NYSERDA

2007-2008

Home Performance with ENERGY STAR®

Program Impact Evaluation Report

Final

Prepared for

THE NEW YORK STATE
ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

Albany, NY

Carley Murray

Judeen Byrne

Project Managers

Prepared by

MEGDAL & ASSOCIATES, LLC

430 Old Ayer Road

Groton, MA 01450-1874

Phone: 978-448-3130

Principal Investigators:
Kathryn Parlin, West Hill & Energy Computing, Inc.

Lori Lewis, Ph.D. and Juliet Nelson Ph.D., Megdal & Associates, LLC

NYSERDA
September 2012

NOTICE

This report was prepared by Megdal and Associates, LCC., in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority (hereinafter the "Sponsor"). The opinions expressed in this report do not necessarily reflect those of the Sponsor or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, the Sponsor, the State of New York, and the contractor make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. The Sponsor, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

Abstract

The New York Home Performance with ENERGY STAR® ("HPwES" or "the Program"), administered by NYSERDA, is a comprehensive retrofit program targeted to existing one- to four-family residential homes, providing electric reduction measures (lighting, refrigerator replacements, space and water heating and more efficient air-conditioning), and home performance measures (insulation, air-sealing, windows and doors, and heating system replacement). The purpose of this impact evaluation of the HPwES program is to establish first year energy savings for HPwES projects completed in 2007 and 2008.

The primary vehicle for estimating savings was a statistical analysis of utility bills covering the pre- and post-installation periods. The rigorous analysis had multiple components with both internal and external validation to ensure that the results of the billing analysis were within a reasonable range. The realization rates of 35% and 65% for electric and natural gas savings, respectively, were applied to estimate evaluated gross savings for 2007 and 2008.

In addition, net program impacts incorporating self-report free ridership (FR) and spillover (SO) were estimated from telephone surveys of participating homeowners, formerly-participating contractors and contractors who had never participated in the Program. The overall net-to-gross ratio (NTGR) was 1.74, indicating that the total net HPwES program impacts are 1.74 times the evaluated gross savings. The NTGR consisted of a FR rate of 20%, participant inside and outside spillover of 14% and 14% (respectively), and non-participant spillover of 66%.

Acknowledgements

This report was prepared with input from Carley Murray, Judeen Byrne, Jennifer Meissner and Patrick O'Shei of NYSERDA's evaluation team and Karen Hamilton, John Ahearn, Bryan Henderson, Laura Bunzey, Beverly Bendix, and Christopher Coll from NYSERDA's Residential Energy Services Program staff.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

List of figures

Glossary of Acronyms and Definitions[1]

AAPOR - American Association for Public Opinion Research – A leading association of public opinion and survey research professionals.

ANCOVA (Analysis of Covariance) - A type of regression model also referred to as a "fixed effects" model. This model allows each individual to act as its own control. The unique effects of the stable but unmeasured characteristics of each customer are their "fixed effects" from which this method takes its name. These fixed effects are held constant.

Autocorrelation - Autocorrelation occurs when observations in a regression model are not independent; the consequence of uncorrected autocorrelation is typically higher calculated statistical precision than is actually the case

Billing Analysis - Estimation of program savings through the analysis of utility 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.

Collinearity - Collinearity refers to the situation where two or more independent variables in a model are highly correlated, such as when two measures tend to be installed together. Collinearity results in higher variances for both predicted and explanatory variables and creates difficulty in partitioning variance among the competing explanatory variables.

Construct Validity - The extent to which an operating variable/instrument accurately taps an underlying concept/hypothesis, properly measuring an abstract quality or idea.

Contact Rate - This is one of the final disposition and outcome rates for surveys defined by the American Association for Public Opinion Research (AAPOR) [2] The contact rate has all outcomes where an eligible respondent was reached and the interview attempted divided by these plus those not contacted. The three contact rate outcomes are: completes, refusals and break-offs (the numerator of the contact rate).

Cooperation Rate - This is one of the final disposition and outcome rates for surveys defined by the American Association for Public Opinion Research (AAPOR)[3]. The proportion of all cases interviewed of all eligible units ever contacted. Those contacted (the denominator) includes completes, refusals and break-offs.[4]

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

---

[1] Parts of the glossary are taken from the *2004 California Evaluation Framework*, which was prepared for the California Public Utilities Commission and the Project Advisory Group in September 2004 by a Team led by TecMarket Works and included a lead role by one of the authors of this report from Megdal & Associates.

[2] American Association for Public Opinion Research (AAPOR) 2011. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, Revised 2011. Each of the rates presented here has multiple more specific categories and definitions provided by AAPOR. *Standard Definitions* is available on AAPOR website: www.aapor.org

[3] *Ibid.*

[4] *Ibid.*

Correlation Coefficient (R) - A measure of the linear association between two variables; in linear regression, it is the square root of the coefficient of determination and measures the linear relationship between the response (dependent) and predictor (independent) variables; the sign indicates whether the relationship is positive or negative.

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

Evaluated Gross Savings – The verified change in energy consumption and/or demand that results directly from program-related actions taken by participants in the program, regardless of why they participated.

FR - Free Riders, Free Ridership - A program participant who would have implemented the program measure or practice in the absence of the program.

Heteroskedasticity - Heteroskedasticity occurs in a regression model when there are subpopulations within the model with unequal variances. Heteroskedasticity does not bias the regression coefficients but can bias the standard errors and standard statistical tests.

Market Effects - A change in the structure or functioning of a market or the behavior of participants in a market that result from one or more program efforts. Typically these efforts are designed to increase in the adoption of energy efficient products, services, or practices and their subsequent energy savings, and are causally related to market interventions.

MW – A megawatt is one thousand kilowatts (1,000 kW). A megawatt or kilowatt is a measure of the amount of electricity delivered to users at a given point in time. It reflects the demand for power at that point in time.

MWh – A megawatt hour is one thousand kilowatt hours (kWh) and measures of the amount of electricity used over time. If a 60W light bulb is on for one hour, it uses 60 Watt hours or 0.060 kWh.

Model Misspecification - This covers large areas of regression misapplication in which the model chosen omits relevant explanatory variables, includes irrelevant explanatory variables, ignores qualitative changes in explanatory variables, or accepts regression equations with incorrect mathematical form.

Non-Participants/ Non-Participating - Any customer or contractor who was eligible but did not participate in the program under consideration. Non-participating contractors can include contractors that have never participated in the program and contractors that formerly participated, prior to the year(s) being evaluated and have not participated since then.

NTG, NTGR – Net-to-Gross, Net-to-Gross Ratio – The relationship between net energy and/or demand savings, where net is measured as what would have without the program, *i.e.*, occurred naturally, and evaluated gross savings. The NTGR is the ratio of net savings to program reported savings. For NYSERDA programs, the NTGR is defined as one minus free ridership plus spillover (1 – FR + SO).

Program Year, PY – The calendar year when a HPwES project was completed.

R^2, R-squared - Proportion of variability in a regression data set that can be explained by the model.

Refusal Rate – This is one of the final disposition and outcome rates for surveys defined by the American Association for Public Opinion Research (AAPOR). [5] The proportion of all cases in which an eligible respondent refuses to be interviewed, or breaks-off an interview, of all potentially eligible cases.

Response Rate - This is one of the final disposition and outcome rates for surveys defined by the American Association for Public Opinion Research (AAPOR) [6] The response rate estimates the fraction of

[5] *Ibid.*

all eligible working numbers where a request for an interview was made. The denominator of this ratio is inclusion of all possible components where a request for an interview could be attempted. More specifically the response rate is the number of completed interviews divided by the sum of: completes, refusals, break-offs, not contacted and the figure estimated for unknown eligibility. Response rate = (Completes)/(Completes+refusals+break-offs+not contacted+(e*(unknown eligibility)).

SO – Spillover: Includes **Participant Inside Spillover (ISO)** and **Participant Outside Spillover (OSO)** and **Non-Participant Spillover** -- Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program, beyond program evaluated gross savings of participants. The rates are these savings estimates divided by program reported savings.

- "Inside" spillover occurs when, due to the project, additional actions are taken to reduce energy use at the same home, but these actions are not included as program savings.
- "Outside" spillover occurs when an actor participating in the program initiates additional actions that reduce energy use at other sites that are not participating in the program.
- "Non-participant spillover" is the reductions in energy consumption and/or demand from measures installed and actions taken or encouraged by non-participating vendors or contractors because of the influence of the program.

***t*-value –** The t-value of a regression coefficient measures whether the value of the coefficient is statistically different from zero. The statistic is the coefficient over its standard error.

[6] *Ibid.*

Executive Summary

This report provides a detailed description of the impact evaluation conducted for the New York Home Performance with ENERGY STAR® Program ("HPwES" or "Program") for projects installed in 2007 and 2008 (referred to as 2007 and 2008 program years in this report). The Executive Summary provides a brief description of the Program, the evaluation approach, the results by measure, net-to-gross (NTG) component and net-to-gross ratio (NTGR) results, results for the non-energy research, and recommendations for the HPwES program and future impact evaluations.

PROGRAM DESCRIPTION

The Home Performance with ENERGY STAR Program encourages home and building owners and tenants of existing one- to four-family homes to implement comprehensive energy efficiency-related improvements and technologies by contractors accredited by the Building Performance Institute and participating in the HPwES program. Eligible measures include building shell measures, such as air sealing and insulation; appliances, such as ENERGY STAR refrigerators; heating measures, such as boilers and furnaces; cooling measures, such as ENERGY STAR room or central air conditioners, and certain renewable energy technologies.

The HPwES program is designed to offer 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 median income, or 80% of state median income, whichever is higher for the county.

EVALUATION APPROACH AND METHODS

The primary purpose of this impact evaluation was to establish first year evaluated gross and evaluated net energy savings for program years' (PY) 2007 and 2008 participants. The primary vehicle for estimating evaluated gross savings was a billing analysis covering the pre- and post-installation periods. Evaluated net savings were obtained by developing a net-to-gross ratio (NTGR) that was applied to the evaluated gross savings. The NTGR was developed from estimates of free ridership (FR) to account for participants who would have installed energy efficiency measures in the absence of the Program, and spillover (SO) to address savings induced by the Program but not included in the Program reported savings. The information used to create the NTG component estimates was gathered from telephone surveys with participating homeowners, participating contractors and non-participating contractors.

Billing analysis was selected for this evaluation due to the characteristics of the HPwES program. Billing analysis is appropriate for retrofit programs where energy-intensive equipment is removed and replaced with high efficiency alternatives and also when the Program savings are expected to be 10% or more of the total consumption. HPwES meets both of these criteria.[7]

Bias and sampling precision are two critical factors that affect the underlying reliability of evaluation results. For a large scale regression model, as was conducted for the HPwES program, there is no sampling as all participants with sufficient billing history are included in the models. Thus, the primary concern for this evaluation was the possibility of bias.

[7] TecMarket Works. *2004 California Evaluation Framework*, prepared for the California Public Utilities Commission and the Project Advisory Group, September 2004, page 101.

Two primary types of bias were considered. The first potential source of bias is that participants without available or sufficient consumption history were excluded from the model (attrition). The second is the extent to which external influences could create change in energy usage and affect the results of the billing analyses.

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. Two aspects of the selected evaluation methods were designed to minimize the impacts of attrition, as explained below.

- Analysis Method: Realization rates were determined by measure group for homes in the model and then applied by measure group to the Program population, which assumes that the realization rates are similar between the homes in the model and the total program. The alternative approach of estimating the evaluated gross savings per measure group would assume that the estimated savings per home (which would reflect the size of the homes and the climate zones of the homes in the model) are the same between the model and the total program projects.
- Regression Model: A fixed effects regression model was used. The fixed effects model compares each home to itself, which means that house-specific differences that are consistent across the analysis period are addressed in the regression analysis.

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.

Some of the critical factors that are unlikely to be affected by attrition in the context of this study and the applied methods are weather effects (directly included in the model), the fixed characteristics of the homes (housing stock, appliance holdings, etc.), the mix of measures, and program delivery strategies (which were constant over all projects). Issues that may potentially introduce bias into the regression results are described below.

- 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. Of the 25 contractors with more than 100 HPwES completed projects during program years 2007 and 2008, there were three that had no homes included in the billing models. This potential source of bias was assessed through a supplemental analysis, as described below, and ruled out.
- Some participants moved during the analysis period and cannot be included in the analysis since the billing records do not cover the critical months before and after the installation. Thus, participants who tend to move often are effectively removed from the analysis as a group. 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.

Overall, the attrition was substantial and all but three utilities were removed from the billing analyses. The largest potential source of bias was the removal of New York State Electric and Gas (NYSEG), Rochester Gas and Electric (RG&E) and National Fuel, as the utilities that could not provide billing data in a format conducive to this evaluation within the required time period.

After completion of the analyses conducted for this evaluation, the Impact Evaluation Team conducted a supplemental analysis of HPwES program activity in 2010 and 2011. This billing analysis included only homes in National Fuel, NYSEG and RG&E territories and homes completed by all three large contractors omitted from the original modeling.[8] This preliminary billing analysis determined that the realization rates for electric and natural gas savings were somewhat higher, but within the confidence intervals of the results presented in this report, *i.e*., the two realization rates from different populations participating at different times and with no overlap in the utility territories were not found to be statistically different. The memo presenting the results from this preliminary analysis is included in Appendix F.

Another possible source of bias is that external influences, such as economic factors or changes in a household composition, could drive changes in energy consumption. This hypothesis was tested in three ways:

1. A restricted billing analysis was conducted using the results of the Energy Change survey to determine whether within-home changes are likely to introduce a bias to program evaluated savings.[9] This exercise was implemented by defining and running numerous models to determine whether there were any changes in the estimated household savings when additional non-program changes were included in the model.
2. Non-participants were added to the billing model to try to incorporate market effects, although this approach was conducted only for comparison purposes as it incorporates net effects in the model and it is not possible with this method to estimate gross savings.
3. Trend lines using publicly available data on gasoline prices and the unemployment rate were included in the billing analysis as an alternative method to incorporate market effects.

The restricted billing analysis was based on a telephone survey of participating homeowners. This survey was conducted to obtain information on non-program impacts that would be likely to affect household energy use, such as changes in occupancy, additions of new equipment and replacing old equipment with new equipment. The wording of the Energy Change survey was carefully designed to aid recall as participants were asked about events that occurred three to four years prior to the survey.

The full billing analysis included all participants with sufficient, uninterrupted and reliable billing records. A fixed effects regression model which addresses house-to-house differences was used. A variety of modeling configurations were tried, beginning with the simplest configuration to estimate savings by household and moving to the inclusion of additional variables to model the installation of specific measure groups. The models were evaluated using a statistical method known as the information-theoretic approach and also considered the ability of the model to improve the estimation of savings. The evaluated gross savings by measure group and for the Program as a whole were based on the results from this model. Regression diagnostics were conducted to assess the validity of the results.

RESULTS

The final models used to estimate evaluated gross program savings were the full regressions models with participants only, no trends lines and measure-level savings. Household savings were also estimated in alternative models, and the savings were found to be similar to the aggregated results of

[8] For this supplemental project, NYSEG and RG&E provided billing data in a different format that addressed the earlier issues that led their data to not be included in the initial evaluation analysis.

[9] "Restricted" billing analysis refers to the fact that only participants who completed the telephone survey were included in the regression model.

the measure-level models. While measure-level results can be variable, particularly for measures with only a few households in the model or measures with small savings, the results of the household models support the use of the final models to estimate total gross savings for the Program for PY2007-2008.

The results of the regression diagnostics suggest that the estimated savings from the natural gas model are reliable and stable. The electric model is less stable, and all alternative models suggest that the actual savings may be lower than estimated savings from the final model used in this evaluation. Natural gas is the predominant energy savings in the Program.

Alternative models were also used to test the impacts of external effects, as discussed above. The results of the restricted model indicate that non-program, within-home effects are not contributing to bias in the final savings estimates. The non-participant and trend line models produced lower savings than the final models, suggesting that market effects are having a downward impact on program savings. However, since interpretation of the alternative models is not clear and the magnitude of the adjustment due to market factors could not be determined with certainty, the Impact Evaluation Team based the evaluated savings on the final models with participants only and without the trend lines.

ELECTRIC MODEL MEASURE SAVINGS RESULTS

An overall realization rate for electricity savings of 35% was obtained from the full billing analysis. There was no sampling and all participants with sufficient and reliable billing data were included in the model. Table ES-1 shows the number of PY2007-2008 projects, the program reported savings, the evaluated gross annual kWh by measure, the realization rate by measure group and the percent of program reported savings associated with the measure group. Lighting, water heater fuel switches and envelope measures, in aggregate, account for three-quarters of the total program reported savings. The two measures (lighting and water heater fuel switch) that make the largest contribution to the total program savings have realization rates of 29% and 33%, respectively. These measures are the major driver for the HPwES electric realization rate of 35%.

Table ES-1. Electric Savings by Measure Group Regression Categories

Measure Group[1]	2007-2008 Projects with Measure[1]	Program Reported Annual kWh[1] Saved	Evaluated Gross Annual kWh[1]	Realization Rate	Percent of Program Reported Savings
ENERGY STAR Lighting	2,335	1,598,460	457,641	29%	36%
Water Heater Fuel Switch	135	1,103,605	359,657	33%	25%
Envelope (*e.g.*, insulation, air sealing, windows and doors)	1,871	629, 045	477,553	76%	14%
Heating System Fuel Switch	35	530,977	155,613	29%	12%
ENERGY STAR Air Conditioning	577	223,746	185,417	83%	5%
ENERGY STAR Refrigerator Replacement	316	206,836	166,999	81%	5%
Water Heater Replacement[3]	323	147,434	0	0%	3%
ENERGY STAR Appliance Replacement (*e.g.* dishwasher, clothes washer)[3]	244	121,133	1,065	1%	3%
Programmable Thermostats[3]	730	74,763	0	0%	2%
Heating System Replacement	33	53,359	44,917	84%	1%
Water Heating Conservation	44	17,173	22,248	130%	0%
Heating System Conservation[2]	100	12,066	12,066	100%	0%
Extra Energy Use – Heating System Replacement[4]	6	(5,461)	0	0%	0%
Extra Energy Use- Other Measures[2, 4]	503	(103,569)	(103,569)	100%	-2%
Extra Energy Use – Water Heater Replacement[2, 4]	52	(6,672)	6,672)	100%	0%
Extra Energy Use – Heating System Fuel Switch[4]	13	(111,644)	(190,875)	171%	-2%
Totals		**4,491,251**	**1,582,060**	**35%**	

[1] Project counts and kWh are divided in this table into those with positive savings versus those with extra use. Measure groups are selected to best match the categories in the final regression model.

[2] These measures were not included in the final regression model; for most measures, there were no homes with these measures in the final regression model. A realization rate of 1.00 was assumed.

[3] There are a few measures with savings that could not be effectively estimated through the model due to the low number of homes in the model, low savings per project or other issues. The realization rates for these measures: appliances, programmable thermostats and water heater replacements, should not be used to make program or policy decisions.

[4] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, generating savings of one fuel type while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

For both lighting and water heater fuel switches, it appears that the Program reported savings per household may be high. The Federal "ENERGY STAR Change the World" campaign estimates average annual residential lighting consumption at 1,950 kWh. Lighting was projected to save 684 kWh per year

per home, which is 35% of the total average residential lighting load[10] and 8% of total average electric use in New York State, suggesting that the 684 kWh per year per home is a high estimate of potential savings. For water heater fuel switches from electric to natural gas, the Program reported savings are 8,175 kWh per year on average for each home. These savings are substantially higher than estimates of total residential household water heating consumption. For example, one analysis of consumption patterns in New York State (2005) indicates residential water heating requires about 2,526 kWh per year.[11]

NATURAL GAS MODEL MEASURE SAVINGS RESULTS

An overall realization rate for natural gas savings of 65% was obtained through the full billing analysis. Envelope measures, including insulation, air sealing, windows and doors, account for almost three-quarters of the claimed natural gas savings and are a very strong driver of the final natural gas realization rate. The realization rate for envelope measures was 53%, indicating that the methods used by the Program are resulting in overstatement of savings for these measure types. It is not uncommon to find that engineering estimates of heating-related measures overstate the actual savings.[12] Heating system replacements has the second largest proportion of claimed savings and obtained a robust realization rate of 101%. Table ES-2 provides additional details on the measure group analysis for the natural gas model.

