

Home Performance with Energy Star: Unregulated Fuels Impact Evaluation (2011-2013)

Final Report

November 2016

Prepared for
**The New York State
Energy Research and Development Authority**

Judeen Byrne
Emily Shusas
Project Managers

Prepared by:
ERS
120 Water Street, Suite 350
North Andover, MA 01845
Phone: 978-521-2550

Principal Investigator:
West Hill Energy and Computing, Inc.

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ABSTRACT

This report describes the impact evaluation for the Unregulated Fuels projects in the Home Performance with Energy Star Program. This study represents the first impact evaluation of the Unregulated Fuels projects.

The impact evaluation focused on unregulated fuels projects installed between January 1, 2011, and December 31, 2013. The evaluation estimated the savings by conducting a billing analysis of the unregulated fuels to quantify the evaluated energy savings by project. The evaluation did not include research into net-to-gross factors associated with free ridership and spillover. The Program's overall fuel realization rate (RR) is 0.60, with individual RR by fuel types of 0.64 for fuel oil, 0.43 for propane, and 1.32 for kerosene (one project). The total evaluated annual energy savings are 6,258 MMBtu and, based on those energy savings, the estimated CO₂e savings are 457 metric tons.

ACKNOWLEDGMENTS

The Impact Evaluation Team wishes to acknowledge the significant contribution of NYSERDA Project Managers Judeen Byrne and Emily Shusas, and the input of the NYSERDA Impact staff. The preparation of this evaluation and report was led by Kathryn Parlin of West Hill Energy and Computing with support from Lucas Sanford-Long and Rumbi Vushe, and collection of the unregulated fuels billing records was conducted by ERS.

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SECTION 1: EXECUTIVE SUMMARY

NYSERDA's Home Performance with Energy Star (HPwES) Program includes "unregulated fuels" (Unreg Fuels) projects. "Unregulated fuels" here refers to fossil fuels (i.e., primarily fuel oil, propane, and kerosene) that are not provided by a regulated utility¹.

This report provides a detailed description and results of the impact evaluation of the Unreg Fuels projects completed between January 1, 2011 and December 31, 2013. The primary objective of the evaluation was to establish rigorous and defensible estimates of evaluated gross savings and emission reductions attributable to Unreg Fuels projects. This study is the first comprehensive impact evaluation of Unreg Fuels.

This impact evaluation measured the savings attributed to unregulated fuel consumption on a house-by-house basis, using participant surveys and billing analysis to establish first year energy savings. The results were then aggregated to the fuel type and program level to calculate an overall realization rate (RR).² The potential savings from heating with wood or wood pellets were not estimated.³

Also discussed in this report are savings of Unreg Fuels projects funded by Regional Greenhouse Gas Initiative (RGGI). RGGI funds are used for cost-effective oil and propane efficiency measures, such as replacing inefficient oil and propane heating equipment and other measures that have a direct impact on reducing Greenhouse Gas (GHG) emissions from oil and propane consumption.

The sample for this evaluation included unregulated fuel projects funded from other funding sources including the American Reinvestment and Recovery Act (ARRA), Energy Efficiency Portfolio Standard (EEPS) and System Benefits Charge (SBC). *Post hoc* stratification was conducted to calculate the RR for the RGGI-funded-only projects (see Section 4.1). This analysis indicated the RR for RGGI projects is almost identical to the RR for the sample as a whole (61% as compared to 60%). The evaluated savings resulting from the Program are presented in Table 1.

¹ Natural Gas is provided by a regulated utility.

² The RR represents the percentage of program-estimated savings that the Impact Evaluation Team estimates as being actually achieved based on the results of the impact evaluation.

³ Estimating the change in wood use due to energy efficiency measures is highly problematic since wood is purchased in cords, which have a highly variable Btu content ranging from 20 to 40 MMBtu per cord depending on the type of wood and homeowners are unlikely to be able to estimate wood use to greater granularity than half a cord. Thus, the margin of error in comparing the wood use from one year to the next is likely to be the same order of magnitude as the estimated savings. While wood pellet fuel is less variable in MMBtu content per ton, there is still some variability and as well similar issues with the reliability of measuring the amount used.

Table 1. Unregulated Fuels (January 1, 2011 through December 31, 2013) Impact Evaluation MMBtu Results by Fuel Type

Fuel Type	Number of Projects in Analysis	Program Reported Savings in MMBtus	Realization Rate	Evaluated Gross Savings in MMBtu	NYSERDA Conversion Factors (pound CO _{2e} /MMBtu)	Estimated Metric Tons CO _{2e} Saved
Fuel Oil	150 ^a	8,385	0.64	5,365	162.9	397
Propane	57 ^a	2,030	0.43	873	136.1	59
Kerosene	1	15 ^b	1.32	20	161.2	2
Total	207^a	10,431	0.60	6,258		457

Sums may not total due to rounding.

^a One of the projects included sufficient program and oil data to calculate savings for both.

^b The Program incorrectly claimed fuel oil savings for the one kerosene project.

The approach used for this evaluation included the following:

1. A participant screener survey to collect key information, including identifying fuel dealers, secondary heating sources and changes in thermostat setting over time
 - a. Respondents were requested to return consent forms to allow us to request billing information from their fuel dealers
2. Collection of billing records from the fuel dealers
3. Conducting a billing analysis using the survey results and program and billing records

The sample frame included participants with over 10 MMBtu of unregulated fossil fuel savings. As part of program participation, many homeowners had already provided signed consent to request billing information from their fuel dealers, which eliminated the step of collecting the consent form for these participants.

The final sample was comprised of participants with complete consumption history for the primary heating fuel used during the analysis period. Normalized Annual Consumption (NAC) modeling was conducted to estimate the change in consumption between the pre- and post-installation periods on a house-by-house basis. These results were then aggregated to the program level to calculate the realization rate.

SECTION 2: INTRODUCTION AND EVALUATION CONTEXT AND ISSUES

This section presents the program description, the evaluation goals, and a summary of the issues faced with this evaluation.

2.1 PROGRAM DESCRIPTION

New York State invests RGGI proceeds to support comprehensive strategies that best achieve the RGGI CO₂ emission reduction goals. These strategies aim to reduce global climate change and pollution through energy efficiency, renewable energy, and carbon abatement technology.

Home Performance with ENERGY STAR (HPwES) is a national program, administered by the U.S. Department of Energy, to help homeowners improve the efficiency and comfort of their homes using a comprehensive, whole-house approach, while helping to protect the environment. As the sponsor for the New York statewide HPwES program, NYSERDA's primary goal is to encourage homeowners to use certified home performance contractors to identify and implement energy improvements. A substantial proportion of homeowners in New York State use unregulated fossil fuels to heat their homes, RGGI funding is used to promote the installation of measures designed to reduce use of these unregulated fossil fuels and to reduce greenhouse gasses.

The HPwES Program encourages home and building owners and tenants of existing one- to four-family homes and small low rise buildings to implement comprehensive energy efficiency-related improvements that save electricity, natural gas and unregulated fossil fuels. Eligible measures include conducting air sealing, replacing or adding insulation, replacing inefficient boilers, furnaces and water heaters and installing water heater conservation measures.

Program tracking by measure is highly detailed and both savings and extra energy use are recorded for each fuel type. Extra energy use can occur when measures switch energy use between two fuel types, such as replacing electric baseboard heat with a natural gas boiler. Table 2. presents program reported savings by fuel type for RGGI and non-RGGI projects with over 10 MMBtu of unregulated fuel savings for program years 2011, 2012, and 2013.

Table 2. Unregulated Fuels Summary of Program Tracking for Savings 2011-2013

Installation Year and Funding Source	Program Reported Annual Savings (MMBtu)			
	# of Projects	Fuel Oil	Propane	Kerosene
2011 RGGI	87	3,614	0	0
2012 RGGI	1,602	73,518	1,291	858
2013 RGGI	1,843	64,399	-2,507	297
Total RGGI	3,532	141,531	-1,215	1,155
2011 Non-RGGI	1,284	59,913	6,306	839
2012 Non-RGGI	872	35,334	709	77
2013 Non-RGGI	792	59,041	849	312
Total Non-RGGI	2,948	154,287	7,865	1,228
Total	6,480	295,818	6,649	2,383

Sums may not total due to rounding.

2.2 EVALUATION CONTEXT AND ISSUES

Billing analysis was selected as the evaluation method since it is appropriate for retrofit programs where the baseline is the existing condition prior to the installation. In addition, the savings need to be large enough to separate the program effects from the month-to-month variability of residential energy consumption. A general rule of thumb is that billing analysis works when the program savings are expected to be 8% to 10% or more of the total consumption.⁴ Sampling precision and bias are discussed in Appendix B.

Billing analysis for unregulated fuels poses challenges not commonly encountered with regulated energy sources. Some of the issues are as follows:

- obtaining billing records requires extensive cooperation from participants and fuel dealers
- fuel deliveries may not occur on a regular basis and the fuel tank may not be filled to capacity during a given delivery
- secondary heating fuels may be used and consumption patterns are more likely to vary in homes with secondary fuels.

The approach to addressing each of these issues follows below.

⁴ TecMarket Works. *2004 California Evaluation Framework*, prepared for the California Public Utilities Commission and the Project Advisory Group, September 2004, page 101. Smaller savings can be found with larger sample sizes.

2.2.1 Cooperation from Participants and Fuel Dealers

The Impact Evaluation Team anticipated that the process of collecting billing records would be difficult and lengthy, as it required numerous steps involving the program staff, survey respondents and fuel dealers. Some fuel dealers were more responsive than others to requests for billing records. Monetary incentives were not offered to fuel dealers.

2.2.2 Irregular Fuel Deliveries

To be able to determine the amount of fuel used during a specific period from billing records, it is necessary to know the date of the delivery, the amount of fuel delivered and whether the tank was filled to capacity. Partial deliveries were identified using information collected from both the participants and the fuel dealers to interpret the billing data for analysis. Three levels of review were conducted to address this issue.

1. In the screener survey, participants were asked how frequently the fuel tank was filled to capacity.
2. Fuel dealers were asked to identify partial deliveries, and some fuel dealers were able to comply with this request.
3. The fuel records were scrutinized and homes with regular deliveries of a specific and even number of gallons (such as 50, 100, or 250) were flagged as partial deliveries.

Homes with many partial deliveries were removed from the billing analysis.

2.2.3 Secondary Heating Fuels

Secondary heat is common in New York homes and NYSERDA program records show that savings are estimated for multiple heating fuels in a home where appropriate. While evaluating energy savings through a whole house analysis including all heating sources may be desirable, not all heating sources' data are always available. For this evaluation no savings from wood were estimated as estimating the change in wood use due to energy efficiency measures is fraught with difficulty.⁵

The realization rate was carefully calculated to include only the savings associated with the fuels that were also included in the billing model. Thus, the comparison of the model results to the

⁵ Wood is purchased in cords, which have a highly variable Btu content ranging from 20 to 40 MMBtu per cord, and homeowners are unlikely to be able to estimate wood use to greater granularity than half a cord. Thus, the margin of error in comparing the wood use from one year to the next is likely to be the same order of magnitude as the estimated savings.

program reported savings was a direct comparison, i.e., NYSERDA calculated the proportion of the savings associated with specific fuels and the model estimated savings for those specific fuels.

Billing analysis is a snapshot and changes in the household energy use patterns over time may affect the longer term savings. The screener survey was used to obtain key details about the use of secondary heat sources and changes in the use of primary and secondary heating fuels between the pre- and post-periods.

SECTION 3: METHODS

This section describes the methods used to estimate evaluated gross savings for unregulated fossil fuels portion of HPwES program. The subsections cover the sample frame, screener survey, attrition in the billing model, preparation of data, calculation of household savings and measure level savings.

3.1 SAMPLE FRAME

The sample frame⁶ consisted of homeowners who installed measures through the HPwES Program during the period of January 2011 through December 2013 and met the following criteria:

1. Used an unregulated fuel as a primary or secondary heating source during the pre-installation period
 - a. participants who switched to natural gas through the Program were included, as well as those who used unregulated fuels in both the pre- and post-periods
2. Had total savings from fuel oil, propane, and kerosene greater than 10 MMBtu
 - a. ten MMBtu was chosen as a cutoff as it represents approximately 10% of an average household's fuel consumption, a large enough impact to be identified in the billing analysis⁷
3. Had at least one phone number in the program database.

The projects were combined by site ID (address) as some homes had more than one project during the analysis period. This resulted in a sample frame with 4,953 homes.

3.2 SCREENER SURVEY

The process of preparing for the unregulated fuel billing analysis began with a screener survey. The screener survey was designed to accomplish the following objectives:

1. Confirm fuel dealer in program records and identify fuel dealers used but not identified in program records
2. Identify respondents who need to sign an additional consent form

⁶ Lohr, S., *Sampling: Design and Analysis*, Duxbury Press, 1999.

