

The following model specification was used to estimate the savings for each separate HEHE heating measure for the census of participants:

$$\mathbf{ADC_{it} = \alpha + \beta_1 ANNPRE_i + \beta_2 AVGHDD_{it} + \beta_3 POST_t * AVGHDD_{it} + \varepsilon_{it}}$$

For the water heating measures, the savings were obtained from the following simpler model that controlled for the difference in the pre- and post- weather, but without interacting the savings with weather:

$$\mathbf{ADC_{it} = \alpha + \beta_1 ANNPRE_i + \beta_2 AVGHDD_{it} + \beta_3 POST_t + \varepsilon_{it}}$$

Where, for each customer i and month t,

- α is the intercept.
- ADC_{it} is the average daily therm consumption during the pre- and post-program periods.
- $ANNPRE_i$ is the annual therm consumption during the pre-program periods
- $AVGHDD_{it}$, is the average daily heating degree days (base 65) based on home location.
- $POST_t$ is a dummy variable that is 1 in the post- period, and 0 otherwise.
- $POST_t * AVGHDD_{it}$ is an interaction of $POST_t$ and $AVGHDD_{it}$.
- β_1 is the total annual therm usage per day, i.e., normalizing for usage differences between customers
- β_2 is the average daily therm participant usage per heating degree day in the pre-program period
- β_3 is the average daily therm participant savings per heating degree day for heating measures, or the average daily savings (in the case of the water heating measures).

After the unadjusted pre-post savings are obtained from the model, the adjustment factor formula is applied to obtain the corrected savings. This model specification improves upon the original simple fixed effects specification proposed in the work plan in two ways. The placement of the annual pre- usage (ANNPRE) controls for the magnitude of usage of the home, ensuring that larger homes or smaller homes don't have a disproportionate influence on the final savings estimate. As mentioned above, the inclusion of this variable is a simpler method of employing a fixed effects model specification. Moreover the inclusion of the interaction of the heating degrees and the post- variable allows for the possibility of obtaining weather-normalized savings

for various utilities and geographic areas by simply entering the associated normal heating degree days for any geographic area.

To ensure that the participants used gas for heating their home in the pre-participation period, only those accounts that had pre- period heating usage over 100 Therms were retained for the analysis. Again, the first method estimated only the average post- consumption, while this alternate modeling approach actually used the post- coefficient (the savings difference from pre- to post- period) coefficient estimate to estimate savings. Table 2-8 summarizes the savings from the fixed effects method.

Table 2-8: Fixed Effects Model Results (Model 3)

	n	Unadjusted Annual Savings from Model (Therms)	Adjustment Factor	Annual Savings above Minimum Standards (Therms)
Furnaces: AFUE 92% or greater	347	181	73%	132
Furnaces: AFUE 92% or greater with ECM	663	195	75%	147
Boilers: AFUE 90% or greater	705	277	66%	182
Boilers: AFUE 85%-89%	160	147	43%	64
Boilers Steam: AFUE 82% or greater	122	227	54%	122
Indirect water heaters	177	102	88%	89
Tankless water heaters: EF>0.82	261	134	83%	111

The savings from the fixed effects modeling method can be compared directly to the PRISM savings results from Table 2-7.[16] This modeling method yields model savings results that are higher than the estimates from the Pre- Post- PRISM Model 2. However, this modeling method employs monthly data, and normalizes for differences in the annual usage and thus has some advantages over the PRISM annual method.

2.2.6 Overview of HEHE Participant and Oil-to-Gas Conversion Nonparticipant Models (Models 4, 5 and 6)

The pre-post methods of determining savings used only participants in determining savings estimates for the HEHE program. They included participants in the HEHE program and participants in the National Grid Oil-to-gas Conversion program who had installed HEHE program-rebated high-efficiency furnaces, water boilers, and steam boilers.

[16] We sought to construct more complex models that included participant survey information to identify participant characteristics that were associated with higher savings. However, only 20-30 accounts were available in each measure category and these did not allow for any statistically meaningful results.

Models 4, 5 and 6 used the participants as well as a nonparticipant group that consisted of National Grid Oil-to-gas Conversion customers who installed standard-efficiency furnaces, water boilers, and steam boilers. Note that Oil-to-gas conversion nonparticipants were available only for the space heating measures: furnaces, water boilers, and steam boilers.

2.2.7 PRISM Model (Model 4)

Using the PRISM methodology, we developed the following annual model which combined the HEHE participants and oil-to-gas conversion nonparticipants for each measure group. In this model, we controlled for the square footage of the home and the heating capacity of the heating equipment as a means for controlling for the differences between HEHE participants and the nonparticipants.

$$\mathbf{HEATNAC_i = \alpha + \beta_1 PART_i + \beta_2 ANNHDD_i + \beta_3 SQFT_i + \beta_4 HEATCAP_i + \varepsilon_i}$$

Where, for customer i,

- α is the intercept.
- $HEATNAC_i$ is the total annual weather normalized heating usage derived from the PRISM methodology.
- $PART_i$ is a dummy variable that is 1 for HEHE participants (those that installed high-efficiency measures), and 0 for nonparticipants (oil-to-gas conversion customers who installed standard-efficiency measures).
- $ANNHDD_i$ is the annual normal heating degrees (base 65) based on home location.
- $SQFT_i$ is the square footage of the home based on home location, controls for differences in square footage between HEHE participants and nonparticipants.
- $HEATCAP_i$ is the heating capacity associated with the equipment in BTUs, controls for differences in heating capacity between HEHE participants and nonparticipants.
- β_1 is the annual heating savings associated with the measure.
- β_2 is the therm usage per normal heating degree day
- β_3 is the usage per square foot
- β_4 is the usage per BTU of heating capacity

This model was developed using only post-period annual data. While the model attempted to control for differences between HEHE participants and the oil-to-gas conversion nonparticipants, there were some differences that could only be captured in the survey. This method yielded models with large standard errors, and unreasonable results when compared to some of the other models presented here.[17] When these models were compared to results from the monthly models that included survey data, the model provided results that were in line with the other models with

[17] The following summarize the reasons why the remaining model results were not usable. The furnace AFUE 92% model, had poor statistical precision level of over 60%,. In the furnace 92% model with ECM, the survey based model (Model 6) showed savings are unreliable without including key survey variables that corrected for differences between the two groups. For boilers AFUE 90% or higher, the models had a large precision level over 50%, and savings estimate that was very low compared to the other model. For the steam boilers model the savings were negative and not statistically significant.

reasonable precision levels only for the boiler 85% efficient or higher group. These results are shown in Table 2-9 below.

Table 2-9: PRISM Model Results (Model 4)

	Nonparticipant n	**Participant n**	**Annual Savings above Minimum Standards** (Therms)
Boilers: AFUE 85%-89%	1974	2547	87

2.2.8 CSA Model (Model 5)

We also developed a CSA (conditional savings) model that used monthly data for the oil-to-gas conversion HEHE participants and nonparticipants for each measure group. In this modeling method, the savings are obtained by comparing the HEHE participant and oil to gas conversion nonparticipant post- usage while accounting for square footage and capacity differences between the two groups. While the pre-post models obtained savings only for HEHE participants, the CSA method obtains the savings by comparing the differences between participants and nonparticipants.

As in Model 4, we again controlled for the square footage of the home and the heating capacity of the heating equipment as a way of controlling for the differences between HEHE participants and nonparticipants.

$$\mathbf{ADC_{it} = \alpha + \beta_1 PARTHDD_{it} + \beta_2 AVGHDD_{it} + \beta_3 SQFTi + \beta_4 HEATCAP_i + \varepsilon_{it}}$$

Where, for customer i and month t,

- α is the intercept.
- ADC_{it} is the average daily therm consumption during the post-program period.
- $PARTHDD_{it}$ is an interaction of heating degrees and a participant flag.
- $AVGHDD_{it}$ is the average daily heating degree days (base 65) based on home location.
- $SQFT_i$ is the square footage of the home, included to control for differences in square footage between participants and nonparticipants.
- $HEATCAP_i$ is the heating capacity associated with the equipment in BTUs, included to control for differences in heating capacity between participants and nonparticipants.
- β_1 is the average savings per heating degree associated with the measure installation.
- β_2 is the therm participant usage per normal heating degree day for nonparticipants
- β_3 is the annual usage per square foot,
- β_4 is the usage per BTU of heating capacity

This model specification worked for all the heating groups except the furnace 92 with ECM, water boilers with 85% AFUE or higher and the steam boilers.[18]

Table 2-10 below is a summary of the reliable results for the CSA Model.

Table 2-10: CSA Model Results (Model 5)

	Nonparticipant n	Participant n	Annual Savings Above Minimum Standards (Therms)
Furnaces: AFUE 92% or greater	203	2470	99
Boilers: AFUE 90% or greater	1970	3821	105

2.2.9 Overview of CSA Model with Survey Data (Model 6)

For Model 6, the CSA (conditional savings) monthly methodology from Model 5 was augmented with the inclusion of the survey variables. Different survey variables were included in each measure category that were useful in controlling for differences between HEHE participants and nonparticipants.

The following monthly model specifications were performed using all HEHE participants and the oil-to-gas conversion nonparticipants who installed standard-efficiency measures for each measure group. As in Models 4 and 5, we controlled for the square footage of the home and the heating capacity of the heating equipment as way of controlling for the differences between HEHE participants and nonparticipants. We additionally ran models that included a range of survey variables including: square footage additions, number of occupants, number of bedrooms, heating setpoints, age of home, number of rooms, number of bathrooms, home type, presence of other natural gas using equipment, and use of programmable thermostats.

Due to small participant survey sample sizes, many of these variables had incorrect signs on the coefficients,[19] were collinear with other independent variables already included in the model such as square footage, and the precision around the savings estimate did not improve after including them suggesting that they added no explanatory power to the model.

The analysis yielded the following final model specifications for the each measure:

Furnaces AFUE>92%:

$$ADC_{it} = \alpha + \beta_1 PARTHDD_{it} + \beta_2 AVGHDD_{it} + \beta_3 SQFT_i + \beta_4 HEATCAP_i + \beta_5 SF_i + \beta_6 WH_NG_{it} + \varepsilon_{it}$$

[18] The following summarize the reasons why the remaining model results were not usable. In the Furnace 92% model with ECM, the survey based model (Model 6) showed savings are unreliable without including key survey variables that corrected for differences between the two groups. The boiler 85% model showed savings nearly twice as much as the other models, and could not be presented. For the steam boilers model, the savings were low and not statistically significant.

[19] For example, negative coefficients on number of occupants or square footage.

Furnaces AFUE>92% with ECM:

$$ADC_{it} = \alpha + \beta_1 PARTHDD_{it} + \beta_2 AVGHDD_{it} + \beta_3 SQFT_i + \beta_4 HEATCAP_i + \beta_6 ENERGYEFF_i + \beta_7 BATHROOMS_{it} + \beta_8 WH_NG_{it} + \varepsilon_{it}$$

Hot Water Boilers AFUE>90%:

$$ADC_{it} = \alpha + \beta_1 PARTHDD_{it} + \beta_2 AVGHDD_{it} + \beta_3 SQFT_i + \beta_4 HEATCAP_i + \beta_5 SF_i + \varepsilon_{it}$$

Where, for customer i and month t,

- α is the intercept.
- ADC_i is the total annual weather-normalized heating usage derived from the PRISM methodology.
- ADC_{it} is the average daily therm consumption during the post-program period.
- $PARTHDD_{it}$ is an interaction of heating degrees and a participant flag.
- $AVGHDD_{it}$ is the average daily heating degree days (base 65) based on home location.
- $SQFT_i$ is the square footage of the home based on home location. Controls for square footage differences between participants and nonparticipants
- $HEATCAP_i$ is the heating capacity associated with the equipment in BTUs. Controls for differences in heating capacity between HEHE participants and nonparticipants.
- SF_i survey variable that is 1 if detached single family, 0 otherwise. Controls for differences between detached single family mix of homes between HEHE participants and nonparticipants
- $ENERGYEFF_i$ survey variable that is 1 if additional energy efficiency actions were taken, 0 otherwise.
- $BATHROOMS_i$ survey variable that is the number of bathrooms in the home. Controls for differences in number of bathrooms between HEHE participants and nonparticipants.
- WH_NG_i survey variable that is 1 if water heating with natural gas, 0 otherwise. Controls for water heating saturation differences between HEHE participants and nonparticipants.
- β_1 is the average savings per heating degree associated with the measure.
- β_2 is the therm participant usage per normal heating degree day for nonparticipants
- β_3 is the usage per square foot, controls for square footage differences between HEHE participants and nonparticipants.
- β_4 is the usage per BTU of heating capacity, controls for differences in heating capacity between HEHE participants and nonparticipants.
- β_5 is the additional usage for detached single family homes
- β_6 is the reduction in usage from installation of additional energy efficiency measures
- β_7 is the usage per bathroom in home
- β_8 is the usage for gas water heating

As with Model 5, we were not able to develop model specifications for hot water boilers with AFUE 85%-89% or for steam boilers.[20]

Table 2-11 below is a summary of the reliable results for the CSA Model with Survey Data.

Table 2-11: CSA Model with Survey Data Results (Model 6)

	Nonparticipant n	Participant n	Annual Savings Above Minimum Standards (Therms)
Furnaces: AFUE 92% or greater	28	174	125
Furnaces: AFUE 92% or greater with ECM	26	126	102
Boilers: AFUE 90% or greater	290	179	108

2.2.10 Comparative Review of Models

Each of the models presented above were developed to estimate program savings, and each have notable advantages and disadvantages, described below.

Model 1: Post- Only PRISM Model (not used to develop final savings estimates)

Advantages: Large sample sizes, simple engineering ratio formula to obtain savings from the normalized post usage.

Disadvantages: Participants only, assumes that savings will occur for all participants, no pre-post data.

Model 2: Pre- Post- PRISM Model

Advantages: Includes both pre- and post- periods to readily obtain savings estimates. Simple savings adjustment calculation used to obtain above code savings.

Disadvantages: Small sample sizes because only three utilities provided sufficient pre-period billing data. Includes participants only.

Model 3: Pre- Post- Fixed Effects Model

Advantages: Includes both pre- and post- periods. Uses monthly data for more accurate weather normalization and greater model degrees of freedom for a more robust model. Simple savings adjustment calculation used to obtain above code savings.

Disadvantages: Small sample sizes because only three utilities provided sufficient pre-period billing data. Includes participants only.

[20] The following summarize the reasons why the remaining model results were not usable. The Boiler 85% model showed savings nearly twice as much as the other models, and could not be presented. For the Steam Boilers model, the savings were low and not statistically significant.

Model 4: Oil-to-Gas Conversion Customer PRISM Model

Advantages: Large sample sizes. Simple model. Simple savings calculations.

Disadvantages: Differences between the HEHE participant and nonparticipants could cause the model to be biased.

Model 5: Oil-to-Gas Conversion Customer CSA Model

Advantages: Large sample sizes. Simple model. Uses monthly data for more accurate weather normalization and greater model degrees of freedom for a more robust model. Simple savings calculation.

Disadvantages: Includes post- period only. Differences between the HEHE participants and nonparticipants could cause the model to be biased.

Model 6: Oil-to-Gas Conversion Customer CSA Model with Survey Data

Advantages: Simple model. Uses monthly data for more accurate weather normalization and more model degrees of freedom for a more robust model. Simple savings calculation, includes survey variables, that control for differences between the participant and nonparticipant groups.

Disadvantages: Small analysis subset because of small survey sample sizes.

Since models 2 and 3 were the only models where it was possible to estimate savings for all measure groups, and models 4-6 also included nonparticipants, there was no clear choice regarding the methodology that provided the best model. If we choose only models 2 and 3 then we would neglect the effect of the nonparticipant group. If we use only models 4-6 then we ignore the pre-post aspect, and some measure categories would not have any savings estimates. We therefore used the average of models 2-6 as providing the most reasonable estimate of the measure-level savings.

2.2.11 Summary of Results

Table 2-12 summarizes the savings from all of the models.