[10] ENERGY STAR Change the World, *Start with ENERGY STAR*, 2011 Campaign General Assumptions Sheet.

[11] Patterns and Trends: New York State Energy Profiles: 1995 to 2009, NYSERDA, January, 2011, Appendix B.

[12] One issue is that engineering models do not address behavioral changes. For example, some participants may increase the thermostat settings when they can improve the comfort level without generating excessively high heating bills. Another possibility is that the billing analysis automatically incorporates interactive effects among heating-related measures and actual interactive effects could be larger than estimated in the analysis tools used by the Program.

Table ES-2. Natural Gas Savings by Measure Group Regression Categories

Measure Group	2007-2008 Projects with MMBtu Savings	Program Reported Annual MMBtu Saved	Evaluated Annual MMBtu Saved	Realization Rate	Percent of Program Reported Savings
Envelope (*e.g.*, insulation, air sealing, windows and doors)	6,430	192,463	101,351	53%	72%
Heating System Replacement	2,523	70,744	71,620	101%	26%
Programmable Thermostats	2,023	19,615	13,282	68%	7%
Water Heater Replacement[3]	1,141	9,959	16,060	161%	4%
Heating System Conservation[1]	175	1,524	1,524	100%	1%
ENERGY STAR Appliance Replacement (*e.g.* dishwasher, clothes washer)[3]	245	1,036	2,922	282%	0%
Water Heating Conservation	145	538	0	0%	0%
Heating System Fuel Switch[1]	4	521	0	0%	0%
Water Heater Fuel Switch[1]	8	335	335	100%	0%
Extra Energy Use – Other Measures[4]	350	(394)	(394)	100%	0%
Extra Energy Use – Heating System Replacement[4]	14	(445)	(412)	93%	0%
Extra Energy Use - Water Heater Fuel Switch[4]	103	(3,040)	(9,744)	321%	-1%
ENERGY STAR Lighting/ Refrigerator[2]	1,879	(3,081)	0.00	0%	-1%
Extra Energy Use – Heating System Fuel Switch[4]	242	(22,740)	(24,089)	106%	-8%
Totals	**--**	**267,035**	**172,455**	**65%**	

[1] These measures were not included in the final regression model; for most measures, there were no homes with these measures in the final regression model. A realization rate of 1.00 was assumed.

[2] Many homes had assumed extra use for refrigerators and lighting. These measures were included in an interim model, and no extra use was found.

[3] There are two measures with savings that could not be effectively estimated through the model due to the low number of homes in the model, lower savings per project or other issues. The realization rates for appliances and water heater replacements should not be used to make program or policy decisions.

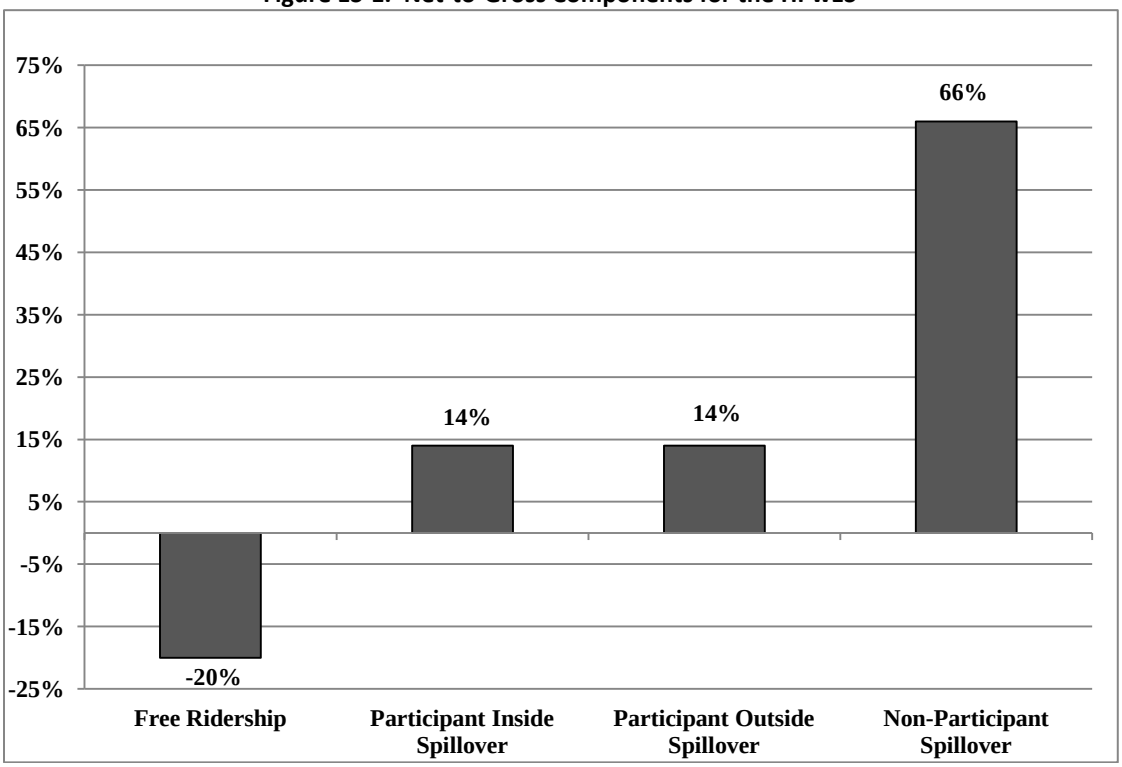
[4] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, creating savings of one fuel while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

NET-TO-GROSS RESULTS

Self-report telephone surveys were conducted to obtain the information to estimate the net-to-gross components and derive a net-to-gross ratio (NTGR). The NTGR is used to calculate net savings. The NTGR follows the formula: 1 minus FR (as the Program's true impact is reduced by those that would have increased efficiency without the Program) plus the various types of spillover (SO). The FR rate was

estimated at 20%, inside spillover rate was 14%, participant outside spillover rate was 14% and the non-participant spillover rate was 66%. Combining these NTG components within this formula resulted in an overall NTGR of 1.74 (1 – 0.2 + 0.14 + 0.14 + 0.66). These rates are illustrated in Figure ES-1.

Figure ES-1. Net-to-Gross Components for the HPwES



EVALUATED NET IMPACTS

Table ES-3 summarizes the overall evaluated net impacts for electricity and natural gas.

The net annual electric savings from HPwES for program year 2007-2008 are 2,753 MWh per year. The kW coincident peak savings associated with these are 2.07 MW. The net natural gas savings from HPwES for program year 2007-2008 are 300,071 MMBtu per year. HPwES generated a net 400,250 MMBtu per year of fossil fuel savings for program years 2007 and 2008. The 90% confidence interval (CI) on the realization rate for natural gas is plus or minus 7.2%. The CI on the electric realization rate is plus or minus 22.1%. The high degree of variability in the electric model estimates is partially due to low magnitude of the savings compared to overall electric usage. However, the electric savings are only a small part of the overall savings. When the electric savings are converted to source MMBtu and combined with the natural gas savings, the electric savings account for less than 1% of aggregated savings. The relative precision of the aggregated savings is about 7% at the 90% confidence level.[13]

[13] The electric kWh savings were converted to source MMBtu using the New York specific conversion rate provided by NYSERDA.

Table ES-4. Summary of 2007-2008 HPwES Savings

	Annual Electric Savings (MWh[1]/Yr)	Summer Peak Demand Savings (MW)[2]	Annual Savings for All Other Fuels[3] (MMBtu/Yr)
NYSERDA Program Reported Savings	4,545		353,890
Realization Rate	35%		65%
Evaluated Gross Savings[4]	1,582	1.19	230,029
Net-to-Gross Ratio	1.74	1.74	1.74
Evaluated Net Impact	2,753	2.07	400,250

[1] A megawatt-hour is 1,000 kilowatt-hours.

[2] This program's target is energy savings and demand savings are not estimated by the Program. The evaluated demand savings are derived from calculations from a demand to kWh ratio of the measures applied to the evaluated energy savings.

[3] The realization rate from the impact evaluation of natural gas is used as the realization rate for the other fossil fuel savings. Non-natural gas fossil fuel savings includes oil, propane, kerosene, wood and pellets. Natural gas covers two-thirds of the fossil fuel savings.

[4] The 90% confidence interval on the realization rate is plus or minus 7.2% for natural gas and 22.1% for electricity. The confidence band on the realization rate reflects variability in the models, not sampling precision, as no sampling was conducted for this analysis. All homes with sufficient billing records were included in the models. Most of the Program savings (with electric savings converted to MMBtus) are the natural gas savings so that the overall precision is 7%.

RESULTS FROM INITIAL INVESTIGATION INTO EQUIPMENT REPLACEMENT

This impact evaluation expanded on previous evaluations of HPwES by adding questions to the participant surveys on the age and condition of the existing equipment prior to the efficient upgrade made through the Program. The primary finding is that most of the equipment replaced is significantly older than the normal manufacturers' claims on expected useful life. Over half (53%) of the participants reported having replaced equipment that was 20 years old or older. While only a few participants reported that the equipment had failed prior to replacement through HPwES, many participants also reported that the existing equipment had required frequent maintenance and was expected to fail within one to two years. Just over one-third (36%) of those who replaced their heating equipment reported that it was in reasonable condition and they did not expect it to quit in the next few years.

The issues surrounding early replacement of equipment appear to be more complicated than initially thought, since some of the information could be interpreted in more than one way. It is possible that the advanced age of the existing equipment is evidence that consumers will not replace an expensive item until absolutely necessary unless they are provided with a financial incentive. However, it is also possible that the fact that the existing equipment is old and required frequent maintenance demonstrates that they would have replaced it in the next few years anyway, without another impetus. The survey did not provide insight into this critical issue and further research in this area is recommended.

PROGRAM RECOMMENDATIONS

The recommendations provided are based upon the findings of this evaluation and the Impact Evaluation Team did not assess the steps needed or resources required to undertake them.

- The low realization rates for some measures, such as lighting and water heater fuel switching for electric savings and envelope (insulation, air sealing, windows and doors) and programmable

thermostats for natural gas savings, indicate that program staff should review and update the process for calculating savings for these measures. The Impact Evaluation Team understands from post evaluation discussions with NYSERDA Evaluation Staff that this review and update is currently underway.

- Program Data Issues. This list of potential enhancements is lengthy and may require substantial time and resources to implement. The items are listed in order of importance:
  - Continue to improve methods to increase the reliability of the utility identification and account numbers of projects completed through the HPwES and other residential programs.
  - Include program data that clearly specifies the measure/equipment and quantity of each in easy to use non-text fields.
  - In the measure tracking file, modify the measure codes and descriptions to clearly define the measures in a way that they can be easily and accurately categorized (lighting fixture, CFLs, dishwasher, refrigerator, freezer, attic insulation, wall insulation, air sealing, foundation insulation, etc.).Add a field to the measure tracking system to connect multiple records associated with the same measure, particularly for fuel switching.
  - Ensure data integrity by improving quality control and error checking procedures for the Program database.
  - Consider adding more detailed household information to the primary program database, such as house type, ownership status, number of occupants, adults and adults 65 and older living in the home most of the year, age of house, presence of central air-conditioning, approximate age of equipment replaced, rather than keeping this data in a secondary database maintained by the Program implementation contractor.
  - Continue evaluation efforts to collect more information on customer decision-making regarding equipment replacement and the age of the existing equipment replaced through the Program.

EVALUATION RECOMMENDATIONS

The recommendations provided are based upon the findings of this evaluation and the Impact Evaluation Team did not assess the steps needed to undertake them or the resources required.

Recommendations for Evaluating Program Reported Savings

- Continue efforts with the utilities to ensure that billing data is complete, useful and can be properly interpreted. It is important to understand the data contained in the variables, yet data dictionaries have seldom been provided to NYSERDA.
- Some suggestions for NYSERDA are listed below:
  - Continue efforts to work with the utilities and the DPS to develop an efficient process to make a higher proportion of high quality billing and consumption data available for use in evaluations.
  - Expand the list of participants that are sent to each utility to ensure that billing records are not missed due to being assigned to the wrong utility.
- Some suggestions for the DPS and New York utilities are listed below:

- Develop a process to store participant billing records for a specified period rather than allowing older data to be placed in archives on the utilities' regular schedule, and potentially rendered unobtainable for retrospective impact evaluation.
- Work with NYSERDA and the utilities' evaluators to develop a standard way to provide billing data to both NYSERDA and the utilities' evaluators, placing the billing data provided for NYSERDA and utility evaluations on the same footing.

Net-to-Gross Evaluation Recommendations

- Continue to include non-participant spillover studies when measuring net effects for HPwES in future impact evaluations. Surveys used to gather data for spillover estimation should be designed to meet quotas for the number of respondents reporting spillover.
- Design future spillover evaluations with full consideration to conducting related market effects studies and follow-up verification studies. This approach may require staging different research elements relating to participant inside spillover, participating contractor spillover, and non-participant spillover (NSPO) from non-participating and formerly-participating contractors, within a context of market change and program-induced market effects. Significantly more time and resources will be needed to conduct this level of research into spillover and market effects.
- Design additional evaluation research to increase the number, depth and breadth of validity checks for the NPSO analysis, as this spillover component reflects efficiency efforts in the larger market and has a multiplier effect in the calculations.

Early Replacement of Equipment

The issues surrounding the early replacement of equipment appear to be more complicated than initially thought, since some of the information could be interpreted in more than one way. It is possible that the advanced age of the existing equipment is evidence that consumers will not replace an expensive household item until absolutely necessary unless they are provided with an incentive. However, it is also possible that the fact that the existing equipment is old and required frequent maintenance demonstrates that they would have replaced it in the next few years anyway, without another impetus. The survey did not provide insight into this critical issue and further research in this area is recommended.

- Develop and implement an enhanced evaluation design to learn more about homeowner or participant decision-making process regarding the replacement of major equipment. The criteria for replacing old equipment, probably by level of cost, should be investigated and be able to ascertain the importance of different criteria in different circumstances. Specific hypotheses to be tested should be developed to allow results or a combination of results to be interpreted in only one way and are worded such that they are meaningful to program and policy decisions. It is important to avoid the situation found in this pilot where important information is gathered but not enough to properly interpret what was found. Flip points, Analytical Hierarchical Process and other decision-making perspectives should be explored and data gathered to have multiple types of analyses used for a more in-depth understanding of homeowner and participant decision-making.

Non-Energy Impacts

Future evaluations desiring to gather information on NEIs need to include measure quotas in its survey and sampling design and evaluation cost estimates.

Section 1:

INTRODUCTION

The **New York Energy $mart℠** programs are funded by an electric distribution System Benefits Charge (SBC) paid by customers of Central Hudson Gas and Electric Corporation (CHG&E), Consolidated Edison Company of New York, Inc. (Con Edison), New York State Electric and Gas Corporation (NYSEG), National Grid, Orange and Rockland Utilities (O&R), and Rochester Gas and Electric Corporation (RG&E). All electric distribution customers who pay into the SBC are eligible to participate in the **New York Energy $mart℠** programs. The New York State Energy Research and Development Authority (NYSERDA), a public benefit corporation established in 1975, began administering the SBC funds in 1998 through NYSERDA's **New York Energy $mart℠** Program.

This report provides a detailed description of the impact evaluation conducted for the New York Home Performance with ENERGY STAR® Program ("HPwES" or "Program") for projects installed in 2007 and 2008 (referred to as 2007 and 2008 program years in this report). There are five sections to this report. The introduction provides a brief description of the main objectives of the impact evaluation, evaluation approach, followed by a discussion of the context for the evaluation. Section 2 contains a description of the HPwES program, summary of HPwES accomplishments during that timeframe, discussion of the characteristics of the sample population and details about the homes included in the billing analysis models. Section 3 details the methods, followed by the presentation of evaluation results in Section 4. Conclusions and recommendations are provided in Section 5.

1.1 EVALUATION OBJECTIVES

The purpose of this impact evaluation is to establish first year evaluated gross and evaluated net energy savings for PY2007 and 2008 participants. This evaluation was designed to estimate the realization rate (RR), *i.e.*, the ratio of the evaluated gross savings to the NYSERDA-reported savings and develop estimates of the net-to-gross (NTG) components free ridership (FR) and spillover (SO). The NTG components were combined with the RR to calculate net savings. Electric demand savings, kW, was estimated based upon the evaluated gross and net electric energy savings.

Savings by major measure group were estimated, providing some insight into whether specific measure groups are more or less likely to achieve the expected savings. In addition, participants were surveyed concerning the reasons they replaced equipment or installed measures and information concerning non-energy impacts.

This evaluation included a billing analysis of all PY2007 and 2008 participants with sufficient billing history, a restricted billing analysis of a sample of approximately 600 households, and causality study (*i.e.*, attribution to the Program to obtain a net savings estimate).

1.1.1: Evaluation Approach

This impact evaluation has three major components:

1. a full billing analysis of all participants with sufficient billing history (full regression model)
2. a restricted billing analysis including only participants who responded to a telephone survey regarding energy usage and changes
3. a NTG study of free riders and spillover

Two telephone surveys of participants were conducted: one to support the restricted billing model and a second to obtain information for the NTG analysis.

A full billing analysis was used as the primary method of estimating program impacts. The Energy Change Survey and restricted billing analysis support the validity of this approach. The NTG analysis was

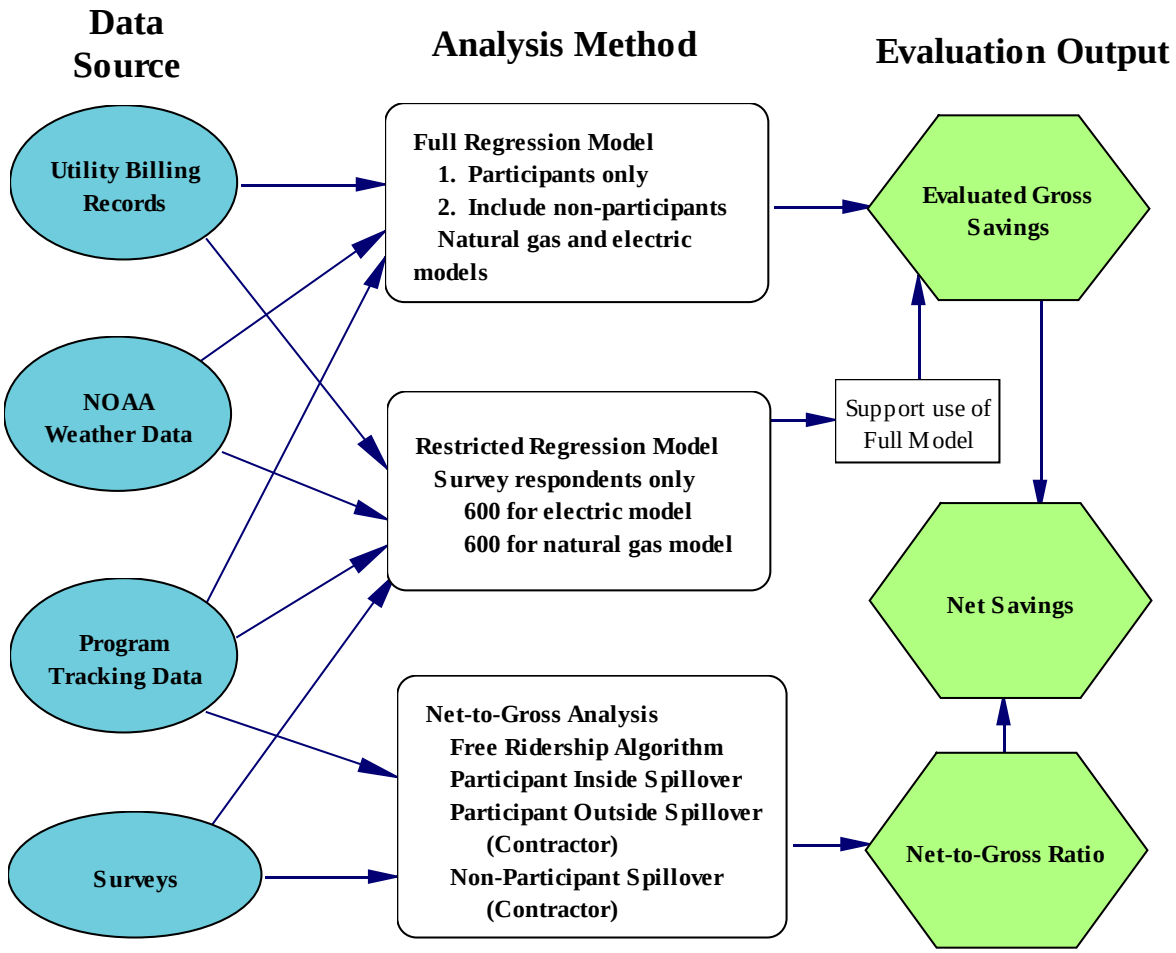
designed to estimate free ridership and spillover factors that are then used to calculate the net-to-gross ratio (NTGR).