⁷ The HPwES PY2010-2013 Impact Evaluation report provides the evaluated MMBtu and the evaluated savings as a percent of the average heating consumption per home for PY2007-2008 and PY2010-2013. The average annual consumption per home is about 108 MMBtu/ year (17.3 MMBtu/16%) and 95 MMBtu/year (13.3/14%) for the earlier and later evaluations, respectively. (Table 6, Home Performance with ENERGY STAR Program Impact Evaluation Report (PY2010-2013) Final Report Volume 2: Phase 1 Billing Analysis, the New York State Energy Research and Development Authority. Prepared by ERS and West Hill Energy and Computing. November 2016.)

3. Confirm measure installations
4. Obtain additional details about heating use and pattern of fuel deliveries to inform the billing analysis

The survey was fielded in two parts. First, a Web-based survey of participants was fielded by Abt/SBRI⁸ between March 31st 2015 and May 11th 2015. Follow up telephone surveys were conducted with those participants who did not respond to the Web survey. Consent forms to collect fuel dealer data were sent to all respondents who completed the survey and no incentives were offered for completing the survey or returning the signed release form. For participants who did not return the signed consent form, the program enrollment forms with the signed consent were used when available.

Ultimately, 1,201 out of the 4,953 eligible participants in the sample frame completed the screener survey. The survey disposition is included as Appendix C and the screener survey instrument is provided in Appendix D. A memo with details about the results of the survey is included as Appendix E. Additional information regarding the collection of the billing records is included in Appendix F.

3.3 ATTRITION IN THE BILLING MODEL

Conducting a billing analysis of unregulated fuels requires multiple steps. In addition to fielding the screener survey and obtaining permission to request billing records from the homeowners, each fuel dealer was contacted individually and had to agree to provide the bills. Some homes were removed from the model due to incomplete billing records, as described below.

Attrition occurred at each step of the process. The evaluation plan called for 200 homes in the final model, and the survey sizes were estimated to account for the expected attrition. This process was successfully resolved with 207 homes in the final model.

In a typical natural gas or electric billing analysis, approximately 40 to 50% of the potential participants are removed due to incomplete data or other anomalies. The attrition due to data cleaning for this evaluation was similar. The billing records received from fuel dealers were reviewed and participants were removed from the billing model for the following reasons:

1. For non-fuel switch projects, less than 300 days of pre-installation or 300 days of post-installation billing records

⁸ Abt/SBRI is NYSERDA's evaluation survey contractor.

2. For fuel switch projects, less than 300 days of pre or post-installation billing records, depending on the period when the fuel was used for heating
3. Some billing records were missing during analysis period, most often because the participant used multiple fuel dealers and some did not provide billing records
4. Billing records were for a fuel that was not used for heating or was mostly or entirely partial fills

A summary of the attrition is included in Table 3. Of the 844 participants with signed consent forms and who completed the survey, billing records were received for 456 (54%) and 25% of these projects were included in the final model.

Table 3: Summary of Billing Data Collection

Description	Number of Participants	Percent of Survey Respondents
Completed screener survey	1,201	
Returned consent forms	299	25%
Consent form available from program records	545	45%
Total with usable consent form	844	70%
Billing records were received	456	38%
Sufficient billing records for analysis	221	18%
In billing model	207	17%

3.4 PREPARING FOR CALCULATING SAVINGS

The data preparation and calculation of savings was conducted in the following order:

1. Identified partial fuel deliveries and combined with the next delivery with a filled tank
2. Identified pre and post installation period and removed projects with insufficient data
3. Converted the gallons of fossil fuel use to MMBtu
4. Calculated heating degree days (HDD) for each delivery period

The inconsistent nature of unregulated fossil fuel deliveries makes billing analysis more complicated. Some participants receive fairly regular fuel deliveries and others may have the fuel tank filled only when it is almost empty. If the fuel tank is filled to capacity, it is possible to determine the amount of fuel used between deliveries since the amount delivered is the total fuel consumed since the last delivery.

The first part of this process was to assess whether the fuel tanks were filled to capacity. This issue was investigated by reviewing information from both participant screener survey and the billing records received from the fuel dealers. This process included the following steps:

1. Participants were asked in the screener survey how often the fuel tank is filled to capacity and almost 82% reported filling the tank all or most of the time.
2. Fuel dealers were asked to identify whether the tank was filled at each recorded delivery and some fuel dealers were able to provide this information.
3. Deliveries of a multiple of 50 gallons, most often 100, 150 or 250 gallons, or with a very short time period to the next delivery, were flagged as potential partial fills.
4. For deliveries identified as potential partial fills, the fuel was combined with the next full delivery so that the delivery would represent the consumption during the period.

Participants with many potential partial fills were dropped from the analysis.

Given the irregular nature of fossil fuel delivery schedules, up to three years of pre and post usage data were used. The inner bounds of the pre/post periods were defined as the delivery dates that were closest to the installation date(s) and still fell within the selected period, *e.g.*, the pre-period ended on the fuel delivery date that was before the installation date and closest to the installation date. Projects with less than 300 days of pre or post data were identified and removed if they were not a fuel switch.

Heating degree days (HDD) for each delivery period (from the previous to the current delivery) were calculated using hourly weather data collected by the National Oceanographic and Atmospheric Administration (NOAA) from seven weather stations as identified by home in the program tracking database. Weather stations with fewer than 10 sites were adjusted to the next closest weather station. The HDD were calculated for each day and summed over each delivery period for use in the regression analysis.

HDD were calculated using 4 different base temperatures (55°F, 60°F, 65°F and 70°F) to cover the range of expected balance points in the homes. Regressions were conducted at all four base temperatures for each home.

3.5 CALCULATION OF HOUSEHOLD SAVINGS

The primary analysis method was similar to the Princeton Scorekeeping Method (PRISM) and involved conducting a house-by-house regression of the heating degree days on fossil fuel

consumption for the pre-installation and the post-installation period and comparing the results. For homes with a fuel switch and sufficient data for only one of the fuels, the savings (or extra use) were calculated for that fuel only.

The steps to calculate the savings are as follows:

1. Conduct pre and post regression analysis using the HDD and MMBtu consumption for each home.
2. Identify the correct regression model to used based on survey information and available data.
3. Remove projects with problematic data or regression results.
4. Calculate savings and summarize final results

The method of estimating savings depended on whether the same fuel was used for both space and water heating.

Homes with the Same Fuel for Space and Water Heating

Based on the survey data, homes using the same fuel for hot water and heating were identified. For these homes the base water heating use was estimated through the addition of an intercept in the regression analysis, as follows:

1. If the estimated intercept for these homes was in a reasonable range, *e.g.*, the intercept was positive and of a magnitude that could signify base use, the heating use was estimated using the intercept model.
2. If the intercept was negative, indicating that the billing records were not granular enough to estimate water heating use, a non-intercept model was used instead.

There were a number of homes without survey responses to determine if the hot water and space heat fuel was the same. For these homes the intercept and non-intercept model were both tested and the model with the better fit was used.

Homes with Space Heating Only

Homes with the heating fuel used for space heating were analyzed differently. For these homes, the regression only included fuel deliveries with at least 8 HDD/day to reduce the uncertainty added from deliveries during the shoulder season and summer. This regression used a non-intercept model as there was no base use in these homes.

Estimating Savings

The regression results were reviewed and homes with low R^2 values (<0.7) or negative intercepts and hot water savings were dropped. The verified savings for the remaining projects were calculated using the 60 °F base HDD for all homes, as a review of the regression results indicated that the 60° F base HDD provided more reliable results for most homes.

For homes using more than one type of unregulated fuel (such as oil and propane), the realization rate was calculated using only the claimed fuel savings (or extra use) for which fuel data was collected.

From the regression models, the savings from the heating measures were determined by calculating the heating slope (MMBtu/HDD) separately for the pre- and post-installation period. The difference in the two values was then multiplied by the 5-year annual average HDD for the appropriate weather station. The water heating savings were calculated as the difference between the pre- and post-period intercepts (MMBtu/day) multiplied by 365 days to obtain an annualized value. In addition to calculating the MMBtu savings, the carbon dioxide savings were estimated from the evaluated savings.

3.6 SOURCES OF UNCERTAINTY

There are two major sources of uncertainty in the savings calculations:

1. Use of a secondary heating fuel, particularly if there is change in use of the secondary fuel between the pre- and post-periods; for example, some homeowners who have a wood stove and an oil or propane central heating system may decide to increase wood use when the price of oil or propane is higher.
2. Determining the balance point and applying the appropriate HDD base temperature, which could vary from home to home as the balance points may be different

In both cases, sensitivity analyses were conducted to assess the potential range of the uncertainty and found that these sources are unlikely to have a substantial impact on the RR. For further discussion, see Appendices B and G.

3.7 MEASURE LEVEL SAVINGS

In addition to the calculation of the household savings, a secondary analysis to estimate measure level savings was conducted for informational purposes. While household savings are reasonably

reliable, the measure level savings are more difficult to estimate with the modeling, and the variability in the model prevents estimating these savings with a high degree of precision.⁹

A pooled regression was conducted to estimate savings at the measure level using the equation:

$$HS = \sum_{i=1}^p \beta_i x_i + \varepsilon$$

where

HS is the household savings in annual MMBtu

x_i is a dummy variable, set to 1 if measure i was installed

β_i is the regression coefficient for measure i , i.e., the savings for the measure in annual MMBtu

ε is the error term

In addition to the dummy variable model, a statistically adjusted engineering (SAE) model was also conducted by replacing x_i with the program reported savings for the measure.

⁹ The precision is generally worse for the second stage regression approach than for the pooled time series models used in the natural gas billing analysis.

SECTION 4: RESULTS AND FINDINGS

The final results of the regression model are shown in Table 4. This includes all homes with unregulated fuel savings regardless of the funding source. The realization rate of the homes with fuel oil savings is higher than for the homes with propane savings. The relative precision of the RR is 11% at the 90% confidence level and the results are consistent with other impact evaluations of the HPwES natural gas projects. In addition, a sensitivity analysis of the impacts of secondary heating sources suggests that the inclusion of homes with secondary heating sources did not introduce bias into the results.¹⁰

Table 4: Evaluated Savings and Realization Rate

Fuel Type	# of Projects in the Analysis	Program Reported Savings in MMBtu	Realization Rate	Evaluated Gross Savings in MMBtu	NYSERDA Conversion Factors (pounds CO ₂ e/MMBtu)	Estimated Metric Tons CO ₂ e Saved
Fuel Oil	150 ^a	8,385	0.64	5,365	162.9	397
Propane	57 ^a	2,030	0.43	873	136.1	59
Kerosene	1	15 ^b	1.32	20	161.2	2
Total	207 ^a	10,431	0.60	6,258		457

Sums may not total due to rounding

^aOne of the projects included sufficient program and oil data to calculate savings for both

^bThe Program claimed as fuel oil the one Kerosene project.

Previous HPwES impact evaluations have estimated the savings for natural gas savings. As natural gas is also a fossil fuel and the HPwES measures installed in homes with all fossil fuels are the same, the primary differences between the two types of fuel is the lower price of natural gas and the access to natural gas through a regulated utility.¹¹ As the HPwES Program is designed to reduce fossil fuel heating use, the results from the current and previous evaluations are compared in Table 5.

¹⁰ Please refer to Appendices B and G for more discussion of the uncertainty.

¹¹ From the impact evaluation perspective, the natural gas utilities were able to provide monthly billing records for most of the program participants in the data request, whereas the Impact Evaluation Team had to collect the propane, oil and kerosene delivery data, which was often irregular, from each fuel dealer. For this reason, the natural gas billing models had many more homes and a pooled regression was used.

Table 5: Comparison of Unregulated Fuel Realization Rates to Realization Rates from Billing Analyses of HPwES Natural Gas Projects

Metric	2011-2013	2010-2011 ¹	2007-2008 ²
	Unregulated Fuel Savings	Natural Gas Savings	Natural Gas Savings
Number of Utilities	N/A	7	3
Realization Rate	0.60	0.48	0.65
Relative Precision	+/- 11%	+/- 1%	+/- 7%
Average Evaluated Savings per Household	28.1 MMBtu	13.3 MMBtu	17.3 MMBtu
Lower 90% Confidence Limit	25.0 MMBtu	13.2 MMBtu	16.1 MMBtu
Upper 90% Confidence Limit	31.2 MMBtu	13.4 MMBtu	18.5 MMBtu
Percent of Pre-Installation Use Saved ³	27%	14%	16%
Number of Homes in Model	207	5,009	2,462

¹ Home Performance with ENERGY STAR Program Impact Evaluation Report (PY2010-2013) Final Report Volume 2: Phase 1 Billing Analysis, the New York State Energy Research and Development Authority. Prepared by ERS and West Hill Energy and Computing. November 2016. Table 6.