Table 2-12: Model Results Summary

		1. Post- Only PRISM Model Annual Savings (Therms)	2. Pre-Post- PRISM Model Annual Savings (Therms)	3. Pre-Post- Fixed Effects Model Annual Savings (Therms)	HEHE Participants vs. Oil-to-Gas Conversion Nonparticipants		
					4. PRISM Model Annual Savings (Therms)	5. CSA Model Annual Savings (Therms)	6. CSA Model with Survey Data Annual Savings (Therms)
Furnaces: AFUE 92% or greater	**Gross Savings per Unit**	**134**	**116**	**132**		**99**	**125**
	Precision	1%	10%	10%		17%	33%
	n	2462	358	347		2470	174
Furnaces: AFUE 92% or greater with ECM	**Gross Savings per Unit**	**160**	**131**	**147**			**102**
	Precision	1%	7%	5%			40%
	n	2790	686	663			126
Boilers: AFUE 90% or greater	**Gross Savings per Unit**	**168**	**153**	**182**		**105**	**108**
	Precision	2%	8%	5%		8%	20%
	n	3421	729	705		3821	179
Boilers: AFUE 85%-89%	**Gross Savings per Unit**	**72**	**65**	**64**	**87**		
	Precision	1%	18%	15%	22%		
	n	2128	162	160	2547		
Boilers Steam: AFUE 82% or greater	**Gross Savings per Unit**	**123**	**96**	**122**			
	Precision	3%	19%	15%			
	n	1036	130	122			
Indirect water heaters	**Gross Savings per Unit**	**82**	**70**	**89**			
	Precision	3%	27%	36%			
	n	3632	178	177			
Tankless water heaters: EF>0.82	**Gross Savings per Unit**	**47**	**82**	**111**			
	Precision	3%	12%	16%			
	n	1114	320	261			

The savings results from the models presented in Table 2-12 were averaged to obtain the final per-unit gross savings estimate. As described earlier, the results from the post-Only PRISM Model 1 were not included in the average, and only models 2-6 were included in the final savings estimate.

The final average estimated overall program per-unit gross savings are shown in Table 2-13. The program level savings estimates are based on the weighted average of the relative proportions of installations of each measure. The gross per-unit savings for the 2007-08 program year are estimated to range between 72 therms for boilers with 85% to 89% AFUE to 137 therms for boilers with 90% or greater AFUE.

Table 2-13: 2007-08 Program Savings Summary

	Number of Installations	Savings per Unit (Therms)		Model Savings Range
		Post- Only PRISM Savings	Average Program Model Savings	
Furnaces: AFUE 92% or greater	4,491	134	**118**	99-132
Furnaces: AFUE 92% or greater with ECM	3,563	160	**127**	102-147
Boilers: AFUE 90% or greater[21]	4,520	168	**137**	105-182
Boilers: AFUE 85%-89%	4,549	72	**72**	64-87
Boilers Steam: AFUE 82% or greater	1,817	123	**109**	96-122
Indirect water heaters	4,785	82	**80**	70-89
Tankless water heaters: EF>0.82	1,621	47	**97**	82-111
Overall Program	25,346	116	**105**	

The average savings estimates in Table 2-13 provide estimates of gross energy savings based on billing analysis models that do not account for free-ridership or spillover. The pre- post- model results (Models 2 and 3) do not use a nonparticipant group at all because there is no pre- data for the nonparticipants. The savings produced from these models are gross savings estimates, which merely account for participant economic trends and behavioral trends. The savings estimates that contain the oil-to-gas conversion control group (Models 4, 5 and 6) in addition to controlling for participant trends, produce adjusted gross estimates, which also account for control group economic factors, and other behavioral trends in the general population but not market based

[21] The boiler models include customers that installed both boilers and indirect water heaters. Separate boiler only models were also estimated, that excluded indirect water heater installations entirely, however these showed only a 2% reduction in savings. Such a small reduction in savings is expected, since the boiler savings are directly tied to heating degree days in the model specifications. Thus, if there would be any savings from the indirect water heaters, they would show up in the base load and intercept terms, and those are not included in the boiler savings. Thus, the boiler savings estimates are not significantly biased upwards by the inclusion of indirect water heaters. Indirect water heater savings are developed only from customers installing indirect water heaters only.

effects like free-ridership and spillover. The billing analysis models with the oil-to-gas conversion nonparticipants attempt to control for as many differences between the entire group of HEHE participants and the oil-to-gas conversion nonparticipants as possible.

The usage-based billing analysis models cannot provide estimates of free-ridership which is based on the reasoning and the intention of participating in the HEHE program. Moreover, since all the customers in the control group by definition installed the minimum AFUE equipment, the billing analysis also does not in any way control for free-ridership or spillover. Billing analysis can account for spillover only if the non-participant group is a random population of customers who happened to installed new equipment outside the program.

Table 2-14 compares the average model savings with the deemed savings. The model estimates are in line for the boilers and instantaneous water heaters but are lower for the furnaces and higher for the indirect water heaters.

Table 2-14: 2007-08 Program and Deemed Savings Summary

Equipment	Post- Only PRISM Savings	Average Program Model Savings	Deemed Savings
Forced hot air furnace w/AFUE of 92%+	134	**118**	211
Forced hot air furnace w/ECM and AFUE of 92%+	160	**127**	196
Forced hot water boiler w/AFUE of 90%+	168	**137**	150
Forced hot water boiler w/AFUE of 85%-89%	72	**72**	80
Steam boiler w/electronic ignition and an AFUE of 82%+	123	**109**	123
Indirect water heaters	82	**80**	40
On-demand tankless water heaters w/ an EF >0.82	47	**97**	78

3 Process & Market Evaluation

3.1 Overview

NMR conducted a process and market evaluation of the HEHE program for the 2007-2009 program years. The process evaluation analyses helped address a number of issues and evaluate a range of facets of the HEHE program.

- **Evaluation of Program Design, Marketing & Delivery**. This was designed to understand the effectiveness of program implementation and operations and the appropriateness of its application in the market. The analyses included understanding contractor promotions of energy-efficient equipment, reasons for recommending high-efficiency equipment, and the value to contractors of interactions with program staff.
- **Evaluation of Program Awareness, Participation, Customer Experience, Satisfaction & Free Ridership**. This was designed to understand the experience of program participants and the perspective of nonparticipants regarding the HEHE program. The analyses included identifying levels and sources of program awareness, the importance of the program to participant decision to purchase high-efficiency equipment, the primary drivers for choosing high-efficiency equipment, participation motivations and barriers, and estimating participant free ridership levels.
- **Contractor Role in Program Implementation and Contractor Installation Practices**. This was designed to understand the role and practices of contractors in delivering the HEHE program. The analyses of the contractors' role included identifying the contractors' role in educating customers about the program and motivating program participation. The analyses of contractor installation practices included equipment sizing methods, duct sealing practices, ECM furnace fan recommendations, and installation of outdoor boiler resets.
- **Evaluation of Rebate Processing Contractor**. This was designed to understand the responsiveness and effectiveness of the rebate processing contractor. The analyses included identifying and determining the extent of any rebate processing issues from the perspectives of contractors, implementer staff, and program staff.
- **Survey of HEHE Fall 2009 Conference Attendees**. The analyses of this survey included sources of awareness, conference program attendance, value of conference trainings, value of conference seminars, impact of conference on contractor practices, satisfaction with the conference, and topics of interest for future conferences.

The market evaluation synthesized information from secondary data from the Energy Information Administration, surveys of participating and nonparticipating contractors, and surveys of participants to estimate sales volumes for standard and high-efficiency boilers, furnaces and water heaters.

3.2 Methodology

The process evaluation drew upon a variety of data sources, including program documents; in-depth interviews with program staff, program implementers, program contractors, rebate processing contractors, circuit riders, supply houses and big box stores; and surveys of HEHE program participants, National Grid oil-to-gas conversion customers (both high-efficiency HEHE participants and standard efficiency), participating contractors, contractors who attended the Fall 2009 HEHE Annual Conference, and nonparticipating contractors. The following table summarizes the data collection activities that were conducted for this evaluation.

Table 3-1: Data Collection Activities

In-Depth Interviews		Surveys	
Group	**Completes**	**Group**	**Completes**
Program Staff	6	2007-08 HEHE Program Participants	625
		2009 HEHE Program Participants	232
Program Implementer	3	Oil-to-Gas Conversion Customers—HEHE participants	752
Program Contractors	10	Oil-to-Gas Conversion Customers—HEHE nonparticipants	751
Rebate Processing Contractor	2	General Population	424
Circuit Riders	1	Participating Contractors	140
Supply Houses / Big Box Stores	5	Non-Participating Contractors	108
Total	27	Survey of Contractors Attending HEHE Fall 2009 Annual Conference	50
		Total	3,082

- **In-Depth Interviews**. NMR Group conducted 27 in-depth interviews with program staff and contractors who administer or are involved with the GasNetworks' program, including six interviews with program sponsor staff (Berkshire Gas, Columbia Gas of Massachusetts, National Grid, New England Gas Company, NSTAR Gas, and Unitil), three interviews with the program implementers at ICF, ten interviews with program heating and plumbing contractors, two interviews with the rebate processing contractor at the Energy Federation, Inc. (EFI) and the Center for Ecological Technology (CET, used in Berkshire Gas territory only), one interview with a circuit rider from Lockheed Martin, and five interviews with supply houses and big box stores. The sample of interview candidates was provided by the GasNetworks sponsors. The ten heating and plumbing contractors were given an incentive of $50 for their cooperation. All interviewing took place over telephone calls in February and March 2010 and took twenty minutes to one hour to administer.

- **Survey of HEHE Program Participants**. The survey of 2007-08 participants was conducted in March 2010 and the interviews took an average of 18 minutes to administer. The survey of 2009 participants was conducted in April 2010 and the interviews took an average of 20 minutes to administer. The data were weighted by the number and type of products purchased by each respondent in the sample to reflect the proportion of boilers, furnaces, and water heaters purchased by participants from each year of the program.
- **Survey of Oil-to-Gas Conversion Customers** (OTG). The surveys were conducted between late February and mid-March 2010 and took approximately 12 minutes to administer. The data were weighted by number and type of products purchased by each respondent in the sample to reflect the proportion of boilers and furnaces purchased by the population of participants in the OTG and HEHE programs.
- **Survey of General Population**. The survey included quota samples of about 70 customers who use natural gas for heating from each of the six Program Administrators (PAs) for a total of 424 heating customers. The sample was drawn from customer lists provided by the PAs. All respondents were screened to exclude HEHE program participants. The survey was conducted in March 2010 and the interviews took an average of 12 minutes to complete. The final sample was weighted to reflect the relative proportions of each PA's gas heating customers as a percentage of the total gas heating customers served by the six PAs.
- **Survey of Participating Contractors.** The sample was drawn randomly from HEHE program records. Respondents were given an incentive of $25 for their cooperation. The survey was conducted in April and May 2010. The interviews took an average of 22 minutes to administer.
- **Survey of Nonparticipating Contractors.** The sample was obtained from an InfoUSA database and was drawn randomly from contractors located in GasNetworks' service territory in Massachusetts, Maine, New Hampshire, and Rhode Island. Respondents were screened to identify gas heating and plumbing contractors who work in the GasNetworks service area and had never participated in the HEHE program or had not participated in the program since 2008. Respondents were given an incentive of $25 for their cooperation. The survey was conducted in April and May 2010. The interviews took an average of 15 minutes to administer.
- **Survey of Contractors Attending HEHE Fall 2009 Annual Conference.** NMR Group received a sample of 395 attendees at the fall 2009 HEHE program conference. However, 78 of the attendees (20%) were representatives of one of the Program Administrators (PAs) in the GasNetworks collaborative. NMR conducted lookups to identify missing phone numbers for any of the remaining attendees. After excluding attendees who were representatives of one of the PAs and any contractors with missing phone numbers, the remaining available sample came to a total of 191 contractors. Using this available sample, NMR completed telephone interviews with a total of 50 contractors who attended the fall 2009 HEHE

program conference. Respondents were offered a $25 incentive for completing the survey. The survey was conducted in April and May 2010 and took an average of 15.6 minutes to administer. Note that the findings from this survey are reported separately in Volume II.

All of the surveys were conducted by Interviewing Services of America using computer assisted telephone interviewing (CATI). NMR performed frequency and crosstabular analyses of the survey data supplemented with the information from the in-depth interviews to develop an integrated understanding of operation and effectiveness of the HEHE program.

4 Free Ridership

4.1 Contractor Estimates

Respondents to the survey of participating contractors were asked to estimate the percentages of each type of high-efficiency equipment that they would have installed in the absence of the rebate. Their responses revealed that, in the absence of the rebate, participating contractors would have installed between 49% and 66% of the rebated high-efficiency heating and water heating equipment (Table 4-1).

Table 4-1: Energy-efficient Equipment That Would Have Been Installed In Absence of a Rebate

Equipment	Sample size	Contractors
Forced hot air furnace w/AFUE of 92%+	*80*	60%
Forced hot air furnace w/ECM and AFUE of 92%+	*68*	51%
Forced hot water boiler w/AFUE of 90%+	*119*	51%
Forced hot water boiler w/AFUE of 85%-89%	*126*	66%
Steam boiler w/electronic ignition and an AFUE of 82%+	*76*	66%
Indirect water heaters	*98*	61%
On-demand tankless water heaters w/ an EF >0.82	*73*	49%
Combined high-efficiency boiler and water heating units≥ 90% AFUE with storage of 2 gallons of less	*61*	50%
Overall*		55%

* Weighted based on the number of installations of each measure type.

4.2 Participant Survey Estimates

Respondents to the survey of HEHE participants were asked a series of questions related to the influence of program elements on their decision to purchase and install high-efficiency equipment instead of standard-efficiency equipment. Initial free ridership percentages were assigned to participants based on their responses to the following questions:[22]

- On a scale of zero ("not at all likely") to ten ("very likely"), participants were asked to rate the likelihood of purchasing the same efficiency level of space heating or water heating equipment at the same time if a rebate had not been available. (FR1)
- On a scale of zero ("strongly disagree") to 10 ("strongly agree"), participants were asked to rate their agreement with the following statement: "If there had been no rebate program, I would have paid the additional [rebate amount] to buy the high-efficiency equipment on my own." (FR2)

[22] See Section 7.3.2 for detailed responses

Based on responses to these questions, initial free ridership percentages were assigned to each respondent using the formula below:

$$Initial\ Free\ Ridership = \frac{(FR1 + FR2)}{2}$$

Where:

- FR1 = Likelihood of purchasing the same efficiency level of equipment if a rebate had not been available
  - 0-1 = 0%
  - 2-3 = 25%
  - 4-6 = 50%
  - 7-8 = 75%
  - 9-10 = 100%
- FR2 = Agreement that if there had been no rebate would have paid the additional rebate amount to buy the high-efficiency equipment.
  - 0-1 = 0%
  - 2-3 = 25%
  - 4-6 = 50%
  - 7-8 = 75%
  - 9-10 = 100%

Table 4-2 shows the average initial free ridership for each measure for 2007-08 participants and 2009 participants.

Table 4-2: Initial Free Ridership by Measure

Equipment type	2007-08 Program Participant Survey		2009 Program Participant Survey	
	n	Initial free ridership	n	Initial free ridership
Forced hot air furnace w/ AFUE of 92% or greater	104	82%	37	80%
Forced hot air furnace w/ ECM and AFUE of 92% or greater	101	77%	41	73%
Forced hot water boiler w/ AFUE of 90% or greater	109	77%	58	77%
Forced hot water boiler w/ AFUE of 85%-89%	101	75%	27	84%
Steam boiler w/ electronic ignition and an AFUE of 82% or greater	102	83%	14	85%
Indirect water heaters	134	75%	71	79%
On-demand tankless water heaters w/ an EF of 0.82 or greater	118	78%	70	76%

For each individual participant, NMR applied an adjustment based on the stated influence of contractors in the decision process. Participants were asked whether they did research on their own or their contractor suggested what equipment to purchase.

Based on their responses the free ridership was adjusted as follows:

- If the participant said, "I did some research on [equipment] and made my own choice," the initial free ridership was not adjusted [*Initial free ridership*]
- If the participant said, "My contractor suggested the particular [equipment] that was installed," their initial free ridership value was changed to reflect the level of free ridership reported by contractors [*Measure-specific contractor free ridership*]
- If the participant said, "My contractor suggested different [equipment] models and I chose one," their initial free ridership value was averaged together with the level of free ridership reported by contractors [*Average of initial free ridership and measure-specific contractor free ridership*]

For example, a HEHE program participant survey respondent giving the following responses would be assigned an initial free ridership value of 63% and an adjusted free ridership value of 61% if they installed a forced hot air furnace with an AFUE of 93% without an ECM fan, and an adjusted free ridership value of 57% if they installed a forced hot air furnace with an AFUE of 93% with an ECM fan.