The evaluation required data from four primary sources:

1. Program data on measures installed in each home, basic characteristics of the homes and contact information for the participant
2. utility billing data of program participants
3. weather data[14]
4. participant surveys

The contribution of each data source to the final results is shown in Figure 1-1.

Figure 1-1. Evaluation Components, Data Sources and Outcomes



[14] Weather data was obtained from the National Oceanographic and Atmospheric Administration (NOAA) for the weather stations in New York State.

1.2 EVALUATION CONTEXT AND ISSUES

Billing analysis was selected for this impact evaluation due to the characteristics of the HPwES program. Billing analysis is appropriate for retrofit programs that meet two criteria: 1) energy-intensive equipment is removed and replaced with high efficiency alternatives and 2) the Program savings are expected to be 10% or more of the total consumption[15]. HPwES meets both of these criteria.

Bias and sampling precision are two critical factors that affect the underlying reliability of evaluation results. For a large scale regression model, as was conducted for the HPwES program, there is no sampling as all participants with sufficient billing history are included in the models. Thus, the primary concern for this evaluation was the possibility of bias.

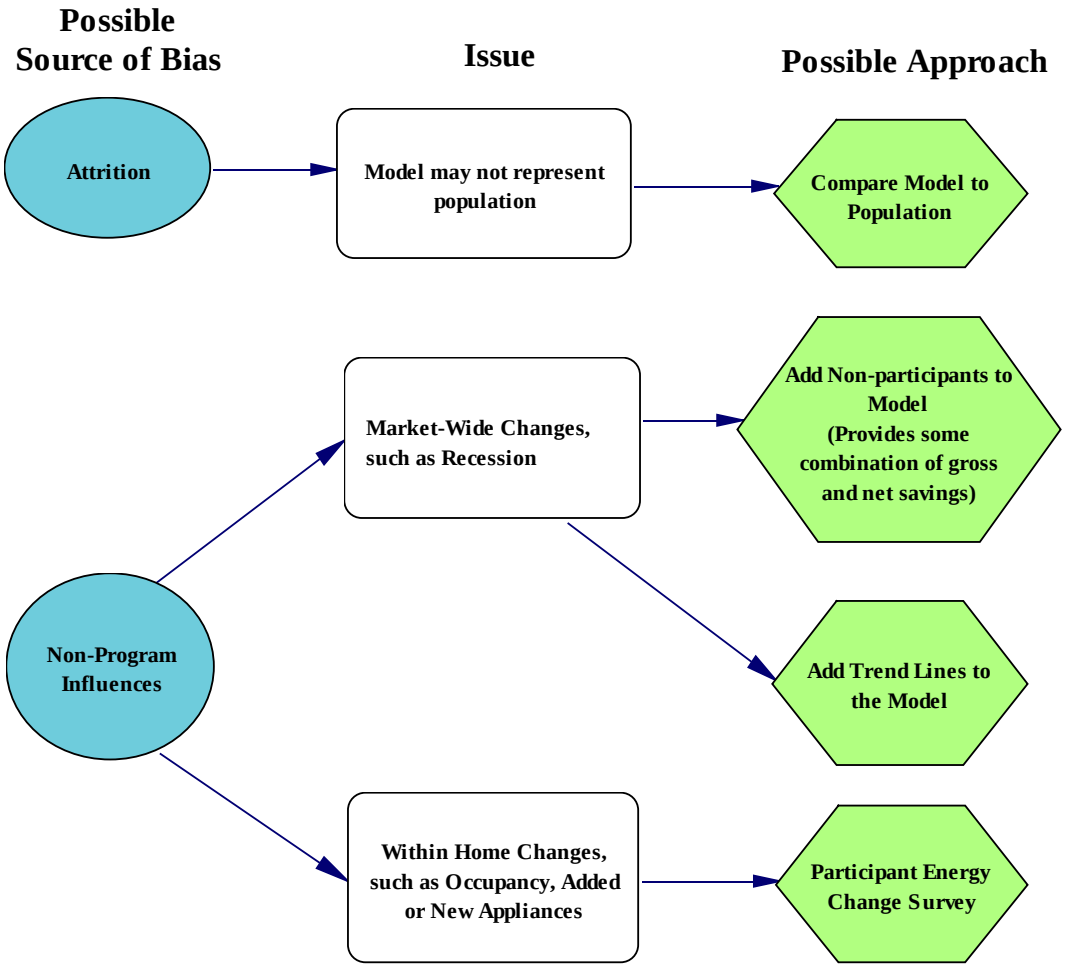
The primary sources of potential bias are as follows:

- 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
- some external (non-program) influences may affect energy use and estimates of program impacts, but cannot be directly included in the regression models

The removal of participants from the regression model due to insufficient billing data is referred to as "attrition." The potential sources of bias and strategies for identifying the degree of bias are described in Figure 1-2 below and discussed in more detail in the following paragraphs.

[15] TecMarket Works. *2004 California Evaluation Framework*, prepared for the California Public Utilities Commission and the Project Advisory Group, September 2004, page 101.

Figure 1-2. Sources of Bias and Strategies for Mitigation



1.2.1 Attrition

The key to ensuring a reliable and defensible billing analysis is the data cleaning process. The purpose of the data cleaning is to identify the homes with complete and reliable billing records to reduce the random error in the model and improve the signal-to-noise relationship. This result of this process is that some homes are removed from the analysis due to insufficient or erratic billing records, which creates attrition. The primary reasons for removal of homes from the billing models are as follows:

- the billing model must cover a sufficient period to ensure that weather impacts throughout the key seasons are incorporated and homes with insufficient billing records must be excluded
- homes with billing data that has estimated, missing, negative (reconciliation) or highly variable reads create additional error in the model and must be reviewed carefully to assess whether to remove them
- utility billing records are not available

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. Two aspects of the selected evaluation methods were designed to minimize the impacts of attrition, as explained below.

- Analysis Method: The estimated program savings were determined for all homes in the regression models. The realization rate was calculated both by major measure group and at the household level by comparing the evaluated savings to the Program reported savings for all homes in the model. The household analysis indicated that there were no additional savings above the measure level savings. The realization rates were then applied to the Program reported savings for all measures to determine the overall evaluated program savings.[16]
- Regression Model: A fixed effects model was used. The fixed effects regression model compares each home to itself, which means that house-specific differences consistent across the analysis period are addressed in the regression analysis.

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.

Some of the critical factors that are unlikely to be affected by attrition in the context of this study and the applied methods are discussed below.

- Weather effects were directly included in the regression models, and thus, there is no reason to expect that there is any impact from attrition associated with the different climate zones.
- Fixed characteristics of the homes, such as housing stock, appliance holdings and lifestyle, are accounted for in the fixed effects model. While it is clear that there may be different baselines due to housing stock, the regression results were applied to the Program totals through the use of realization rates. The fixed effect regression model essentially uses each house as its own control. The pre-retrofit usage and the pattern specific to each house acts as its baseline. Using realization rates also helps alleviate possible issues if there is a systematic difference in housing type or size or other characteristics between Program homes in the regression as compared to the Program population. It is theoretically possible that bias could exist if there is a systematic process for estimating program savings that result in consistently high or low savings for one or more specific types of housing stock. The Impact Evaluation Team has no evidence that this situation is occurring in HPwES.
- The mix of measures may vary among subgroups of the Program participants. Since the realization rates were developed by measure group as well as at the household level, any differences in the mix of measures between the participants in the model and those that were removed from the model should not affect the evaluated program savings.
- Program staff has been very clear that the HPwES program is implemented consistently across utilities, suggesting that one would not expect to see differences in realization rates due to a variety of delivery strategies.

Issues that may potentially introduce bias into the regression results are described in the following text.

- 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,

[16] An alternative strategy would be to use the regression results 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.

attrition could present a potential source of bias. This potential source of bias was assessed through a supplemental analysis, as described below, and ruled out.

- Some participants moved during the analysis period and cannot be included in the analysis since the billing records do not cover the critical months before and after the installation. Thus, participants who tend to move often are effectively removed from the analysis as a group. 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.

HPwES is different from utility energy efficiency programs in that NYSERDA, rather than the utility, is delivering services to the participants. This led to an unanticipated complexity by adding a layer to the process of obtaining the billing records, resulting in additional attrition due to the fact that some HPwES participants could not be identified in the utility billing systems. In addition, National Fuel, Central Hudson Gas and Electric and Saint Lawrence Gas were not able to provide billing data at all.[17] For the electric model, the impact was minor, with about 1% of HPwES projects removed from the model for this reason. However, about 33% of potential gas model participants were customers of the three utilities who did not provide any billing data (primarily National Fuel).

In addition, once the modeling was underway, it became clear that the billing data from two utilities, NYSEG and RG&E), contained many unidentified estimated reads and reconciliations, thus breaking the direct relationship between consumption and the weather impacts during the specific billing periods. The final models were run both with and without data representing these two utilities. The statistical reliability of the analysis dropped dramatically and the estimated savings from the model were substantially lower when all utilities were included in the model. Since the inclusion of NYSEG and RG&E had such a deleterious effect on the reliability of the regression results, the final evaluated savings are based on the model without data from these two utilities.

Overall, the attrition was substantial and all but three utilities were removed from the billing analyses. For the most part, the reasons for attrition, such as failure to locate specific HPwES participants in the utility billing systems, are likely to be random and would not be expected to introduce bias into the results. However, to the extent that entire utilities were removed, there could be unintended consequences in that specific large contractors may have been also eliminated from the analysis. The largest potential source of bias was the removal of NYSEG, RG&E and National Fuel as utilities with many Program participants which led to loss of three of the larger contractors. The other utilities not in the final regression model account for only a very small fraction of program activity. Of the 25 contractors with more than 100 HPwES completed projects during program years 2007 and 2008, there were three that had no homes included in the billing models.

After completion of the analyses conducted for this evaluation, the Impact Evaluation Team conducted a supplemental analysis of HPwES program activity in 2010 and 2011. This billing analysis included only homes in National Fuel, NYSEG and RG&E territories.[18] All three of the large contractors eliminated from the analysis presented in this report were included in the supplemental analysis. This preliminary billing analysis determined that the realizations rates for electric and natural gas savings were somewhat higher, but within the confidence intervals of, the results presented in this report, *i.e.*, the two

[17] This request for utility billing data was one of the first made during this evaluation cycle, and some utilities had initial issues with setting up their systems. These issues were subsequently addressed and the larger of the two utilities have provided billing data for other evaluations. The other utility is quite small and accounts for only a very small proportion of program participants.

[18] For this supplemental project, NYSEG and RG&E provided billing data in a different format that addressed the data quality issues.

realization rates from different populations participating at different times and with no overlap in the utility territories were not found to be statistically different. The memo presenting the results from this preliminary analysis is included in Appendix F.

Details of the attrition process and outcomes are described in Section 2.4.

1.2.2 External Influences

External factors often have as much, or more, impact on energy use than efficiency programs. When savings are estimated from a billing analysis, these external factors may have no effect on the Program impact or they may introduce either an upward or downward bias to the results. Given that the national economy was moving into a period of contraction during the 2007 and 2008 program years, one could speculate that energy consumption may be reduced across the board, making it likely that reported program savings may be under- or over-estimated, depending upon the timing of the pre- and post-installation periods.

The fixed effects model controls for the characteristics of the home that are stable over time and for seasonal changes in energy use that can be directly incorporated into the model, such as weather and monthly or annual variations. Heating and cooling degree days were included in the regression models to account for weather-dependent energy consumption. While additional weather variables, such as humidity or wind, may be useful when conducting a house-specific analysis, the aggregated billing models used in this evaluation are based on monthly reads and there is no evidence that monthly humidity or wind readings, for example have a direct impact on weather-dependent energy use.

However, it is possible that 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 or losing household members, duration of vacation, or having a change in occupant work schedules

These issues were considered and addressed separately in this evaluation. Strategies for assessing the impacts of these external factors have been tested in previous billing analyses and were used in this evaluation, as discussed further in the following sections.

<u>Global External Influences</u>

There are three common approaches to address the global factors within the statistical billing analysis:

1. include a non-participant comparison group directly in the billing analysis
2. incorporate trend lines based on consumption of the non-participant comparison group
3. incorporate trend lines from third party data on critical market trends, such as the unemployment rate, into the analysis

The first strategy provides some combination of gross and net effects into the models. In the end, a billing analysis that includes both participants and a non-participant comparison group will likely produce savings estimates that are somewhere in between gross and net effects and is, thus, difficult to interpret with any degree of accuracy. However, this comparison was conducted as a test to determine whether non-participants were experiencing a reduction or increase in use over the same period.

Trend lines reflecting changes in gasoline prices and the unemployment rate were incorporated into the model to assess the potential impacts. It was not possible to develop trend lines using a non-participant

comparison group due to issues with identifying non-participants who would be considered to be similar to the HPwES participants and obtaining non-participant billing data.

Within Home Influences

Many changes occur over time that are completely outside the influence of the Program and yet have an impact on energy use within homes. Making changes to heating equipment or the addition of a new member to the household are likely to change the patterns of energy use. Information about these types of changes is not available when conducting a billing analysis alone.

One could also argue that non-program changes within households, such as a new birth or a college student returning to live at home for an extended period of time, could affect energy use as much or more than some program measures. The approach of including all homes with sufficient billing history is intended to maximize the number of homes in the model and allow these non-program variations across homes to balance out.

For the HPwES evaluation, the Impact Evaluation Team also fielded a participant survey to inform the billing analysis. The purpose of this exercise was to determine whether there were any changes in the estimated household savings when additional non-program changes are included in the model. Some of the key features of this component of the evaluation are explained below.

- The restricted model was not intended to develop alternative estimates of program savings, as a smaller model with only 400 participants would be expected to produce less reliable results than the full model.
- By starting with the base model to estimate household savings each potential major type of change was added to the model to ascertain whether the household savings changed.

The survey instrument was designed to obtain additional information regarding typical changes occurring with the residence during the pre- and post-installation periods (such as adding or replacing major appliances and changes in schedules and occupancy). The survey instrument was carefully reviewed to cover the key topics and keep the survey to a manageable length; it was not possible to investigate every possible change that could occur and still stay within a reasonable length for a residential survey.

Section 2:

PROGRAM DESCRIPTION AND PARTICIPANT ENERGY USE

2.1 HOME PERFORMANCE WITH ENERGY STAR PROGRAM DESCRIPTION

The Home Performance with ENERGY STAR Program encourages the implementation of comprehensive energy efficiency-related improvements and technologies by qualified contractors in existing one-to-four family residential homes within New York State.[19]

HPwES is designed to create a "one-stop shopping" experience for consumers looking to make energy efficiency improvements to their homes. Participating contractors provide comprehensive home assessments (CHA) and are able to prepare a scope of work and install the recommended energy efficiency measures. The Program also fosters consumer protection by offering training to program contractors, a robust quality assurance/quality control (QA/QC) process and by requiring third party certification and accreditation of participating contractors in the building sciences. Energy efficiency improvements covered by HPwES include building shell measures, such as air sealing and insulation; appliance measures, like ENERGY STAR refrigerators; heating measures, such as boilers and furnaces; cooling measures, such as ENERGY STAR room or central air conditioners, and certain renewable energy technologies. Eligible homeowners can elect to receive financing from the New York Energy $mart^{SM} Loan Fund or the New York ENERGY STAR financing option.

The HPwES program is designed to offer 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 Median Income, or 80% of State Median Income, whichever is higher for the county.

The Assisted component of the Program offers cost subsidies of up to 50%, subject to an overall cap, of the approved work scope for making program eligible improvements to income-qualified households. Rental properties with one-to four-units are also eligible for cost subsidies at varying levels depending upon the number of income-qualified households residing within the building. Table 2-1 details the Home Performance with ENERGY STAR Program's five year goal. Table 2-2 shows the Program's reported accomplishments during program years 2007 and 2008.

[19] Residents are eligible for the Program if they are located in an utility territory that pays into the System Benefit Charge, making residents of municipal utilities and the Long Island Power Authority not eligible for participation in the Program.

Table 2-1. Home Performance with ENERGY STAR Goals (SBC III Operating Plan)

Activity	Five-Year Goal (2006-2011)
Existing market rate homes served	16,125
Existing low to moderateincome homes served	10,500
Electricity Savings (GWh)	26.1
Fuel savings (MMBtu)	1,199,000

Source: System Benefits Charge, Proposed Plan for New York Energy $mart[SM] Programs (2006-2011), as amended March 2, 2006.

Table 2-2. Home Performance with ENERGY STAR Reported Accomplishments (2007-2008)

Activity	Program Reported Participation and Savings
Existing market rate homes served	6,697
Existing low to moderate income homes served	2,790
Total Program Reported Electricity Savings (GWh)	4.5
Program Reported Fuel savings (MMBtu)	353,890

2.2 HOME PERFORMANCE WITH ENERGY STAR ESTIMATED SAVINGS

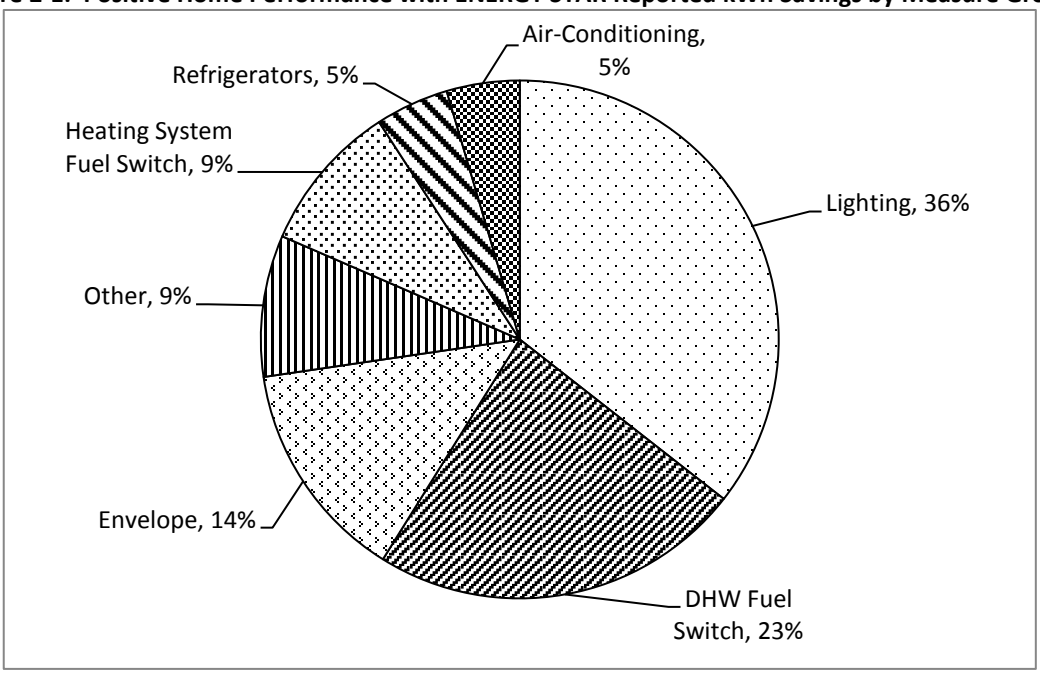
HPwES contractors conduct comprehensive home assessments to identify opportunities for improving the energy efficiency of existing homes. Measure groups were created to organize and evaluate the Program eligible measures and associated claimed savings. The definitions for the measure groups are provided in Table 2-3. For example, the insulation measure group includes adding insulation in the walls, attics, basement and air sealing.