² NYSERDA 2007-2008 Home Performance with ENERGY STAR® Program Impact Evaluation Report Final, the New York State Energy Research and Development Authority. Prepared by Megdal & Associates, LLC. September 2012.

³ The annual consumption per home during the pre-installation period was averaged for all homes in the billing models. The “percent of pre-installation use saved” is the average annual evaluated savings divided by the annual average pre-installation consumptions.

4.1 RGGI PROGRAM SAVINGS

Post hoc stratification was conducted to estimate the RR for the 132 RGGI funded projects separately from the other homes. The 70 non-RGGI homes were funded by ARRA, SBC and EEPS. When the RGGI funded projects are evaluated alone, the RR is very close to the overall RR (61% as compared to the program RR of 60%). As the program implementation is identical regardless of the fuel type, this outcome is expected. However, the smaller sample of RGGI projects results in a reduction in relative precision from +/-11% to +/-19%. Consequently, the Impact Evaluation Team recommends using the RR from the entire sample.

Table 6: Evaluated Savings and Realization Rates for RGGI Funded Projects

Fuel Type	# of Projects in the Analysis	Program Reported Savings in MMBtu	Realization Rate	Evaluated Gross Savings in MMBtu	NYSERDA Conversion Factors (pounds CO _{2e} /MMBtu)	Estimated Metric Tons of CO _{2e} Saved
Fuel Oil	105 ^a	5,167	0.64	3,307	162.9	244
Propane	28 ^a	782	0.45	352	136.1	22
Kerosene	0	0	0.00	0	161.2	0
Total	132 ^a	5,949	0.61	3,629	27,655	266

Sums may not total due to rounding

^aOne of the projects included sufficient program and oil data to calculate savings for both

4.2 MEASURE LEVEL RESULTS

These measure level results are included for informational purposes only as the precision is much worse than the household level results. Overall, the RRs are in the same range for the envelope and heating system measures (around 55%). The RR for fuel switching savings is higher at 73%. The measure-level model had a slightly lower overall RR than the household model (57% as compared to 60%),¹² suggesting that the remaining 3% of the savings could not be assigned to a specific measure. As can be seen by the wide range between the lower and upper confidence levels, there is a fair amount of variability in these results.

Table 7: Measure Level Savings (for Informational Purposes Only)

Measure	Projects	Average Savings per Home (Informational Only)				Realization Rate
		Program Reported (MMBtu/yr)	Evaluated Gross (MMBtu/yr)	Lower 90% Confidence Limit (MMBtu/yr)	Upper 90% Confidence Limit (MMBtu/yr)	
Envelope Measures	169	36.0	19.5	14.9	24.1	0.54
Heating System Measures	52	14.8	8.1	(0.1)	16.3	0.55
Fuel Switching Measures ¹	31	102.9	74.7	64.8	84.6	0.73
Fuel Switch Extra Use ²	3	(72.4)	(36.4)	(67.6)	(5.2)	0.50
Total ³	207	48.1	27.4			0.57

¹The estimator for heating system measures was not statistically significant at the 90% confidence level.

²In these three “extra use” projects, fuel oil was replaced with liquid propane. This extra use reflects the additional propane use following the fuel switch. The precision is poor for this measure due to the very low number of homes.

³Totals do not match due to overlapping measures.

4.3 SUMMARY

Key findings from the analysis are as follows:

- The realization rate for the unregulated fuels is in the same range as the RR’s for natural gas evaluation from previous evaluations.
- The percent of pre-installation consumption saved for the unregulated fuels is higher than previous evaluations of HPwES natural gas savings (27% as compared to 14-16%).
- The average household savings are about two times larger for unregulated fuels than the most recent impact evaluation of natural gas (28 MMBtu as compared to 13 MMBtu and 27% of pre-install use as compared to 14%). While the precision of the results for the unregulated fuels is

¹² See Tables 4 and 7.

higher (worse) than the natural gas evaluations due to the smaller number of homes in the model, this difference is substantial and is statistically significant.

- The realization rate seems to be fairly similar across the major measure categories, suggesting that there is not a particular measure category driving the low realization rate.

A recent comparison of residential retrofit programs in the Northeast suggests that the 27% savings in comparison to pre-installation bills is an excellent outcome, at least as compared to natural gas savings. Of the seven programs with natural gas savings in this comparison, the program with the highest percent savings achieved 22% of the pre-installation natural gas consumption.¹³

The HPwES historical and current RR's and this comparison to other, similar programs suggest that the Unregulated Fuels Component of the HPwES Program is achieving substantial savings. However, the program estimated savings are overstated by a large margin. This issue has been investigated as part of the HPwES Phase 2 Impact Evaluation, and the final report will be published later in 2016.

¹³ Bartsch, A., Danaher, C. "The Shell Game: Finding Thermal Savings in Residential Retrofit Programs," 2014 Berlin Conference, Berlin, Germany: International Energy Policy and Programme Evaluation Conference, September, 2014. The program was a high-use residential program operated by Vermont Gas.

APPENDIX A: GLOSSARY OF TERMS¹⁴

attrition -The reduction in number as a result of failure to meet criteria.

billing analysis - Estimation of program savings through the analysis of billing records comparing consumption prior to program participants and following program participation. This term encompasses a variety of types of analysis, from simple pre/post to complex regressions.

building shell/envelope - The assembly of exterior components of a building which enclose conditioned spaces, through which thermal energy may be transferred to or from the exterior, unconditioned spaces, or the ground. The measures in HPwES in this category include insulation (attic and wall insulation), window and door replacement, and air sealing.

DHW - domestic hot water, also water heater or water heating

evaluated gross savings-The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, as calculated by the program Impact Evaluation Team.

fossil fuel - Fuels formed from buried deposits of organic material, for example natural gas, fuel oil, propane and kerosene

heating degree days (HDD) -A measure of the heating requirements for a building based on the difference between the exterior temperature and a base temperature. The base temperature used should be the temperature at which no heating is needed, and varies based on a building's heating settings and internal gains.

Home Performance with Energy Star (HPwES) -A comprehensive energy efficiency services program for existing one- to four-family homes and low-rise residential buildings. The Program uses a network of Building Performance Institute (BPI) Gold Star contractors to perform diagnostic testing on the home, recommend improvements, determine the payback period for those improvements, and install improvements selected by the homeowner. The Program uses RGGI funds for cost-effective oil and propane efficiency measures, such as replacing inefficient oil and propane heating equipment and other measures that have a direct impact on reducing GHG emissions from oil and propane consumption. Income-qualified homeowners are eligible for higher incentive rates to make energy improvements.

normalization -For the purpose of billing analysis this generally refers to temperature normalization. It is a process of adjusting the savings to represent a year of typical temperatures rather than any variation in temperatures between the pre and post installation years.

R², R-squared - Proportion of variability in a regression data set that can be explained by the model.

realization rate (RR) – The ratio of the evaluated gross savings to the program reported savings. The RR calculation for electric energy for a sampled project is shown below:

$$RR = \frac{kWh_{evaluation}}{kWh_{program}}$$

where,

RR is the realization rate

kWh_{evaluation} is the evaluated kWh savings (estimated by the impact evaluation contractor)

¹⁴ NYSERDA generally follows and uses the terms as defined in the “Northeast Energy Efficiency Partnerships Glossary of Terms,” found at http://neep.org/uploads/EMV%20Forum/EMV%20Products/EMV_Glossary_Terms_Acronyms.pdf. This glossary defines those terms absent from the NEEP report or provides more-specific definitions to generalized NEEP terms.

$kWh_{program}$ is the kWh savings claimed by program

Regional Greenhouse Gas Initiative -In New York State, the Regional Greenhouse Gas Initiative (RGGI) program has been implemented through two complementary regulations: the New York State (NYS or the State) Department of Environmental Conservation (DEC) established New York's Carbon Dioxide (CO₂) Budget Trading Program (6 NYCRR Part 242, 6 NYCRR Part 200, General Provisions), and the New York State Energy Research and Development Authority (NYSERDA) established the CO₂ Allowance Auction Program (21 NYCRR Part 507).

New York State invests RGGI proceeds to support comprehensive strategies that best achieve the RGGI CO₂ emission reduction goals. These strategies aim to reduce global climate change and pollution through energy efficiency, renewable energy, and carbon abatement technology.

secondary heating fuel - Fuels used as a secondary heating source, often wood or electric, but can also be another fossil fuel.

unregulated fuels/unregulated fossil fuels -fuels (e.g., fuel oil, propane, and kerosene) used for space or water heating, but not subject to regulation by the State of New York or federal authorities

APPENDIX B: BIAS AND SAMPLING PRECISION

Bias and sampling precision are two critical factors that affect the underlying reliability of evaluation results. The evaluation was designed to generate a sufficiently large sample size to address the sampling precision. The primary sources of potential bias are as follows:

- the final list of participants who have sufficient billing history and are included in the model may not be representative of the entire program population due to *attrition*
- some *external* (non-program) *factors* may influence energy use but cannot be directly included in the regression models
- *net effects*, such as spillover, may be partially captured in models intended to estimate gross savings
- while it is assumed that the program is strictly retrofit, some measures, particularly heating equipment, may in fact be market opportunity as the equipment has reached the *end of its useful life*

Each of these potential sources of bias is discussed below.

Attrition

The concern regarding attrition is whether the removal of specific groups of homes with similar characteristics may introduce bias into the regression results. The potential impacts of attrition are dependent upon the relationship between the type of homes removed from the model and the program delivery mechanisms, as well as the methods used to conduct the analysis and calculate evaluated program savings.

The results from the billing analysis were translated to the program as a whole via realization rates, *i.e.*, the relationship between the verified and program claimed savings was used as opposed to estimating average savings per home.¹⁵ Thus, in assessing the potential bias associated with attrition from the billing analysis, the key issue is whether there is any expectation that specific groups of homes have different realization rates rather than whether the homes in the model are a good match to the homes in the population.

¹⁵ An alternative strategy would be to use the billing analysis to establish program savings by measure group or by household, apply these values to the program as a whole to estimate the evaluated program savings and then calculate the realization rate for the whole program on this basis. Under this scenario, it would be important to ensure that the participants in the model were similar to the program as a whole in terms of housing stock, weather conditions, and other factors.

There are two known issues that may potentially introduce bias into the analysis results. If specific large contractors are better or worse at estimating programs savings and if all homes completed by one or more of these large contractors are completely removed from the analysis, attrition could present a potential source of bias. The second potential source of bias comes from participants who tend to move often and are effectively removed from the analysis as a group since there is insufficient pre- or post-installation billing records to be able to estimate savings. There is no way to assess the impact of this effect or modify the billing models to address it. Potential bias from these sources on the realization rate could be either upward or downward.

External Factors

External factors may impact energy use. When savings are estimated from a billing analysis, these external impacts may introduce either an upward or downward bias to the results. The NAC model controls for seasonal changes in energy use that can be directly incorporated into the model, such as weather. However, it is possible the estimation of program impacts can be affected by other factors that change over time. These types of changes can be conceptualized in two broad categories:

1. Changes in the overall economy that affect the residential market in a global way, such as volatile gasoline prices, unemployment rates, or an increase in home heating costs.
2. Individual changes that affect specific homes, such as acquiring new household members, taking a longer vacation, or having a change in one's work schedule

The most common approach to investigating the external factors is to incorporate non-participant billing data by developing a trend line of non-participant consumption patterns, assessing overall changes in non-participant energy consumption during the same period or directly incorporating non-participants' billing records in the regression models.

Collecting the billing data for this analysis was a long and difficult process, and it was not possible collect nonparticipant billing data. It should also be noted that the use of nonparticipant billing data could introduce net effects, such as free ridership or spillover, into the models. In the end, a billing analysis that includes both participants and a nonparticipant comparison group will likely produce savings estimates that are somewhere in between gross and net effects and, thus, difficult to interpret with any degree of accuracy.

Many changes occur over time within homes that are completely outside the influence of the program and yet have an impact on energy use within homes. The approach of including all homes with sufficient billing history in the model is intended to provide a sufficient number of homes in the sample to allow these variations to balance out. This conclusion was supported by a recent residential impact evaluation

which included detailed surveys of homeowners and a restricted billing analysis. This evaluation concluded that modeling the individual changes within each home did not affect the savings estimates.¹⁶

Homeowner surveys were conducted for all participants in the model. The purpose of these surveys was to obtain permission to verify that homes are heating with unregulated fossil fuels, request billing records from fuel dealers, and identify the way that participants used secondary heating sources before and after program services.