- FR1 = 8 (75%)
- FR2 = 6 (50%)
- Contractor free ridership for hot air furnace without an ECM fan = 60%
- Contractor free ridership for hot air furnace with an ECM fan = 51%
- Stated influence of contractor = "My contractor suggested different [equipment] models and I chose one"

These adjustments were made to account for free ridership in cases where the contractor was partially or fully responsible for the decision to implement a high-efficiency measure.

After these calculations were completed on an individual participant basis, NMR calculated the mean adjusted free ridership values separately for each measure category. Accordingly, the final free ridership estimate for 2007-08 HEHE program ranged from 60% for forced hot water boilers with AFUE of 90% or greater to 69% for forced hot water boiler with AFUE of 85%-89% (Table 4-3).

Table 4-3: Initial and Adjusted Free Ridership

Equipment type	2007-08 Program Participant Survey		2009 Program Participant Survey	
	Initial free ridership	Adjusted free ridership	Initial free ridership	Adjusted free ridership
Forced hot air furnace w/ AFUE of 92% or greater	82%	67%	80%	66%
Forced hot air furnace w/ ECM and AFUE of 92% or greater	77%	62%	73%	55%
Forced hot water boiler w/ AFUE of 90% or greater	77%	60%	77%	61%
Forced hot water boiler w/ AFUE of 85%-89%	75%	69%	84%	73%
Steam boiler w/ electronic ignition and an AFUE of 82% or greater	83%	67%	85%	68%
Indirect water heaters	75%	66%	79%	68%
On-demand tankless water heaters w/ an EF of 0.82 or greater	78%	63%	76%	59%
Combined high-efficiency boiler and water heating units*	--	50%	--	50%

* Very few combo units were rebated and the participant surveys did not find any respondents who had purchased this equipment. Accordingly, the free ridership number for this equipment is based solely on the contractor estimates.

Note that these high free ridership percentages are consistent with data from other states and programs.

- Two-thirds (67%) of the furnaces sold in 2007 in Connecticut were high-efficiency (88% or greater AFUE) as compared with fewer than two-fifths (37%) nationally.[23] This preponderance of high efficiency furnace sales in Connecticut, also a New England state, provides evidence indicating support for the finding of high free ridership in Massachusetts, Rhode Island, New Hampshire and Maine.
- An evaluation of the 2006-2008 residential energy efficiency programs run by the Investor-Owned Utilities (IOUs) in California determined free ridership to be 81% for high-efficiency natural gas furnaces with 90% or greater AFUE and 78% for high-efficiency natural gas tank storage water heaters (EF=>.62).[24]

[23] Data from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
[24] The Cadmus Group. 2010. *Residential Retrofit High Impact Measure Evaluation Report*, conducted for the California Public Utilities Commission.

- A market transformation model for high-efficiency gas furnaces in Oregon indicated that 2009 free ridership levels were between 60% and 68%.[25]
- An evaluation of 2005-2006 Energy Trust of Oregon Home Energy Solutions Program estimated free ridership for high-efficiency gas furnaces (ECM and non-ECM) to be between 56% and 58%.[26]

[25] Summit Blue Consulting. 2009. *Gas Furnace Market Transformation Model Development and Market Research*, conducted for the Energy Trust of Oregon.
[26] ECONorthwest. 2008. *Process and Impact Evaluations of the 2005-2006 ETO Home Energy Solutions Program*, conducted for the Energy Trust of Oregon.

5 Equipment Sales

5.1 Sales Volumes Estimation Methodology

NMR estimated the 2009 sales volumes based on synthesizing data from the following sources:

1. **Energy Information Administration (EIA) Databases:** Data on the number of natural gas consumers and the Residential Energy Consumption Survey (RECS) was used to estimate the number of 2009 installations of natural gas space heating and water heating equipment.
2. **Survey of Participating and Nonparticipating Contractors**: screening calls to the InfoUSA sample database also allowed us to identify the percentage of qualified contractors who were participating in the HEHE program (11%) and the percentage that were nonparticipating contractors (89%).
3. **Survey of Participating and Nonparticipating Contractors**: The survey responses also provided estimates of the average installations by contractors of each equipment type.

Our overall methodology for calculating the estimated equipment sales was as follows:

1. From the EIA database we estimated the total 2009 installations in the GasNetworks service area of natural gas space heating and water heating equipment.
2. From the survey of participating and nonparticipating contractors, we obtained the average number of installations of each equipment type.
3. For space heating equipment, we used the overall following steps: (i) we allocated the total estimated installations of space heating equipment into total estimated installations of furnaces and boilers; (ii) these total estimated installations of furnaces and boilers were then distributed by model type; (iii) the total installations of furnace and boiler models were then allocated into participating and nonparticipating contractors.
    i. We used the relative proportions of total furnaces and boilers installed by both participating and nonparticipating contractors (as reported in the survey) to divide the total estimated space heating equipment installations (from the EIA database) into the total number of installations of natural gas furnaces and boilers.
    ii. We allocated the total installations of furnaces into the different furnace models based on the relative proportions of installations of furnaces reported in the contractor surveys. This method was repeated for boiler models.
    iii. We used the relative percentage of participating and nonparticipating contractors (from the survey screening calls) to divide the total estimated installations of furnaces and boilers into the total number of installations of furnaces and boilers by participating contractors and by nonparticipating contractors. The installations of high-efficiency models by participating contractors were corrected to match program data on rebated equipment.

4. For water heating equipment, we used the overall following steps: (i) the total estimated installations of water heaters were distributed by model type; (ii) the total installations of water heaters were then allocated into participating and nonparticipating contractors.
    i. We allocated the total installations of water heaters into the different water heater models based on the relative proportions of installations of water heaters reported in the contractor surveys.
    ii. We used the relative percentage of participating and nonparticipating contractors (from the survey screening calls) to divide the total estimated installations of water heater models into the total number of installations of water heater models by participating contractors and by nonparticipating contractors. The installations of high-efficiency models by participating contractors were corrected to match program data on rebated equipment.

5.2 Boiler Installations

Table 5-1 through Table 5-3 show the estimates of natural gas boilers installed in 2009 in the GasNetworks service area. In general, the participating contractors exhibit a somewhat higher likelihood of installing only one of the three high-efficiency boiler models. These estimates suggest that the HEHE program appears to have influenced relatively more installations of forced hot water boilers with an AFUE of 90% or greater. However, these data also suggest that program's influence on motivating installations forced hot water boilers with an AFUE of 85%-89% and steam boilers with electronic ignition may have been more limited.

Looking at the "Market Shares within Contractor Groups," we see that participating contractors (51%) were more likely than nonparticipating contractors (13%) to install forced hot water boilers with an AFUE of 90% or greater. However, the participating contractors may have been somewhat less likely than nonparticipating contractors to install forced hot water boilers with an AFUE of 85%-89% (31% vs. 48%, respectively).

Note that about three out of four of the boilers installed by nonparticipating contractors were high-efficiency natural gas boilers that would have qualified for a HEHE rebate—which provides supporting evidence for the finding of the high free ridership levels noted earlier.[27]

[27] In conflict with this, in the in-depth interviews, the supply house staff reported that, on average, about one-half of the contractors who purchased high-efficiency equipment participated in the HEHE program. It is possible that the supply house staff may be assuming that contractor awareness of the HEHE program—which is very high—implies that they are also participating and that is not necessarily the case.

Of the 38,000 natural gas boilers that were installed in the Gas Networks service area, 28,800 (76%) were high-efficiency boilers and 4,999 (12%) of these were rebated by the HEHE program. Further, the HEHE program rebated 78% of participating contractors' 2009 sales of about 6,400 high-efficiency boilers.

Table 5-1: 2009 Contractor Natural Gas Boiler Sales Volumes (approximate estimates)

	Participant	Nonparticipant	Total
Forced hot water w/AFUE less than 85%	800	8,400	9,200
Forced hot water w/AFUE 85%-89%	2,200	14,700	16,900
Forced hot water w/AFUE of 90% or greater	3,700	4,000	7,700
Steam boiler w/ electronic ignition and an AFUE of 82% +	500	3,600	4,200
Total	7,200	30,800	38,000

Table 5-2: 2009 Contractor Market Shares for Natural Gas Boilers

	Participant	Nonparticipant	Total
Market Shares within Contractor Groups			
Forced hot water w/AFUE less than 85%	11%	27%	24%
Forced hot water w/AFUE 85%-89%	31	48	45
Forced hot water w/AFUE of 90% or greater	51	13	20
Steam boiler w/ electronic ignition and an AFUE of 82% +	7	12	11
Market Shares across Contractor Groups			
Forced hot water w/AFUE less than 85%	9%	91	
Forced hot water w/AFUE 85%-89%	13%	87	
Forced hot water w/AFUE of 90% or greater	48%	52	
Steam boiler w/ electronic ignition and an AFUE of 82% +	12%	86	
Total	19%	81	

Table 5-3: 2009 HEHE Rebated Natural Gas Boilers

	HEHE Rebates	% of Participant Sales	% of Total Sales
Forced hot water w/AFUE 85%-89%	782	36%	5%
Forced hot water w/AFUE of 90% or greater	3,710	100%	48%
Steam boiler w/ electronic ignition and an AFUE of 82% +	507	100%	20%
Total	4,999	78%	12%

5.3 Furnace Installations

Table 5-4 through Table 5-6 show the estimates of natural gas furnaces installed in 2009 in the GasNetworks service area. In general, the participating contractors exhibit a somewhat higher likelihood of installing only one of the two high-efficiency furnace models. These estimates suggest that the HEHE program appears to have influenced relatively more installations of forced hot air ECM furnaces with AFUE 92% or greater.

Looking at the "Market Shares within Contractor Groups," we see that participating contractors (37%) were more likely than nonparticipating contractors (11%) to install forced hot air ECM furnaces with AFUE 92% or greater. However, the participating contractors (51%) are about as likely as nonparticipating contractors (61%) to install forced hot air furnaces with AFUE 92% or greater.

Note that nearly three out of four (72%) furnaces installed by nonparticipating contractors were high-efficiency natural gas furnaces that would have qualified for a HEHE rebate—which provides supporting evidence for the finding of the high free ridership levels noted earlier.

Of the 27,200 natural gas furnaces that were installed in the GasNetworks service area, about 20,300 (75%) were high-efficiency furnaces and 3,848 (19%) of these were rebated by the HEHE program. Further, the HEHE program rebated all (100%) of participating contractors' 2009 sales of high-efficiency furnaces.

Table 5-4: 2009 Natural Gas Furnace Sales Volumes (approximate estimates)

	Participant	Nonparticipant	Total
Forced hot air w/AFUE less than 92%	500	6,400	6,900
Forced hot air w/AFUE 92% or greater	2,200	14,000	16,200
Forced hot air w/ECM w/AFUE 92% or greater	1,600	2,500	4,100
Total	4,300	22,900	27,200

Table 5-5: 2009 Contractor Market Shares for Natural Gas Furnaces

	Participant	Nonparticipant	Total
Market Shares within Contractor Groups			
Forced hot air w/AFUE less than 92%	12%	28%	25%
Forced hot air w/AFUE 92% or greater	51	61	60
Forced hot air w/ECM w/AFUE 92% or greater	37	11	15
Market Shares across Contractor Groups			
Forced hot air w/AFUE less than 92%	7%	93	
Forced hot air w/AFUE 92% or greater	14%	86	
Forced hot air w/ECM w/AFUE 92% or greater	39%	61	
Total	16%	84	

Table 5-6: 2009 HEHE Rebated Natural Gas Furnaces

	HEHE Rebates	% of Participant Sales	% of Total Sales
Forced hot air w/AFUE 92% or greater	2,236	100%	14%
Forced hot air w/ECM w/AFUE 92% or greater	1,612	100%	39%
Total	3,848	100%	19%

5.4 Water Heater Installations

Table 5-7 through Table 5-9 show the estimates of natural gas water heaters installed in 2009 in the GasNetworks service area. In general, the participating contractors exhibit a higher likelihood than nonparticipating contractors of installing high-efficiency water heater models. However, with the possible exception of indirect water heaters attached to an ENERGY STAR® hot water boiler, the HEHE program does not appear to have influenced relatively more installations of any specific model type.

Looking at the "Market Shares within Contractor Groups" in Table 5-8, we see that participating contractors (26%) may have been somewhat more likely than nonparticipating contractors (15%) to install indirect water heaters attached to an ENERGY STAR® hot water boiler. Note also that about one-half of the water heaters installed by participating contractors (51%) and more than two out of three water heaters installed by nonparticipating contractors (71%) were regular tank storage water heaters.

Of the 120,800 natural gas water heaters that were installed in the GasNetworks service area, about 37,900 (31%) were high-efficiency water heaters and 5,504 (17%) were rebated by the HEHE program. Further, the HEHE program rebated approximately 72% of participating contractors' 2009 sales of 6,500 high-efficiency water heaters.

Table 5-7: 2009 Natural Gas Water Heater Sales Volumes (approximate estimates)

	Participant	Nonparticipant	Total
Regular tank storage	6,800	76,100	82,900
Indirect attached to ENERGY STAR® hot water boiler	3,500	16,100	19,600
On-demand tankless	2,300	11,100	13,400
Combined w/high-efficiency boiler w/AFUE of 90%+ and hot water storage of 2 gallons or less	700	4,200	4,900
Total	13,300	107,500	120,800

Table 5-8: 2009 Contractor Market Shares for Natural Gas Water Heaters

	Participant	Nonparticipant	Total
Market Shares within Contractor Groups			
Regular tank storage	51%	71%	69%
Indirect attached to ENERGY STAR® hot water boiler	26	15	16
On-demand tankless	17	10	11
Combined w/high-efficiency boiler w/AFUE of 90%+ and hot water storage of 2 gallons or less	5	4	4
Market Shares across Contractor Groups			
Regular tank storage	8%	92	
Indirect attached to ENERGY STAR® hot water boiler	18%	82	
On-demand tankless	17%	83	
Combined w/high-efficiency boiler w/AFUE of 90%+ and hot water storage of 2 gallons or less	14%	86	
Total	11%	89	

Table 5-9: 2009 HEHE Rebated Natural Gas Water Heaters

	HEHE Rebates	% of Participant Sales	% of Total Sales
Indirect attached to ENERGY STAR® hot water boiler	3,537	100%*	18%
On-demand tankless	1,575	68%	12%
Combined w/high-efficiency boiler w/AFUE of 90%+ and hot water storage of 2 gallons or less	392	56%	8%
Total	5,504	72%	17%

* Exceeds 100% slightly and therefore estimated to be 100% of participant sales.

5.5 Trends in Sales Volumes

5.5.1 Past Sales

Nonparticipating contractors were asked their opinion of customer demand for high-efficiency heating and water heating equipment over the past year. Just over one-half (52%) of the nonparticipating contractors said that they thought many more customers wanted high-efficiency equipment, and another one-fourth (24%) said that a few more customers wanted it; only 7% of nonparticipating contractors said that fewer customers had wanted high-efficiency equipment over the past year (Table 5-10).

Table 5-10: Customer Demand for High-efficiency Heating and Water Heating Equipment over Past Year

	Nonparticipant
Sample size	*108*
Many more customers want high-efficiency equipment	52%
A few more want high-efficiency equipment	24
Haven't noticed any change	15
Somewhat fewer customer want high-efficiency equipment	3
A much lower number of customers want high-efficiency equipment	4
Don't know/refused	3

The supply house staff said that contractor interest in high-efficiency equipment had increased over the past year, which was mainly driven by the price of fuel. They also thought that customers are interested or very interested in high-efficiency equipment and that homeowner interest increased in 2009.[28] Supply house staff also reported that the program had been influential in determining the equipment they stocked in the store and would expect their high-efficiency equipment stock to diminish in the absence of a program.

5.5.2 Future Sales Expectations

Participating contractors, supply house staff, and program staff generally expect that the demand for all of the energy-efficient systems will increase over the next year. Supply house staff said that increased contractor interest in high-efficiency equipment over the past year was mainly driven by the price of fuel. They also said that customers are interested or very interested in high-efficiency equipment and that homeowner interest increased in 2009. Program staff noted that federal rebates on energy-efficient products may also increase awareness and interest in high-efficiency equipment among customers.

Around four out of five participating contractors said they expected increased demand for on-demand water heaters with an EF greater than 0.82, forced hot water boilers with an AFUE of

[28] The interest in high efficiency equipment is likely part of a longer-term trend toward increased consumer interest in energy efficiency and purchase of energy efficient equipment.