Table 2-3. Home Performance with ENERGY STAR Eligible Measure Group Definitions

Measure Group	Description	Fuel Saved	Fuel with Extra Use
Lighting	Hardwired fixtures, CFL, bulbs and torchieres	Electricity	None
Water Heater Fuel Switch	Replacement of an electric water heater with a fossil fuel water heater (most common) or replacement of a fossil fuel water heater with an electric heat pump	Electricity or natural gas, depending on the existing water heater fuel in the home at the time of the audit	Electricity or natural gas, depending on the fuel type of the new water heater installed through the Program
Envelope	Insulation and Air Sealing: Installation of additional insulation and air sealing, insulation of attic access, basement and floors, walls, surface insulation, and visual inspection. Windows and Doors: Replacement of windows and/or doors	Electricity or natural gas, depending on the fuel used for space heating	None
Heating System Fuel Switch	Replacement of an electric heating system with a fossil fuel heating system or replacement of a fossil fuel heating system with an electric heat pump	Electricity or natural gas, depending on the fuel used for heating	Electricity or natural gas, depending on the fuel type of the new heating system installed through the Program
Air-conditioning	Replacing an air-conditioner with an ENERGY STAR one	Electricity	None
Refrigerator Replacement	Refrigerator replacement and freezer replacement with an ENERGY STAR one	Electricity	None
Water Heater Replacement	Replace the existing water heater with an ENERGY STAR water heater	Electricity or natural gas, depending on the water heater fuel in the home	None
Appliance	Replacement of appliance often with an ENERGY STAR appliance, such as clothes washer and dishwasher (not to include refrigerator/freezer)	Electricity. Natural gas, depending on the fuel used for heating	None
Programmable Thermostat	Replacement of a manual thermostat with a programmable thermostat	Electricity and/or natural gas, depending on the fuel used for heating; electricity if used for cooling controls	None
Heating System Replacement	Replacement of the heating system with an ENERGY STAR one	Electricity or natural gas, depending on the fuel used for heating	None
Water Heating Conservation	Pipe wrap, low flow showerheads, tank wraps	Electricity or natural gas, depending on the water heater fuel in the home	None
Heating and Cooling System Conservation	Distribution system improvement, HVAC duct sealing, HVAC pipe insulation, ventilation	Electricity or natural gas, depending on the fuel used for heating; electricity for cooling	None

The majority of reported electric energy savings from the HPwES program can be attributed to lighting efficiency and switching from electric water heating to natural gas water heating. Lighting measures account for 36% of program reported savings and 25% of reported savings was from electric water heater fuel switches. [20] Together these two end uses account for 61%.

Figure 2-1. Positive Home Performance with ENERGY STAR Reported kWh Savings by Measure Group[1]



[1] There are measure groups with negative electricity savings, as can be seen in Table 2-4, but negatives cannot be portrayed in a pie chart.

[20] This includes the extra use in other end uses due to the lower levels of heat generated by the more efficient lights or extra use due to fuel switches. Using only the positive values of measures makes lighting savings 36% and water heater fuel switch 23% of program-reported savings.

Table 2-4. Home Performance with ENERGY STAR Reported Electric Savings by Measure Group

Measure Group	2007-2008 Projects with kWh Savings	Program Reported Annual kWh Saved	Program Reported Annual kWh Savings per Project	Percent of Program Reported kWh Savings
ENERGY STAR Lighting	2,335	1,598,460	685	36%
Water Heater Fuel Switch	135	1,103,605	8,175	25%
Envelope (*e.g.*, insulation, air sealing, windows and doors)	1,871	629,045	336	14%
Heating System Fuel Switch	35	530,977	15,171	12%
ENERGY STAR Air Conditioning	577	223,746	388	5%
ENERGY STAR Refrigerator Replacement	316	206,836	655	5%
Water Heater Replacement	323	147,434	456	3%
ENERGY STAR Appliance Replacement (*e.g.* dishwasher, clothes washer)	244	121,133	496	3%
Programmable Thermostats	730	74,763	102	2%
Heating System Replacement	33	53,359	1,617	1%
Water Heating Conservation	44	17,173	390	0%
Heating System Conservation	100	12,066	121	0%
Extra Energy Use - Heating System Replacement	6	(5,461)	(910)	0%
Extra Energy Use – Other Measures	503	(103,569)	(206)	-2%
Extra Energy Use – Water Heater Replacement	52	(6,672)	(128)	0%
Extra Energy Use - Heating System Fuel Switch	13	(111,644)	(8,588)	-2%
Total		**4,491,251**		**100%**

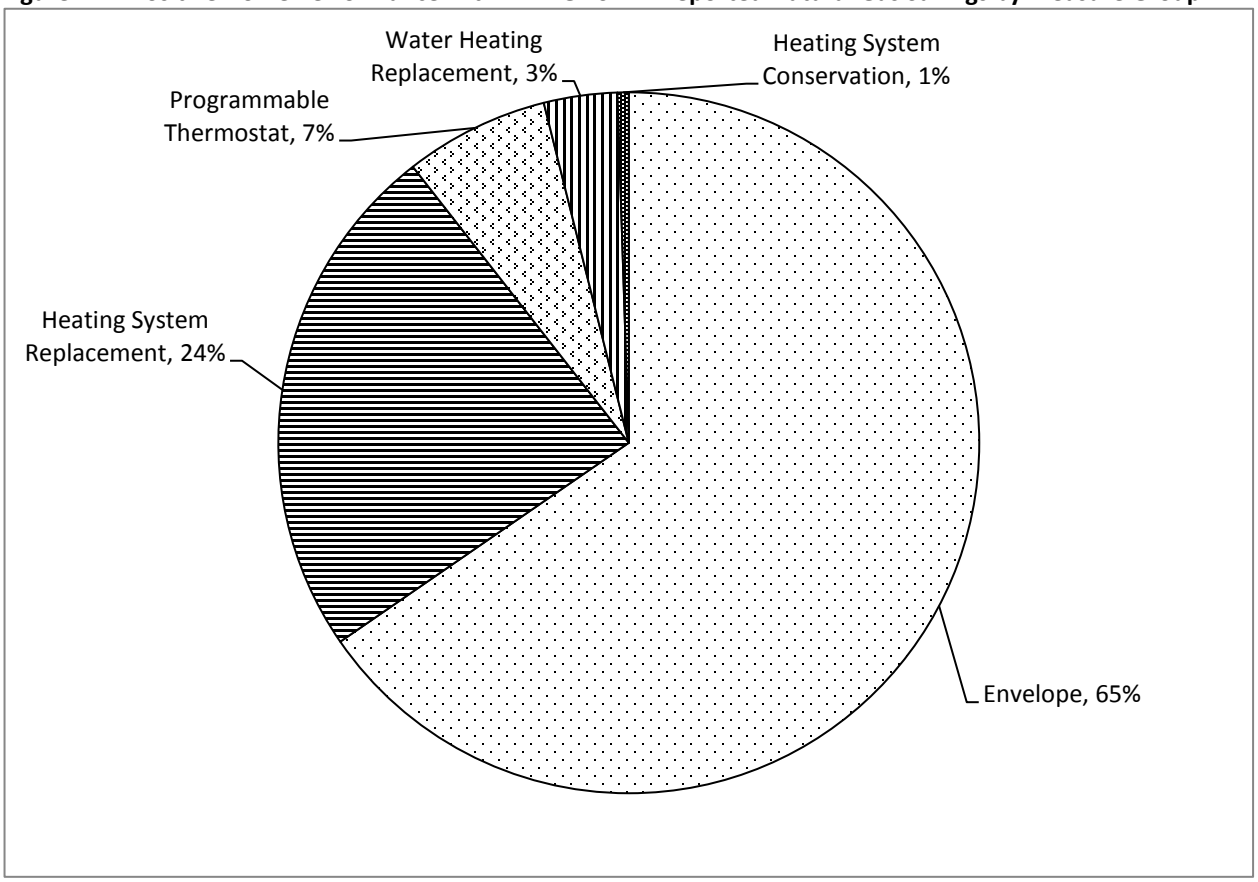
As with electric savings, a large portion of the reported savings from natural gas is driven by two measure groups. Envelope measures (including insulation, air sealing and windows and doors) and heating system replacement, combined, account for 84% of the program reported natural gas savings. The remaining 16% of the program reported savings are from programmable thermostats, water heater replacement, appliances, and conservation measures (such as low flow showerheads and pipe insulation).

Table 2-5. Home Performance with ENERGY STAR Reported Natural Gas Savings by Measure Group

Measure Group	Number of Projects	Program Reported Annual MMBtu Savings[1]	Annual MMBtu Savings per Project	% of Total Program Savings
Envelope (insulation, air sealing, windows and doors)	6,430	192,463	30	72%
Heating System Replacement	2,523	70,744	28	26%
Programmable Thermostats	2,023	19,615	10	7%
Water Heater Replacement	1,141	9,959	9	4%
Heating System Conservation	175	1,524	9	1%
ENERGY STAR Appliance Replacement	245	1,036	4	0%
Water Heating Conservation	145	538	4	0%
Water Heater Fuel Switch	8	335	42	(1)%
Heating System Fuel Switch	4	521	130	(8)%
Extra Energy Use – Other Measures	350	(394)	(1)	0%
Extra Energy Use - Heating System Replacement	14	(445)	(32)	0%
Extra Energy Use – Water Heater Fuel Switch	103	(3,040)	(30)	(1)%
Extra Energy Use – ENERGY STAR Lighting and Refrigerator	1,879	(3,081)	(2)	(1)%
Extra Energy Use - Heating System Fuel Switch	242	(22,740)	(94)	(8)%
Total		**267,035**		**100%**

[1] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, creating savings of one fuel while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

Figure 2-2. Positive Home Performance with ENERGY STAR Reported Natural Gas Savings by Measure Group[1]



[1] There are measure groups with negative natural gas savings, as can be seen in Table 2-5, but negatives cannot be portrayed in a pie chart.

2.3 ANALYSIS OF ENERGY CONSUMPTION

Consumption patterns are central to assessing potential savings. It seems intuitively obvious, for example, that homes with more occupants would have overall higher consumption than homes with fewer occupants and would also tend to have higher savings for some measures, such as low flow showerheads. Research has supported this assumption as other studies have shown that higher savings for the same measure tend to be achieved in homes with higher pre-installation consumption.[21]

In Table 2-6 below, the average energy consumption for HPwES participants included in the billing model is compared to the average use of all residential households in New York State. This comparison shows that HPwES participant households use slightly more energy (both natural gas and electricity) than the average residential customer; the average electric consumption for HPwES participants is approximately 6% higher and the average natural gas consumption is about 2% higher than the average residential use.

[21] Examples can be found in the following two documents:
Impact Evaluation of the 2005 California Low Income Energy Efficiency Program, Final Report, prepared for Southern California Edison Company by West Hill Energy & Computing, Inc., August 2008
Blasnik, Michael. 2004. *Ohio Electric Partnership Program Impact Evaluation*, final report prepared for the Ohio Office of Energy Efficiency.

Table 2-6. Comparison of Residential Annual Consumption in New York to Home Performance with ENERGY STAR Participants

Consumption	New York State Residential Average Consumption per Home[1]	Participant Average Consumption per Home Prior to HPwES Services (Billing Model)
Annual Electric Consumption (kWh)	8,272	8,700a
Annual Natural Gas Consumption (MMBtu)	103	105b

[1] The Residential Energy Consumption Survey (RECS, 2005) conducted by the Energy Information Agency was used to estimate the average annual use by housing type for single family attached, single family detached and one-to-four unit apartments; the US Census Bureau American Community Survey Five Year Estimate of Housing Units 2006 to 2010 for New York State was used to estimate the proportion of housing units in each of the categories and develop a weighted average of the annual energy consumption.

a This estimate has a sample size, n, of 27,421 pre-installation bills.

b This estimate has a sample size, n, of 13,845 pre-installation bills.

2.4 ATTRITION IN THE BILLING ANALYSIS

To estimate savings using the billing model, participants with sufficient utility billing data throughout the pre- and post-installation periods are required. The utility data obtained for participants was cleaned to identify homes that could be included in the billing analyses. The first step in the data cleaning process was to review the participant billing data provided by the utilities, remove duplicative entries, combine projects to the household level, and examine the billing records for erratic or erroneous entries (as further described below). The next step was to identify those participants with sufficient billing data to be included in the models. This process involved a number of distinct activities, as described below.

- Utility account numbers, names and addresses were matched between the HPwES program data set and the utility billing records. Given that the account numbers in the NYSERDA program database were not completely reliable (as would be expected for long strings of unrelated numbers), matching was necessary to verify that the billing data was associated with a specific HPwES participant.
- The billing data was assessed for each participant to ascertain whether there were sufficient pre- and post-installation records for the model. Each participant was required to have at least nine months of billing records before and nine months after the installation of measures to ensure heating and cooling seasons during both the pre and post-installation periods were included for each household in the analysis.
- The billing data was reviewed for anomalies, such as a high number of estimated reads, zero reads and missing data.
- The Program and billing data were merged to ensure that the participants in the sample frame had natural gas and electric measures with associated savings.

The results of this process are summarized in Table 2-7 below. No billing data was obtained from the utilities for approximately 48% and 66% of the electric and natural gas participants, respectively, with reported savings and they were eliminated for this reason. This attrition may be partially due to issues associated with matching the Program participants to utility records and identifying the correct utilities associated with each participant. All participants with sufficient billing records and measure installations

in years 2007 through 2009 were included in the regression models to increase the number of homes in the models.

Table 2-7. Summary of Attrition in the Billing Models

	Participants with Electric Service	% of Electric Participants/ Households with Savings[1]	Participants with Natural Gas Service	% of Natural Gas Participants/ Households with Savings[1]
2007-2009 Projects	15,350		15,130	
Projects Consolidated by Account	425		420	
2007-2009 Participants/Households	14,925		14,710	
Participants with Billing Data	7,794		5,054	
Participants without Any Billing Data		48%		66%
Participants Removed due to Insufficient or Erratic Billing History	3,729	25%	1,879	13%
Total Participants in Analysis[2]	**4,025**	**27%**	**2,811**	**21%**

[1] This percentage reflects the number of participating households in the category divided by the total number of participating households with savings (from row 4).

[2] The final attrition rate includes those without any billing data plus those removed for insufficient billing data and other criteria, divided by the total number of participating households with savings. These numbers include the two utilities with problematic billing data discussed below.

HPwES is different from utility energy efficiency programs in that NYSERDA, rather than the utility, is delivering services to the participants. The process of coordinating with and obtaining participant billing data from each utility resulted in a significant delay in completing the billing analysis component of the evaluation. This HPwES impact evaluation was one of the first NYSERDA evaluations to request complete utility billing records for all program participants in PY 2007 and 2008. Obtaining access to the participant billing data by utility required extensive coordination, establishing and executing confidentiality agreements, formal requests for data, and delivery of the data sets using secure data transfer techniques between NYSERDA and each utility. Ultimately, NYSERDA was not able to establish a timely agreement with three utilities: National Fuel, Central Hudson Gas and Electric and Saint Lawrence Gas were not able to provide billing data at all.[22] For the electric model, the impact was minor, with about 1% of HPwES projects removed from the model for this reason. However, about 33% of potential gas model participants were customers of the three utilities who did not provide any billing data (primarily National Fuel).

In addition, once the modeling was underway, it became clear that the billing data from two utilities, New York State Electric and Gas (NYSEG) and Rochester Gas and Electric (RG&E), contained many unidentified estimated reads and reconciliations, thus breaking the direct relationship between

[22] This request for utility billing data was the first made during this evaluation cycle, and some utilities had initial issues with setting up their systems. These issues were subsequently addressed and the larger of the three utilities have provided billing data for other evaluations. The other utilities are quite small and account for only a very small proportion of program participants.

consumption and the weather impacts during the specific billing periods.[23] The final models were run both with and without data representing these two utilities. The statistical reliability of the analysis dropped dramatically and the estimated savings from the model were substantially lower when all utilities were included in the model. Since the inclusion of NYSEG and RG&E had such a deleterious effect on the reliability of the regression results, the final evaluated savings are based on the model without data from these two utilities.

The total number of participating households by utility for HPwES 2007-2009 program year participants is shown in Table 2-8. Most of the HPwES participants are concentrated among the utilities with the largest number of non-multifamily households (those eligible for the HPwES program), as would be expected.

Table 2-8. Home Performance with ENERGY STAR Distribution of Participant and Households by Utility

	Participants with Electric Savings		**Participants with Natural Gas Savings**	
Utility	Participants	% of Participants	Participants	% of Participants
National Grid	8,662	58%	5,110	35%
National Fuel	0	0%	3,896	26%
Rochester Gas & Electric	3,177	21%	3,251	22%
NYSEG	2,350	16%	1,198	8%
Multiple Providers	4	0.03%	388	3%
Consolidated Edison	389	3%	288	2%
Central Hudson Gas & Electric	200	1%	190	1%
St. Lawrence	0	0%	133	1%
Orange and Rockland	142	1%	128	<1%
KeySpan	0	0%	97	<1%
Municipal or Unknown Provider	1	0.01%	31	<1%
Total[1]	**14,925**	**100%**	**14,710**	**100%**

[1] The totals are 2007-2009 HPwES participating households and correspond to row 3 in Table 2-7.

Table 2-9 lists the customer distributions from the three utilities that were used in the final electric and natural gas models. The final regression models have over 1,400 participants in the natural gas and over 2,500 in the electric model.

[23] The NYSEG and RG&E billing data were carefully reviewed to try to address the issues, including attempting to match reconciliations with actual reads and evaluating the frequency of estimated reads. Many homes had a high number of estimated reads, often sequentially. These efforts were ultimately unsuccessful in improving the models.

Table 2-9. Home Performance with ENERGY STAR Regression Model Distribution of Customers by Utility

Utility	Electric	Natural Gas
National Grid	2,350	1,318
Consolidated Edison	115	71
Orange and Rockland	71	73
Total	**2,536**	**1,462**

As discussed above in Section 1.2.1 the selected analysis method tends to reduce the potential impacts of attrition through the application of measure-level realization rates and the use of the fixed effects regression models. For the most part, the reasons for attrition, such as failure to locate specific HPwES participants in the utility billing systems, are likely to be random and would not be expected to introduce bias into the results. The total number of participants remaining in the model is well over 1,000 for each model, which is more than sufficient to obtain reliable estimates.

However, the overall attrition was substantial and all but three utilities were removed from the billing analyses, with one utility accounting for the vast majority of the participants included in the model. To the extent that entire utilities were removed, there could be the potential for bias in that specific large contractors may have been eliminated from the analysis if the contractors' activities fell within geographic regions covered by the excluded utilities, and it is possible that realization rates for specific large contractors may vary.

The largest potential source of bias was the removal of NYSEG, RG&E and National Fuel. As also explained in Section 1.2.1, a subsequent preliminary billing analysis of more recent HPwES participants in National Fuel, NYSEG and RG&E territories produced realizations rates for electric and natural gas savings that were somewhat higher but within the confidence intervals of the results presented in this report, *i.e.*, the two realization rates from different populations participating at different times and with no overlap in the utility territories were not found to be statistically different. The memo presenting the results from this preliminary analysis is included in Appendix F.

METHODS

This section describes the methods used to estimate evaluated gross and evaluated net savings, investigation into the reasons for equipment replacement, and assessment of non-energy impacts. The subsections cover each major component and analysis area within the evaluation, *i.e.*, the energy change survey, the restricted billing analysis, the full billing analysis, the NTG/non-energy impact (NEI) surveys, estimating the NTG components and NTGR, equipment replacement information, and non-energy impacts.