Net Effects

The objective of this impact evaluation was to estimate savings for the program, *i.e.*, the reduction in energy use at the home directly due to measures installed through the program.

The analysis included participants only, as obtaining non-participant billing data was not feasible with the time line and budget. However, the participant-only models may also include net effects in the form of participant Inside Spill Over. This type of spillover occurs when a program participant learns about efficiency through the program and then elects to install additional measures on their own at the same location. Since this net effect occurs in response to information learned through program participation, it can only occur after the program-related installation and will tend to reduce consumption during the post-installation period.

Replacement at End of Equipment Life

Water and heating system replacements are the measures which could possibly be market opportunity if the existing equipment was at the end of its useful life. While estimating retrofit savings for market opportunity measures would tend to introduce an upward bias into the evaluated savings, the majority of heating system replacements were fuel switches and there were relatively few water system replacements. Thus, this issue is unlikely to have a substantial impact on the results.

¹⁶ NYSERDA 2007-2008 EMPOWER NEW YORKSM Program Impact Evaluation Report, Prepared for The New York State Energy Research and Development Authority. Prepared by Megdal & Associates, LLC. February 2012.

APPENDIX C: SURVEY DISPOSITION

The table below is a summary of the sample disposition table for the home owner's survey. Less than half of the total participants in the sample were contacted as Abt stopped when the target of 1,200 was reached. The survey is included in Appendix D.

Sample Survey Disposition

Description		Number of Participants in Sample Frame	Percent of Participants in Sample Frame
Total Sample Frame Provided to Abt ¹		4,953	
Used Sample Frame ¹		2,025	100%
Excluded Sample	No working/Unusable number	87	4%
Not contacted	Respondent never available/didn't call back	446	23%
Unknown eligibility	No answer/Busy	105	5%
Not Eligible	Not Eligible/Not Qualified	16	1%
Refused/Break-off		170	8%
Completed Interview		1,201	59%
Contract Rate			76% ^a
Cooperation Rate			88% ^b
Response Rate			63% ^c

¹ Abt (Survey house contractor) only needed to use a portion of the total sample frame to obtain the required 1,200 completes.

a Contact rate = (Completes+refusals+break-offs)/(Completes+refusals+break-offs+not contacted)

b Cooperation rate = Completes/(Completes + refusals + breakoffs)

c Response rate = Completes/[Completes + refusals + breakoffs + not contacted+ (e*(unknown eligibility))] For this study, e = .991

Definitions of Contact Rate, Cooperation rate and Response rate were established by AAPOR (American Association for Public Opinion Research).

APPENDIX D: HOMEOWNERS SURVEY

**Unregulated Fuel Impact Evaluation
Home Performance with ENERGY STAR®: Homeowners Survey
March 6, 2015**

CONTACT INFORMATION SHEET

Respondent Name	
Address	
City/State/ZIP	
Phone	
Customer ID	
Contractor	
Date Work Completed	
Measures Installed SM1-Insulation SM2-Air Sealing SM3-Replacement windows or doors SM4-Heating System SM5-Programmable Thermostat SM6-Water Heater SM7-Hot water conservation measures	
Program Primary Fuel	
Program Fuel Dealer	
Interview Date	
Interviewer Initials	

Section	Purpose	Questions
SCR	Find correct person	SCR1- SCR5
M	Confirm installed measures	M1-M11
BPI	BPI recognition	BPI1-BPI2
HS	Heating system and fuel use information	HS1-HS8
FD	Fuel dealer and delivery	FD1-FD6
B	Barriers to installation	B1-B3
T	Thermostat settings	T1-T5
WH	Water heater	WH1-WH2
OCC	Occupancy changes	OCC1-OCC8
D	Demographic information	D1-D3
C	Consent form reminder/questions; closer question allowing additional comments on Program	C1-C6

SURVEY COMPLETE: FIELD UNREGFUEL=1 AT END OF SURVEY

4.4 FORMATTING NOTES: ALL TEXT IN CAPS (EXCEPT WHEN DENOTING THE ENERGY STAR PROGRAM) IS NOT INTENDED TO BE READ. DIRECTIONS ARE IN SQUARE BRACKETS IN BOLD.

[IF A NAME IS PROVIDED, ASK TO SPEAK WITH NAMED CONTACT. OTHERWISE, ASK TO SPEAK TO AN ADULT (IF NECESSARY). WHEN PERSON COMES TO THE PHONE OR IF PERSON ANSWERING PHONE ASKS WHAT THIS IS ABOUT, READ:]

Phone number to dial: (<area>) <prefix>-<suffix>, ext: <PHEXT>

Interviewer notes: <INTNOTE:O>

Hello, may I please speak to [NAME]?

My name is _____ and I'm calling on behalf of the New York State Energy Research and Development Authority or NYSERDA.

We're calling households that installed efficiency upgrades through NYSERDA's Home Performance with ENERGY STAR Program. We're calling today to ask you some questions about your experience with this Program to help us evaluate how NYSERDA might serve people better. NYSERDA recently sent you a letter telling you that we would be calling.

[READ IF NECESSARY OR ASKS HOW WE GOT THEIR INFO:]

Our records show that you worked with a participating ENERGY STAR contractor to have an energy audit and install efficiency upgrades.

[READ THE FOLLOWING PARAGRAPH FOR ALL RESPONDENTS]

You were selected as part of a carefully designed sample and feedback about your experience with this program is very important to future planning for energy efficiency programs in New York. Your responses to this survey will be kept confidential to the extent permitted by law.

SCR1. I have your name down as the contact for the Home Performance with ENERGY STAR Program. Do you recall installing energy efficiency upgrades through the Home Performance with ENERGY STAR Program?

1. YES [GO TO SCR3]
2. NO
- 96 DON'T KNOW [THANK AND TERMINATE]
- 97 REFUSED [THANK AND TERMINATE]

SCR2. Is there someone else in your household that might be able to help me?

- 1. YES [ASK TO SPEAK TO NEW CONTACT, RESTART AT INTRO]
- 2. NO [THANK AND TERMINATE]
- 96 DON'T KNOW [THANK AND TERMINATE]
- 97 REFUSED [THANK AND TERMINATE]

[ONCE CORRECT PERSON IS ON THE LINE, REINTRODUCE AND CONTINUE.]

This survey will take about 10 minutes to complete, depending on your answers.

[IF NECESSARY]: Can we schedule a time for me to call you back?

[IF NOT A CONVENIENT TIME, SCHEDULE A FOLLOW-UP DATE AND TIME, AND RECORD IT BELOW.]

APPOINTMENT DATE AND TIME: _____

SCR3. Our records show that your address is [ADDRESS] in [TOWN], is this correct?

- 1. YES
- 2. NO – [PLEASE SPECIFY: _____]
- 96 DON'T KNOW [THANK AND TERMINATE]
- 97 REFUSED [THANK AND TERMINATE]

SCR4. Our records also show that your home had energy efficiency upgrades completed by [CONTRACTOR]. Is this correct?

- 1. YES
- 2. NO –NEVER HAD EFFICIENCY UPGRADES DONE AT MY HOME [THANK AND TERMINATE]
- 3. NO –WRONG CONTRACTOR NAME [PLEASE SPECIFY CORRECT NAME]:

- 96 DON'T KNOW
- 97 REFUSED

SCR5. Were all of the energy efficiency upgrades completed in [MONTH/YEAR COMPLETED]?

- 1. YES – [CONTINUE TO NEXT SECTION]
- 2. NO –WRONG YEAR [PLEASE SPECIFY CORRECT MONTH/YEAR]:

- 96 DON'T KNOW
- 97 REFUSED

MEASURE INSTALLATIONS

The next set of questions refers to the efficiency upgrades installed through the Program.

[FOR EACH INSTALLED MEASURE MARKED IN THE SAMPLE FRAME FILE, ASK QUESTION M1, M2 AND M3. FOR MEASURES SM4 AND SM6, CONTINUE WITH QUESTIONS M4 THROUGH M6 AND THEN RETURN TO M1 FOR THE NEXT MEASURE. FOR MEASURES SM1, SM2, SM3, SM5 AND SM7, ASK M1, M2 and M3 ONLY. CONTINUE TO M7 AFTER QUESTION M3 FOR SM7. TABLE 1 PROVIDES THE [MEAS] AND [SMDESC] LANGUAGE USED IN QUESTIONS M1 THROUGH M6. ASK THE SERIES FOR UP TO 4 SPECIFIED MEASURES.]

Table 1.

Survey Measures [MEAS]	Description [SMDESC]
SM1. [INSULATION]	SMDESC1. insulation
SM2. [AIR SEALING]	SMDESC2. air sealing
SM3. [REPLACEMENT WINDOWS OR DOORS]	SMDESC3. high efficiency windows or doors
SM4. [HEATING SYSTEM]	SMDESC4. a high efficiency heating system
SM5. [PROGRAMMABLE THERMOSTAT]	SMDESC5. a programmable thermostat
SM6. [WATER HEATER]	SMDESC6. a high efficiency water heater
SM7. [HOT WATER CONSERVATION MEASURES] (e.g., low flow showerhead, tank wrap, or pipe insulation)	SMDESC7. hot water conservation measures

[START MEASURE LOOP; SM[X]=1 TO MEASNUM. MEASNUM = TOTAL NUMBER OF MEASURES IDENTIFIED IN THE SAMPLE FRAME.]

M1. Did you install SMDESC[X]?

- 1. YES
- 2. NO
- 96 DON'T KNOW
- 97 REFUSED

M2. **[IF X NE 3 AND X NE 7]** Was the MEAS[X] recommended in the Home Performance with ENERGY STAR audit report?

[IF X = 3 OR X= 7] Were the MEAS[X] recommended in the Home Performance with ENERGY STAR audit report?

- 1 YES
- 2 NO

96 DON'T KNOW

97 REFUSED

M3. Were you planning to make this upgrade before receiving the audit?

1. YES

2. NO

96 DON'T KNOW

97 REFUSED

[IF [MEAS[X]] = SM4 OR SM6; ASK M4 THROUGH M6. FOR OTHER MEASURES,IF X=MEASNUM, CONTINUE TO NEXT SECTION. OTHERWISE, GO TO TOP OF MEASURE LOOP.]

M4. Did the new [MEAS[X]] replace your previous [MEAS[X]]?

1. YES

2. NO [LOOP TO M1 IF X < MEASNUM]

96 DON'T KNOW

97 REFUSED

M5. To the best of your recollection, how old in years was the original [MEAS[X]]? [RECORD AGE IN YEARS]

RECORD AGE IN YEARS: _____ RANGE = 1 to 80

96 DON'TKNOW

97 REFUSED

M6. Which of the following best describes the condition of the original MEAS[X]? [RECORD ONE]

1. It was in good working condition.

2. It worked well, but was old and inefficient.

3. It required frequent maintenance.

4. It had serious defects and would probably have been replaced within the next couple of years.

5. It had failed or was about to fail.

6. OR SOMETHING ELSE? [SPECIFY: _____]

96 DON'T KNOW

97 REFUSED

[END MEASURE LOOP]

M7. In addition to incentives or loans provided through the Home Performance Program, did you receive any other incentives or tax credits to help pay for the upgrades?

1. YES

2. NO [GO TO M9]

96 DON'T KNOW [GO TO M9]

97 REFUSED [GO TO M9]

M8. Who provided the other incentives or tax credits?[MULTIPLE RESPONSES ARE ALLOWED.]

1. NYSERDA

2. UTILITY COMPANY

3. STATE GOVERNMENT

4. FEDERAL GOVERNMENT

5. OTHER [SPECIFY: _____]

96 DON'T KNOW

97 REFUSED

M9. Did you install any other energy efficiency upgrades to reduce your heating costs?

1. YES

2. NO [GO TO BPI1]

96 DON'T KNOW [GO TO BPI1]

97 REFUSED [GO TO BPI1]

M10. What other efficiency upgrades did you make to reduce your heating costs.

ENTER DESCRIPTION: _____

97 REFUSED [GO TO BPI1]

M11. In approximately what month and year was this efficiency upgrade installed?

MONTH : _____

YEAR: _____

96 DON'T KNOW

97 REFUSED

BPI QUESTIONS

BPI1. Have you heard of the Building Performance Institute?

1. YES

2. NO [GO TO HS1]

96 DON'T KNOW [GO TO HS1]

97 REFUSED [GO TO HS1]

BPI2. When selecting the contractor, did you look for a BPI contractor?

1. YES

2. NO

96 DON'T KNOW

97 REFUSED

HEATING SYSTEM INFORMATION

[SET UNREGFUEL=1.]

HS1. Which heating fuels do you use? Please list all heating fuels, including space heaters. **[DO NOT READ ON PHONE. LIST ALL ON WEB VERSION, CHOOSE AS MANY AS APPLY]**
WEB Question: Which of the following heating fuels do you use, including space heaters?