90% or higher, and forced hot air furnaces with an ECM and an AFUE of 92% or higher (Table 5-11). In the in-depth interviews, all of the participating contractors also noted an increased demand for high-efficiency heating systems in the past year and most expected the demand to increase over the coming year. The reasons for the anticipated increase in demand include greater customer interest, increased desire to be green, and concern about energy costs.

Table 5-11: Expected Change in Demand for Energy-efficient Systems in Next Year
(by participating contractors who reported having installed each type of high-efficiency system)

	Sample size	Increase	Stay the Same	Decrease	Don't know/refused
Forced hot air furnaces w/AFUE of 92%+	*80*	70%	25%	4%	1%
Forced hot air furnaces w/ECM and w/AFUE of 92%+	*68*	78%	19	3	-
Forced hot water boilers w/ AFUE 90%+	*119*	79%	17	3	1
Forced hot water boilers w/ AFUE 85%+	*126*	50%	28	22	-
Steam boilers w/electronic ignition w/AFUE 82%+	*76*	49%	40	12	-
Indirect water heaters	*98*	69%	24	6	1
On-demand tankless water heaters w/an EF>0.82	*73*	84%	14	3	-
Combined high-efficiency boiler and water heating unit≥90% AFUE w/storage of 2 gallons or less	*61*	69%	20	8	3

In the in-depth interviews, all of the participating contractors noted an increased demand for high-efficiency heating systems in the past year and most expected the demand to increase over the coming year.

One-half of the supply house staff expected the percentage of high-efficiency water heating systems stocked and sold in 2010 to increase. Most of the program staff also expected homeowner interest for high-efficiency heating and water heating systems to increase over the next year. They added that federal rebates on energy-efficient products may also increase awareness and interest in high-efficiency equipment among consumers.

5.6 Incremental Costs

5.6.1 Boilers and Furnaces

The survey asked participating contractors to estimate the incremental costs of various higher efficiency upgrades compared to a forced hot water natural gas boiler with an AFUE less than 85%, in the absence of any applicable rebates or tax credits. As Table 5-12 shows, participating contractors said that the average cost would be nearly $2,000 more (range: $0 to $8,000) for a customer to purchase and install a forced hot water natural gas boiler with an AFUE of 90% or

greater. The average incremental cost estimate to upgrade to a forced hot water natural gas boiler with an AFUE of 85% or greater was $1,316 (range: $0 to $5,000) and the average incremental cost estimate to upgrade to a higher efficiency steam boiler with electronic ignition with an AFUE of 82% or greater was $942 (range: $0 to $6,000).

The survey also asked participating contractors to estimate the incremental costs of higher efficiency natural gas forced hot air furnaces compared to a natural gas forced hot air furnace with an AFUE of less than 92%. As

Table 5-13 shows, contractors estimated that average incremental cost for a forced hot air furnace with ECM and an AFUE of 92% or greater was $1,266 (range: $0 to $4,000) and $963 for a forced hot air furnace with an AFUE of 92% or greater (range: $0 to $4,000).

Table 5-12: Incremental Cost of Higher Efficiency Natural Gas Boilers Compared to Lower Efficiency Forced Hot Water Boiler with AFUE less than 85%

	Sample size	Average Cost	Range
Average incremental cost for boiler with AFUE of 90% or greater	*119*	$1,991	$0 - $8,000
Average incremental cost for boiler with AFUE of 85%-89%	*126*	$1,316	$0 - $5,000
Average incremental cost for steam boiler with electronic ignition with AFUE of 82% or greater	*75*	$942	$0 - $6,000

Table 5-13: Incremental Cost of Higher Efficiency Natural Gas Forced Hot Air Furnaces Compared to Lower Efficiency Forced Hot Air Furnace with AFUE less than 92%

	Sample size	Average Cost	Range
Average incremental cost for forced hot air furnace with AFUE of 92% or greater	*80*	$963	$0 - $4,000
Average incremental cost for forced hot air furnace with ECM and AFUE of 92% or greater	*68*	$1,266	$0 - $4,000

In the in-depth interviews, six participating contractors said that the forced hot air furnaces with an AFUE of 92% or greater usually cost their customer an average of around $850 (range: $500 to $1,000) more than standard-efficiency equipment, after rebates. Eight participating contractors stated that forced hot water boilers with and AFUE of 90% or greater, after rebates, also cost an average of around $850 (range: $100 to $1,200) more than standard-efficiency equipment.

5.6.2 Water Heaters

The survey asked participating contractors to estimate the incremental costs of various higher efficiency upgrades compared to a regular tank storage natural gas water heater in the absence of any applicable rebates or tax credits. As Table 5-14 shows, participating contractors said that it would cost an average of nearly $2,500 more (range: $0 to $8,000) for a customer to purchase

and install a combined high-efficiency boiler and water heating system with an AFUE of 90% or greater and a hot water storage of two gallons or less. The average incremental cost to upgrade to an on-demand tankless water heater with electronic ignition and energy factor greater than 0.82 was $1,776 (range: $0 to $5,000), slightly more than the estimated $1,673 average incremental cost to upgrade to an on-demand tankless water heater (range: $0 to $5,000). The smallest estimated upgrade cost of $1,351 was for an indirect water heater attached to an ENERGY STAR hot water boiler (range: $0 to $3,000).

Table 5-14: Additional Cost of Water Heating System Incurred by Customer

	Sample size	Average Cost	Range
Average incremental cost for indirect attached to ENERGY STAR hot water boiler	*98*	$1,351	$0 - $3,000
Average incremental cost for on-demand tankless	*81*	$1,673	$0 - $5,000
Average incremental cost for on--demand tankless w/electronic ignition and an energy factor greater than 0.82	*73*	$1,776	$0 - $5,000
Average incremental cost combined w/high-efficiency boiler w/AFUE of 90%+ and hot water storage of 2 gallons or less	*61*	$2,493	$0 - $8,000

In the in-depth interviews, participating contractors estimated that customers who had high-efficiency water heating systems installed paid $975 more on average for the equipment than they would have if they had installed standard-efficiency equipment, after rebates.

6 Energy Efficiency Awareness & Program Participation

6.1 Awareness of Equipment Efficiency Levels

Respondents to the HEHE participant survey were asked if they were aware of the different efficiency levels available for heating and water heating equipment prior to participating in the program (Table 6-1). Overall, about seven out of ten respondents (69%) said that they were previously aware of the different efficiency levels. About four out of ten (38%) of respondents who were previously aware of efficiency levels available for heating and water heating equipment said that they first learned about high-efficiency equipment from a contractor.

Table 6-1: Awareness of Efficiency Levels

Previously aware of efficiency levels	**HEHE Participants**
Sample size	*857*
Yes	69%
No	29
Don't know/Refused	2
First learned about high efficiency	**HEHE Participants**
Sample size	*567*
Contractor	38%
Internet	20
Friend/relative/neighbor	11
Read about it/research	6
From the utility	5
Previous knowledge	4
ENERGY STAR	2
TV/radio/advertisement	3
Supply house/salesperson	3
Energy audit	1
Other	3
Don't know	3

6.2 Awareness of AFUE Levels

Respondents the HEHE participant survey who installed either a furnace or boiler were asked if they were aware of the AFUE levels for heating equipment. About three out of ten of these respondents (29%) said that they were aware of AFUE levels (Table 6-2).

The majority of respondents (71%) who were aware of different efficiency levels did not know that the term "AFUE" is used as a measure of furnace or boiler efficiency (Table 6-2). Contractors and others who talk to the public about efficiency levels should keep this in mind.

Table 6-2: Awareness of "AFUE" Levels for Furnaces and Boilers

	HEHE Participants
Sample size	*675*
Yes	29%
No	66
Don't know/Refused	5

6.3 HEHE Program Awareness

Both the general population as well as nonparticipating contractors exhibit high awareness levels of the High Efficiency Heating and Water Heating Equipment Rebate Program. About one-half of the general population respondents (49%) and a large majority of nonparticipating contractors (85%) had heard of the HEHE Program (Table 6-3).

Mailings from GasNetworks or program sponsors may be an important channel for building program awareness. As Table 6-3 shows, mailings from GasNetworks or the program sponsors were a notable source of program awareness among the general population and among nonparticipating contractors. However, these data also suggest that the role of market actors in the equipment supply chain may be more important to promoting actual program participation as HEHE participants most often heard about the HEHE program from their contractors, and nonparticipating contractors most often heard about the HEHE program from their suppliers/distributors.

General population respondents who were aware of the HEHE program were most likely to have learned of it through an insert in their utility bills or mailings (33%)—significantly more often than the 10% of HEHE participants who cited utility bills or mailings as their source for first learning about the program. In contrast, one-half of HEHE participants (50%) first heard of the program from their contractors—significantly more than the one in ten general population respondents (8%) who cited contractors as their source for first learning about the program. Note however that a relatively small percentage of general population respondents reported purchasing new heating (14%) or water heating system (20%) within the prior three years; whereas all of the HEHE participants were recent buyers of high-efficiency heating or water heating systems.

One-third of nonparticipating contractors (33%) said they heard about the program through their supplier/distributor and about one-seventh heard (15%) about it through GasNetworks mailings.

Table 6-3: How Learned of the Program / Source of Program Awareness
(respondents who have heard of the program;
multiple responses for General Population and HEHE participants; single response for contractors)

	General Population	HEHE Participants	Nonparticipating Contractors
Sample size	*424*	*857*	*108*
Aware of program	49%	100%	85%
Sample size	*184**	*857*	*92*
Insert in utility bill/Mailing from gas utility	33%	10%	7%
Newspaper ad	14%	6%	
Friend/Neighbor/Relative/Word of mouth	12%	4%	7
Contractor/Another contractor	8%	50%	3
Customer			7
Supply store/Supplier/distributor	8%	6%	33
Internet	7%	13%	2
TV ad	6%	2%	
Radio ad	4%	1%	
Advertising			2
Through the mail/Mailing from GasNetworks	3%	2%	15
Gas company	1%	4%	
Utility website	<1%	5%	
Seminar/Class/Trade show			9
Trade magazine			3
Manufacturer representative			2
Flyers/mailings (unspecified)			2
Other	10%	6%	7
Don't know	9%	6%	

* Note that the General Population sample was weighted to reflect the relative proportions of each PA's gas heating customers as a percentage of the total gas heating customers served by the six PAs.

6.4 Program Participation and Equipment Purchase Motivations

Although HEHE program participants were motivated to participate in the program primarily by the rebates, the primary factors driving their choice of high-efficiency equipment were energy efficiency followed by the contractor's recommendation. While the most frequently mentioned primary factor driving the choice of high-efficiency equipment by Oil-to-Gas program participants also was energy efficiency, these program participants also were strongly motivated by reasons related to switching fuels and by the reduced purchase price the rebate provided. General population customers with new (under three years old) heating or water heating systems reported purchase price as the most frequently mentioned factor; reliability also was cited

frequently as a consideration when purchasing a heating system; and energy efficiency also was cited frequently as a consideration when purchasing a water heating system.

Nonparticipating contractors reported that they would be motivated to participate in the HEHE program by increased business opportunities and financial incentives.

6.4.1 Program Participation Motivations

Respondents to the HEHE participant survey were asked about the primary reason they decided to participate in the HEHE program. Overall, more than one-half of respondents (54%) said they participated to obtain the rebate or to save money on the purchase price (Table 6-4). About one in five respondents (19%) said they participated to save on energy bills (10%) or to save energy (9%).

Table 6-4: Primary Reason for Participation in HEHE Program

	HEHE Participants
Sample size	*857*
To obtain rebate / Save money on purchase price	54%
To save on energy costs/bills	10
To save energy	9
Already considering/planning to get new equipment	6
Replacement equipment/age of old equipment/needed heat	5
To help the environment	2
Contractor recommended/made selection	3
Higher quality product	1
No reason	1
Wanted to change fuels	1
Improved air quality of home	1
Because it was available	1
Improved comfort/temperature of home	<1
Reliability	<1
Wanted larger amount of hot water available	<1
Wanted faster delivery of hot water to faucets	<1
Other	2
Don't know/Refused	3

6.4.2 Equipment Purchase Motivations

The respondents to the HEHE participant and General Population surveys were asked whether they had replaced equipment that was broken or still operating, or if they had purchased the equipment for a new home that they were building. About two out of three HEHE participants (67%) and nearly three out of five General Population respondents (57%) said that they had replaced a heating system that was still operating. Although nearly three out of five HEHE

participants (58%) said that they had replaced a water heating system that was still operating, only about one in ten General Population respondents (9%) had done so (Table 6-5).

Table 6-5: Why New Equipment Was Purchased

(HEHE participants who bought only heating / water heating equipment and general population respondents not in new homes with heating / water heating systems under three years old)

How equipment was purchased	Space Heating Equipment		Water Heating Equipment	
	General Population	HEHE Participants	General Population	HEHE Participants
Sample size	*46*	*463*	*78*	*167*
Replaced still operating system	57%	67%	9%	58%
Replaced broken system	17	1	69	36
Built a new home	17	30	15	4
Don't know/Refused	9	1	8	2

6.4.3 Replaced Equipment

The respondents to the HEHE participant survey who had replaced working equipment were asked for the primary reason they chose to replace the equipment (Table 6-6). Energy inefficiency of the old equipment was the most frequently cited reason. Overall, nearly six out of ten respondents (56%) who replaced working equipment did so because the old system used too much energy. The second most frequently cited response among respondents was that the old system was unreliable, with about one out of six respondents (16%) citing this reason.

Table 6-6: Primary Reason for Replacing Working Equipment

	HEHE Participants
Sample size	573
The old system was inefficient and used too much energy	56%
The old system was too unreliable	16
The old system did not provide the comfort or capacity that I wanted	9
The old system used a fuel source that I wanted to switch from	11
The old system cost too much to service and maintain	8

Respondents were also asked about the age and efficiency of the equipment that they replaced through the program. As one might expect, the age of respondents' equipment appears to be related to perceptions of its efficiency. One-half (50%) of these participants reported that the equipment they replaced was below average energy efficiency and a similar percentage (48%) said that their equipment was at least 21 years old (Table 6-7). This apparent relationship between age and efficiency is more likely driven by participants who purchased new furnaces and boilers, as water heaters have a life expectancy of only about 12 years.

Table 6-7: Age and Efficiency of Replaced Equipment

Efficiency	**HEHE Participants**
Sample size	*857*
Above average energy efficiency	8%
Average energy efficiency	33
Below average energy efficiency	50
Don't know/Refused	9
Age	
Less than 5 years old	2%
5 to 10 years old	14
11 to 20 years old	29
21 to 30 years old	21
31 to 40 years old	13
More than 40 years old	14
Don't know/Refused	7

6.4.4 Equipment Selection Criteria

In contrast to the primary financial motivations that were cited for program participation (Table 6-4), when asked about their most important criterion when deciding what equipment to purchase, about two-fifths of HEHE participants (41%) reported energy efficiency as their primary criterion and about one-fourth (24%) reported the recommendation of a contractor (Table 6-8). It is important to note that these participants did not mention purchase price among their most important criteria for selecting equipment.

Oil-to-gas conversion customers who install high-efficiency equipment may not be aware of their participation in the HEHE program. However, we can learn about their motivations for choosing high-efficiency equipment from the primary criteria that they cited for choosing such equipment. Paralleling the responses of HEHE participants, nearly one in three oil-to-gas conversion customers who installed high-efficiency equipment said that energy efficiency (30%) was the most important criterion when deciding what equipment to purchase; about one in five cited a reason related switching from oil to gas (21%) and a slightly smaller percentage mentioned purchase price (17%).