3.1 ENERGY CHANGE SURVEY

Telephone surveys were completed for a total of 699 participants, with 501 who could be included in the electric and natural gas regression models, 99 eligible for the natural gas only model and 99 for the electric only model. The survey was conducted from July 7, 2011 to August 29, 2011. The purposes of the survey are listed below:

1. to assess non-program-related changes that occurred within the home during the analysis period that may have affected the energy consumption
2. to confirm or determine the presence and use of major energy-using equipment
3. to assess whether the measures installed through HPwES are still in place and operational

Although this survey is primarily designed to support the billing analysis, it is possible that some responses may assist in understanding participant behavior and may be useful to NYSERDA staff for program delivery purposes. Thus, some of the key results of the survey are summarized and presented in Appendix E. The individual responses were used to populate the restricted regression model.

For the HPwES evaluation, the Impact Evaluation Team also fielded a participant survey to inform the billing analysis. The purpose of this exercise was to determine whether there were any changes in the estimated household savings when additional non-program changes are included in the model. Some of the key features of this component of the evaluation are explained below.

- The restricted model was not intended to develop alternative estimates of program savings, as a smaller model with only 400 participants would be expected to produce less reliable results than the full model.
- By starting with the base model to estimate household savings, each potential major type of change was added to the model to ascertain whether the household savings changed.
- Estimated savings are most likely to be affected by non-program changes that are coincident with the installation of measures. Each of the variables representing potential non-program changes included in the models reflected the timing of the change in relationship to the timing of the installation of program measures.

The survey instrument was designed to obtain additional information regarding typical changes occurring with the residence during the pre- and post-installation periods that would be expected to change energy usage (such as adding or replacing major appliances and changes in schedules and occupancy). The survey instrument was carefully developed to cover the key topics and keep the survey to a manageable length; it was not possible to investigate every possible change that could occur and still stay within a reasonable length for a residential survey. Some of the topics covered in this survey include the following:

1. changes in the number, schedule and employment status of year-round household occupants
2. length and timing of periods of vacancy of the home (such as winter and summer vacations)

3. presence and use of heating and cooling equipment and other energy-intensive appliances[24]
4. presence and use of measures installed through HPwES

The survey instrument drafted by the Impact Evaluation Team with input from APPRISE, Inc., NYSERDA survey implementation contractor, and NYSERDA Program and Evaluation staff. The survey instrument was approved by NYSERDA and the DPS prior to fielding the survey. Advance letters to introduce the survey were sent by NYSERDA on NYSERDA letterhead to all potential participant contacts before they were called by the survey contractor. This survey instrument is attached as Appendix A.

3.1.1 Sampling

Sampling was conducted for the Participating Homeowner Energy Change Telephone Survey ("Energy Change Survey") following the data cleaning process. The sample frame consisted of all participating homeowners included in the billing analysis testing (as described above). Thus, the sample frame was developed using the Program and billing data.

No stratification was conducted for the telephone survey. The initial sample frame provided to NYSERDA's survey contractor included all participants who could be included in both the natural gas and electric billing models. However, there was a high non-response rate, largely due to the inability to reach many of the participants on the list. Consequently, it was necessary to supplement the sample frame with participants who could be included only in the natural gas model or only in the electric model. All participants who could be included in the natural gas model were contacted. The supplemental sample frame for the electric model was the remaining participants eligible for inclusion in the electric billing model and a random sample of these participants was contacted.

3.1.2 Timing

Considerable discussion and thought was given to the challenges of designing and fielding a survey to obtain information about energy use changes made three to four years prior. A common concern with administering self-report surveys is that participants may not be able to answer the questions at all or may not provide reliable responses. Reliability is a common concern with self-reports, and the lag time may exacerbate the situation. For this reason, the wording of the questions was carefully considered and many questions were benchmarked to current practices. However, future survey reliability would likely increase with less lag time.

3.1.3 Sample Disposition

The interviews were conducted using a computer-assisted telephone interview (CATI) survey instrument. Comprehensive checks were conducted by NYSERDA's survey contractor prior to fielding to ensure that all skip patterns were correct and all question wording was comprehensible to respondents. Five participating homeowner surveys were conducted as a pretest to assess the survey instrument for length, respondent comprehension, and interview flow. Refinements were made to the instruments as indicated by the pre-test and the finalized instrument was provided to NYSERDA and the DPS.

Interviewers called potential respondents during daytime weekday hours and calls were rotated between the morning and afternoon on different days of the week to minimize non-response bias. A total of 699 surveys were completed and included in the data set provided to the Impact Evaluation Team. The sample disposition is shown in Table 3-1 below.

[24] The survey was focused on appliances and equipment that would be likely to result in major fluctuations in energy use. Household electronics were not covered in the survey as the additional use represented by these items would be expected to be small in relationship to total energy use and would most likely not be able to be found in the regression models.

Table 3-1. Sample Disposition for the Energy Change Survey of Home Performance with ENERGY STAR Participants

Disposition		Number of Participating Homeowners In Sample Frame	Percent of Participating Homeonwers
Total Sample Used		1,764	100%
Unusable Sample	Not working/Unusable number	290	16%
Not Contacted (A minimum of eight calls were made.)	Respondent never available	9	1%
	Answer Machine	121	7%
	Call back/Left 800#	187	10%
Unknown Eligibility	No Answer/Busy	99	5%
	Records not yet called/ Screener Not Complete	49	3%
Not Eligible	Respondent Not Eligible[1]	133	7%
Refused	Refused	177	10%
Break-off	Break-off	0	0%
Completed interview		699	40%
Contact rate = ([699+177]/[699+177+217] =.801) a			80%
Cooperation rate = (699/[699+177] =.798) b			80%
Response rate = (699/[699+177+217+(.738*(148)] =.5801) c			58%

[1] It was not possible to reach the household member who could answer questions related to household participation in HPwES.

See the Glossary for definitions of Contact Rate, Cooperation rate and Response rate as defined by AAPOR.

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 =.738

3.2 NET-TO-GROSS/NON-ENERGY IMPACT SURVEYS

Surveys of homeowners and participating and non-participating contractors were conducted to estimate the NTGR and to collect information regarding NEIs. A description and sample plan is provided below for the two categories of surveys (homeowner and contractor) and is followed by the sample dispositions for all three surveys.

3.2.1 Participating Homeowner Net-to-Gross/ Non-Energy Impact Survey

The participating homeowner net-to-gross/non-energy impacts ("NTG/NEI") survey was designed to collect sufficient information from participating homeowners to estimate free ridership and inside spillover, as well as to obtain information about NEIs. The survey was conducted between August 9, 2011 and August 23, 2011.

The NTG survey included four primary areas of interest:

1. free ridership
2. spillover

3. non-energy impacts
4. information on the timing of, and the decision to install, equipment replacement

The NEI component of the survey was designed to assess whether the Program achieved additional benefits for participants beyond the energy savings gained from installing energy efficient measures, such as less frequent bulb replacement and use of less clothes washer detergent. The last area of interest for this survey instrument concerned equipment replacement. The timing of equipment replacement is a key input into whether measures should be defined as early replacement with savings calculated in comparison to the existing equipment or market opportunity using a new standard efficiency product as the baseline.

As with the Energy Change survey, considerable discussion and thought was given to the challenges of designing and fielding a survey to obtain information from homeowners about participation in a program that occurred three to four years prior. Reviewers were concerned that participants may answer questions about intentions to install efficient products through the lens of their current perspective. Due to the recent economic upheaval and the increasing emphasis on energy efficiency in the media, it is possible that external changes between program years 2007 and 2008 could possibly influence homeowner responses to the NTG survey questions. For this reason, a series of questions were added to the survey to aid recall. The questions focused on memorable events during the time period when the decision was made and asked respondents to try to assess whether changes in economic condition and/or increased awareness of energy efficiency were factors in their responses.

Information was also collected on participant demographics. The survey instrument was drafted and approved by NYSERDA and the DPS prior to fielding the survey. The survey was implemented by NYSERDA's survey contractor. Advance letters to introduce the survey were sent by NYSERDA to all potential primary participant contacts before they were called by the survey contractor. The participating homeowner NTG/NEI survey instrument is attached as Appendix B. The sample plan is discussed below.

Sampling

The homeowner survey was originally designed to include both energy change and NTG questions. Due to the length of the survey, the Impact Evaluation Team subsequently decided to field the NTG component of the survey separately.

The sample frame for the Energy Change Survey included all participants with sufficient utility billing data for both the natural gas and electric models and the entire sample frame was used in the process of completing that survey. To avoid overlapping sample frames and the potential for bias, the subset of the Program participants without any billing data were used as the sample frame for the NTG survey. This approach was adopted as there does not appear to be any systematic reason for the inability to match participants to specific utility accounts.[25] Since the sample frame consisted of participants with no utility billing data, participants in all utility territories were included. The sample size for the NTG survey was 77 homes to allow the inquiry to meet the 90/10 confidence/precision target for a yes/no question.[26]

[25] Participants who were removed from the billing analysis model due to insufficient or erratic billing history are likely to be more difficult to reach and not necessarily representative of the program as a whole, as discussed above in Section 2.4. Since the sample frame of participants included in the billing models had already been exhausted, using participants who could not be found at all in the utility billing system was the best approach to avoid the potential for bias.

[26] The sample size depends on the type of statistical analysis being conducted and the type and variability of the specific parameters to be estimated. For example, a simple random sample required to achieve 90% confidence and 10% sampling precision for a yes/no question is about 67 for a large population. However, if the variable of interest has a coefficient of

3.2.2 Contractor Surveys

The participating contractor survey was designed to obtain information about the timing of equipment replacement through HPwES and to estimate free ridership, spillover and NEIs for participating contractors for the 2007 and 2008 HPwES program years. The non-participant contractor survey was designed to obtain information about the installation of program eligible measures and equipment in homes outside of the Program but influenced by the Program, or NPSO. The participating contractor survey instrument is provided as Appendix C and the non-participating contractor instrument is Appendix D. The development of the sample frame and sampling plan for each contractor survey is described below.

Participating Contractors

The sample frame of all participating contractors was developed from a list of contractors that are currently participating in the HPwES program and those that had participated in the past. The participating contractor data set was obtained from the HPwES program database in two parts; the first list contained all contractors currently participating in the Program and the second one covered the historical record of all contractors who had participated in the Program at any point. For the purposes of this evaluation, participating contractors were defined as those who installed efficiency measures in at least one HPwES program project during PY 2007 and/or 2008. These two lists were merged and then cross-referenced with the 2007-2008 program dataset for this evaluation to obtain the list of contractors meeting this evaluation's criteria for participating contractors. Contractors that participated in HPwES prior to January 2007 and had not completed a project through the Program since then were identified and categorized as formerly-participating contractors.

A total of 178 participating contractors installed efficient measures in at least one project during the Program years of 2007 and 2008.[27] The sample size of 50 was selected to meet the 90/10 confidence precision target for proportions, incorporating the finite population correct factor. The sample design was a stratified random sample based on the number of participating projects in which the contractors installed efficient measures. The purpose of the stratification was to ensure that the sample adequately represented the contractors with the largest contribution to the number of projects completed through the Program.

Table 3-2 highlights the three participating contractor strata groups. The two highest strata were a census attempt and the remaining sample size of 28 was allocated to the lowest stratum. Since the lowest stratum had the most number of contractors and was likely to include many smaller contractors, this group was likely to have the highest variation and allocating the bulk of the sample to this group helped to improve precision and reliable results. The sample for the lowest stratum was randomly selected.

variation of 0.75 a simple random sample would require a sample size of 152 to achieve the same precision and confidence level.

[27] The 178 contractors represent all contractors who completed a HPwES project during program years 2007 and 2008, *i.e.*, this list was not restricted to contractors who completed projects included in the billing analysis.

Table 3-2. Summary of Participating Home Performance with ENERGY STAR Contractors and Sample Sizes

Size Based on Number of Program Projects for PY2007-2008	Number of HPwES Contractors	Total Number of Program Projects with Installed Measures	% of Program Projects with Installed Measures	Sample Size	Minimum Number of Projects/ HPwES Contractor	Maximum Number of Projects/ HPwES Contractor
Small	156	4,965	32%	28	1	178
Moderate	16	4,949	32%	16	182	415
Large	6	5,436	35%	6	476	1279
Totals	178a	15,350	100%	50		

a The total of 178 includes all contractors who completed a project during program years 2007 and 2008.

Non-Participating Contractors

The non-participating contractor sample consisted of formerly-participating contractors and those who had never participated in the HPwES program. Since the formerly-participating contractors learned about energy efficient methods and applications through the HPwES program, the spillover among this subset of contractors may be higher. Consequently, the formerly-participating contractors are treated as a separate subgroup of the non-participating contractors for the Program years being evaluated. Formerly-participating contractors were identified from the list of contractors provided by NYSERDA, which was cross referenced with NYSERDA program data that contained all unit production from program inception through 2010 program years. The formerly- participating contractors were defined as contractors who installed efficiency measures in at least one HPwES project prior to January 2007 and did not complete any installations through the Program after January 1, 2007 through the end of December 2008. This portion of the sample consisted of a census of the 61 formerly-participating contractors.

A Dun & Bradstreet (D&B) list of all of the general and specialized contractors based in the State of New York (excluding Nassau and Suffolk Counties) was provided by NYSERDA's survey contractor to the Impact Evaluation Team. [28] Dun & Bradstreet builds their list using public records, trade references, phone directories, and other sources and then sells these lists.

The D&B list drawn for the non-participating contractors contained 6,683 firm names and contact information. Data was analyzed to identify and remove as many participating and formerly-participating contractors as possible by comparing the data for these groups to the D&B list of contractors by company name, primary and secondary phone numbers, and address. Eighty (80) contractors matched at least one of these criteria and were removed to create the non-participating dataset, accounting for 20% of the participant/former-participant list.[29] In addition, 57 of the listed contractors had no entry in the "sales volume" field and these contractors were also removed, leaving 6,546 non-participating contractors in the sample frame.

Contracting firms are expected to have a lot of variability in the size of its business and influence on the market. The only relevant variable in the D&B data set is sales volume. However, the sales volume was not necessarily a good indicator of the home performance contracting activity. The sales volume levels

[28] The following Standard Industrial Classification (SIC) codes were included in the sample frame: 1521-0100 (single family home remodeling, additions, and repairs), 1521-0101 (general remodeling single family), 1711-0400 (heating and air conditioning contractors), 1711-0405 (warm air heating and air conditioning contractors), 1742-0203 (insulation, buildings), and 1751-0202 (window and door installation).

[29] The survey instrument also included a screening question to ensure all respondents were non-participating contractors.

for quite a few firms exceeded what is possible from the New York residential home improvement market; these contractors are most likely to be involved in a variety of activities. Consequently, a simple random sample of the non-participating contractors was selected. To avoid obtaining a sample of very small contractors, only contractors with sales volume at or above $75,000 were included, resulting in the removal of an additional 756 contractors with sales volume below $75,000.

The final sample frame included 5,790 non-participating contractors. A simple random sample of 70 non-participating contractors was selected to meet the confidence/precision target of 90/10 based on the formula for estimating proportions.

3.2.3 Sample Dispositions

All three surveys were fielded from August 9, 2011 to August 23, 2011 by NYSERDA's survey contractor. The NTG component of the NTG/NEI homeowner survey instrument was developed in conjunction with the homeowner survey for the NYSERDA EmPower Program given the similarities between the two programs.[30] EmPower's NTG survey was pre-tested and fielded prior to the HPwES version, and minor adjustments from that survey were later applied to the HPwES version. Questions were added to cover NEIs, the early replacement of equipment and issues regarding the recent economic upheaval and increased awareness of energy efficiency. As with the other surveys, the survey instrument was reviewed by NYSERDA'S survey contractor and approved by NYSERDA and the DPS.

As detailed in Table 3-3, 77 of 200 participating homeowners and 51 of 90 participating contractors were interviewed and included in the final data file for these respondents. The Participating Homeowner NTG/NEI Survey achieved a contact rate of 66%, the cooperation rate was 79%, and the overall response rate was 49%. Contact, cooperation, and overall response rates for the participating contractor survey were, 71%, 89% and 64% respectively. These rates and the detail counts are provided in Table 3-3.

[30] NYSERDA 2012. *NYSERDA 2007-2008 EmPower New York^{SM} Program Impact Evaluation*, prepared by Megdal & Associates, LLC. with Kathryn Parlin from West Hill Energy & Computing, Inc. as the principle investigator, April.

Table 3-3. Sample Disposition for the Home Performance with ENERGY STAR NTG Survey of Participating Homeowners and Contractors

Disposition		Number of Participating Homeowners (NTG)	Percent of Participating Homeonwers (NTG)	Number of Participating Contractors (NTG)	Percent of Participating Contractors (NTG)
Total Sample Used		200	100%	90	100%
Unusable Sample	Not working/Unusable number	27	13%	8	9%
Not Contacted (A minimum of eight calls were made.)	Respondent never available	7	3.50%	23	26%
	Answer Machine	43	21%	0	0%
	Call back/Left 800#	0	0%	0	0%
Unknown Eligibility	No Answer/Busy	9	4%	0	0%
	Records not yet called/ Screener Not Complete	2	1%	0	0%
Not Eligible	Respondent Not Eligible[1]	14	7%	2	2%
Refused	Refused	12	6%	6	7%
Break-off	Break-off	9	4%	0	0%
Completed interview		77	39%	51	57%
Contact rate = [Homeowner ((77+9+12)/(77+9+12+7+43)) = 98/148 = .662]a			66%		71%
Cooperation rate = [Homeowner (77/(77+9+12)) = 77/98 =.786]b			79%		89%
Response rate = [Homeowner (77/[77+12+9+7+43+ (.7831*(9+2))] = 77/[148+(.7831*(11))] =.4917]c			49%		64%

[1] It was not possible to reach the household member or contractor employee who could answer questions related to participation in HPwES.

See the Glossary for definitions of Contact Rate, Cooperation rate and Response rate as defined by AAPOR.

[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 =.783 for participating homeowners and 0 for participating contractors.

A census attempt was conducted for the surveys with the formerly-participating contractors. Of the 54 firms included in the sample of formerly-participating contractors 12 were interviewed giving a 75% cooperation rate, a 53% contact rate and resulting in a 40% response rate. The details of the sample disposition for the formerly-participating contractors and the non-participating contractors are provided in Table 3-4.

Completing the surveys with non-participating contractors proved quite difficult. Completing the required 70 surveys involved a sample of 800 and a $100 incentive; the final cooperation rate was 45% and the response rate was 17%.

Table 3-4. Sample Disposition for the Home Performance with ENERGY STAR Survey of Formerly-participating and Non-Participating Contractors

Disposition		Number of Formerly-participating Contractors In Sample Frame	Percent of Formerly-participating Contractors	Number of Non-Participating Contractors In Sample Frame	Percent of Non-Participating Contractors
Total Sample Used		54	100%	800	100%
Unusable Sample	Not working/Unusable number	16	30%	179	22%
Not Contacted (A minimum of eight calls were made.)	Respondent never available/ Answer Maching (Eligible)	14	26%	149	19%
Unknown Eligibility	No Answer/Busy/ Answer Machine (Eligibility Unknown)Not complete	0	0%	221	28%
Not Eligible	Not Eligible/ Not Qualified	8	15%	95	12%
Refused/ Break-off	Refused/ Break-off	4	7%	86	11%
Completed interview		12	22%	70	9%
Contact rate = ((12+4)/(12+4+14) =.53.3) a			53%		51%
Cooperation rate = (12/(12+4) =.75) b			75%		45%
Response rate = (12/[12+4+14+(.556*0)] =.40) c			40%		17%

See the Glossary for definitions of Contact Rate, Cooperation rate and Response rate as defined by AAPOR.

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=0.556 for the formerly-participating contractors and e=0.527 for the non-participating contractors.

3.3 THE BILLING ANALYSIS

The basic regression model was a fixed effects model including weather and efficiency measures installed through the Program. The type of modeling used in the restricted and full regression models is often referred to as cross-sectional, time series (CSTS) analysis, in which the Program-level data provided at the household level comprise the "cross-sectional" component and the monthly billing records are the "time series" data. These two sources of data are merged with the weather data to create a CSTS data set. The regression models also have customer-specific intercepts to take into account the characteristics of the home that do not vary over time. [31]

The participant model included completed projects for program years 2007 through 2009 to maximize the total number of projects used in the final models. In the alternative model that incorporated non-participants, the 2009 completed projects were removed from the participant group and identified as the "non-participant" group. The rationale behind this approach is that "future" participants are more like current participants than any other population. Acting as a comparison group meant the non-participant group included no post-retrofit billing data for the comparison model.