1. FUEL OIL

2. NATURAL GAS (NOT PROPANE)

3. LIQUID PROPANE GAS

4. ELECTRIC

5. WOOD

6. WOOD PELLETS

7. KEROSENE

8. OTHER (SPECIFY: _____)

97 REFUSED [SET UNREGFUEL TO 0; GO TO B1]

[SET FUELNUM= NUMBER OF RESPONSES TO HS1 (1 THROUGH 8). IF FUELNUM=1, SKIP TO HS3.]

HS2. Please rank the fuels by how much each one contributes to heating your home, with the primary fuel at the top. **[IF NEEDED:** For example, if you heat with oil and have a wood stove that you use occasionally, oil is ranked as the first fuel and wood as the second. **NOTE TO INTERVIEWER: RANKING IS IMPORTANT, EVEN IF THERE IS LITTLE DIFFERENCE BETWEEN THE USE OF THE FIRST AND SECOND FUELS.]**

- 1 FUEL 1: _____
- 2 FUEL 2: _____
- 3 FUEL 3: _____
- 4 FUEL 4: _____
- 5 ALL FUELS ARE USED EQUALLY

[IF HS2 = 5, ASSIGN FUEL1 TO THE FIRST FUEL SELECTED IN HS1, AND FUEL2 TO THE SECOND, ETC.]

HS3. What was your primary heating fuel prior to your work being done? **[DO NOT READ, CHOOSE ONE]**

- 1. FUEL OIL
- 2. NATURAL GAS (NOT PROPANE)
- 3. LIQUID PROPANE GAS
- 4. ELECTRIC
- 5. WOOD
- 6. WOOD PELLETS
- 7. KEROSENE
- 8. OTHER (SPECIFY: _____)
- 97 REFUSED [SET UNREGFUEL TO 0; GO TO B1]

[IF NO MENTION OF FUEL OIL, PROPANE OR KEROSENE IN HS1 THROUGH HS3, SET UNREGFUEL=0 AND GO TO THE BARRIERS SECTION, STARTING WITH B1.]

[HEATING SYSTEM LOOP I=1 TO FUELNUM.]

HS4. What type of FUEL[I] heating system do you have? **[RECORD ALL THAT APPLY. PROMPT IF NECESSARY.]**

1. HOT AIR FURNACE
2. WATER OR STEAM BOILER
3. RADIANT
4. WOODSTOVE OR WOOD FIREPLACE INSERT
5. PELLET STOVE OR PELLET FIREPLACE INSERT
6. FIREPLACE
7. ELECTRIC BASEBOARD
8. SPACE HEATER
9. OTHER [Please describe type:_____]
- 96 DON'T KNOW
- 97 REFUSED

[IF FUELNUM=1, EXIT HEATING SYSTEM LOOP AND GO TO FD1.]

HS5. Which of the following best describes how you use the FUEL[I] heat since the work was done? **[READ LIST, RECORD ONE]**

1. Throughout the entire heating season from September to May
2. Only during the coldest months from December to February]
3. Only in the Spring and Fall
4. Only on the coldest days
5. Rarely
6. OTHER (SPECIFY: _____)
96. DON'T KNOW
- 97.REFUSED

HS6. Approximately what percent of your living space is heated by the FUEL[I] heating system? **[READ LIST, RECORD ONE]**

1. 100%
2. 81 to 99%

- 3. 61 to 80%
- 4. 41 to 60%
- 5. 21 to 40%
- 6. Less than 20%
- 96 DON'T KNOW
- 97 REFUSED

HS7. Comparing the winter since your work was done to the winter before the work, did you change the way you use your FUEL[I] heat? For example, did you make a decision to increase or decrease the use of your FUEL[I] heat? Please stop me when you hear the appropriate response. **[READ LIST, RECORD ONE]**

- 1. No, I used the FUEL[I] heat about the same during the winter before the work was done
- 2. Yes, I did not use the FUEL[I] heat at all during the winter before the work was done
- 3. Yes, I used the FUEL[I] heat a lot less during the winter before the work was done
- 4. Somewhat less
- 5. Somewhat more
- 6. Or a lot more during the winter before the work was done
- 96 DON'T KNOW
- 97 REFUSED

[END LOOP]

[ASK HS8 AND HS8a IF FUEL1, FUEL2, FUEL3 OR FUEL4 IS WOOD OR WOOD PELLETS.]

HS8. Approximately how many cords of wood did you burn last winter 2013/2014?

- 1. _____ **[RECORD RESPONSE]**
- 96 DON'T KNOW
- 97 REFUSED

HS8a. Approximately how many tons of pellets did your burn last winter of 2013/14?

- 1. _____ **[RECORD RESPONSE]**
- 96 DON'T KNOW

97 REFUSED

FUEL DEALER QUESTIONS

FD1. [IF FUELDEALER1 IS FILLED IN] Our records indicate that you purchase fuel from [FUELDEALER1]. Is this correct?

1. YES

2. NO

96 DON'T KNOW

97 REFUSED

FD2. Have you used more than one fuel dealer during the past five years? [IF FUELNUM>1, ADD:] Please include fuel dealers for all of your heating fuels.

1. YES

2. NO [GO TO FD4]

96 DON'T KNOW [GO TO FD4]

97 REFUSED [GO TO FD4]

FD3. How many fuel dealers have you used during the past five years?

1. TWO

2. THREE

3. MORE THAN 3

96 DON'T KNOW

97 REFUSED

FD4. [IF FD1=YES AND FD2=NO, GO TO FD5.]

[IF FD2=NO, ASK:] What is the name of your fuel dealer?

[IF FD2=YES, ASK:] What are the names of your fuel dealers?

ENTER NAMES: _____

96 DON'T KNOW

97 REFUSED

FD5. Approximately how often do you receive fuel deliveries during the winter months of December through March? Do you receive deliveries ... **[READ LIST, RECORD ONE RESPONSE]**

- 1. Once a month or more often
- 2. Once every two months
- 3. Once or twice a year, or
- 4. When needed
- 5. Other (SPECIFY: _____)
- 96 DON'T KNOW
- 97 REFUSED

FD6. When you receive fuel deliveries, does the fuel dealer fill the tank to capacity... **[READ LIST, RECORD ONE RESPONSE]**

- 1. Every time
- 2. Most of the time
- 3. Some of the time
- 4. Rarely
- 5. Never
- 96 DON'T KNOW
- 97 REFUSED

BARRIERS TO INSTALLATION

B1. Please tell me in your own words why you participated in the Home Performance with ENERGY STAR Program.

1. **[RECORD VERBATIM]**

96 DON'T KNOW

97 REFUSED

B2. Thinking back to before your Home Performance audit, can you tell me why you decided to request the audit and install the efficiency upgrades?

1. **[RECORD VERBATIM]**

96 DON'T KNOW

97 REFUSED

B3. What prevented you from taking action earlier?

1. **[RECORD VERBATIM]**

96 DON'T KNOW

97 REFUSED

[IF UNREGFUEL=0, SKIP TO D1.]

THERMOSTAT USE

T1. How do you control your FUEL1 heat? Do you... **[READ LIST, RECORD ONE RESPONSE; RANDOMIZE RESPONSES 1 TO 3]**

1. Set it at one temperature and leave it

2. Manually adjust the temperature as needed

3. Set it back using a programmable thermostat

4. OTHER, **[SPECIFY: _____]**

96 DON'T KNOW

97 REFUSED

T2. Comparing the winter before your efficiency upgrades were completed to the winter after, did you notice a change in your heating fuel bills?

1. YES

2. NO

- 96 DON'T KNOW [GO TO WH1]
- 97 REFUSED [GO TO WH1]
- T3. After the work was completed, did you change the way you use the FUEL1 heat? Which of these best describes your reaction? **[READ LIST, CHOOSE ONE; RANDOMIZE RESPONSES.]**
1. You turned up the thermostat
 2. You turned down the thermostat
 3. You left thermostat setting the same [GO TO WH1]
- 96 DON'T KNOW [GO TO WH1]
- 97 REFUSED [GO TO WH1]
- T4. Did you change the thermostat setting by 5 degrees or more?
1. YES
 2. NO
- 96 DON'T KNOW
- 97 REFUSED
- T5. Thinking back to before the work was done, how did you control the [FUEL1] heat? Did you... **[READ LIST, RECORD ONE RESPONSE IF RESPONDENT INDICATES MULTIPLE RESPONSES, READ: How do you control the heat in your living room and kitchen?]**
1. Set it at one temperature and leave it
 2. Manually adjust the temperature as needed
 3. Set it back using a programmable thermostat
- 95 OTHER [SPECIFY: _____]
- 96 DON'T KNOW
- 97 REFUSED

WATER HEATING

- WH1. What fuel do you use to heat your water? **[PROMPT IF NECESSARY. IF RESPONDENT SAYS GAS, CLARIFY: Do you heat your water with natural gas or propane?]**
1. NATURAL GAS, NOT PROPANE
 2. ELECTRIC

3. PROPANE
4. FUEL OIL
5. SOLAR WITH ELECTRIC BACK UP
6. SOLAR WITH PROPANE BACK UP
7. OTHER [SPECIFY: _____]
- 96.DON'T KNOW [GO TO OCC1]
- 97.REFUSED [GO TO OCC1]

WH2. What fuel did you use to heat your water prior to the work? [PROMPT IF NECESSARY. IF RESPONDENT SAYS GAS, CLARIFY: Do you heat your water with natural gas or propane?]

1. NATURAL GAS, NOT PROPANE
2. ELECTRIC
3. PROPANE
4. FUEL OIL
5. SOLAR WITH ELECTRIC BACK UP
6. SOLAR WITH PROPANE BACK UP
7. OTHER [SPECIFY: _____]
- 96.DON'T KNOW
- 97.REFUSED

OCCUPANCY

READ FOR ALL

We would like to ask you some questions about any changes you might have had in the number of people living in your home and in your day-to-day schedule before the work and after.

OCC1. Which seasons of the year is your home occupied?

[CHECK ALL MENTIONED. PROMPT IF NECESSARY]

1. ALL FOUR SEASONS (YEAR AROUND)
2. WINTER
3. SUMMER
4. SPRING

- 5. FALL
- 6. OTHER [SPECIFY: _____]

96. DON'T KNOW

97. REFUSED

OCC2. Including all adults and children, how many people currently live in your household more than nine months out of the year?

1. [RECORD NUMBER] Range = 1 to 10, where 10 = 10 or more

96. REFUSED [GO TO OCC4]

97. DON'T KNOW [GO TO OCC4]

OCC3. Thinking back to before the work was done, how many people were living in your home?

1. [RECORD NUMBER] Range = 1 to 10, 10 = 10 or more

96. DON'T KNOW

97. REFUSED

OCC4. Compared to the winter months before the work was done, was there a change in your vacation schedule or the number of weeks when no one was at home? [IF RESPONDENT SAYS NO, RECORD AND GO TO NEXT SECTION. IF RESPONDENT SAYS YES, PROMPT WITH 2 AND 3.]

1. NO, NO CHANGE IN SCHEDULE. [GO TO D1]

2. YES, less time away since the work was done. [GO TO OCC5]

3. YES, more time away since the work was done. [GO TO OCC6]

96 DON'T KNOW [GO TO OCC7]

97 REFUSED [GO TO OCC7]

OCC5. Was the time away since the work shorter by... [READ LIST]

1. More than 2 weeks [GO TO OCC7]

2. Less than 2 weeks [GO TO OCC7]

96 DON'T KNOW [GO TO OCC7]

97 REFUSED [GO TO OCC7]

OCC6. Was the time away since the work longer by... [READ LIST]

1. More than 2 weeks

2. Less than 2 weeks

96 DON'T KNOW

97 REFUSED

OCC7. Did any members of your household have a change in day-to-day schedule when comparing before the work was done in your home and after?

1. YES
 2. NO [GO TO D1]
- 96 DON'T KNOW [GO TO D1]
- 97 REFUSED [GO TO D1]

OCC8. How did the schedule change? Were members of your home... [READ LIST]

1. At home more since the work
2. At home less since the work
3. OTHER [SPECIFY: _____]

96 DON'T KNOW

97 REFUSED

DEMOGRAPHICS

I have a few general questions for statistical purposes. This information will be combined across all respondents and will not be shared with anyone outside of the NYSERDA evaluation team.

D1. What is the highest level of education completed by a homeowner in this household? Please stop me when I reach the correct response?