Table 6-8: Primary Criteria for Choosing Equipment

	HEHE Participants	Oil-to-Gas HEHE Participants
Sample size	*857*	*754*
Energy efficiency	41%	30%
Contractor recommended	24	1
Reliability	11	6
Purchase price	8	17
Capacity and/or size of equipment	3	--
Operating / Maintenance costs	2	11
Lasts a long time / How long equipment lasts	2	1
Brand/reputation	1	--
Needed it / Problems with old equipment	1	6
Whether or not equipment was covered by rebates / Program rebate or discount	1	2
Quality	<1	--
Other	4	2
Don't know/Refused	3	2
Responses related to switching from oil to gas	na	21
Lower, more consistent bills	na	6
Cleaner energy	na	4
Wanted gas / Didn't want oil	na	2
No delivery	na	2
More convenient	na	2
Other responses related to switching fuels	na	5

6.4.5 Equipment Selection Process

Respondents to the survey of HEHE participants and oil-to-gas conversion (OTG) participants installing high-efficiency models were asked to indicate which of several statements best described how they made their selection of new heating equipment. More than seven out of ten HEHE participants (73%) and nearly two out of three OTG participants (63%) reported that their contractor played a key role in selecting the equipment. Nearly one-half of both participant groups said their contractor suggested the equipment that was installed (48% and 46%, respectively). One-fourth of HEHE participants (25%) and nearly one-fifth of OTG participants (17%) said that their contractor suggested several different equipment models and they chose one. Among those respondents who said their contractor suggested several different equipment models, about four out of five HEHE participants (79%) and nearly three out of four OTG participants (73%) said their contractor suggested models with varying levels of efficiencies (Table 6-9).

Table 6-9: Description of Selection Process

	HEHE Participants	Oil-to-Gas Conversion Participants (High Efficiency)
Sample size	*857*	*754*
I did some research on equipment and made my own choice	27%	29%
My contractor suggested the particular equipment that was installed	48	46
My contractor suggested different equipment models and I chose one	25	17
Don't know/Refused	1	8
Did Contractor Suggest Different Efficiency Levels?		
Sample size	*193*	*127*
Yes	79%	73%

Among those participants who said they did research on equipment themselves and made their own choice, more than twice as many HEHE participants (70%) as OTG participants (30%) said that they did their research on the Internet. In contrast, the OTG participants (35%) were more likely to have learned about the equipment through information from National Grid. (Table 6-10).

Table 6-10: Sources for Research (multiple responses)

	HEHE Participants	Oil-to-Gas Conversion Participants (High Efficiency)
Sample size	*218*	*221*
Internet	70%	30%
National Grid (e.g., website, flyer, phone)	--	35%
Contractor	26%	18%
Friends/family/neighbors	11%	23%
Store/supply house/salesman	8%	--
Equipment manufacturer	--	2%
Read about it	5%	4%
Other	7%	10%
Don't know/Refused	1%	3%

6.4.6 Contractor Motivations

Nonparticipating contractors who were familiar with the HEHE program were asked what would motivate them to participate in the program. Two general motivators emerged: more business and finances. Sixteen percent of nonparticipating contractors said that increased customer demand was a factor that would motivate them to participate and another 10% noted that they would like more business leads. The financial motivations cited focused on more money or reduced cost of participating in the program[29] (11%), rebates[30] (11%), and rebates to contractors[31] (7%).

Table 6-11: Primary Factors that would Motivate Nonparticipating Contractors to Participate in the HEHE Program

	Primary Motivation
Sample size	*92*
Customer demand	16%
Money/cost (unspecified)	11
Rebates (unspecified)	11
Rebates to contractor	7
More business leads for contractor	10
Simplified paperwork process	8
More reliable equipment	5
Better communication	4
Knowledge of program/equipment	2
Training	2
Other	13
Don't know/Refused	11

[29] Responses included "cost savings for customers," "minimal or no cost to participate in program," "money/business/installations."
[30] Responses included "rebates would help," "the ability to offer the customer rebate," and "rebates for customers help them jump to a more efficient unit."
[31] Responses included "If they did better for the plumber…we make no profit on the boilers," "If I could get the rebates," and "Give me money back."

6.5 Barriers to Participation

6.5.1 Customer Barriers

Respondents to the survey of HEHE participants were asked if they had concerns about the program prior to their participation. Overall, the vast majority of respondents (93%) said that they had no concerns about the program prior to participation and thus did not mention any possible barriers to participation.

The most common reason for not participating in the HEHE program cited by the general population survey respondents who were aware of it was that they were not interested in installing the rebated measures (29%) and about one in ten respondents said that participating would be too expensive (9%).

6.5.2 Contractor Barriers

One out of five participating contractors said they had encountered barriers that kept them from participating in the HEHE program as often as they would have liked (Table 6-12). These contractors mentioned that the paperwork was too much of a hassle (18%), that they were not on the HEHE program list (14%), that there were rebate issues (11%),[32] and that customers did not want to spend the money (14%) or could not afford it (11%).

Table 6-12: Barriers to Participating in Program

	Participants
Sample size	*140*
Experienced Barriers to Participation	20%
Barriers	
Sample size	*28*
Paperwork is too much hassle	18%
Customers don't want to spend the money	14
Not on the HEHE program list	14
Can't afford it	11
Rebate issues	11
Not enough equipment on the list	7
Nothing available for propane	7
Running out of time for permits	4
Not enough information available	4
Other	11

[32] Responses included "long turn-around time on rebates," "a lack of rebate availability," and a "lack of rebate availability in a situation where the customer owns, but does not occupy the home where the installation of high-efficiency equipment will be made."

In the in-depth interviews, participating contractors reported that the program presented no barriers to selling and installing high-efficiency equipment. Although the majority of these contractors said the incentives provided by the program were adequate, they added that higher rebates and more marketing would make selling high-efficiency equipment easier.

About one-third (32%) of nonparticipating contractors who were aware of the HEHE program said that they had participated in the program in 2008 or earlier. As Table 6-13 shows, the most commonly cited explanations for no longer participating in the program were associated with a lack of demand: customers did not want to spend the money for energy-efficient equipment (14%), customers did not ask for it (14%), and that customers could not afford it (10%).

Table 6-13: Reasons for No Longer Participating in the HEHE Program

	Nonparticipants
Sample size	*92*
Participated in program in 2008 or earlier	32%
Reasons for No Longer Participating	**Nonparticipants**
Sample size	*29*
Customers do not want to spend the money for energy-efficient equipment	14%
No business/customers do not ask for it	14%
Business is focused on other areas than residential installations	14%
Can't afford it	10%
Ran out of time for permits	3%
Not enough equipment on the list	3%
No opportunity in the equipment they install	3%
Other	20%
Don't know/Refused	17%

Interviews with supply house staff revealed that an indirect hurdle to contractors participating in the program may be the physical barriers presented in the venting and installation required for some high-efficiency equipment.[33] Other barriers noted by the supply house staff included a lack of contractor knowledge of the high-efficiency equipment and an aversion to extra work or paperwork.

Older contractors in particular may be less inclined to HEHE program participation because they are habituated to installing particular types of equipment and are averse to learning how to install newer, high-efficiency equipment. Program staff remarked that contractors who have become accustomed to installing specific types of standard-efficiency equipment may be disinclined to

[33] A venting or drainage system upgrade is often required when replacing an old furnace or boiler with higher efficiency, condensing furnaces or boilers. Condensing furnaces and boilers can create corrosive condensate that requires special venting strategies for furnaces and drainage strategies for boilers.

change their practices. One of the supply house staffers observed that the younger the contractor the more interested they were in installing high-efficiency equipment.

6.6 Post-participation Actions

6.6.1 Actions Taken

Respondents to the survey of HEHE participants and oil-to-gas conversion (OTG) participants installing high-efficiency models were asked if they had installed four specific measures since participating in the program or converting from oil to gas. As Table 6-14 shows, around three in ten HEHE participants installed energy-efficient appliances (31%), insulation (30%), and new windows (27%). About three in ten OTG high efficiency participants installed more efficient appliances (29%), and nearly two in ten installed new windows (18%) and/or insulation (17%). About two in ten OTG standard efficiency participants installed more efficient appliances (21%) and new windows (17%).

Table 6-14: Specific Actions Taken since Participation
(multiple responses)

	HEHE Participants	Oil-to-Gas Conversion Customers	
		High Efficiency	Standard Efficiency
Sample size	*857*	*754*	*751*
Energy-efficient appliances	31%	29%	21%
Add insulation	30%	17%	13%
Install new windows	27%	18%	17%
More efficient heating system	20%		
More efficient cooling system	13%	7%	5%

Respondents who installed windows, insulation, heating equipment, cooling equipment, or energy-efficient appliances since participating in the program were asked to rate the influence of the program on their decision to install each measure on a scale of zero to ten, where zero is "no influence at all" and ten is "a very strong influence." Overall, both HEHE and oil-to-gas conversion (OTG) participants indicated that the program had at best a moderate influence on their decision to install energy-efficient measures (Table 6-15).

Table 6-15: Influence of Program on Installations

(average rating on a 0-10 scale, where 0="no influence at all" 10="a very strong influence)"

	Windows	Insulation	Heating	Cooling	Appliances
Sample size	*225*	*201*	*151*	*113*	*257*
HEHE Participants	**3.3**	**3.9**	**5.6**	**4.3**	**4.3**
Sample size	*125*	*112*		*53*	*119*
Oil-to-Gas Conversion Customers-High Efficiency	**3.2**	**5.2**		**5.6**	**3.8**
Sample size	*125*	*89*		*36*	*155*
Oil-to-Gas Conversion Customers-Standard Efficiency	**3.6**	**4.7**		**2.4**	**3.9**

7 Program Marketing and Delivery

7.1 Program Marketing and Messaging

The HEHE program has been promoted through a variety of marketing methods, including customer mailings, contractor trainings, home shows, and building conferences. Relationship building with vendors, suppliers, and contractors also has been a large part of marketing the program. Circuit riders or account manager visits to supply houses have been effective in educating contractors. Implementation contractors reported that they have promoted the HEHE program through regular visits to supply houses by circuit riders and account managers. They added that they have had good cooperation from supply houses and this cooperation has increased as high efficiency has become more popular. The supply houses reported that that they thought the HEHE program marketing and promotions were mostly effective.

About one-third (34%) of participating contractors said they do not do any advertising at all. Among those who do, over four out of five (85%) said that their advertising promotes the fact that they install energy-efficient heating or water heating equipment (Table 7-1).

Table 7-1: Contractor Promotion of Energy-efficient Equipment
(base: those who do advertising)

	Participants
Sample size	*126*
Promotes energy-efficient equipment	85%
Does not promote energy-efficient equipment	15

Table 7-2 shows the primary reasons that participating and nonparticipating contractors gave for recommending high-efficiency equipment. Both participating and nonparticipating contractors most frequently cited saving money on operating costs when promoting high-efficiency heating and water heating equipment to customers. They also mentioned saving energy as an important reason for recommending high-efficiency heating and water heating equipment. Participating contractors additionally mentioned the program rebates, particularly for high-efficiency heating equipment. Note that these data suggest that most nonparticipating contractors are recommending high-efficiency equipment but they are not doing so through the HEHE program—only 1% of nonparticipating contractors said they do not recommend high-efficiency equipment and 3% said they do not recommend anything. This supports the earlier finding of high free ridership among program participants.

Table 7-2: Primary Reasons for Recommending High-efficiency Equipment

	Participating Contractors		Nonparticipating Contractors
	Heating	Water Heating	Heating and Water Heating
Sample size	*137*	*111*	*108*
Saves customer money on operating costs	45%	37%	54%
Save energy	21	12	19
Customers get a rebate	16	6	2
Help the environment/global warming	4	5	3
Equipment is higher quality / more reliable / lasts longer / needs less maintenance	4	5	1
Size/Can install it anywhere	1	1	1
Contractor makes more money on high-efficiency equipment	1	-	3
Tax credits	1	-	-
Venting/Does not use chimney	1	1	2
Contractor doesn't recommend anything	1	-	3
Contractor does not recommend high-efficiency equipment	-	-	1
It makes sense/more beneficial for the customer	1	-	-
Payback period	1	-	-
Quiet equipment	1	-	-
Health reasons	-	1	1
Other	-	2	8
Don't know/refused	1	24	3

7.2 Program Delivery

7.2.1 Contractor Ratings of Program Staff

Participating contractors gave positive ratings to their interactions with program staff. Using a scale of zero to ten, where zero was 'not useful and effective at all' and ten was 'extremely useful and effective,' these contractors gave an average rating of 7.6 to their interactions with program staff. Nearly three out of five contractors (58%) rated their interactions with program staff as very or extremely useful and effective. Note, however, that 20% of the contractors did not provide a rating (Table 7-3).

Table 7-3: Interactions with HEHE Program Staff

Usefulness of Interactions with Program Staff	
Sample size	*140*
Mean rating (0='not useful and effective at all' to 10=extremely useful and effective')	7.6
Percent giving 7-10 rating	58%
Don't know/refused	20%

7.2.2 Role of Supply Houses

Validating the HEHE program's focus on supply houses, the surveys of participating and nonparticipating contractors found that supply houses are the predominant source for nearly all of the heating and water heating equipment sold. Practically all of participating (98%) and nonparticipating contractors (99%) said that they purchased energy-efficient furnaces and boilers from a supply house. Similarly, nearly all of participating (95%) and nonparticipating contractors (99%) said that they purchased energy-efficient water heating equipment from a supply house.

7.3 HEHE Rebates & Rebate Processing

7.3.1 HEHE Rebates

Rebates are a key component of the HEHE program, designed to encourage customers to purchase high-efficiency equipment by helping to offset the higher upfront costs of the equipment compared to standard-efficiency equipment. Rebate levels are established by program sponsors generally by looking at the incremental cost between standard and high-efficiency equipment and setting the incentive at about 50% to 100% of the incremental cost, according to program staff. Newer technologies or slower moving technologies might receive higher incentive levels than equipment that seems to be selling on its own. Incentive levels are evaluated and adjusted as necessary on an annual basis.

Sponsors reported that the HEHE program has already achieved its goal of transforming the market for 90% AFUE furnaces – so the rebate for that equipment has ended. As the market

share increased, the program reduced the rebate until it was dropped completely; now the bar has been raised as heating technologies become more prevalent in the market place. According to the sponsors, the boiler market, however, has been slower to transform, in part because the equipment is more expensive. Note, however, that the free ridership analysis revealed high levels of free ridership for high-efficiency boilers, suggesting that this may not be the case.

Program staff noted that the rebates did not necessarily cover all the costs of installing high-efficiency products and as such it takes additional effort to convince customers of the long-term savings. While an installation rebate would be helpful, an increase in the rebate amount would require extra savings to justify the expense, which installation work may or may not produce.

7.3.2 Influence of Rebates

The respondents to the survey of HEHE participants were asked to rate the likelihood that, had a rebate not been available from GasNetworks, they would have installed equipment of the same efficiency level as their new equipment and at the same time. Similarly, respondents to the survey of oil-to-gas conversion participants who installed high-efficiency equipment were asked to rate the likelihood that, had the equipment not been available at a discounted price from GasNetworks, they would have installed equipment of the same efficiency level as their new equipment and at the same time. On a scale from zero ("not at all likely") to ten ("very likely,") about four out of five HEHE program participants (82%) and nearly three out of five of these OTG participants (57%) said they would have been likely (i.e., gave a likelihood rating of seven or greater) to install the equipment at the same time without a rebate or discount from GasNetworks (Table 7-4).

Table 7-4: Likelihood of Installing Equipment at the Same Time without Rebates

	HEHE Participants	Oil-to-Gas Conversion Participants (High Efficiency)
Sample size	*857*	*596*
Average Rating	**7.8**	**6.8**
10 "Very likely"	40%	22%
9	10	7
8	12	17
7	10	11
6	5	6
5	7	13
4	2	2
3	2	3
2	2	5
1	<1	1
0 "Not at all likely"	4	6
Don't know/Refused	5	7

To gauge the influence of rebates on the decision to purchase a high-efficiency product, respondents to the HEHE participant survey were asked to rate their agreement with the statement, "The rebate was a critical factor in my decision to purchase a high-efficiency product." Similarly, the respondents to the survey of oil-to-gas conversion participants who installed high-efficiency equipment were asked to rate their agreement with the statement, "The discounted price for the equipment was a critical factor in my decision to purchase a high-efficiency product." On a scale from zero ("strongly disagree") to ten ("strongly agree"), about three out of five HEHE participants (62%) disagreed that the rebate was a critical factor (i.e., gave a response of five or lower); and about one in five (19%) strongly disagreed (i.e., gave a response of zero). In contrast, only about one in five (19%) of the OTG participants disagreed with the statement (Table 7-5).