3.3.1 Data Sources

The evaluation required data from four primary sources:

1. program data on measures installed in each home
2. billing records from the utilities
3. weather data
4. participant surveys

A description of each data source is provided below.

Program Data

NYSERDA provided the Impact Evaluation Team the full program database, which included both project-level and measure-level data, to the evaluators. A substantial amount of information was provided at the project level including the fuel source of the space and water heating systems. Some information that would have been useful to the billing analysis was not included in the Program tracking data, such as the number of occupants in the home and whether a home has a working central or room air conditioner.

Utility Billing Data

The data request to the utilities included numerous fields. Some utilities provided most or all of the fields and other utilities provided just a subset. An example of a missing field is whether the meter read was estimated. This information is important for interpreting the utility data and its usefulness.

Weather Data

Weather data was obtained from the National Oceanographic and Atmospheric Administration (NOAA) for the weather stations in New York State and used to calculate the heating and cooling degree days.

[31] A common alternative approach is the normalized annual consumption (NAC) model. In this case, the monthly billing records are collapsed to a pre-installation estimate of use and a post-installation estimate of use, and these two values are compared to estimate the savings for each household. This approach was not selected as it does not directly incorporate monthly variations and thus, additional information to inform the modeling is lost. In the *California Evaluation Protocols*, the NAC method is defined as "basic rigor" whereas the fixed effects models are identified as "enhanced rigor."

The base temperature was 65°F for heating degree days and 75°F for cooling degree days. Homes were matched to the nearest weather station by zip code using a file provided by NYSERDA for this purpose.

Data Cleaning

Data cleaning is a critical component of any billing analysis and is generally the most time-consuming step in the process. The Impact Evaluation Team carefully reviewed the billing data for the following reasons:

- identify billing records with a sufficient period of pre- and post-installation, generally a minimum of nine months before, and nine months after, the installation of all measures and covering two complete heating season (for the natural gas model) or two complete cooling seasons (for electric model)
- identify breaks in billing history which indicate a possible lapse in service - typically monthly reads with no energy use or missing reads
- verify overall use is within the typical range of residential use[32]
- assess billing records for high variability or a see-saw pattern which may indicate estimated reads that were not labeled as such

While many, if not most, participants in the model had billing data that covered 12 months before and 12 months after the installation of measures, a minimum of nine months was set as the standard rule if the billing data also included two complete heating seasons (for natural gas) or two complete cooling seasons (for electric). This approach allowed for the inclusion of additional homes in the model without compromising the ability to estimate savings for seasonal measures.

When the modeling was underway, it also became clear that the billing data from two utilities (as discussed in the previous section) contained many unidentified estimated reads and reconciliations, thus breaking the direct relationship between consumption and the weather impacts during the specific billing periods. For this reason, the models were run twice - first, with all participants and then with the billing data from these two utilities removed.

The Program data were reviewed for internal consistency. For instance, there were inconsistencies in the units used to report natural gas savings, requiring conversion to a common unit (MMBtu). A number of issues were identified and discussed with the NYSERDA HPwES Program and Evaluation Managers, such as seemingly high insulation and air sealing savings in some homes which were then identified as vintage homes with maintenance issues.

Several projects were discussed and provided to the NYSERDA evaluation manager to assess whether corrections should be made to the Program database. The projects discussed and removed from the Program data for the impact evaluation included the following unresolved issues:

- projects with zero savings for all fuel types (due to initial data entry into the Program tracking database for projects that were not completed or were later combined with another project)
- negative electric savings and zero fossil fuel savings in the same project
- zero electric savings and negative fossil fuel savings in the same project
- projects with no measure level savings
- positive savings for both electric and natural gas in the same project measure where unexpected (such as a fuel switch measure)

[32] Homes with electric space heating tend to have higher use; homes using more than 50 MWh per year may have some type of mixed use. Sometimes the consumption level is lower than would be required to run a refrigerator and a few lights, suggesting that the home may be unoccupied for periods of time.

- data entry issues that resulted in projects with inexplicable, negative insulation and air sealing savings

A few other projects with anomalies were also removed from the data set. For example, a few projects with programmable thermostat installations also resulted in significant extra use. This inconsistency occurred in projects with multiple units, suggested the single utility billing account number available in the database was inappropriate.

3.3.2 The Regression Model

Weather effects and HPwES measure installations were included as predictor (independent) variables and the response (dependent) variable was the daily energy consumption. The regression coefficients for program variables were used to estimate the Program savings. For the restricted model including only respondents to the telephone survey, the variables were expanded to include specific changes in the household over the analysis period, such as changes in occupancy. Separate natural gas and electric models were developed.

The model was a generalized linear model with customer-specific intercept of the form shown in the equation below.

$$C_{it} = \alpha_i + \tau_t + \sum_{j=1}^{p} x_{ijt}\beta_j + \sum_{k=1}^{q} z_{ikt}\gamma_k + \varepsilon_{it} \qquad (1)$$

where:

Cit is the monthly consumption for the household i in period t, expressed in monthly kWh per day,

α_i is the "customer-specific" intercept (or error) for household *i*, accounting for unexplained difference in use between households associated with the characteristics of the house (size, orientation, number of windows, age), number of occupants, appliance holdings and lifestyle,

τ_t is the "time-specific" error for period *t*, reflecting the unexplained difference in use between time periods,

x_{ijt} are the predictor variables reflecting the installation of energy efficiency measure *j* for household *i* in period *t,*

β_j are the slope coefficients that quantify the average influence of modeled efficiency measure *j* on monthly consumption,

p is the total number of energy efficiency measures included in the model,

z_{it} are the predictor variables reflecting non-program related effect *k* (such as weather impacts) for household *i* in period *t,*

γ_k represents the slope coefficients that quantify the average influence of modeled non-program related effect *k* on monthly consumption,

q is the total number of non-program related effects included in the model, and

ε_{it} is the error term that accounts for the difference between the model estimate and actual consumption for household *i* in period *t.*

The model used dummy variables, in which the *x's* for the installed measures are one or zero to indicate the installation and the coefficients reflect the savings for the measures. A dummy variable to capture any changes during the post-installation period was not included as it tends to create collinearity with the measure-level variables. However, the models were run with only a household variable to estimate total household savings and also with measure-level variables and the results were compared to ensure that savings found in the billing models were not overlooked.

The use of SAE modeling was considered. This approach replaces the *x's* with the Program-estimated energy savings for the measure or household and the coefficients represent the realization rate. The SAE model works well when the savings estimates are site-specific and calibrated to pre-installation use, as is done in the HPwES program. However, if there is random error in the *x's,* the coefficients may be biased downward. SAE modeling was applied but did not produce usable results.

3.3.3 Model Selection Process

A component of the modeling process is to compare alternative models to determine the model that best fits the data and to assess the relative importance of specific variables or groups of variables. Standard statistics, such as the coefficient of determination (R^2) and t-values for specific parameters were compared. In addition, the information-theoretic approach to model selection was employed to ensure that the selection of the final model is based on objective statistical standards.[33] This approach was used in conjunction with a review of the modeling results to ensure that the "best model" in terms of the statistical properties also allowed for improved estimation of the variables of interest.

The information-theoretic approach is designed to allow a group of candidate models to be compared and ranked by use of Akaike's Information Criterion (AIC). The model with the lowest value of the AIC is the one that best fits the data set, *i.e.*, the model that minimizes the information loss.

The AIC is calculated from the log likelihood function with an added penalty reflecting the number of parameters in the model, as shown below:

$$AIC = -2\log(\mathrm{L}(\hat{\theta}|y)) + 2K \qquad (2)$$

where $\log(\mathrm{L}(\hat{\theta}|y))$ is the value of the log likelihood function at its maximum point for the vector of parameters designated by θ, given the data y, and K is the number of estimable parameters, including the intercept and the residual variance.[34]

If the candidate models are fit by least squares regression and the outcomes are not transformed, the maximum likelihood estimate (MLE) of the residual variance can be calculated directly from the residual sum of squares (RSS/n) (Burnham and Anderson 2002).[35]

The AIC's of all models in the set of candidates can be rescaled to simplify the comparison and ranking process:

[33] In billing analysis, the analyst makes many decisions regarding the statistical characteristics of the model and the specific parameters to be included. Thus, there are typically a number of possible models that could be used to estimate savings. The information-theoretic approach provides an objective framework for selecting the best model among a series of competing candidate models. Please refer to *Model Selection and Multimodel Inference* by Kenneth Burnham and David Anderson, Springer-Verlag, NY, 2002.

[34] Maximum likelihood methods allow for the estimation of the parameters of interest, given a set of data and an assumed model. A brief introduction to maximum likely theory is provided in the Burham and Anderson text.

[35] The maximum likelihood estimator (MLE) is the value of the parameter for which the log likelihood function is at its maximum.

$$\Delta_i = \mathrm{AIC}_i - \min(\mathrm{AIC}) \quad (3)$$

where index i indicates the number of the model and min(AIC) is the smallest AIC value.

The relative values of Δ_i indicate the level of support for the given model. A rule of thumb is that models varying by only one or two from the best model have strong support; models with Δ_i's between three and seven show less support and a value of ten or more indicates little to no support (Burnham and Anderson, 2002). However, these ground rules presume that all of the basic assumptions of linear regression are met.

There are some limitations to applying the information-theoretic approach. The candidate models must have the same number of observations and a similar structure. Models in which the dependent variable is transformed or that assume a lognormal distribution of errors (for example) cannot be compared with untransformed models.[36]

3.4 RESTRICTED BILLING ANALYSIS

The purpose of the restricted model was to determine whether non-program, within-home changes in energy consumption introduce a bias into the savings estimates. The purpose of this exercise was to determine whether there were any changes in the estimated household savings when additional non-program changes are included in the model. Some of the key features of this component of the evaluation are explained below.

- The restricted model was not intended to develop alternative estimates of program savings, as a smaller model with only 400 participants would be expected to produce less reliable results than the full model.
- By starting with the base model to estimate household savings, each potential major type of change was added to the model to ascertain whether the household savings changed.
- Estimated savings are most likely to be affected by non-program changes that are coincident with the installation of measures. Each of the variables representing potential non-program changes included in the models reflected the timing of the non-program change in relationship to the installation of program measures.

To achieve this objective, regression variables were constructed from the Energy Change Survey, included in the model, and the regression coefficients, t-statistics, R-square and savings were compared. This comparison assessed whether adding the change variables provided reliable models and made a significant difference in the resulting savings estimates.

The Energy Change Survey resulted in detailed information regarding changes made within the participating households during the analysis period. Two strategies were employed to obtain information about energy changes:

1. Questions about changes in the use of energy-intensive equipment and schedule were constructed by comparing the pre-installation period to the post-installation period.
2. Additions or replacements of appliances and changes in occupancy were recorded by inquiring about the timing of the change, *i.e.*, the change could occur at any point throughout the analysis period.

[36] Please refer to *Model Selection and Multimodel Inference* by Kenneth Burnham and David Anderson, Springer-Verlag, NY, 2002.

The variables included in the restricted model were designed to compare changes between the pre- and post-installation periods. However, the timing of the change also affects the magnitude of the impact on the regression estimates. For example, a home with a change made early in the pre-installation period and then remaining in place throughout the rest of the analysis period is not particularly different from a home with no change at all. For these questions, the variables for the regression model were constructed by developing an average value for the pre-installation period and for the post-installation period.

Utilizing the information from the survey data, variables were constructed to model the difference in appliance holdings, occupancy, schedules, and energy use patterns between the pre-installation and post-installation periods.

All model results were compared against the base case, which included only the variables available from the Program tracking data and the NOAA weather files, *i.e.*, only the variables that could be included in the full regression model. Survey-based variables reflecting the major potential sources of variation in energy use were then added to the base model to assess whether there was any change in the savings. The candidate models are described in Table 3-5 and Table 3-6. Variables expected to result in a change in heating or cooling use were interacted with heating or cooling degree days for those homes with self-reported electric space heating or cooling use, respectively.

Table 3-5. Candidate Models for the Restricted Electric Model

Model Number	Description	Variables
1	Base model	Base model, household savings, heating degree days and cooling degree days (these variables are included in all candidate models)
2	Electric space heat or air conditioner (A/C) usage	Self-reported electric space heating or cooling use interacted with heating or cooling degree days as appropriate
3	Change in occupancy and cooling use	Increase in occupancy, decrease in occupancy, increase in air conditioner use (new A/C added), decrease in air conditioner use (old A/C replaced)
4	Changes that would increase base, space heating or cooling use	Composite variable that includes any change expected to increase use, such as adding electric appliances, self-reported increase in use of A/C or space heating
5	Changes that would decrease base, space heating or cooling use	Composite variable that includes any change expected to decrease use, such as replacing old electric appliances, self-reported decrease in use of air conditioning or space heating
6	Both increase or decrease base, space heating or cooling use	Both composite variables as described for models 4 and 5 above
7	Schedule changes	Self-reports of changes in vacation schedule or time at home

Table 3-6. Candidate Models for the Restricted Natural Gas Model

Model Number	Description	Variables
1	Base model	Base model, household savings, heating degree days (these variables are included in all candidate models)
2	Thermostat control	Heating savings separately for participants who set the thermostat at one temperature and those who setback either manually or with a programmable thermostat
3	Use of supplemental heat	Heating savings separately for participants who use a supplemental (non-natural gas) heat source and those who do not
4	Changes in occupancy	Increase in occupancy, decrease in occupancy
5	Changes that would increase base or space heating use	Composite variable that includes any change expected to increase use, such as adding natural gas appliances, self-reported increase in use of space heating, scheduling changes or an increase in occupancy
6	Changes that would decrease base or space heating use	Composite variable that includes any change expected to decrease use, such as adding natural gas appliances, self-reported increase in use of space heating, scheduling changes or an increase in occupancy
7	Both increase or decrease in base or space heating use	All variables described in items #5 and #6 above
8	Schedule changes	Self-reported changes in vacation schedule or time at home

3.5 FULL BILLING ANALYSIS

The savings estimates were developed using two regression models: one for electric measures and one for natural gas. Customer intercepts are incorporated into both models.[37] These intercepts were established for each home in the model and account for the fixed characteristics of the home, such as house size and presence of major appliances. The customer intercepts explain a large part of the differences in use from house to house, and consequently the R-squared statistic for these models tends to be high.

3.5.1 Common Model Specifications

Time Period Effects and Definition of the Pre and Post Periods

To estimate measure savings, the measure variables are interacted with a dummy variable (dpost), which defines the pre and post periods. All measure variables interacted with this dummy variable are set to zero during the pre-installation period and one for the post-installation period. The pre-installation period is defined as all activity prior to the initial CHA, and the post-installation period begins following the installation of the last efficiency measure installed through the Program. Given that energy consumption during the period between the date of the initial energy assessment and the date of the installation of the last measure tends to be volatile due to the measure installation process, these records were eliminated from the analysis on a house-by-house basis.

The electric model includes monthly variables to account for the time effects and allow the ability to account for the monthly variation in usage that is not related to the Program or other known factors. In

[37] By using customer-specific intercepts, changes in use between the pre- and post-installation periods are estimated for each home in comparison to the average use in the home. This approach allows the model to account for house-to-house differences in size, housing stock, occupancy and life style.

the natural gas model, a dummy variable for each year was incorporated into the model to pick up changes in use over time.[38] The terms for space heating and cooling effects in the models were interacted with average daily heating or cooling degree days to reflect weather-dependent use.

3.5.2 Measure Groups

Program eligible measures were grouped into categories to simplify the modeling process and improve the ability of the model to estimate savings by measure group. These groups are defined below.

[38] The measure installations were spread throughout the program years of 2007 through 2009, indicating that there would be little likelihood that the year variable would coincide with the entire pre-installation periods (or post-installation period) for large groups of participants included in the model.

Table 3-7. Definitions of Measure Groups in the Final Models

Measure Group	Variable Name	Model (G=Natural Gas, E=Electric, B=Both)	HPwES Measures Included
Lighting	dltg	E	Hardwired fixtures and some CFLs
Water Heater Fuel Switch	dhwfs	E	Water heater fuel switch kWh or MMBtu savings, depending on model fuel type
Envelope	dEnv	B	Insulation and air sealing, windows and doors
Heating System Fuel Switch	dhsfs	B	Heating replacement with positive kWh savings and extra MMBtu use
Air Conditioning	dac	E	Air conditioning replacement with new ENERGY STAR model.
Refrigerator Replacement	dref	E	Refrigerator and freezer replacement with new ENERGY STAR models.
Water Heater Replacement	dhwrep	B	Water heater replacement with new ENERGY STAR model with kWh or MMBtu savings but no extra fuel use of either type
Appliances	dappl	B	Appliances – clothes and dishwasher replacements with new ENERGY STAR models
Programmable Thermostats	dtstat	B	Programmable thermostat
Heating System Replacement	dhsrr	B	Heating replacement with kWh or MMBtu savings but no extra fuel use of either type
Water Heating Conservation	dhwcons	B	Pipe wrap, low flow showerheads, tank wraps
Extra Energy Use from Heating System Replacement	dhsfsextr	B	Extra use from heating system replacement
Extra Energy Use from Water Heater Fuel Switch	dhwfsextra	E	Extra use from water heater fuel switch
Extra Energy Use from Heating System Fuel Switch	dhsfsextr	B	Extra use from heating fuel switch

3.5.3 Weather Effects

The heating and cooling degree day variables in the regression model were calculated based on the daily temperatures for each billing cycle. Temperature data was obtained from NOAA, and these data were averaged and summed to obtain the heating and cooling degree days for each billing cycle. The weather station associated with each participant's home was assigned by zip code. The Program and weather data were merged with the billing history for use in the regression model. All regression models included terms to control for temperature (heating and cooling degree days).

3.5.4 Calculation of Savings from Estimators

Savings for the non-temperature-dependent measures were estimated by the direct inclusion of a binary variable set to zero during the pre-installation period and one during the post-installation period.

The resulting estimators were in units of kWh or therms per day, and were multiplied by 365 days to calculate energy savings per year.

All measures designed to save space heating energy use were modeled by estimating the heating slope for the post-installation period and the heating slope over the entire analysis period; the post-installation variable reflects the difference in heating slopes, and thus the savings. The resulting estimators were in units of therms savings per degree day, and were multiplied by the annual heating degree days for the participants with the measure to calculate energy savings per year. Both variables were specific to the homes that received the measure, as this approach tends to improve the ability to estimate savings.

3.5.5 Electric Model Variables

The electric model was used to estimate the savings from refrigerator and freezer replacement, lighting, water heating conservation, water and space heating fuel switches and clothes dryer fuel switches. Homes tended to receive a few measures, which lowers the potential for collinearity[39] which would be the case if most homes had most of the measures but also lowers the number of homes for each specific measure group making it more difficult to separate savings by measure group. Collinearity refers to the situation where two or more independent variables in a model are highly correlated, such as when two measures tend to be installed together. Collinearity results in higher variances for both predicted and explanatory variables and tends to result in instability in the model estimators*, i.e.*, large swings in the magnitude of the estimators depending upon the variables included in the model, and may result in estimators of the wrong sign, *i.e.*, estimators indicating that a measure results in an increase in use rather than savings.

A hierarchical structure was tested for assigning the specific measure to be estimated from the several options in each home to avoid collinearity. For example, if the water heating fuel was switched from electric to fossil fuel, no other measures (except lighting and "other" measures) were estimated from that home. The larger, less frequently installed measures were placed at the top of the hierarchical structure and the smaller, frequently installed measures at the bottom. This approach also prevents the savings from smaller measures, such as those for DHW conservation, to be artificially inflated by the savings from other measures. However, further analysis of program data indicates that many homes installed only one or two measures, and thus the hierarchical structure may not improve the measure estimates. The hierarchical model was not used to determine the final savings estimates.