1. Less than high school
2. High school graduate
3. Some college/vocational or technical school (including Associate's degree)
4. College graduate (Bachelor's degree)
5. Some graduate school
6. Post graduate degree

97 REFUSED

D2. Please stop me when I read the range that contains the total combined income of all members of your household for 2014. **[READ LIST, RECORD ONE]**

1. Less than \$25,000
2. \$25,000 to less than \$50,000
3. \$50,000 to less than \$75,000
4. \$75,000 to less than \$100,000
5. \$100,000 to less than \$150,000
6. \$150,000 to less than \$200,000
7. \$200,000 or more

96 DON'T KNOW

97 REFUSED

D3. And your gender? **[ASK IN WEB VERSION, RECORD IN PHONE VERSION]**

1. MALE
2. FEMALE

BILLING HISTORY RELEASE FORM

[IF UNREGFUEL=0, SKIP TO C5, OTHERWISE, READ THE FOLLOWING]

C1. **[UNREGFUEL=1]** The next step is to sign and mail back the form giving us permission to request your usage information from your natural gas and electric utilities. We will send you the form in the mail, or you may download it from the Internet.

[IF NEEDED: Your usage information will be used to estimate the savings from Home Performance efficiency upgrades. Your usage information will be kept confidential. IF MORE IS NEEDED: Only the aggregated results of the analysis will be made available to the public.]

May I confirm your name, mailing address and e-mail? We have your name as ...

[NAME]

RECORD NAME CORRECTIONS: _____

[ADDRESS]

RECORD MAILING ADDRESS CORRECTIONS: _____

[EMAIL]

RECORD EMAIL CORRECTIONS: _____

C2. [UNREGFUEL=1] If you would prefer to download the form, it is available at XXX. Would you like us to mail or e-mail you the permission form?

1. MAIL
2. E-MAIL
3. NEITHER, WILL DOWNLOAD

C5. Is there anything else you would like to tell us about the Home Performance Program?

1. [RECORD VERBATIM]

97.REFUSED

C6. That is all of the questions I have for you today. We may be conducting a follow-up survey in the next three to four months. Would you be willing to participate?

1. YES
2. NO

97. REFUSED

Please return your billing history release form as soon as possible. Thank you again for your assistance with this study.

APPENDIX E: SURVEY RESULTS MEMO

DATE: November 4, 2015
TO: Judeen Bryne, Tracey DeSimone, NYSERDA
FROM: Kathryn Parlin, Rumbi Vushe, Lucas Sanford-Long, West Hill Energy and Computing
RE: Draft Results from the Survey of Home Performance with ENERGY STAR® Program Participants with Unregulated Fuel Savings, Program Years 2011-2013

1 INTRODUCTION

The Home Performance with ENERGY STAR® Program (HPwES or “Program”) encourages homeowners to implement energy efficiency improvements that will reduce costs and energy use. The program offers comprehensive free or reduced-cost energy audits conducted by a Building Performance Institute (BPI) certified contractor and financial assistance to help qualifying homeowners make energy efficiency upgrades. Audit recipients may choose the HPwES contractor to install recommended measures through the Program or install efficiency measures on their own. Homeowners who participate in the Program are eligible for incentives and the savings for these projects are tracked and reported under the HPwES Program. A substantial proportion of HPwES participants use unregulated fuels such as fuel oil, propane, kerosene or wood as their primary heating source.

This impact evaluation was designed to verify the savings achieved by the Home Performance with ENERGY STAR® Program (HPwES or “Program”) in homes using unregulated fuels for heating. Several previous impact evaluations have estimated the verified natural gas and electric savings, as billing records can be more easily obtained from these regulated utilities.

This impact evaluation has three major components:

1. A survey of participating homeowners to a) verify installation, b) identify all fossil fuel dealer(s) used during the analysis period and c) collect information about household characteristics to inform the billing analysis
2. Collection of the billing records from the fossil fuel dealers
3. Billing analysis

This memo addresses the results of the participant survey. The remaining sections of this memo provide a brief description of the program, an overview of methods, results, and conclusions.

2 PROGRAM DESCRIPTION AND ACTIVITY

The Home Performance with ENERGY STAR® Program (HPwES or “Program”) encourages home and building owners and tenants of existing one- to four-family homes and small low rise buildings to implement comprehensive energy efficiency-related improvements. Improvements and technologies are installed by a participating contractor with at least one employee accredited by the Building Performance Institute (BPI). Eligible measures include building shell measures, such as air sealing and insulation; efficient appliances, such as ENERGY STAR refrigerators; heating measures, such as boilers and furnaces; cooling measures, such as ENERGY STAR room or central air conditioners; water conservation measures; domestic hot water improvements; efficient lighting; and certain renewable energy technologies.

The HPwES Program also offers enhanced assistance to low- to moderate-income households. The “Assisted” component of the HPwES Program is available to residents with up to 80% of area or state median income, whichever is higher.

A wide range of energy efficiency measures are installed through the Program, from screw-in CFLs and replacement refrigerators to insulation and heating system replacements. While the vast majority of measures have net energy savings, specific measures sometimes result in savings from one fuel and additional use of another fuel. This situation occurs due to measures that are designed to shift energy use from one fuel to another and from some measures that are primarily designed to save one fuel, but may cause an increase in consumption of another fuel.

Program tracking by measure is highly detailed and both savings and extra use (which occasionally results when measures switch energy use between two fuel types, such as replacing electric baseboard heat with a natural gas boiler) are recorded for each fuel type.

Table A below shows that a large proportion of households that participated in the survey installed envelope measures (insulation and air sealing). Figure 1 shows that over 90% of the Program reported unregulated fuel savings were associated with heating system repair or replacement, air sealing and insulation measures.

Table A: Measure Installations

Measure Description	Number of Respondents ¹	Percentage of Respondents ¹
Insulation	953	79%
Air sealing	938	78%
Windows or doors	85	7%
Heating System	492	41%
Programmable thermostat	273	23%
Water heater	286	24%
Hot water conservation measures	160	13%
Total Respondents ¹	1,201	

¹ The total number of respondents reflects the unique number of households that installed any of the measures. The columns do not add to total as some participants installed multiple measures.

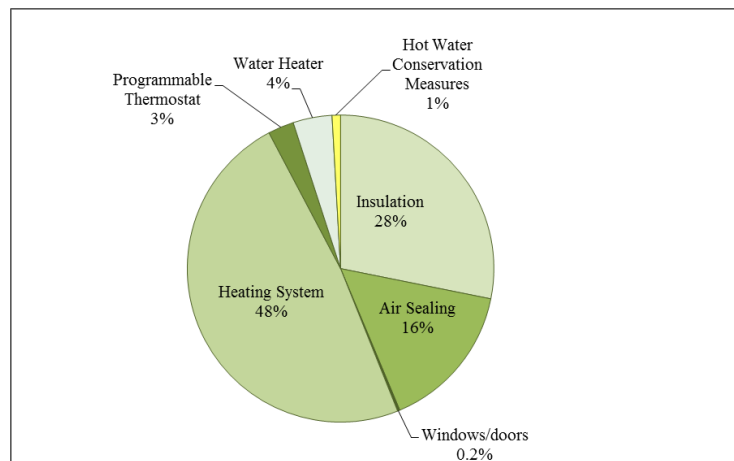


Figure 1: Program Reported Unregulated Fuels Savings by End Use

3 METHODS

This section describes the methods used in the survey analysis. It covers the sample frame, survey fielding, and eligibility for the billing analysis and release form collection.

3.1 SAMPLE FRAME

The sample frame consisted of homeowners who installed measures through the HPwES Program during the period of January 2011 through December 2013 and met the following criteria:

1. Used an unregulated fuel as a primary or secondary heating source during the pre-installation period; participants who switched to natural gas through the Program were included, as well as those who used unregulated fuels in both the pre- and post-periods
2. Had total savings from fuel oil, propane, and kerosene greater than 10 MMBtu; ten MMBtu was chosen as a cutoff as it represents approximately 10% of an average household's fuel consumption, a large enough impact to be identified in the billing analysis¹⁷
3. Had at least one phone number in the program database.

The projects were combined by site ID as some homes had more than one project during the analysis period. This resulted in a sample frame with 4,953 sites.

3.2 SURVEY FIELDING

The survey was fielded in two parts. First, a Web-based survey of participants was fielded by Abt/SBRI between March 31st 2015 and May 11th 2015. Follow up telephone surveys were conducted with those participants who did not respond to the Web survey. Utility release forms to collect fuel dealer data were sent to all respondents who completed the survey. No incentives were offered for completing the survey or returning the signed release form. The survey disposition is shown in Table B.

Table B: Survey Disposition

Description		Number of Respondents	Percent of Respondents
Total Sample Frame Provided to Abt		4,953	
Used Sample Frame ¹		2,025	100%
Excluded Sample	Not working/Unusable number	87	4%
Not contacted	Respondent never available/call back	446	23%
Unknown Eligibility	No Answer/Busy	105	5%
Not Eligible	Not Eligible/Not Qualified	16	1%
Refused/Break Off		170	8%
Completed Interview		1,201	59%
Contact Rate			76%a
Cooperation Rate			88%b
Response Rate			63%c

¹ Abt only needed to use a portion of the total sample frame to obtain the required 1,200 completes.

a Contact rate = (Completes+refusals+break-offs)/(Completes+refusals+break-offs+not contacted)

b Cooperation rate = Completes/(Completes+refusals+breakoffs)

c Response rate = Completes/[Completes+refusals+breakoffs+not contacted+ (e*(unknown eligibility))]. For this study e =.00881

¹⁷The previous billing analyses show that the average heating consumption for HPwES participants with natural gas is about 100 MMBtu per year. (Memorandum of February 4, 2014 from the ERS Impact Evaluation Team to NYSERDA detailing the results of the HPwES Phase I evaluation, Table 1.)

Due to an error in the skip pattern, a number of participants who responded through the Web survey did not answer the questions on heating system controls, hot water use and occupancy. A follow up survey was done for these participants to collect the missing information, but not all participants responded. Consequently, 341(28%) of the 1,201 respondents who qualified for billing analysis do not have responses to those questions. This information is helpful but not necessary for the billing analysis.

A copy of the survey instrument is included as Attachment A.

3.3 ELIGIBILITY FOR THE BILLING ANALYSIS

The sample frame consisted of homeowners who were identified in the program database as having unregulated fuel savings. Respondents were asked to identify their primary heating fuel before and after completing the energy efficiency upgrades. Some survey respondents did not identify an unregulated fuel. Since there was a discrepancy between program records and survey responses, the number of households eligible for billing analysis will be determined by the returned permission forms. For the purposes of this evaluation, unregulated fuels were defined as bulk delivered fossil fuels that include fuel oil, wood pellets, propane and kerosene.

The results of this survey analysis are based on all respondents who participated in the survey. Of the 1,201 homeowners who participated in the survey, 93% (1,112) reported using an unregulated fuel as the primary heating source during the pre-installation period. Out of the remaining 89 respondents, 57% (51) used wood, 27% (24) used either electric or natural gas and the rest reported using coal or provided invalid responses.

3.4 RELEASE FORMS

The actual contract for the work is between the customer and the contractor, however, as part of the contracting process, the participants sign a release form¹⁸ allowing NYSERDA to request billing records from their fuel dealers. However, participants may change fuel dealers over time and/or use multiple fuel dealers; in these cases, one or more fuel dealers may not be listed on the release form and a new release form needs to be obtained.

Consequently, participants needed to be contacted to verify their fuel dealers and ascertain whether an additional release form is needed, the first step in the evaluation was a screener survey. The screener survey was designed to meet the following objectives:

1. Confirm fuel dealer in program records and identify respondents with more than one fuel dealer
2. Obtain name(s) of fuel dealers used but not identified in program records
3. Identify respondents who need to sign an additional release form
4. Confirm measure installations
5. Obtain additional details about heating use and pattern of fuel deliveries to inform the billing analysis

The Impact Evaluation team is currently contacting the fuel dealers to request the billing records.

3.5 MOTIVATIONS FOR PARTICIPATING

The survey included three open ended questions (below) to investigate the reasons for participating and barriers to participation:

¹⁸ The program implementer, Conservations Services Group (CSG), collects and maintains these release forms. CSG is under contract with NYSERDA to deliver the HPwES Program.

1. Please tell me in your own words why you participated in the Home Performance with Energy Star Program.
2. Thinking back to before your Home Performance audit, can you tell me why you decided to request the audit and install the efficiency upgrades?
3. What prevented you from taking action earlier?

These inquiries allow respondents to explain the motivations and barriers to participation in their own words, and provides insights into participant behavior that may be helpful for future program design. In this evaluation, the questions were open ended and responses were not restricted. As part of the survey analysis, the responses were reviewed and coded. The first two questions were analyzed together, as the answers were often similar.

4 RESULTS

The primary goals of the survey was to identify a) all of the fuel dealers used by respondents during the analysis period and b) those respondents requiring an additional release form to collect billing records. The secondary objective was to collect additional information on household characteristics for the billing analysis. The first part of the results section covers the number of fuel dealers and progress in collecting the release forms. The subsequent sections provide information on patterns of household fuel use.