Table 7-5: Influence of Rebates on Purchase

Rebate / discounted price was a critical factor in my decision to purchase	**HEHE Participants**	**Oil-to-Gas Conversion Participants (High Efficiency)**
Sample size	*857*	*596*
Average rating	**4.5**	**7.5**
10 "Strongly agree"	8%	31%
9	3	9
8	8	22
7	9	10
6	5	7
5	20	9
4	5	2
3	7	2
2	8	1
1	3	1
0 "Strongly disagree"	19	4
Don't know/Refused	4	2

Respondents to the HEHE participant survey were also asked to rate their agreement with the statement, "If there had been no rebate program, I would have paid the additional [amount of rebate] to buy the high-efficiency equipment on my own."[34] Similarly, the respondents to the survey of oil-to-gas conversion participants who installed high-efficiency equipment were asked to rate their agreement with the statement, "If I had not received the equipment at a discounted price from National Grid, I would have paid the full market price to buy the high-efficiency equipment on my own."[35] On a scale from zero ("strongly disagree") to ten ("strongly agree"), more than two out of three out HEHE participants (69%) agreed that they would have paid the full price for the equipment (i.e., gave a response of seven or higher); and nearly two out of five (38%) strongly agreed (i.e., gave a response of ten). Also, one-half (50%) of the OTG participants agreed with the statement and one in five (20%) strongly agreed.

Table 7-6: Would Have Purchased Without Rebates

Would have paid the [additional amount / full market price] to buy high efficient equipment without [rebate / discounted price]	**HEHE Participants**	**Oil-to-Gas Conversion Participants (High Efficiency)**
Sample size	*857*	*596*
Average rating	**7.7**	**6.2**
10 "Strongly agree"	38%	20%
9	8	5
8	14	16
7	9	9
6	5	6
5	12	14
4	3	5
3	2	7
2	1	5
1	1	1
0 "Strongly disagree"	4	9
Don't know/Refused	5	4

[34] Respondents were asked about the actual rebate value received through the program and were prompted with the specific piece of equipment they purchased.
[35] Respondents were prompted with the specific piece of equipment they purchased.

7.3.3 Importance of Rebates

Respondents to the survey of participating contractors were asked to rate the importance of the HEHE program rebate to customers' decisions to install each measure, using a scale of zero to ten where zero was 'not at all important' and ten was 'extremely important.' As Table 7-7 shows, participating contractors rated the rebates for forced hot air furnaces with ECM (mean rating: 8.2), forced hot water boilers with AFUE of 92% and higher (mean rating: 8.3), and combined high-efficiency and water heating units (mean rating: 8.2) were most important to customers. Participating contractors gave a somewhat lower importance to the rebate for installing steam boilers with electronic ignition (mean rating: 6.1).

Table 7-7: Importance of Program Rebate in the Decision to Install Equipment among Participants

Equipment	Sample size	Mean rating*
Forced hot air furnace w/AFUE of 92%+	*80*	7.9
Forced hot air furnace w/ECM and AFUE of 92%+	*68*	8.2
Forced hot water boiler w/AFUE of 90%+	*119*	8.3
Forced hot water boiler w/AFUE of 85%+	*126*	7.3
Steam boiler w/electronic ignition and an AFUE of 82%+	*76*	6.1
Indirect water heaters	*98*	7.1
On-demand tankless water heaters w/ an EF >0.82	*73*	7.9
Combined high-efficiency boiler and water heating units≥ 90% AFUE with storage of 2 gallons of less	*61*	8.2

* Scale of zero to ten where 0='not at all important' and 10='extremely important'

Note, however, that the high levels of free ridership suggest that program rebates may not be as important as rated by these participating contractors. Indeed, as we saw in previous section, the program participants themselves did not give strong influence ratings to the HEHE rebates.

7.3.4 Rebate Application Process

To receive a rebate for the heating and/or water heating system installed using a participating contractor, customers have to submit an application to the HEHE program. EFI, along with CET for Berkshire Gas customers, process rebates for the HEHE program.

The survey asked participating contractors if they or their customers applied for the HEHE program rebate for all of the high-efficiency heating or water heating equipment they installed in 2009 that qualified for the HEHE program. Seven out of ten (69%) contractors applied for the rebate, while 20% said that they left it up to the customer to apply.

As Table 7-8 shows, in the small number of cases where contractors said high-efficiency equipment was installed without applying for a rebate, participating contractors said it was the customer decision (seven contractors), that their focus was still to save money or energy (two contractors), or that they still tried to push the rebate (two contractors).

Table 7-8: Frequency of Application to the Program

Applied for rebate for every high-efficiency heater/water heater installed	**Percent**
Sample size	*140*
Yes	69%
No	9
It's up to the customer to file for rebate	20
Don't know/refused	2
Reason for installing equipment outside of the program	**Number of responses**
Sample size	*12*
Customer decision	7
Saves money/energy	2
Other	2
Don't know/refused	1

Participating contractors who said that it was the customer decision (seven contractors) not to apply for a rebate said that that was because the paperwork was too difficult, the customer chose other equipment, and there was no time to apply for the rebate (Table 7-9).

Table 7-9: Reasons Customer Did Not Apply for Rebate

	Number of responses
Sample size	*7*
Paperwork is difficult	2
Chose other equipment	2
No time	1
Other	1
Don't know/refused	1

In the in-depth interviews, implementation contractors reported that one of the biggest challenges the program faced was helping the contractor feel at ease with the rebate form so that they could help the customer fill out the form and receive the rebate. Without guidance, end customers often had incomplete or incorrectly filled out rebate forms and they sought assistance from the program implementer because the installation contractor and supply houses could not provide adequate information.

7.3.5 HEHE Rebate Processing

By necessity, the program requires detailed documentation from customers and contractors to ensure that the incentive funding is being spent on verifiable measures, which makes compliance difficult for some applicants. Implementation contractors reported that one of the biggest challenges the program has faced has been helping contractors feel at ease with rebate requirements and confident in their ability to help customers complete the rebate application. Minimizing delays in disbursement of the rebate is particularly important because customers have already paid contractors the full price of the equipment.

About one-quarter (24%) of participating contractors said that they had experienced some problems in processing the rebate. As Table 7-10 shows, the problems were mainly because the rebate took too long (35%) or there were issues with the paperwork (27%).

Table 7-10: Rebate Processing Issues

Experienced an issue	
Sample size	*140*
Yes	24%
No	74
Don't Know	2
The Issue	
Sample size	*34*
Rebate took too long	35%
Issues with paperwork	27
Issue was resolved/not an issue	18
Problems with a certain model	12
Other	9

The rebate processing contractors, EFI and CET, indicated that 80% of the time they processed HEHE participant rebates within four weeks. Reasons that some rebates took longer than four weeks to process included incomplete data entry on the form, program changes, and invoicing cutoff dates. Program staff acknowledged that there have been some program changes involving incentives, such as changing the inspection process, which had originally required that the rebate be withheld until inspection of a sample of customers was completed and caused customer irritation; this has since been addressed.

Internal reporting of rebate processing was another area highlighted for improvement. The circuit rider reported difficulty getting feedback from EFI concerning the number of rebate forms supplied by circuit riders that were resulting in rebates. A similar concern was expressed by implementation contractors who requested information about where processed applications had originated. Aside from meeting that need, implementers described the data tracking process as complete and updated frequently. Program staff noted that the rebate processors had been responsive to their data requests and that they had worked with EFI to establish better reporting

guidelines, such as extracting equipment pricing information from the rebate forms that they process. However, they believe there is opportunity for further optimization of EFI's reporting system by eliminating manual reporting and having EFI enter all information directly into the data processing systems of program sponsors.

7.4 Program Satisfaction

The 2007-09 HEHE program participants have been very satisfied with the program overall, with an average satisfaction rating of 9.1 out of 10 (Table 7-11). From their perspective, the process of participating in the program works well and as a whole they are satisfied with the rebates and the equipment they installed. Overall, only about one in twenty respondents reported a satisfaction rating of 5 or less. Moreover, over one-third of the 2007-08 respondents with scores of less than five said that they had expected greater savings on their energy bills as a result of installing the equipment they purchased through the program than they had actually achieved in the past year. Thus, respondents were very satisfied with the program overall, whether they had participated in 2007-08 or in 2009.

Table 7-11: Satisfaction with HEHE Program

	2007-08 Participants	2009 Participants	Total
Sample size	*625*	*232*	*857*
Average Rating	**9.1**	**9.1**	**9.1**
10 "Very satisfied"	61%	57%	59%
9	16	13	15
8	14	14	14
7	3	4	3
4-6 "Somewhat satisfied"	5	5	5
0-3 "Not satisfied"	1	1	1
Don't know/Refused	1	6	3

The 2009 HEHE participants were asked to rate their satisfaction with the program sponsored equipment that they installed. On a scale of zero to ten, where zero is "not at all satisfied" and ten is "very satisfied," these participants gave an average satisfaction rating greater than nine for all of the program sponsored equipment (Table 7-12).

Table 7-12: Satisfaction with Equipment
(Base: 2009 Participants)

	Boiler	Furnace	Water Heater
Sample size	*98*	*77*	*141*
Average Rating	**9.4**	**9.5**	**9.3**
10 "Very satisfied"	63%	69%	63%
9	21	13	17
8	10	16	11
7	2	3	5
6	1	--	1
5	3	--	3
0-4 "Not satisfied"	--	--	--
Don't know/Refused	--	--	--

The 2009 participants were also asked to rate their satisfaction with various aspects of the installation process using the same scale. In general, participants exhibited high levels of satisfaction with the installation process. Average satisfaction ratings ranged from 8.7 for "contractor advice" to 9.3 for "contractor courteousness" (Table 7-13).

Table 7-13: Satisfaction with Contractors & Installation Process
(Base: 2009 Participants)

	Inter-actions	Advice	Courteous-ness	Scheduling & Timing	Installation Process	Completion of Project on Schedule	Know-ledge
Sample size	*222*	*221*	*222*	*221*	*219*	*222*	*221*
Average Rating	**8.9**	**8.7**	**9.3**	**9.1**	**9.2**	**9.1**	**9.0**
10 "Very satisfied"	57%	56%	69%	66%	59%	68%	63%
9	13	12	12	14	20	14	14
8	14	15	12	8	12	10	11
7	7	5	3	5	5	3	4
4-6 "Somewhat satisfied"	6	7	2	3	4	2	4
0-3 "Not satisfied"	3	4	2	5	2	6	3

8 Contractor Role and Installation Practices

8.1 Key Role of Contractors

8.1.1 Equipment Purchase Channel

Contractors were the primary source for purchases of heating and water heating systems especially for HEHE participants but also for the general population. Respondents to the survey of HEHE and Oil-to-Gas participants were asked how they purchased their new equipment. About three out of five general population respondents (62%) and three out of four HEHE participants (75%) reported that contractors had purchased their new space heating systems.[36] Note, however, that a substantial share (20%) of general population respondents could not say how they had purchased their new heating systems. The general population respondents (46%) were significant less likely than the HEHE participants (77%) to report that a contractor had purchased their new water heating system (Table 8-1).

Table 8-1: How New Equipment was Purchased

(HEHE participants who bought only heating / water heating equipment and general population respondents not in new homes with heating / water heating systems under three years old)

	Space Heating Equipment		Water Heating Equipment	
How equipment was purchased	**General Population**	**HEHE Participants**	**General Population**	**HEHE Participants**
Sample size	*38*	*463*	*78*	*167*
The contractor purchased it for me	62%	75%	46%	77%
I purchased it myself through a retailer or supply house	18	24	44	20
Purchased it through the utility	1	1	1	2
Other	--	--	1	--
Don't know/Refused	20	<1	8	1

8.1.2 Contractor Role Summary

Contractors played a key role in HEHE participants' decision to install high-efficiency equipment and were a major source of information about the HEHE program. Contractors also were very influential in motivating oil-to-gas conversion customers to install high-efficiency equipment; the majority of participants said that their contractors had suggested the particular model or models that ended up being installed.

[36] In this section, program participants who had purchased only heating systems are compared with the general population with systems under three years old; similarly, program participants who had purchased only water heating systems are compared with the general population with water systems under three years old in the following section. Program participants who had purchased both heating and water heating systems are excluded from these analyses since they were not asked separate questions about their heating and water heating systems.

- One-half of the respondents to the HEHE participant survey (50%) said that they first learned about the program rebates from their contractor.
- Four out of five respondents to the HEHE participant survey (81%) said that their contractor had told them about the program rebates (even if they previously had learned about them elsewhere)
- Contractors had suggested the new heating systems that were installed for about one-half of HEHE program participants (49%) and three out of five (58%) general population respondents.
- HEHE program respondents (25%) were significantly more likely than general population respondents (8%) to have had the contractor suggest multiple heating systems.
- HEHE program participants were (30%) significantly more likely than the general population (10%) to mention a contractor recommendation as a primary factor in purchasing a new water heater.
- Over one-third of respondents to the HEHE participant survey who purchased a boiler with a "top tier" energy efficiency rating (35%) said that their choice was based on contractor recommendation. Note, however, that more than one-half (55%) said that they had wanted a more efficient boiler.
- Over two-fifths of respondents to the HEHE participant survey who purchased a "top tier" furnace (44%) said that their choice was based on contractor recommendation. Note, however, that a similar share (47%) said that they had wanted a more efficient furnace.
- Nearly one-half of respondents to the oil-to-gas conversion survey who purchased high-efficiency equipment (46%) said that their choice was based on contractor recommendation.

8.2 Contractor Installation Practices

8.2.1 Equipment Sizing

Participating contractor practices for equipment sizing do not generally adhere to energy-efficient installation standards—only one-tenth reported using Manual J. Although participating contractors indicated that the HEHE program had only a mild influence on their sizing practices, their self-reported practices suggest that the program influence on sizing is actually very weak.

Almost one-half of participating contractors (46%) said that they most often determined the size of the furnaces and boilers based on BTU per square foot or cubic foot. Other participating contractors also determined size through calculations including a heat loss/load calculation (16%) and ACCA Manual J or manufacturer software based on Manual J (10%). However, as Table 8-2 shows, one-fifth of the participating contractors commonly used no sizing calculations

and relied on methods that included installing a larger size when there was not enough heat (9%), installing the same size as the previous equipment (6%), and relying on supplier recommendations (5%). Nonparticipating contractors reported that they most often determined the equipment size through heat loss/load calculations (34%) and based on BTU per square foot or cubic foot (24%). Twelve percent of nonparticipating contractors simply relied on the size of the previous equipment.

Table 8-2: Methods Used to Size Furnace and Boilers Installed

	Participant	Nonparticipant
Sample size	*137*	*93*
Based on BTU per square foot or cubic foot	46%	24%
Heat loss/load calculation	16	34
ACCA Manual J / Manufacturer software based on Manual J	10	2
A larger size when there wasn't enough heat	9	1
The size of previous equipment	6	12
Supplier recommendation	5	2
Connected load	2	1
Measure baseboard/radiators	2	3
Square footage	-	7
Number of people in house	-	2
Engineer recommendation	-	2
Other	2	7
Don't know/refused	1	2

Two out of five (39%) participating contractors said that there was no difference in their approach to sizing energy-efficient versus standard-efficiency equipment and another 28% said that they did not know if they used different approaches to sizing based on efficiency. However, as Table 8-3 shows, 10% of participating contractors said they would specify a smaller size for high-efficiency equipment, 5% said they would look at the output in BTUs, and only 4% said they would use heat loss calculations or Manual J for sizing high-efficiency equipment.

Table 8-3: Difference in Sizing Energy-efficient Versus Standard-efficiency Equipment

	Participant
Sample size	*137*
No difference	39%
Smaller for high efficiency	10
Look at output in BTUs	5
Do not install standard-efficiency equipment	5
Use heat loss or Manual J	4
Do more research on high efficiency	1
Other	10
Don't know/refused	28

As Table 8-4 shows, participating contractors indicated that the HEHE program has had a mild influence on their sizing practices, giving the program an average influence rating of 4.1 on a zero to ten scale. Note, however, from Table 8-2 that only 10% of contractors reported using the program-recommended Manual J for equipment sizing and this suggests an even lower program influence than the rating provided by these contractors.

Table 8-4: Program Impact on Selecting Size of Energy-efficient Equipment

Zero to Ten Scale	Participants
Sample size	*137*
Average rating	**4.1**
Rating 0-3—Low influence	47%
Rating 4 to 6	15
Rating 7 to 10—High influence	37
Don't know/refused	1

8.2.2 Duct Sealing

Although participating contractors were significantly more likely than nonparticipating contractors to engage in some type of duct sealing practice, their duct sealing and testing practices do not generally adhere to energy-efficient installation standards—only about one-tenth of contractors reported using mastic or mastic duct tape and a similar percentage report doing

duct blaster tests (11%). The participating contractors indicated that the HEHE program had a weak influence on their duct sealing and testing practices. However, their self-reported practices suggest that the program influence on sizing may actually be nearly non-existent.