<u>Electric Model Selection</u>

All measures intended to estimate savings for heating- or cooling-related measures were interacted with heating or cooling degree days, respectively. The candidate models reflect different strategies to modeling the savings, starting with the simplest approach of estimating savings by household, and moving to more complicated models with all measure groups estimated separately. Through this process, the highest ranked model according to the information-theoretic model was model number six, which consisted of savings measures and extra use measures without measure hierarchy. There was little difference between hierarchical and non-hierarchical measure definitions, suggesting that the hierarchical structure did not improve the measure estimates.

[39] Collinearity refers to the situation where two or more independent variables in a model are highly correlated, such as when two measures tend to be installed together. Collinearity results in higher variances for both predicted and explanatory variables and creates difficulty in partitioning variance among the competing explanatory variables.

Specifications of the Final Electric Model

The final model as determined by the model selection process included variables for all of the measure groups as defined above in Section 3.5.2. Savings for cooling-related measures were calculated using cooling degree days normalized for years 2003 through 2009. The final models were tested for violations of assumptions.

3.5.6 Natural Gas Model Variables

As with electric measures a hierarchical structure was tested for assigning the specific measure to be estimated from the several options in each home to avoid collinearity. Only one heating-related measure was identified for each home. The hierarchy was established as follows:

1. heating system replacement
2. insulation and air sealing (envelope measures)
3. programmable thermostats

Thus, savings from programmable thermostats were estimated only for homes with this measure that did not receive heating system or envelope measures. This approach also prevents the savings from smaller measures, such as programmable thermostats, to be artificially inflated by the savings from other measures. The same approach was used for the water heating measures, *i.e.*, the water heating conservation measures were estimated only from homes that did not receive a water heating replacement measure.

There was little difference between hierarchical and non-hierarchical measure definitions proving that the model could be more inclusive and use the non-hierarchical structure.

Natural Gas Model Selection

The natural gas model selection was similar to the process used for the electric model. The base model started with the simplest form, estimating savings by household, and the candidate models increased in complexity by adding measure groups. Except where otherwise noted, each model built upon the previous one.

Using the information-theoretic approach, model number four was the top contender and the measures included are as in the earlier measure group definition table. Savings for heating-related measures were calculated using heating degree days normalized for years 2003 through 2009.

The final models were tested for violations of assumptions.

3.5.7 Final Comparisons

The final models were run using all participants with sufficient billing history, omitting participants from the two utilities with billing data that seemed to include many unidentified estimated reads. (See Section 3.3.1 Data Sources). After the final models had been selected, the models were run in a number of different ways, as specified below:

1. the two utilities with problematic billing records were added
2. a comparison group of non-participants were added to assess impacts from external factors
3. trend lines to take into account economic factors were added, also to assess impacts from external factors

Non-participants were defined as HPwES 2009 participants prior to their participation, i.e., only billing data during the pre-installation period were used. These "future" participants are expected to match closely to the PY07/08 participants, and consequently, are a reasonable comparison group. HPwES participants with completed projects in 2009 were included in the participant model to increase the number of homes in the model. For the non-participant model, 2009 participants were removed from

the participant group and only the pre-installation billing data was used in the non-participant comparison group. With the understanding that the results from the combined model may include net effects, the model estimators were compared for illustrative purposes.

In addition, trend lines were added to the full billing analysis to reflect the change in unemployment rate and gasoline prices over the period. The monthly unemployment rate and gasoline price were obtained from the Department of Labor and the U.S. Energy Information Administration (EIA) web sites,

3.6 ESTIMATING SUMMER PEAK DEMAND SAVINGS

The electric billing analysis provided estimates of the average energy (kWh) savings per household. To estimate the summer peak demand savings, these values were converted to kW by using a conversion factor developed by major measure group from NYSERDA's Deemed Savings Database (DSD). The conversion factor was calculated as follows:

kW/kWh conversion factor = summer peak kW savings / annual kWh savings

The values are presented below.

Table 3-8. Conversion Factors by Measure Group: kW/kWh

Measure Group	Summer Peak Conversion Factor (kW/annual kWh)
Lighting	0.00008
Refrigerator Replacement	0.00014
Water Heating Conservation	0.00005
Water Heater Replacement	0.00005
Water Heater Fuel Switch	0.00005
Air Conditioning	0.00168
Envelope	0.00168
Other Electric Measures[1]	0.00011
Heating System Fuel Switch	0.00000

[1] The conversion factor for the "other" measures was calculated as a savings-based weighted average of the other measure groups.

3.7 ESTIMATING NET-TO-GROSS COMPONENTS

Evaluated net impacts are often estimated by assessing the proportion of program savings associated with free riders (FR) and the proportion of program savings due to spillover (SO). These factors are used to develop the net-to-gross ratio (NTGR), which becomes the adjustment factor to derive net impacts.

The definitions for the net-to-gross ratio's (NTGR) two primary components are described below.

1. Free Ridership (FR) - The Program-supported measures (or the proportion of the savings) participants would have adopted within the same time frame in the absence of the Program.
2. Spillover (SO) - Additional efficiency actions adopted by participants and non-participants that are not directly attributed to the Program but are caused by the Program.

Spillover estimates are developed for all the market actors that could be affected, whether these are participants or not, and whether it occurs at the Program site or another site. Inside Spillover (ISO) occurs when energy saving actions are taken at the site by participants but are not done as part of the Program. Outside Spillover (OSO) occurs when energy saving actions are taken by participating owners or contractors at sites that are not part of program participation. Non-participant spillover is savings resulting from actions taken due to the Program but not part of the Program through formerly-participating contractors as well as those contractors who have never participated in the Program.

3.7.1 Free Ridership Rate

To determine direct FR, participants are asked the likelihood of installation without the Program incentive for each measure installed. Since the Program may be effective in influencing the participant to expand the scope of work, participants are also asked to estimate the share (proportion) of the efficient measures that would have been installed without the Program, *e.g.*, the percentage of the light fixtures that would have been upgraded to efficient fixtures if the participant had not participated in HPwES.

The effect of the Program on the timing of the installation as reported by the participant is multiplied by the proportion of savings obtained from a given measure. These measure-level FR estimates are then averaged and weighted by savings to produce the direct FR for each home.

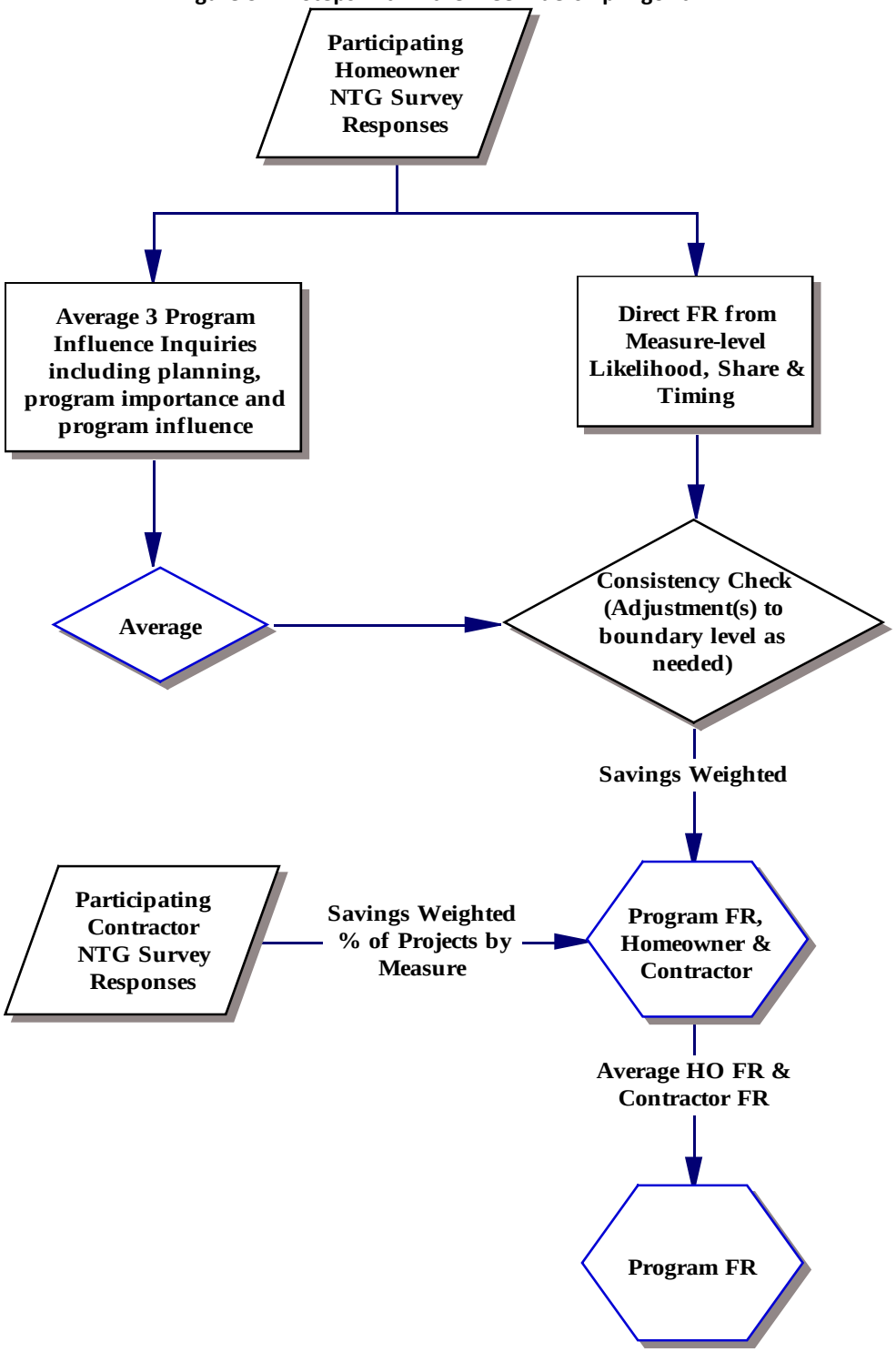
A consistency check was performed by comparing the preliminary overall FR estimate, developed through the above process, to an average of responses to three questions regarding the influence of the Program.[40] The three survey questions that comprised the consistency check inquired about plans for high efficiency prior to program participation, the influence of the Program on the installation of efficiency measures and the importance of the Program in making the decision to improve the efficiency of the home. An upper and lower range of plausible FR values was developed based on the response to the questions about program influence. If the participant's preliminary overall FR estimate fell below the lower or above the upper bounds, the preliminary FR estimate for that site was adjusted upward or downward to the edge of those bounds. This process resulted in the final FR estimate for each household.

The HPwES participating contractor survey included questions regarding the percent of the home improvement projects contained energy efficiency improvements that were installed through the HPwES program and the percent of the projects with each efficient measure that would have occurred without the HPwES program. The energy efficient measures and projects that are undertaken through the Program but would have occurred without the Program (*i.e.*, any aspect of the Program, such as incentives or technical assistance or advertising) are the free riders. Each respondent's final FR was the average of the contractor's measure level responses weighted by measure savings.

[40] Over 20 years of experience in estimating self-report free ridership for energy efficiency program evaluation has set standards for quality FR measurement. One of these is to include additional inquiries and perform consistency checks across the inquiries. The FR calculation also needs to measure what would have occurred in the absence of the Program, not what the participant "intended" to occur (as many good intentions do not actually become results). Estimating the hypothetical construct of FR based upon a decision that the participant might never have faced is quite difficult. This enhances the importance of the measurement method to be designed for construct validity. This is more important to obtaining a rigorous FR estimate than sampling precision.

A final FR value from the homeowner survey and a final value from the contractor survey were calculated as the savings weighted average across all projects. The final program FR is the simple average of the two FR values (homeowner and contractor). This process is illustrated in Figure 3-1.

Figure 3-1. Steps within the Free Ridership Algorithm



3.7.2 Spillover Estimation

The participating homeowner survey included questions to estimate participant inside spillover (ISO), covering whether or not additional actions were taken in their home due to the Program and, if so,

identifying the energy savings expected from those actions as compared to the magnitude of savings achieved through the Program.

To estimate the participating contractor outside spillover (OSO), the participating contractors were asked about the Program's influence on their work outside the Program.

Both participating homeowners and contractors could produce OSO. Participating homeowner OSO would occur when a participating homeowner is influenced by the Program to induce the purchase and installation of high efficiency equipment at another house, for example a home owned by a relative. Participating contractors may find that they are able to induce other customers to invest in additional high efficiency measures outside of the Program.

Outside spillover is more likely to occur due to actions by participating contractors with non-participating customers. Counting the same savings twice, *i.e.*, double counting, is a concern when estimating SO from two separate sources (participating homeowner and participating contractors). For example, it is possible a homeowner who is influenced by HPwES to upgrade to efficient equipment outside of the Program could potentially be reported as spillover by both the homeowner and the contractor. To ensure this does not occur, the measurement of outside SO is based only on the contractor responses.

Non-participant spillover (NPSO) was estimated using the responses from the non-participating contractor NTG survey. There were two types of non-participating contractors surveyed: those home improvement contractors who had never participated in the HPwES program and those that were former participating contractors who did not participate during the 2007-2008 program period. Non-participant spillover was derived for each of these two groups separately.

The non-participating contractor survey included questions asking respondents to estimate the percentage of their 2007-2009 home improvement jobs that included each measure group, the percent of those jobs that were due to the influence of energy efficiency programs in New York and then what percent were due to NYSERDA's HPwES. The same series of questions were asked for measures designed to save electricity and natural gas.

Participating contractors were asked to estimate participant inside and outside spillover by using the electric and natural gas savings obtained through the Program as a benchmark. For non-participating contractors, the number of home improvement projects for each of the high efficiency measures was calculated from the measure level survey responses. The annual NPSO savings by fuel type per project was calculated by applying the average measure level program savings from the 2007-2008 HPwES program database to the estimated number of projects with each high efficiency measure.

The total NPSO rates were calculated by dividing the total (natural gas and electric) NPSO savings per year by the total Program (natural gas and electric) savings per year. The electric spillover estimated kWh savings were converted to source MMBtu using the New York specific conversion rate provided by NYSERDA and then dividing by the Program estimated savings in MMBtus.

3.7.3 Net-to-Gross Ratio

The FR and SO rates are combined to produce a net-to-gross ratio that is applied to evaluation-estimated gross savings to produce net savings.

Net-to-Gross Ratio (NTGR) =	1	–	Free Ridership Factor	+	Total Participant Spillover Factor	+	Non-participant Spillover Factor

This process ensures that the final net program savings estimate incorporates both free riders and spillover in a balanced manner.

3.8 EARLY EQUIPMENT REPLACEMENT

HPwES currently calculates program reported savings assuming that measures are installed as an early replacement, *i.e*., the efficient equipment is installed to achieve energy savings and before the existing equipment is at the end of its life. In this case, the savings are estimated as the difference between the use of the existing and efficient equipment. However, if the equipment is replaced at the end of its useful life, then the replacement is a market opportunity measure and the savings are estimated as the difference between a standard efficiency new product and the efficient equipment. One purpose of this impact evaluation was to investigate the prevalence of early replacement measures to assess whether savings are estimated correctly.

Questions were added to the survey for this purpose to inquire about the age and condition of the existing equipment. These questions were asked for all the major equipment changes offered through the Program, ENERGY STAR refrigerators and freezers, appliances, heating systems and related fuel switches, water heater systems and related fuel switches, and cooling systems.

3.9 NON-ENERGY IMPACTS

Non-energy impacts (NEIs) are additional benefits accruing from the installation of efficiency measures, such as improved comfort, lower maintenance expenses or reduced use of other resources. For instance, high efficiency clothes washers use substantially less water than a standard clothes washer. Questions about residential NEI impacts were included in the NTG survey instrument. The final sample sizes for these inquiries ended up being quite small. The results might not be reliable or unbiased so they are not reported in this evaluation. It is recommended that future evaluations desiring to gather information on NEIs include measure quotas in its survey and sampling design and evaluation cost estimates.

In addition, participating contractors were asked a series of questions to ascertain the non-energy impacts related to sales and profitability. This series of questions was designed to guide the survey interviewee through the thought process to enable more reliable answers to the question of program impact on profitability.

The survey instrument is provided as Appendix C. This series of questions is paraphrased below.

1. Excluding the Program incentives, did their firm's annual sales revenue change in between 2007and2009 due to their participation in HPwES and, if so, did it increase or decrease?
2. What was the change in annual sales revenue in terms of dollars?
3. Did the change in sales revenue change their profitability and, if so, did it increase or decrease the firm's profit? By how many dollars?

RESULTS

This section provides a summary of the results of the major components of this impact evaluation and how these components contribute to the overall results. Measure level savings from other jurisdictions in the northeast are discussed to assist with interpreting the results. The summary of evaluated gross savings is presented in Section 4.4.

4.1 BILLING ANALYSIS

4.1.1 Restricted Billing Analysis

The Participating Homeowner Energy Change Survey was designed to identify additions or replacements of equipment and changes in occupancy as they occurred throughout the analysis period. The purpose of the restricted model was to determine whether non-program, within-home changes in energy consumption introduce a bias into the savings estimates. This exercise was implemented by defining and running numerous models to determine whether there were any changes in the estimated household savings when additional non-program changes were included in the model.

All model results were compared against the base case, which included only the variables available from the Program tracking data and the NOAA weather files, *i.e.*, only the variables that could be included in the full regression model. Survey-based variables reflecting the major potential sources of variation in energy use were then added to the base model to assess whether there was any change in the savings.

This analysis indicated that the savings in the restricted models remained reasonably stable (within 4% for the natural gas model and 9% for the electric model), regardless of the composition of the model variables. In many cases, the survey variables did not produce the expected results; for example, reported actions with would be expected to increase use were often found to be associated with a decrease in use. This outcome suggests that the restricted electric model did not improve the ability to model the non-program and program effects.

Since non-program effects tend to be random, the variations in energy use do not introduce either an upward or downward bias to the final savings estimated as long as the number of homes in the model is sufficiently large. The restricted model indicated that the within-home variations do not introduce a bias into final estimated savings. Thus, the results from the full billing model are a reliable estimate of program savings.

4.1.2 Full Billing Analysis

The full billing analysis was conducted first in its simplest form, which estimated the savings by household, and then with measure groups to estimate the savings by group. The final results were based on the participant-only model including the utilities with reliable billing data. Some of the characteristics of the final models are described below:

- The coefficient of determination (R2), reflecting the proportion of the change in consumption explained by the model, are quite high at 0.82 for the natural gas model and 0.67 for the electric model. Fixed effects models generally have a very high R2 as much of the variation is explained by the house-to-house differences reflected in the customer-specific intercepts.
- Most of the measure group coefficients are of the correct sign and most of these have t-statistics ranging from well over 2 to almost 40. Most of the measure group savings were

reasonably consistent under different definitions of the model variables, as discussed in more detail below in Section 4.3.[41]

- For the most part, the measure group results are in the range of savings per project found for other, similar programs.
- Measure-level results may be variable, particularly for measures with only a few households in the model or measures with small savings. However, the results of the measure-level models are similar to the alternative models estimating household savings, which supports the use of the aggregated results to estimate program savings. A review of measure-level results is presented below in Section 4.3.

The Impact Evaluation Team also assessed the reliability of the results by reviewing the standard statistical output from the regression analysis. The sign (positive or negative) and statistical significance (t-value) of the regression coefficients were considered. Coefficients of the wrong sign may indicate that there are too few homes in the model to estimate the savings, the magnitude of the savings is so small that they are lost in the signal-to-noise ratio, there is high house-to-house variability in the savings for the measure, or there is collinearity in the model.[42] A t-value of 1.645 or more indicates that the regression coefficient is statistically significant at the 10% confidence level.

Table 4-1 presents the Program measure variables, their coefficients and t-values for the final electric regression model for this HPwES impact evaluation. Estimators in parentheses are negative, which indicates program savings. Thus, any measure with savings would be expected to have a negative estimator and measures with extra use, such as fuel switching, would be expected to have a positive estimator.

[41] Coefficients of the unexpected sign can be a sign of collinearity. These results indicate that collinearity is not an issue in this model.

[42] Collinearity occurs when there is overlap among coefficients within the homes, as might occur when multiple measures are installed in every home. This issue is unlikely to be an issue in the HPwES models as many homes had a very limited number of measures installed.