4.1 FUEL DEALERS AND RELEASE FORMS

Both NYSERDA and the fuel dealers require written permission from the HPwES participants prior to requesting billing records. As part of program implementation, all participants sign a release form listing their fuel dealer(s). If one or more fuel dealers used during the analysis period were not listed on the release form collected by the Program or the fuel dealer was missing in the program records, additional efforts are required to collect an updated form.

The number of fuel dealers used provides an indicator of whether an updated release form is necessary and also gives a sense of the level of difficulty of obtaining complete fuel records for the home. Survey respondents were asked the number of fuel dealers they used during the analysis period and whether the program records correctly identified their fuel dealer. Respondents were asked to confirm the fuel dealer listed in the program records. Table C shows the percentage of respondents that reported having one or more fuel dealers over the analysis period.

Table C: Number of Fuel Dealers per Respondent

Number of Fuel Dealers	Number of Respondents	Percent of Respondents
One	798	66%
Two	276	23%
Three	61	5%
More than 3	28	2%
Don't know	38	3%
Total Respondents	1,201	

As of October 9, 2015, there are usable forms for 844 respondents and complete billing data has been received for 327. The original goal was to have 200 homes in the final model, which will most likely require collecting billing data for about 400 respondents as 40% to 50% is typically eliminated in the data cleaning process. The Impact Evaluation Team is currently collecting additional billing data and entering and reviewing the billing data already received. Even under the worst case scenario of 327 respondents with billing data, it is likely that the final model will have about 160 homes, which should be sufficient to

provide reliable results. However, the Impact Evaluation Team is taking steps to ensure that additional respondents can be added to the model.

4.2 CONFIRMATION OF MEASURE INSTALLATIONS

Survey respondents were asked which measures were installed through the HPwES Program and the Impact Evaluation Team compared them to the program tracking records. The findings are discussed below.

- Almost all of the respondents with insulation measures, programmable thermostats and heating system replacements indicated that these measures were installed.
- While only 64% (600) of the respondents with air sealing reported that this measure was installed, another 24% (225) responded “Don’t know,” suggesting a high degree of uncertainty about this measure.

In aggregate, these measures account for 96% of the program savings.

4.3 HEATING FUELS

Survey respondents were asked to identify their primary heating fuel type during the pre-installation period. The percentage of each fuel used as a primary heat source is shown in Table D; the predominant primary fuel is heating oil.

Table D: Primary Heating Fuel during the Pre-Installation Period

Description	Number of Respondents (n=1,199) ¹	Percent of Respondents
Fuel Oil	916	76%
Propane	162	14%
Wood/Wood Pellets	64	5%
Electric/Natural Gas	24	2%
Kerosene	21	2%
Geothermal/Other	12	1%

¹Two respondents refused to answer the question.

About 40% of the survey respondents reported using a secondary heat source. As shown in Table E, more than half of the respondents with a secondary heat source cited wood or electric as a supplementary source of heat.

Table E: Secondary/Supplementary Heating Fuels Used during Post-Installation Period

Description	Number of Respondents (n=1,199) ^{1,2}	Percent of Respondents ²
Electric	278	23%
Wood	183	15%
Propane	74	6%
Wood Pellets	47	4%
Fuel Oil/Kerosene	38	3%
Geothermal/Other	25	2%
Natural Gas	5	0%
No secondary heat	706	59%

¹Two respondents refused to answer the question.

²Multiple responses were allowed and responses reflect all secondary heat use. Thus, the percentages do not add up to 100%.

4.4 FUEL SWITCHES

Fuel switching involves replacing one fuel with another. NYSERDA's HPwES Program offers a variety of options, including switching from one unregulated fuel to another unregulated fuel.

The purpose of the billing analysis is to verify the magnitude of the savings in participating homes using unregulated fuels. When fuel switching is recommended through the Program, the unregulated fuel savings are the amount of fuel that is replaced by another source. Thus, it is possible to include homes that used an unregulated fuel in the pre-installation period, even if they switched to a regulated fuel in the post-installation period. For those participants who switched from one unregulated fuel to a different unregulated fuel, it may be possible to verify both the savings from the initial, replaced fuel and extra use of the new fuel.

The survey included questions about pre-installation and post-installation primary heating fuel; Table F and the below bullets provide specifics on the fuel switching for primary space heat. Four hundred and thirty-eight (438) respondents changed their heating fuel in the post-installation period:

- 49% (216) switched from fuel oil to natural gas.
- 9% (38) switched from an unregulated heating fuel to electric heat, primarily heat pumps.
- Overall, 60% (263) of the 438 respondents switched from an unregulated to a regulated fuel (mostly natural gas) while the rest switched from one unregulated fuel to another.

Table F: Fuel Switching for Primary Space Heat

Pre-Installation Fuel	Number of Homes with Fuel Switches	Number of Homes Switched to a Regulated Fuel	Number of Homes Switched to Another Unregulated Fuel
Fuel Oil/Kerosene	350	240	110
Wood/Wood Pellets	46	4	42
Propane	28	17	11
Electric	12	2	10
Natural Gas	2	0	2
Total Respondents	438	263	175

4.5 FUEL DELIVERY METHODS

A critical part of the billing analysis is determining how much fuel was used during a specific period of time. To interpret the billing records, the Impact Evaluation Team needs to understand the frequency of deliveries and whether the tank was filled at the time of delivery.¹⁹ The participant survey provided the opportunity to assess how often the fuel tanks are filled and whether they are filled to capacity.

The results outlined in Table G, shows that 64% (611) have fuel deliveries once a month or every two months.²⁰ About 23% (221) of the respondents receive deliveries on an as needed basis.

¹⁹ The requests to the fuel dealers explicitly list whether or not the tank was filled for each delivery.

²⁰ The question was asked assuming that the fuel delivery method was consistent over the analysis period. However, it was confusing to respondents who switched fuels. Some of these respondents provided the answer for their previous, unregulated fuel, and others simply said that they were currently using natural gas, electric or geothermal.

Table G: Delivery Frequency of Unregulated Fuels

Description	Number of Respondents	Percent of Respondents
Once a month or more often	373	39%
Once every two months	238	25%
Once every three or four months	21	2%
Once or twice a year	100	10%
When needed	221	23%
Automatic delivery	8	1%
Total Respondents ¹	961	

¹ One hundred seventy-one respondents (171) currently use natural gas or electricity as primary heating fuel and did not respond to this question, 44 responded “don’t know” and 25 were not asked the question due to an error in the skip pattern.

Table H shows how often the fuel tank was filled to capacity. Eighty-two percent (82%) of the respondents reported that the fuel tanks were filled to capacity every time or most of the time. From previous experience with this type of impact evaluation in another jurisdiction, the Impact Evaluation Team has found that it is usually possible to identify the deliveries that are less than a full tank from the number of gallons delivered.

Table H: Fuel Tank Filled to Capacity

Description	Number of Respondents	Percent of Respondents
Every time	679	67%
Most of the time	151	15%
Some of the time	60	6%
Rarely	32	3%
Never	90	9%
Total Respondents ¹	1,012	

¹ One hundred sixty-four respondents (164) reported “don’t know” or refused to answer the question. Twenty-five respondents were not asked the question due to a skip pattern error.

4.6 HEATING SYSTEM CONTROLS

Heating systems are controlled by thermostats, which may be manual or programmable. Understanding how respondents control their heating systems can help to interpret the results of the billing analysis. One example is assessing the occurrence of “snapback,” which occurs when energy bills go down due to efficiency upgrades and homeowners respond by increasing the thermostat setting to be more comfortable.²¹ Snapback has implications for the impact evaluation:

1. Snapback can be considered a non-energy benefit of the Program as program participants are more comfortable
2. If there is snapback, the billing analysis will show lower savings as the home is warmer and uses more energy during the post-installation period

Questions about how the thermostat is used can provide insight into whether snapback is occurring and quantifying the potential size of the snapback may help to explain why the realized savings are lower than the program reported savings.

²¹ See “rebound effect” in the Wikipedia article on Efficient Energy Use, https://en.wikipedia.org/wiki/Efficient_energy_use

The first step in this analysis is to consider the overall heating control strategies and changes in these strategies between the pre- and post-installation patterns. As shown in Table I, the largest change between the two periods is the number of respondents who started using programmable thermostats in the post-installation period.

Table I: Use of Heating System Controls

Description	Percent of Respondents	
	Pre-Installation Period ^{1,2} (n=860)	Post-Installation Period (n=860)
Set at one temperature and leave it	16%	20%
Manually adjust as needed	25%	27%
Set back with programmable thermostat	38%	51%
Other	5%	2%
Don't know	17%	0%
Total ¹	100%	100%

¹ Out of 860 respondents who reported their heating system control use during the post period, about 17% did not know how they controlled their heating system during the pre-installation period.

² Percentages do not add up to 100% due to rounding

To investigate snapback, survey respondents were asked these questions:

- Did you notice a change in your heating fuel bills after the upgrades?
- Did you change the way you use your heating fuel after the work was completed?
 - If the respondents answered yes to the second question, they were asked whether they increased or decreased their thermostat setting by 5°F or more.

Snapback would be expected in homes where respondents reported that they noticed a change in their heating bills and turned the thermostat up (e.g., from 63°F to 68°F).

As shown in Table J, a total of 643 respondents stated that they noticed a change in their heating bills after the installation of the efficiency measures.²² About 52% (389) of these respondents reported leaving the thermostat setting the same after the work was completed; for those that did change the thermostat settings, substantially more respondents reported turning the thermostat down (23%) than turning it up (8%).

²² This survey did not inquire about changes in fuel costs.

Table J: Changes in Thermostat Use

After the work, did you notice a change in heating bills?	Number of Respondents	Percent of Respondents	After the work, did you change the way you use your heating fuel?	Number of Respondents	Percent of Respondents
Yes	643	85%	Turned thermostat up	57	8%
			Turned thermostat down	173	23%
			Left thermostat setting the same	389	52%
			Don't know	24	3%
No	111	15%	Turned thermostat up	7	1%
			Turned thermostat down	15	2%
			Left thermostat setting the same	80	11%
			Don't know	9	1%

Of the 721 respondents who reported either changing their heating system use in the post-installation period or leaving it the same, 100 (14%) reported changing the thermostat setting by 5°F or more. Only 3% (20) of respondents reported that they noticed a change in their heating bill and increased their thermostat setting by 5°F or more. These results suggest that snap back is a rare occurrence.

4.7 WATER HEATING FUEL

Typically, space and water heating equipment are the two largest energy-consuming devices in residential homes. Space heating use is highly dependent on outside temperature, but water heating consumption tends to remain relatively constant throughout the year. To interpret the billing records, evaluators need to know whether the heating fuel is used for both space and water heating, or just one.

About 43% of 942 respondents used the same fuel (oil or propane) for both space and water heating during the post-installation period. As with space heating, some participants changed the water heating fuel after participating in the Program, primarily from fuel oil to natural gas.

Figure 2 provides a summary of these results.

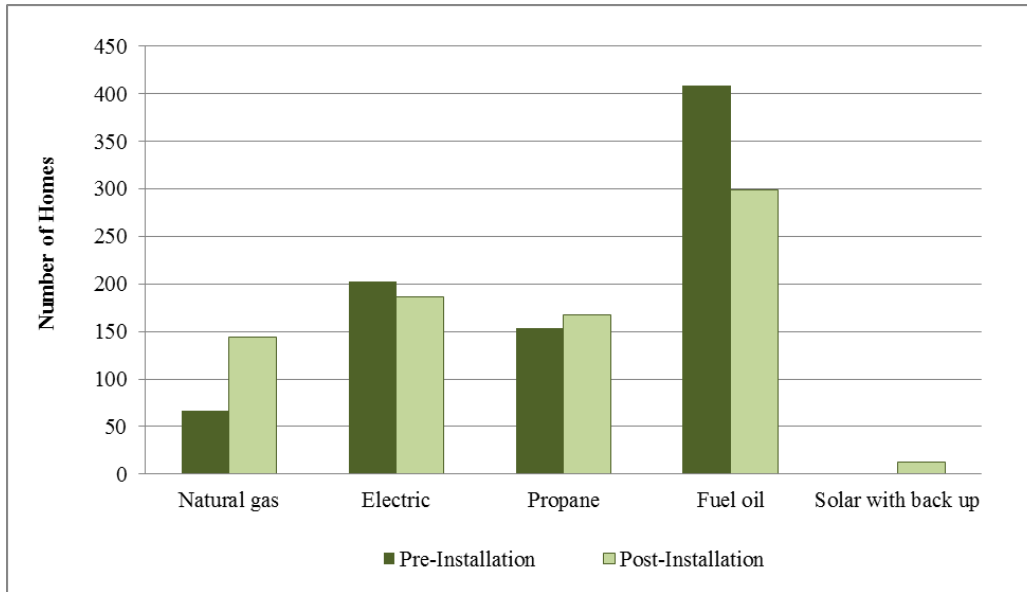


Figure 2: Water Heating Fuel in the Pre- and Post-Installation Period

4.8 REASONS FOR PARTICIPATING IN THE HOME PERFORMANCE PROGRAM.

This section describes the responses to the open ended questions about motivations for, and barriers to, participating in HPwES.²³ One thousand one hundred and eighty (1,180) respondents provided valid answers to questions on motivation for participation and 1,104 respondents provided valid responses to the barriers questions. Motivations are discussed first, followed by barriers.