Participating contractors were significantly more likely than nonparticipating contractors to engage in some type of duct sealing practice. In fact, 32% of nonparticipating contractors said that they did not seal the duct work, whereas only 2% of participating contractors said they did no sealing (Table 8-5).

Duct sealing methods were varied—about one-third (34%) of participating and one-fifth (20%) of nonparticipating contractors performed an unspecified type of duct sealing. Twenty-nine percent of participating contractors and 11% of nonparticipating contractors said they used duct tape. About one-quarter of participating contractors (24%) and one-tenth of nonparticipating contractors (11%) said they insulated all ducts.

Table 8-5: Duct Sealing Practices
(multiple responses)

	Participant	Nonparticipant
Sample size	*82*	*54*
Duct sealing (unspecified)	34%	20%
Duct tape	29%	11%
Insulate all ducts	24%	11%
Pressure/duct blaster test	11%	2%
Mastic	7%	6%
Insulate unconditioned space	6%	-
Mastic duct tape	2%	2%
Do not seal ducts	2%	32%
Other	11%	17%
Don’t know/refused	15%	6%

As Table 8-6 shows, participating contractors indicated that the HEHE program has had minimal influence on their methods used to seal ducts and test for leakage, giving the program an average influence rating of 3.2 on a zero to ten scale. Note again that only 9% of contractors report using mastic or mastic duct tape and a similar percentage report doing duct blaster test (11%). This suggests that the program influence on duct sealing and testing practices may be even lower than the rating provided by these contractors.

Table 8-6: Program Impact on Duct Sealing and Leakage Testing

Zero to Ten Scale	Participant
Sample size	*82*
Average rating	**3.2**
Rating 0-3—Low influence	46%
Rating 4 to 6	18
Rating 7 to 10—High influence	18
Don't know/refused	17

8.2.3 ECM Furnace Fan Recommendations

Participating contractor practices regarding instructions provided to customers for using ECM furnace fans are not consistent with the proper practices for usage of these fans. In general, the recommended furnace fan mode is "automatic." A furnace fan set to an "automatic" mode will use far less energy than a furnace fan that is set to run continuously. As Table 8-7 shows, about one-half of them (51%) reported recommending to customers that the fan be run continuously (35%) or they do not give any recommendation at all (16%). As Table 8-8 shows, the survey of HEHE participants indicates that the contractors may not giving any recommendation even more frequently (66%) than reported by the contractors.

Table 8-7: Frequency of Recommendation to Run Furnace Fan on High-efficiency Furnaces with ECM

	Participant	Nonparticipant
Sample size	*68*	*26*
All the time	35%	35%
Most of the time	16	12
Once in a while	9	-
Never	16	18
Customer decision	-	12
Other	13	23
Don't know/refused	10	-

Respondents to the HEHE participant survey who were aware of their ECM furnace fan were asked what recommendations, if any, their contractor gave them for using the fan. Overall, about two-thirds (66%) of the respondents said that their contractor did not make any recommendations about using the ECM fan (Table 8-8). This is surprising as homeowners are likely unaware of the appropriate operating mode for their furnace fan.

Table 8-8: Contractor Recommendations for ECM Furnace Fan

	HEHE Participants
Sample size	43
Did not say anything about it	66%
Use when the furnace is on	8
Automatic-requires no action	10
Leave it on all the time	3
Don't know	14

Participating contractors said that when they install high-efficiency boilers they also install an outdoor reset an average of 70% of the time, as compared with nonparticipating contractors who install an outdoor reset 50% of the time, significantly less frequently (Table 8-9).

Table 8-9: Installation of Outdoor Reset

Installed when installing high-efficiency boilers	Participant	Nonparticipant
Sample size	*130*	*82*
Average percentage	70%	51%
0%--Never	12%	23%
1 to 25%	10	21
26 to 50%	8	9
51 to 75%	5	4
76 to 99%	12	15
100%--Always	49	29
Don't know/refused	4	-

9 Program Strengths and Improvement Opportunities

9.1 Program Strengths

The HEHE program rebates were the most commonly mentioned program strength, cited by nearly two out of five participating contractors (37%). As Table 9-1 shows, participating contractors also cited other program strengths including promoting high efficiency (17%) and advertising (12%). Most contractors said that they primarily sold higher efficiency equipment based on the lower initial cost combined with lower operating costs and the rebate improved that proposition. The supply house staff echoed the contractors and said that the rebates were the program's greatest strength and also mentioned program advertising. The circuit rider observed that a major strength was the HEHE name awareness provided by the program.

Table 9-1: Program Strengths

	Participants
Sample size	*140*
Rebates	37%
Promotes high efficiency	17
Advertising	12
Save on operating costs	8
Paperwork/processing	4
Availability of the program	3
Switch fuels	1
None	1
Other	7
Don't know/refused	9

The implementation contractors observed that the participating contractors earned a higher profit when installing energy-efficient equipment and were able to offer a wider variety of higher margin equipment when they participated in the program. Program staff also thought that participating contractors could make more money when selling high-efficiency equipment because the markup on high-efficiency equipment was higher than on standard equipment and the installation of high-efficiency equipment required more work.

9.2 Opportunities for Program Improvement

Notwithstanding the fact that participating contractors considered the HEHE rebates to be the program's greatest strength, they also suggested these as areas for program improvement, most frequently citing higher rebates (21%) followed by better advertising (11%). In the in-depth interviews, a majority of contractors said the incentives provided by the program were adequate,

but higher rebates would make selling the high-efficiency equipment easier, particularly for water heating systems.

Supply house staff thought the program could be improved through additional marketing and referrals, increased rebates, and a quicker turnaround in getting newer products on the qualified product list. Program implementers suggested that an on-line application system and a day-to-day program manager who could make decisions without needing to go to the full committee could help improve the program. The program implementers also thought that more of an effort was needed to reach the contractor population that is not participating—possibly by attending smaller contractor association meetings and events.

Program staff thought that an installation rebate would be helpful, but if the program increased the rebate, they would need extra savings to justify the expense, which installation work may not produce.

10 Demographics & Firmographics

10.1 Participant & Nonparticipant Demographics

General population respondents are significantly less likely than HEHE program and oil-to-gas conversion participants to own their homes and to live in a detached single-family home (Table 10-1).

Table 10-1: Home Ownership and Type of Home

	HEHE Participants	Oil-to-Gas Conversion Customers		General Population
		High Efficiency	Standard Efficiency	
Sample size	*857*	*754*	*751*	*424*
Own	96%	96%	94%	78%
Rent	1	1	3	18
Don't know/Refused	3	2	2	4
Type of Home				
Single-family detached	84%	79%	72%	65%
Single-family attached (duplex, row home)	8	8	11	15
Apartment with 2-4 units	5	8	11	13
Apartment with 5+ units	1	<1	--	4
Mobile home	<1	3	5	<1
Other	1	1	1	2
Don't know / refused	2			2

Table 10-2 shows that respondents from all of the customer groups are well educated, with over one-half of respondents from every group having had a college education or higher.

Table 10-2: Highest Level of Education

	HEHE Participants	Oil-to-Gas Conversion Customers		General Population
		High Efficiency	Standard Efficiency	
Sample size	*857*	*754*	*751*	*424*
Less than high school	1%	1%	3%	3%
High school graduate	12	19	21	18
Technical or trade school graduate	2	2	2	2
Some college, no degree	10	12	11	19
College graduate	32	30	32	24
Some graduate school	4	--	--	3
Graduate or professional degree	32	24	20	23
Don't know / refused	8	12	11	7

General population respondent incomes tend to be lower than those of HEHE program and Oil-to-Gas conversion participants—general population respondents (29%) are more likely than HEHE (11%) and Oil-to-Gas (16%, 20%) participants to have annual household incomes under $50,000.

Table 10-3: Annual Household Income

	HEHE Participants	Oil-to-Gas Conversion Customers		General Population
		High Efficiency	Standard Efficiency	
Sample size	*857*	*754*	*751*	*424*
$9,999 or less	<1%	1%	2%	2%
$10,000 to $14,999	1	1	1	4
$15,000 to $49,999	10	14	17	23
$50,000 to $74,999	10	11	13	10
$75,000 to $99,999	11	11	11	11
$100,000 to $149,999	13	12	9	10
$150,000 or more	11	8	7	5
Don't know/refused	43	42	40	37

General population respondents also tend to be younger than HEHE program and oil-to-gas conversion participants—general population participants (27%) are more likely than HEHE (19%) and Oil-to-Gas (18%, 12%) participants to be under 45 years old (Table 10-4).

Table 10-4: Respondent Age

	HEHE Participants	Oil-to-Gas Conversion Customers		General Population
		High Efficiency	Standard Efficiency	
Sample size	*857*	*754*	*751*	*424*
18 to 24	<1%	1%	<1%	1%
25 to 34	4	3	3	5
35 to 44	15	14	9	21
45 to 54	20	20	18	19
55 to 64	24	23	26	24
65 or other	27	28	34	21
Don't know/refused	10	12	10	9

General population (46%) and oil-to-gas conversion (60%, 58%) respondents were more likely to be males than those who responded to the HEHE participant survey (38%) (Table 10-5).

Table 10-5: Respondent Gender

	HEHE Participants	Oil-to-Gas Conversion Customers		General Population
		High Efficiency	Standard Efficiency	
Sample size	*857*	*754*	*751*	*424*
Female	62%	40%	42%	54%
Male	38	60	58	46

10.2 Contractor Firmographics

Participating contractors have an average of nearly five employees and nonparticipating contractors have an average of 6.5 employees. As Table 10-6 shows, the average participating contractor has been in business for an average of 21 years and about one-quarter (23%) of participating contractors have been in operation for five years or less. Nonparticipating contractors have been in business for 32 years on average, significantly longer than participating contractors.

Table 10-6: Firm Characteristics

	Participant	Nonparticipant
Sample size	*140*	*108*
Average number of employees	**4.7**	**6.5**
Average age of company (years)	**21**	**32**
1 to 2 years	4%	2%
3 to 5 years	19	8
6 to 10 years	16	7
11 to 20 years	17	18
21 to 30 years	22	28
31 or more years	19	37
Don't know/refused	2	-

11 Findings and Recommendations

11.1 Key Findings

11.1.1 Gross Program Savings

The NMR team developed six billing analysis models to determine program savings. The first method was based on a post-only PRISM methodology that calculated post-installation energy consumption for each HEHE measure category and then calculated savings using an estimate of the efficiencies of the installed units and the assumed baseline units. The next two models were pre- post- models based on billing data for all HEHE program participants (including customers from National Grid's oil-to-gas conversion program who installed qualifying HEHE equipment). These models use a ratio of the baseline efficiency to the pre- efficiency to correct for the fact the pre- post- analysis measured savings relative to the furnace replaced, not the baseline furnace they would have installed. The remaining three models were participant/nonparticipant models based on post- billing data for all HEHE program participants and nonparticipants. The participants in this model included participants in the HEHE program and participants in the National Grid Oil-to-gas Conversion program who had installed HEHE program-rebated high-efficiency equipment; the nonparticipants included customers who installed standard-efficiency gas equipment through National Grid's oil-to-gas conversion program.

The six models that were run are summarized below:

1. **Post Only PRISM Model**. Total weather-normalized annual consumption (NAC) for all customers for the post- period only. This method does not have a pre/post component, nor does it employ a nonparticipant group, but instead uses a simple ratio method to obtain a proxy of savings. This savings estimate makes an assumption that each participant will save energy and does not account for any behavioral or pre-post adjustment. This method (Model 1) is not included in obtaining the final average gross savings estimate.
2. **Pre- Post- PRISM Model**. Total weather-normalized annual consumption (NAC) for all customers for the pre- and post- periods.
3. **Pre- Post- Fixed Effects Model**. A fixed effects model based on pre- and post- differences in monthly usage by measure category.
4. **HEHE Participant vs. Nonparticipant PRISM Model**. Total weather-normalized annual consumption (NAC) based on differences between HEHE participants and oil to gas conversion nonparticipants who installed standard-efficiency heating systems, by measure category.
5. **HEHE Participant vs. Nonparticipant CSA Model**. A pooled conditional savings (CSA) model based on differences in monthly usage by measure category between HEHE participants and oil to gas conversion nonparticipants who installed standard-efficiency heating systems.

6. **HEHE Participant vs. Nonparticipant CSA Model with Survey Data**. A pooled conditional savings (CSA) model based on differences in monthly usage between HEHE participants and oil to gas conversion nonparticipants who installed standard-efficiency heating systems by measure category enhanced with survey data information.

Table 11-1summarizes the savings for all the proposed modeling methods.

Table 11-1: Gross Savings Summary

Measure Type	1. Post Only PRISM Model Annual Savings (Therms)	2. Pre-Post-PRISM Model Annual Savings (Therms)	3. Pre-Post-Fixed Effects Model Annual Savings (Therms)	HEHE Participants vs. Oil-to-Gas Conversion Nonparticipants		
				4. PRISM Model Annual Savings (Therms)	5. CSA Model Annual Savings (Therms)	6. CSA Model with Survey Data Annual Savings (Therms)
Furnaces: AFUE 92% or greater	134	116	132		99	125
Furnaces: AFUE 92% or greater with ECM	160	131	147			102
Boilers: AFUE 90% or greater	168	153	182		105	108
Boilers: AFUE 85%-89%	72	65	64	87		
Boilers Steam: AFUE 82% or greater	123	96	122			
Indirect water heaters	82	70	89			
Tankless water heaters: EF>0.82	47	82	111			

The estimated measure-level and overall program per-unit gross savings are shown in Table 11-2. The overall program gross savings estimates are based on the weighted average of the relative proportions of installations of each measure. The gross per-unit savings for the 2007-08 program year are estimated to range between 72 therms for boilers with 85% to 89% AFUE to 137 therms for boilers with 90% or greater AFUE.

Table 11-2: 2007-08 Gross Program Savings Summary

	Number of Installations	Savings per Unit (Therms)		Model Savings Range
		Post- Only PRISM Savings	Average Program Model Savings	
Furnaces: AFUE 92% or greater	4,491	134	**118**	99-132
Furnaces: AFUE 92% or greater with ECM	3,563	160	**127**	102-147
Boilers: AFUE 90% or greater	4,520	168	**137**	105-182
Boilers: AFUE 85%-89%	4,549	72	**72**	64-87
Boilers Steam: AFUE 82% or greater	1,817	123	**109**	96-122
Indirect water heaters	4,785	82	**80**	70-89
Tankless water heaters: EF>0.82	1,621	47	**97**	82-111
Overall Program	25,346	116	**105**	

11.1.2 Market Overview & Free Ridership

All of the HEHE rebated measures have very high free ridership and nonparticipating contractors are estimated to account for the large majority of sales of all of the high-efficiency boilers, furnaces and water heaters. Furthermore, the contractors and supply houses interviewed for this study observed that there had been increased interest in high-efficiency equipment over the prior year and expect that sales of high-efficiency equipment will increase over the next year. Additionally note the following from Table 11-3.

- High-efficiency equipment estimated to account for three-quarters of all sales of boilers and furnaces in the GasNetworks service area
    - Nonparticipating contractors are estimated to account for the majority of those sales of high-efficiency furnaces and boilers
- Although high-efficiency water heaters also have high free ridership, they account for only about one-third of all water heater sales in GasNetworks service area
    - Nonparticipating contractors are estimated to account for majority of the sales of high-efficiency water heaters

Table 11-3: Measure Free Ridership and Sales Data

	2009 Free Ridership	Rebated Equipment		% Sales by Nonparticipating Contractors	% Total Sales of Equipment Type
		% of Participating Contractor Sales	% of Total Sales of Equipment		
Furnaces					
AFUE 92%+	66%	100% (2,236)	14%	86%	60% (16,200)
ECM Furnace	55%	100% (1,612)	39%	61%	15% (4,100)
Boilers					
AFUE 85%-89%	73%	36% (780)	5%	87%	45% (16,900)
AFUE 90%+	61%	100% (3,700)	48%	52%	20% (7,700)
Steam Boilers	68%	100% (500)	20%	86%	11% (4,200)
Water Heaters					
Indirect	68%	100% (3,537)	18%	82%	16% (19,600)
On-demand tankless	59%	68% (1,575)	12%	83%	11% (13,400)
Combo Units	50%	56% (392)	8%	86%	4% (4,900)

These data for the GasNetworks program are corroborated by similar information from other states and programs on high free ridership and high market share for energy-efficient equipment. According to GAMA/AHRI sales shipment data, two-thirds (67%) of the furnaces sold in 2007 in Connecticut were high-efficiency models.[37] An evaluation for the CPUC found free ridership in the California IOU programs to be to be 81% for high-efficiency (90%+ AFUE) natural gas

[37] Data from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

furnaces and 78% for high-efficiency natural gas tank storage water heaters.[38] A market transformation model for high-efficiency gas furnaces in Oregon indicated that 2009 free ridership levels ranged between 60% and 68%.[39]

11.1.3 Program Awareness & Participation

Both the general population of end users (49%) as well as nonparticipating contractors (85%) exhibit high awareness levels of the HEHE Program. Mailings from GasNetworks or the program sponsors were a notable source of program awareness among the general population (36%) and among nonparticipating contractors (22%). However, these data also suggest that the role of market actors in the equipment supply chain may be more important to promoting actual program participation: HEHE participants (50%) reported that they most often heard about the HEHE program from their contractors.