Motivations

Respondents were asked why they requested the audit and installed measures through HPwES. The key findings are as follows:

- Saving energy and money were the most often cited reasons for participation, with well over half of the respondents mentioning one of these two reasons.
- Over a quarter (315) of the respondents listed improving the comfort of their homes.
- About 20% (237) indicated that they participated to take advantage of the free audit and/or the financial incentives offered by the program.
- Another 16% (193) gave reasons that were unrelated to energy use or other program-related services, such as recently purchasing the home or starting a remodeling project.

The responses are illustrated in Figure 3 below.

²³See Section 3.5 for the wording of the questions and preparation for the analysis.

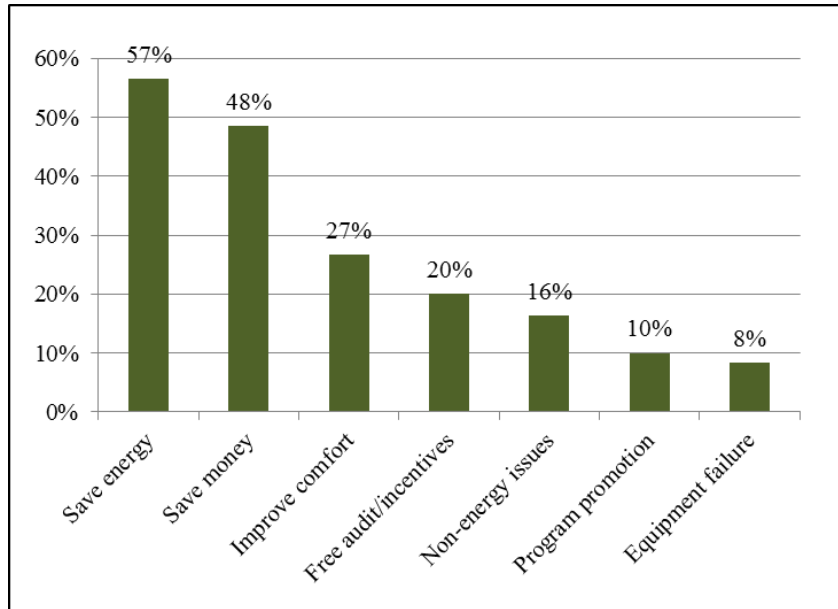


Figure 3: Reasons for Participating in HPwES and Installing Measures

Barriers

The survey question asked why respondents did not take action earlier. Concern about paying for the upgrade was the most commonly cited barrier to taking action to improve the efficiency of the homes, with 35% (414) of respondents. Non-energy related issues, such as recently purchasing the home or procrastination, were the second most common, followed closely by lack of information. Only 2% (23) of respondents indicated that they were concerned about finding a contractor. These results are summarized in Figure 4.

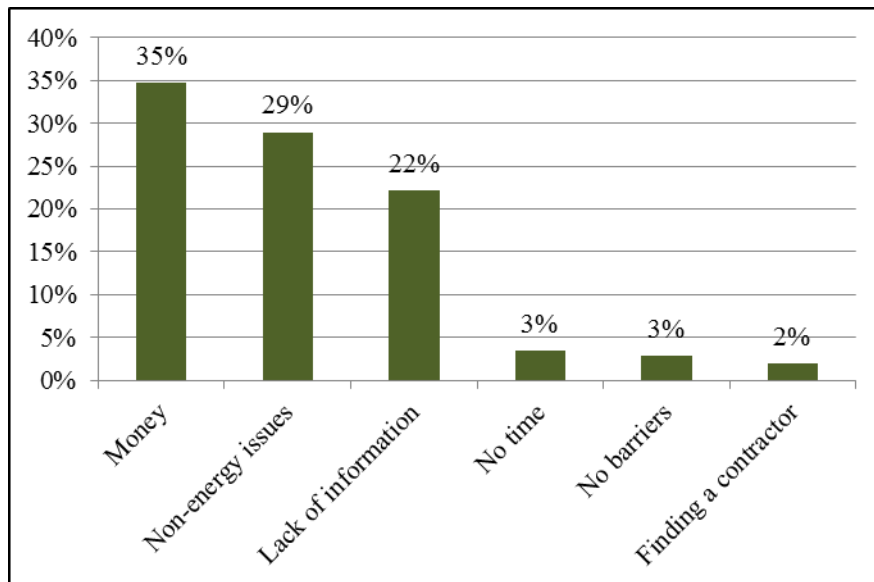


Figure 4: Barriers to Participating in HPwES and Installing Measures

At the end of the survey, respondents were asked if they would like to provide additional comments on any aspect of the Program, and about 600 of the 1,201 respondents did so. Approximately 68% (413) of

the comments were positive, indicating that the respondents were pleased with the results. About 31% (190) were negative, expressing dissatisfaction. The primary sources of concern were 1) the contractor, reflecting either poor customer service and/or poor installation quality, and 2) the savings were less than projected or the project was not worth the cost.

5 CONCLUSIONS

The primary objective of the screener survey was to obtain the release forms for collecting data from the fuel dealers. From the 1,201 respondents, signed release forms have been collected for 844 and complete billing records for 327 to date, and data collection efforts are continuing. From previous experience in other jurisdictions, the original work plan was based on obtaining signed release forms for 1,000 respondents, resulting in receiving fuel bills for about 500 respondents and 200 homes in the final billing model. While the overall number of participants with signed release forms is lower than expected, preliminary data collection efforts suggest that contractor cooperation may be higher. Given the 327 participants with billing records to date, it seems likely that there will be at least 160 homes in the billing analysis, which is likely to be sufficient to obtain reliable results.

The review of household fuel delivery and heating use were reasonably consistent with other, similar evaluations, suggesting that there will not be any unanticipated barriers to the billing analysis. Over 90% of the respondents used either one or two fuel dealers during the analysis period, which simplifies the billing data collection. A large majority of respondents have regular fuel deliveries, and less than half use the same fuel for space and water heating.

The investigation into motivations for, and barriers to, participation provide insight into the mindset of the participating homeowners. While the most often-cited reasons for participation were to save energy and/or money, a smaller but still substantial proportion (20%) wanted to take advantage of the free energy audit and/or incentives and 10% (118) responded to some type of program promotion (home show, recommendations from participating contractors or friends). Concerns about money was the primary barrier, followed by non-energy (or personal) issues and lack of information. Few respondents mentioned lack of time or finding a contractor.

The response rate for this survey was quite high (63%), suggesting that non-response bias is not likely to be an issue. The survey provided the key information needed for identifying which respondents need to sign an updated release form and also for providing an initial assessment of the critical factors affecting the billing analysis.

APPENDIX F: FUEL DEALER DATA COLLECTION DETAILS

As a part of the fuel dealer data collection each fuel dealer was contacted by phone initially to determine if they were willing to provide the fuel delivery records for the customers who had provided permission forms. The phone call was followed with a letter (sample below) including the request details if the dealer was willing to participate. Some reasons data was not provided are included:

- Refused to provided data (no reason given)
- Only provide data to the customer
- No longer had older data
- Did not have a customer on record
- The program-collected permission forms were too old

Sample Letter/Fax/Email:

July 29, 2015

«Fuel_Dealer_Name»

«Dealer_Address»

«Dealer_Town», «Dealer_State»«Dealer_Zipcode»

Dear «Fuel_Dealer_Name»,

Energy and Resource Solutions (ERS), on behalf of the New York State Energy Research and Development Authority (NYSERDA), would like to thank you for your willingness to assist in our evaluation of the Home Performance with ENERGY STAR® (HPwES) Program. This program helps New York homeowners implement energy efficiency improvements by providing energy assessments and assistance with planning, financing, and implementing energy saving measures. Common measures include air sealing and insulation, heating system replacement, and ENERGY STAR® appliances.

The evaluation is designed to measure the savings from these energy efficiency upgrades by comparing the amount of delivered fuel (adjusted for weather) before and after the installations. The cooperation of your company and other fuel dealers makes this important research possible.

At this time we have received consent forms for «Number_of_Customer_Records_Requested» participants that listed «Fuel_Dealer_Name» as their fuel provider. The customer information for these participants is outlined in the table below. Please provide all fuel delivery records available for each customer on the table from the Start Date through the End Date indicated below.

«Fuel_Dealer_Name»Customer Request

Participant Name	Address	City	Zipcode	Fuel Type	Account Number	Start Date	End Date

In order to be able to use the data in our analysis, it must include at a minimum: delivery date, quantity delivered, type of fuel, and whether the tank was filled. Please complete and return the form below with your data to help us interpret your billing system.

Fuel Information Requested	Where to find this in delivery records
Delivery date	
Fuel type	
Amount & Unit of fuel (gallons, etc.)	
Was the tank filled?	

Attached to this letter you will find copies of the signed participant consent forms for each customer. NYSERDA’s analysis will not identify individual participants, and the information provided will be kept confidential to the extent permitted by law.

Fuel records can be returned by the following methods:

Email: HPwES@ers-inc.com

Mail: Energy and Resource Solutions
 120 Water Street, Suite 350
 North Andover, MA 01845
 Attn: Ari Michelson

Fax: 978-521-4588

Should you have any questions about this study, please feel free to contact Tracey DeSimone at NYSERDA, 518-962-1090 ext. 3452 or tracey.desimone@nyserda.ny.gov. Specific questions about this request can be directed to Ari Michelson at ERS, amichelson@ers-inc.com or 978-332-5826.

Sincerely,

Ari Michelson
 ERS Project Manager

APPENDIX G: SOURCES OF UNCERTAINTY

The two major sources of uncertainty, *i.e.*, the presence of secondary heating fuels and variable balance points, are discussed in more detail below.

Secondary Heating Fuels

Almost half of the homes in the analysis (87 of the 207) self-identified as having a secondary heat source in the survey. The use of a secondary fuel causes uncertainty because a change in the use of the secondary fuel can result in an apparent increase or decrease in use that would be attributed to the program. In particular, the use of secondary heating sources like wood or wood pellets can vary based on the difference in cost between wood and oil or propane and/or winter temperatures.

During the survey, respondents were asked about changes in fuel use, and 31 (15% of homes in the model) identified some change in use. However, many respondents appeared to report changes in fuel use due to the Program, *e.g.*, eight reported changing their use due to a fuel switch and 6 reported a decrease in the use of all fuels. These responses indicates that most homeowners did not report a change in the use of secondary fuels.

When compared to the overall realization rate, the homes with a secondary fuel have a slightly lower realization rate (56% vs 60%) that the program overall. This small difference indicates secondary fuel use is unlikely to have much of an impact on the RR.

Variable Balance Points

The balance point of a home is the outside temperature at which the heating system turns on. Thermostat settings and internal gains are contributing factors and the balance point often varies from homes. A pooled billing analysis, however, often treats all homes as if they have the same balance point.

As this analysis was based on conducting house-by-house regressions, there was the potential to model each home with a different balance point. Accordingly, the regression was run for each project using a HDD base of 55, 60, 65 and 70. The the fits of the regression were compared to determine the appropriate HDD base temperature and regression to use for the calculation of savings.

This analysis showed that the HDD base temperature with the highest R^2 did not necessarily relate to the model with the most reasonable estimates, *e.g.*, for many homes using the same fuel for water and space heating, the “best” model resulted in a negative intercept suggesting that there was no base (water heating) use. In addition, the R^2 values varied by only a few percent and the

“best” model tended to be either 70°F or 55°F. The models using 60°F or 65°F generally had more reasonable base use in the intercept models, with fewer negative intercepts or very high intercepts.

Ultimately, the HDD base 60°F was used for all homes in the analysis. A sensitivity analysis was done by calculating the savings using other HDD base temperatures. The realization rate using difference base temperatures ranged from 59% to 61%, which bracket the 60% RR using a base temperature of 60°F. This indicates that the different base temperatures did not have a large impact on the overall results. The Impact Evaluation Team is most confident in the individual regressions using the base temperature of 60°F.