11.1.4 Motivations for Program Participation & Equipment Purchases

Although about one-half of HEHE participants (54%) participated in the program to obtain the rebate, their most important criterion when deciding what equipment to purchase was energy efficiency (41%), followed by contractor recommendation (24%).

Both participating and nonparticipating contractors most frequently cited saving money on operating costs when promoting high-efficiency heating and water heating equipment to customers. Some also mentioned saving energy.

Nonparticipating contractors who were familiar with the HEHE program were asked what would motivate them to participate in the program. Two general motivators emerged: more business and financial benefits. Sixteen percent of nonparticipating contractors said that increased customer demand would motivate them to participate and ten percent noted that they would like more business leads. The financial motivations cited focused on more money or reduced cost of participating in the program (11%), rebates (11%), and rebates to contractors (7%).

11.1.5 Barriers to Participation

The financial barrier of customer unwillingness to pay for the upfront costs of high-efficiency equipment is a common theme that runs through the barriers mentioned by contractors, customers, and program staff. Note, however, that the high market shares for energy-efficient equipment and the high free ridership levels described previously suggest that the financial barrier is not much of an obstacle as survey results would lead one to believe.

- The most common reason for not participating in the HEHE program cited by the general population survey respondents who were aware of it was that they were not interested in

[38] The Cadmus Group. 2010. *Residential Retrofit High Impact Measure Evaluation Report*, conducted for the California Public Utilities Commission.
[39] Summit Blue Consulting. 2009. *Gas Furnace Market Transformation Model Development and Market Research*, conducted for the Energy Trust of Oregon.

installing the rebated measures (29%); and about one in ten respondents said that participating would be too expensive (9%).

- One out of five participating contractors said they had encountered barriers that kept them from participating in the HEHE program as often as they would have liked. These contractors mentioned that the paperwork was too much of a hassle (18%), that they were not on the HEHE program list (14%), that there were rebate issues (11%), and that customers did not want to spend the money (14%) or could not afford it (11%). About one-third (32%) of nonparticipating contractors who were aware of the HEHE program said that they had participated in the program in 2008 or earlier.
- The most commonly cited explanations for no longer participating in the program were associated with a lack of demand: customers did not want to spend the money for energy-efficient equipment (14%), customers did not ask for it (14%), and that customers could not afford it (10%).

Participating contractors mentioned barriers such as paperwork hassle, an incorrect HEHE list of contractors from which their names were missing, and rebate issues. Interviews with supply house staff revealed that an indirect hurdle to contractor participation in the program may be the physical barriers presented in the venting and installation required for some high-efficiency equipment.[40] Supply house staff also noted that a lack of contractor knowledge of the high-efficiency equipment may be another barrier to their participation in the program. Older contractors in particular may be less inclined to HEHE program participation because they are habituated to installing particular types of equipment and are averse to learning how to install newer, high-efficiency equipment. Program staff observed that contractors who have become accustomed to installing specific types of standard-efficiency equipment may be disinclined to change their practices. One of the supply house staffers observed that the younger the contractor the more interested they were in installing high-efficiency equipment.

11.1.6 Post-Participation Actions

Respondents to the survey of HEHE participants and oil-to-gas conversion (OTG) participants installing high-efficiency models were asked if they had installed four specific measures since participating in the program or converting from oil to gas. Around three in ten HEHE participants installed energy-efficient appliances (31%), insulation (30%), and new windows (27%). About three in ten OTG high-efficiency participants installed more efficient appliances (29%), and nearly two in ten installed new windows (18%) and/or insulation (17%). About two in ten OTG standard-efficiency participants installed more efficient appliances (21%) and new windows (17%). Overall, both HEHE and OTG participants indicated that the program had at best a moderate influence on their decision to install these energy-efficient measures.

[40] A venting or drainage system upgrade is often required when replacing an old furnace or boiler with higher efficiency, condensing furnaces or boilers. Condensing furnaces and boilers can create corrosive condensate that requires special venting strategies for furnaces and drainage strategies for boilers.

11.1.7 Program Marketing

The HEHE program has been promoted through a variety of marketing methods, including customer mailings, contractor trainings, home shows, and building conferences. Relationship building with vendors, suppliers, and contractors also has been a large part of marketing the program. Circuit riders or account manager visits to supply houses have been effective in educating contractors. Implementation contractors reported that they have promoted the HEHE program through regular visits to supply houses by circuit riders and account managers.

About one-third (34%) of participating contractors said they do not do any advertising at all. Among those who do, more than four out of five (85%) said that their advertising promotes the fact that they install energy-efficient heating or water heating equipment.

Both participating and nonparticipating contractors most frequently cited saving money on operating costs when promoting high-efficiency heating and water heating equipment to customers. They also mentioned saving energy as an important reason for recommending high-efficiency heating and water heating equipment. Participating contractors additionally mentioned the program rebates, particularly for high-efficiency heating equipment. Most nonparticipating contractors are recommending high-efficiency equipment but they are not doing so through the HEHE program—only 1% of nonparticipating contractors said they do not recommend high-efficiency equipment and 3% said they do not recommend anything. This supports the finding of high free ridership.

11.1.8 Influence of Rebates

Although, as noted previously, the HEHE rebates are a primary motivator of the customer decision to participate in the HEHE program, they are not perceived to be very strong influencers of the decision to purchase the energy-efficient equipment. Most HEHE program participants indicated a strong likelihood of purchasing the energy-efficient equipment in the absence of the rebates.

- Free ridership ranges from 50% to 73%, depending upon the program measure.
- About four out of five HEHE program participants (82%) and nearly three out of five OTG participants (57%) said they would have been likely to install the equipment at the same time without a rebate or discount from GasNetworks.
- About three out of five HEHE participants (62%) disagreed that the rebate was a critical factor and about one in five (19%) strongly disagreed. In contrast, only about one in five (19%) of the OTG participants disagreed with the statement.
- More than two out of three out HEHE participants (69%) agreed that they would have paid the full price for the equipment and nearly two out of five (38%) strongly agreed. One-half (50%) of the OTG participants also agreed with the statement and one in five (20%) strongly agreed.

OTG participants also exhibited a notable, but not as strong, likelihood of purchasing the equipment had it not been available at a discounted price from National Grid.[41]

Note, however, that participating contractors gave high ratings to the importance of rebates to customers' decisions to install each of the HEHE measures—ranging between 6.1 and 8.3 (on a scale of zero to ten where zero was 'not at all important' and ten was 'extremely important'). However, as we saw in previous section, the program participants themselves did not give strong influence ratings to the HEHE rebates and the high levels of free ridership suggest that program rebates may not be as important as rated by these participating contractors.

11.1.9 Rebate Application Process

EFI, along with CET for Berkshire Gas customers, process rebates for the HEHE program. In the survey of participating contractors, seven out of ten (69%) contractors applied for the HEHE rebate for qualifying equipment they had installed in 2009, while 20% said that they left it up to the customer to apply. In the in-depth interviews, implementation contractors reported that one of the biggest challenges the program faced was helping the contractor feel at ease with the rebate form so that they could help the customer fill out the form and receive the rebate.

11.1.10 HEHE Rebate Processing

About one-quarter (24%) of participating contractors said that they had experienced some problems in processing the rebate. The problems were mainly that it took too long to receive the rebate (35%) or that there were issues with the paperwork (27%). The rebate processing contractors, EFI and CET, indicated that 80% of the time they processed HEHE participant rebates within four weeks. Reasons that some rebates took longer than four weeks to process included incomplete data entry on the form, program changes, and invoicing cutoff dates.

Internal reporting of rebate processing was another area highlighted for improvement. The circuit rider reported difficulty getting feedback from EFI concerning the number of rebate forms supplied by circuit riders that were resulting in rebates. A similar concern was expressed by implementation contractors who requested information about where processed applications had originated. Aside from meeting that need, implementers described the data tracking process as complete and updated frequently. Program staff noted that the rebate processors had been responsive to their data requests and that they had worked with EFI to establish better reporting guidelines, such as extracting equipment pricing information from the rebate forms that they process. However, they believe there is opportunity for further optimization of EFI's reporting system by eliminating manual reporting and having EFI enter all information directly into the data processing systems of program sponsors.

[41] It is important to note that the discounted price provided to these participants incorporated both the HEHE rebate and the National Grid fuel conversion rebate and this may account for these ratings by the oil-to-gas participants.

11.1.11 Key Role of Contractors

The role of market actors in the equipment supply chain appears to be crucial to promoting actual program participation: HEHE participants most often heard about the HEHE program from their contractors. Contractors, in particular, are the linchpin for effective delivery of the HEHE program as strong influencers of the customer decision to install high-efficiency equipment. They are the primary point of contact with customers and are critical to informing customers about the HEHE program, influencing them to make the decision to purchase high-efficiency equipment, and following proper installation practices so that the equipment savings are fully realized.

- One-half of the respondents to the HEHE participant survey (50%) said that they first learned about the program rebates from their contractor.
- Contractors had recommended the specific models of heating systems that were installed for about one-half of HEHE program participants (49%) and three out of five (58%) general population respondents.
- HEHE program participants were (30%) significantly more likely than the general population (10%) to mention a contractor recommendation as a primary factor in purchasing a new water heater.
- Nearly one-half of respondents to the oil-to-gas conversion survey who purchased high-efficiency equipment (46%) said that their choice was based on contractor recommendation.

In light of the key role of contractors, it is important to understand the steps that the HEHE program could take to make it easier and more attractive for contractors to participate. In addition to the program barrier of lack of customer interest cited earlier, participating contractors mentioned barriers including paperwork hassle, an incorrect HEHE list of contractors from which their names were missing, and rebate issues. A notable percentage of participating contractors reported that they do not do any advertising at all. Nonparticipating contractors reported that they would be motivated to participate in the program by the prospect of more business.

- One out of five participating contractors said they had encountered barriers that kept them from participating in the HEHE program as often as they would have liked, and one in five said that the paperwork was too much of a hassle (18%); others said that they were not on the HEHE program list (14%), or that there were rebate issues (11%).
- The majority of participating contractors (56%) said that their advertising promotes the fact that they install energy-efficient heating or water heating equipment. However, one-third (34%) said they do not do any advertising at all. About one in ten participating contractors suggested better advertising (11%) as an area for program improvement.
- More than one-half of nonparticipating contractors reported that they would be motivated to participate in the HEHE program by increased business opportunities and financial incentives. Sixteen percent of nonparticipating contractors said that increased customer demand was a primary factor that would motivate them to participate and another 10%

noted that they would like more business leads. Financial motivations focused on the money or cost of participating in the program (11%), rebates (unspecified—11%), and rebates to contractors (7%)

- Supply house staff members thought the program could be improved through additional marketing and referrals.
- Implementation contractors and program staff observed that participating contractors could make more money when selling high-efficiency equipment because the markup on high-efficiency equipment was higher than on standard equipment and the installation of high-efficiency equipment required more work.
- Program implementers also thought that more of an effort needed to be made to reach the contractor population that is not participating—possibly by attending smaller contractor association meetings and events.
- Older contractors in particular may be less inclined to HEHE program participation because they are habituated to installing particular types of equipment and are not inclined to learn how to install newer, high-efficiency equipment. Program staff remarked that contractors who have been used to installing specific types of standard-efficiency equipment may be disinclined to change their practices; and supply house staff observed that the younger the contractor the more interested they were in installing high-efficiency equipment.

11.1.12 Contractor Installation Practices

The survey of participating contractors revealed installation practices that are sub-standard, which can reduce or negate the savings from the installations of the rebated equipment. The HEHE program has had little or no influence on these installation practices. Specifically, most participating contractors are not using Manual J for equipment sizing, using mastic for duct sealing, or giving the correct instructions to customers on using an ECM furnace fan. Note as well that program staff have considered an installation rebate but have not been able to justify the expense.

- Participating contractor practices for equipment sizing do not generally adhere to energy-efficient installation standards—only one-tenth reported using Manual J (10%). Although participating contractors indicated that the HEHE program had only a mild influence on their sizing practices, their self-reported practices suggest that the program influence on sizing is actually very weak.
- Although participating contractors were significantly more likely than nonparticipating contractors to engage in some type of duct sealing practice, their practices for duct sealing do not generally adhere to energy-efficient installation standards— only about one-tenth of contractors reported using mastic or mastic duct tape (9%). The participating contractors indicated that the HEHE program had a weak influence on their duct sealing practices. However, their self-reported practices suggest that the program influence on duct sealing may actually be nearly non-existent.

- Participating contractor practices regarding instructions to customers for using ECM furnace fans are not consistent with the proper practices for usage of these fans. About one-half of them reported recommending to customers that the fan be run continuously (35%) or they do not give any recommendation at all (16%).
- A lack of contractor knowledge of the high-efficiency equipment was one of the barriers noted by the supply house staff.
- Program staff thought that an installation rebate would be helpful, but if the program increased the rebate, they would need extra savings to justify the expense, which installation work may not produce.

11.1.13 Program Satisfaction

The 2007-09 HEHE program participants have been very satisfied with the program overall, with an average satisfaction rating of 9.1 out of 10. From their perspective, the process of participating in the program works well and as a whole they are satisfied with the rebates and the equipment they installed.

11.1.14 Participant Profile

HEHE participants are more likely than the rest of the population to live in single-family detached homes which they own. HEHE participants also have higher household incomes—11% of HEHE participants had an annual household income under $50,000 as compared to 29% of the general population. The participants also tend to be older: 19% of HEHE participants were under 45 years old as compared to 27% of the general population.

11.2 Recommendations

The GasNetworks HEHE program has been active for well over a decade. In that period, the market for high-efficiency equipment has changed to a point where today there is strong awareness of and substantial interest in such equipment. Indeed, all of the HEHE rebated measures have very high free ridership and nonparticipating contractors are estimated to account for the large majority of sales of all of the high-efficiency boilers, furnaces and water heaters.

1. NMR therefore recommends that the HEHE program drop all current rebates for furnaces, forced hot water boilers, steam boilers, and water heaters.
2. NMR recommends that the HEHE program should assess the feasibility of working to effect a change in the state standards for forced hot water boilers to 90% AFUE.
3. NMR further recommends that the HEHE program consider a new program for early replacement of newer, less efficient boilers.
4. NMR also recommends that the HEHE program continue to nurture its relationship with contractors because of the key role they play in customer education and energy-efficient equipment purchase and installation.

i. The program should evaluate the potential savings from offering an installation incentive to contractors for adhering to energy-efficient criteria for equipment sizing, duct testing, and duct sealing. Note that if the HEHE program decides to drop rebates for some or all equipment models, in addition to ensuring proper installations, offering installation incentives would also provide continued motivation to contractors to promote installations of high-efficiency equipment.
ii. The program should educate contractors and participants on correct usage of ECM furnace fans, and check settings during verification visits.
iii. The HEHE program can further increase its value to contractors by helping them grow their business in energy efficiency installations. Examples of approaches that would be attractive to them include offering co-op advertising and providing referrals.
iv. Make greater efforts to reach out to nonparticipating contractors. Approaches to doing so could include:
    - Facilitating program participation by older contractors. Examples of approaches might be to have exhibits at trade shows that demonstrate installations of high-efficiency systems, and if possible, demonstrate how the installation practices are simply an extension of what techniques they are already familiar with.
    - Increasing the number and frequency of educational offerings.

5. Finally, NMR recommends that the HEHE program conduct a survey of distributors in HEHE states and elsewhere to get a better estimate of market-level sales by efficiency level, and the possible long-term spillover both within and outside the HEHE states.