This review shows that most of the regression coefficients are the expected sign and are statistically significant. The measure groups are ordered by their contribution to the Program reported savings, with the largest savers on top. The weather dependent factors (heating and cooling degree days) meet both criteria (sign and statistical significance), as do all of the measures that make a major contribution to total program savings. The only measure with an estimator of the wrong sign that is statistically significant is programmable thermostats. Savings from programmable thermostats are difficult to estimate in a billing model due to the behavioral issues, *e.g.*, some participants may be setting the thermostat back manually prior to the installation and may actually see an increase in use.[43]

Typically, the R^2 values are high for fixed effect models with customer-specific intercepts, since much of the variation in use is explained by explicitly modeling the house-to-house differences.[44] This model had an R^2 value of 0.73.

[43] The recent impact evaluation of the EmPower program found that setback behavior affected the ability to estimate savings from heating related measure in a billing model. In the restricted billing analysis, the additional information about setback behavior from the participant survey was included in the model with the following results: "The savings from heating measures are less variable and substantially higher (by 80%) for the 25% of respondents who reported that they set the thermostat at one temperature and leave it, in comparison to those who either reported some type of setback (manual or programmed) or did not provide a valid response to the question." NYSERDA *2007-2008 EmPower New York℠ Program Impact Evaluation Report*, prepared for NYSERDA by Megdal & Associates, April, 2012, Appendix D.

[44] The R-squared (R^2) measures the proportion of variability in a regression data set that can be explained by the model.

Table 4-1. Summary of Final Electric Regression Model Results by Measure Group

Measure Group	Estimator[4]	t-value[5]	Unit of Estimator	Number of Measure Groups in Regression	Percent of Program Reported Savings
ENERGY STAR Lighting	(0.510)	3.0	kWh/Day	935	36%
Water Heater Fuel Switch[1]	(6.817)	10.2	kWh/Day	112	25%
Envelope (*e.g.*, insulation, air sealing, windows and doors) [1]	(0.034)	4.0	kWh/Heating Degree Day	629	14%
Heating System Fuel Switch	(0.671)	7.8	kWh/Heating Degree Day	7	12%
ENERGY STAR Air Conditioning[2]	(3.654)	5.3	kWh/Cooling Degree Day	237	5%
ENERGY STAR Refrigerator Replacement	(1.648)	3.5	kWh/Day	98	5%
Water Heater Replacement[1]	0.243	0.5	kWh/Day	112	3%
ENERGY STAR Appliance Replacement	(0.014)	0.0	kWh/Day	101	3%
Programmable Thermostats[1]	0.031	2.3	kWh/Heating Degree Day	100	2%
Heating System Replacement	(0.439)	4.3	kWh/Heating Degree Day	6	1%
Water Heating Conservation	(1.208)	0.9	kWh/Day	9	0%
Heating System Conservation	NA[6]	NA[6]	kWh/Heating Degree Day	0	0%
Extra Energy Use – Heating System Replacement[1, 3]	(0.016)	0.1	kWh/Heating Degree Day	5	0%
Extra Energy Use – Other Measure[3]	NA[6]	NA[6]	kWh/Heating Degree Day	0	0%
Extra Energy Use – Water Heater Replacement[3]	NA[6]	NA[6]	kWh/Heating Degree Day	0	-2%
Extra Energy Use – Heating System Fuel Switch[1, 3]	1.434	14.4	kWh/Heating Degree Day	8	0%
Heating Degree Days	0.103	7.7			N/A
Cooling Degree Days	4.355	21.6			N/A
R-Square[7]		0.67			

[1] Interacted with heating degree days (HDD).
[2] Interacted with cooling degree days (CDD).
[3] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, generating savings of one fuel type while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.
[4] The "estimator" is the regression coefficient and reflects the impact of the variable on the change in average daily use.
[5] The t-value of a regression coefficient measures whether the value of the coefficient is statistically different from zero. The t-statistic is the regression coefficient over the itsstandard error. A t-value of 1.64 indicates the coefficient is statistically different from zero at the 90% confidence level.
[6] Variable not in final model.
[7] The R-squared (R^2) measures the proportion of variability in a regression data set that can be explained by the model.

Table 4-2. Summary of Final Natural Gas Regression Model Results by Measure Group

Measure Group	Estimator[3]	t-value[4]	Unit of Estimator	Number of Measure Groups in Regression	Percent of Program Reported Savings
Envelope (*e.g.*, insulation, air sealing, windows and doors) [1]	(0. 023)	29.0	Therms/Heating Degree Day	1,195	72%
Heating System Replacement[1]	(0.042)	32.1	Therms/Heating Degree Day	378	26%
Programmable Thermostats[1]	(0.006)	1.3	Therms/Heating Degree Day	38	7%
Water Heater Replacement	(0.280)	6.5	Therms/Day	184	4%
Heating System Conservation	NA	NA	Therms/Day	453	1%
ENERGY STAR Appliance Replacement	(0.252)	2.8	Therms/Day	245	0%
Water Heating Conservation	0.335	2.2	Therms/Day	145	0%
Heating System Fuel Switch	NA	NA	Therms/Day	4	0%
Water Heater Fuel Switch	NA	NA	Therms/Day	8	0%
Extra Energy Use – Other Measures[1]	NA	NA	Therms/Day		0%
Extra Energy Use – Heating System Replacement[1, 2]	0.115	5.3	Therms/Heating Degree Day	14	-1%
Extra Energy Use – Water Heater Fuel Switch	(0.840)	5.0	Therms/Day	103	-1%
ENERGY STAR Lighting and Refrigerators	NA	NA	Therms/Day	1,968	-8%
Extra Energy Use – Heating System Fuel Switch[1, 2]	0.097	21.2	Therms/Heating Degree Day	242	0%
Heating Degree Days	0.098	39.5			N/A
R-Square[5]		0.82			

[1] Interacted with heating degree days (HDD)

[2] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, generating savings of one fuel type while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

[3] The "estimator" is the regression coefficient and reflects the impact of the variable on the change in average daily use. .

[4] The t-value of a regression coefficient measures whether the value of the coefficient is statistically different from zero. The t-statistic is the regression coefficient over the its standard error. A t-value of 1.64 indicates the coefficient is statistically different from zero at the 90% confidence level.

[5] The R-squared (R^2) measures the proportion of variability in a regression data set that can be explained by the model.

Alternative Models and External Effects

After completion of the model selection process, the final household model was run under a variety of scenarios to assess the impacts of potential influences on the results. Overall, this additional analysis

supported the use of the participants-only model using the utilities with reliable billing data. The alternative scenarios are described below.

- All Utilities
  The two utilities with problematic billing records were added to include all utilities in the participant-only model. In both electric and natural gas models, the R-squared statistic dropped substantially. The R-squared dropped from 0.67 to 0.45 for the electric regressions and from 0.82 to 0.38 for the natural gas models. Typically, the R^2 values are high for fixed effect models with customer-specific intercepts, since much of the variation in use is explained by explicitly modeling the house-to-house differences. Consequently, the low R^2 value raises serious questions about the validity of the results for the all-utilities models.

- Comparison Group
  The non-participant comparison group was added to the model, including only the utilities with reliable billing data, to provide some initial feedback on potential external factors affecting the larger residential population.[45] Prior evaluation research has pointed out a major disadvantage of conducting a billing analysis with participant and non-participants in that the results are somewhere between evaluated gross savings and evaluated net savings making it impossible to disentangle the two.[46] The comparison group billing analysis models (both natural gas and electric) in this evaluation showed a reduction in savings. The realization rate from the electric model dropped from 35% to 28%, a reduction of 7 percentage points. The realization rate from the natural gas model decreased from 65% to 58%, a reduction of 6 percentage points.

  The interpretation of these results is unclear. It could be a result of a decrease in overall use between the pre- and post-installation period that is not associated with the Program. Another possible interpretation is that the lower savings reflect partial net effects, as non-participants in the comparison group may have installed some efficiency measures on their own and some of these efficiency upgrades could be spillover from participating or non-participating contractors. As this approach could introduce net effects into the results, it was used only for comparison purposes.

- Trend Lines
  Trend lines reflecting the changes in gasoline prices and unemployment rate were added to the models to address economic factors.[47] The overall effect across the detailed measure level model resulted in a modest reduction in realization rate. The electric model went from a realization rate of 35% to 31%, a reduction of 4 percentage points. The natural gas model went from 65% to 61%, a reduction of 4 percentage points. While this analysis suggests that there may have been a wide scale reduction in use over the analysis period in response to external

[45] The comparison group was drawn from "future" program participants, *i.e.*, those who participated in 2009, including only the billing data in the period prior to program participation. Proxy "installation" dates were assigned to the comparison group to allow simulation of the "pre-installation" and "post-installation" periods. The proxy dates were assigned by taking the most recent available read prior to the HPwES audit and subtracting one year. This approach resulted in a distribution of the comparison group billing data that was similar to the participants'.

[46] TecMarket Works. *2004 California Evaluation Framework*, prepared for the California Public Utilities Commission and the Project Advisory Group, September 2004, page 143.
Paquette, Eric. "Why Discrete-Continuous Billing Models Miss-Estimate Net Savings of DSM Programs." American *Council for an Energy Efficient Economy Summer Study*: Asilomar, CA. 1996, pp. 6.129-6.132.

[47] The unemployment rates and gasoline prices were taken from the Bureau of Labor Statistics' and Department of Energy's Web sites. These sites provided monthly figures for the 2006 through 2010 time period. These figures were provided by month, but were translated to daily numbers (the same number for each day of the month). The daily values were then averaged over billing cycles of each participant.

factors, the impact on the evaluated savings is modest and the final model without the trend lines was used to calculate the verified savings.

All of the alternative models produced lower savings, suggesting that market effects are having a downward impact on program savings. However, since interpretation of these alternative models is not clear and the magnitude of the adjustment due to market factors could not be determined with certainty, the Impact Evaluation Team based the evaluated savings on the final models with participants only and without the trend lines.

4.2 REGRESSION DIAGNOSTICS

The regression methods are based on the assumptions that the error term is independent, has a constant variance, and is normally distributed. Regression diagnostics were conducted for the final models (natural gas and electric) to determine whether there were any major deviations from these assumptions. The effects of heteroskedasticity (unequal variances), collinearity, autocorrelation (lack of independence among observations) and influential data points were assessed as part of the model diagnostics.

Heteroskedasticity is often caused by the wide fluctuations between high use and lower use homes and results in estimates showing higher variability than actually exists. The Goldfeld-Quandt test statistic was used to test for heteroskedasticity. This test statistic was 9.26 for the final electric model and 3.37 for the natural gas final model, indicating that heteroskedasticity exists in both models.

The models were also tested with and without outliers. Influential data points, or outliers, were determined using a DFFITS statistic, which is a scaled measure of change with and without an observation. The cut-off level was modified as recommended by Belsley, Kuh and Welsch,[48] The DFFITS values were summed by household to identify homes that are outliers. Once detected, the outlier households were removed and the regression analysis was run again to assess their impacts on the results. Using this method, 17 homes were identified as outliers in the electric model and three in the natural gas model. Removing outliers from the electric model resulted in a reduction in overall savings of more than 20%. This result is partially due to the small number of homes with large-impact measures (such as fuel switching). Removing outliers from the natural gas model created nearly imperceptible changes. Since the full models more correctly account for all of the Program effects, the final estimates were based on the full models.

Collinearity was not an issue in the model as there was little overlap in measure group installations. Autocorrelation is typically an issue in this type of billing model as use in one month is closely related to consumption in the following month within each home. In a CSTS, the pooled Durbin-Watson test is commonly used to assess the presence of autocorrelation. Due to time constraints, this test was not conducted; it is highly likely that it was found in these models. The effect of autocorrelation is to reduce the variability in the model, *i.e.*, the savings estimates appear to be less variable than they actually are.

Heteroskedasticity and autocorrelation do not result in biased estimators; rather they affect the reported variability of the model. These two effects, both of which are likely to be present in the billing models, tend to have opposite impacts, with heteroskedasticity increasing the estimated error in the model and autocorrelation decreasing it.

[48] This adjustment was set at 2 x square root (p/n), where p is the number of variables and n is the number of observations. Belsley, D.A., Kuh, E., and Welsch, R.E. *Regression Diagnostics*, New York: John Wiley & Sons, Inc., 1980.

The results of the regression diagnostics suggest that the estimated savings from the natural gas model are reliable and stable. The electric model is less stable, and all alternative models suggest that the actual savings may be lower than estimated savings from the final model used in this evaluation.

4.3 SAVINGS BY MEASURE GROUP

As discussed above, the measure-level results are most reliable for measures that are well-represented in the model and have higher savings in comparison to pre-installation consumption. While the estimated savings may be variable for some measures, the overall, aggregated savings from the model as estimated from the measure-level results are similar to the results of alternative models that estimated the household savings. These results indicate that the models provide a reasonable estimate of the Program savings. However, savings for specific measure groups with either few homes in the model or small savings are not necessarily reliable. Consequently, the regression results were also compared to savings and end use consumption estimates from alternative sources, including other impact evaluations, deemed savings and federal estimates.

4.3.1 Electric Model Results

Table 4-3 shows the savings by measure group and by household for the homes included in the electric model. The measure groups that make the largest contribution to overall program savings are discussed in more detail below.

Table 4-3. Electric Savings by Measure Group

Measure Group	2007-2008 Projects with kWh Savings	Program ReportedAnnual kWh Saved	Evaluated Annual kWh Saved	Realization Rate
ENERGY STAR Lighting	2,335	1,598,460	457,641	29%
Water Heater Fuel Switch	135	1,103,605	359,657	33%
Envelope (*e.g.*, insulation, air sealing, windows and doors)	1,871	629,045	477,553	76%
Heating System Fuel Switch	35	530,977	155,613	29%
ENERGY STAR Air Conditioning	577	223,746	185,417	83%
ENERGY STAR Refrigerator Replacement	316	206,836	166,999	81%
Water Heater Replacement[2]	323	147,434	0	0%
ENERGY STAR Appliance Replacement (*e.g.* dishwasher, clothes washer)	244	121,133	1,065	1%
Programmable Thermostats	730	74,763	0	0%
Heating System Replacement	33	53,359	44,917	84%
Water Heating Conservation	44	17,173	22,248	130%
Heating System Conservation[1]	100	12,066	12,066	100%
Extra Energy Use – Heat System Replacement[3]	6	(5,461)	0	0%
Extra Energy Use- Other Measures[1, 3]	503	(103,569)	(103,569)	100%
Extra Energy Use – Water Heater Replacement[1, 3]	52	(6,672)	(6,672)	100%
Extra Energy Use – Heating System Fuel Switch[3]	13	(111,644)	(190,875)	171%
Totals		**4,491,251**	**1,582,060**	**35%**

[1] These measures were not included in the final regression model; for most measures, there were no homes with these measures in the final regression model. A realization rate of 1.00 was assumed. These measures have a very small impact on the overall program savings.

[2] The regression coefficient was of the wrong sign for this measure; the evaluated savings and realization rate were set to 0.

[3] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, generating savings of one fuel type while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

Lighting

Lighting is the measure with the largest percentage of HPwES claimed savings at 36% for PY 2007-2008. Approximately 25% of the HPwES projects for PY 2007-2008 have lighting measures. The realization rate for the lighting measures was found to be 29%, which is the primary driver for the overall electric realization rate of 35%. While lighting savings are small in comparison to pre-installation use and the regression results are somewhat variable, other evidence supports the conclusion that the Program may be overestimating savings from these measures, as explained below.

The Federal "ENERGY STAR Change the World" campaign estimates average annual residential lighting consumption at 1,950 kWh. HPwES lighting was projected to save 684 kWh per year per home, which

represents 35% of the total average residential lighting load[49] and 8% of total average electric use in New York State. Thus, the 684 kWh per year per home seem like a high estimate of potential savings.

Evaluations around the country for different types of residential programs have been consistently finding low realization rates and/or high free ridership for CFL lighting. Combined impact, process and home saturation and usage studies are required to determine the reasons for this result, but these studies are expensive and generally not available. In some cases, the hypotheses are that programs providing a large number of CFLs are seeing those CFLs being installed into lower and lower usage sockets. As the price of CFLs have dropped and knowledge of them has become widespread, the naturally occurring usage of CFLs has increased significantly, and lamps provided through efficiency programs are installed in fixtures with lower usage or stored for future use.

The HPwES program database shows that almost all of the homes with lighting measures installed at least one high efficiency lighting fixture. Thus, it does not appear that the high saturation of CFL screw-in bulbs is the issue. Further investigation by program staff and/or evaluators is warranted to better understand the issues involved to ensure that modifications to the Program are designed to address the true underlying cause(s).

Water Heater Fuel Switch

The second largest percentage of program reported electric savings in PY 2007-2008 is from water heater fuel switches. The number of projects is low, 145, but the Program reported savings per project is quite high at 7,611 kWh, making this measure 23% of program reported electric savings. The evaluation found a 33% realization rate for this measure, the second major contributor towards the electric realization rate of 35%. For water heater fuel switches from electric to natural gas, the Program reported savings are 7,611 kWh per year on average for each home. These savings are substantially higher than estimates of total residential household water heating consumption. A report on New York energy use patterns estimates average residential water heater usage of electricity at about 2,526 kWh per year (2005).[50]

Envelope

Envelope measures are the third largest among claimed electric savings. The realization rate for this measure is 75% and the measure is found in more than half the participating homes. It is still only 10% of claimed savings and not enough to counterbalance the low realizations rates for lighting and water heater fuel switches. Comparisons to impact evaluations in other states are not relevant to heating-related measures due to the wide fluctuations in housing stock and weather conditions.

Other Measures and Measures Excluded from the Billing Model

The evaluation was designed to estimate the savings at the Program level, and the results are reliable at the Program level. The measure-level analysis was intended to identify program performance of the major measure groups. There are, however, a few measures that were not included in the model or whose coefficients were of the wrong direction due to the small number of homes with the measure, low savings per project or other issues. In aggregate, these measures account for a very small percentage of the Program savings. The electric measures in this category are water heater replacement, heating system conservation, appliances, and the extra use from water heater replacements and other measures. In these cases, evaluators recommend that the measure-level realization rates from the model should not be used for either program or policy changes without further investigation. .

[49] *ENERGY STAR Change the World, Start with ENERGY STAR*, 2011 Campaign General Assumptions Sheet.
[50] *Patterns and Trends: New York State Energy Profiles: 1995 to 2009*, NYSERDA, January, 2011, Appendix B.

4.3.2 Natural Gas Model Results

The challenge with the natural gas model is to distinguish between heating and base (non-temperature dependent) use. Heating use is closely related to outdoor temperature, but the characteristics of the relationship vary from one home to the next. For example, the thermostat settings, the outdoor temperature that triggers the use of the heating system and the methods of controlling the thermostat are all highly individual to specific homes. In addition, the water inlet temperature drops during the winter, leading to higher water heating loads, which to some extent mimics the increase in natural gas use during the heating season.

Even with these challenges, the natural gas model shows statistically significant savings for many measure groups, including the three accounting for almost all of the program reported savings. Table 4-4 shows the measure-level results from the modeling and specific issues with each measure group are discussed in more detail below.

Table 4-4. Natural Gas Program Reported and Evaluated Savings by Measure Group

Measure Group	2007-2008 Projects with MMBtu Savings	Program Reported Annual MMBtu Saved	Evaluated Annual MMBtu Saved	Realization Rate
Envelope (*e.g.*, insulation, air sealing, windows and doors)	6,430	192,463	101,351	53%
Heating System Replacement	2,523	70,744	71,620	101%
Programmable Thermostats	2,023	19,615	13,282	68%
Water Heater Replacement	1,141	9,959	16,060	161%
Heating System Conservation[1]	175	1,524	1,524	100%
ENERGY STAR Appliance Replacement (*e.g.* dishwasher, clothes washer)	245	1,036	2,922	282%
Water Heating Conservation	145	538	0	0%
Heating System Fuel Switch[1]	4	521	0	0%
Water Heater Fuel Switch[1]	8	335	335	100%
Extra Energy Use – Other Measures[3]	350	(394)	(394)	100%
Extra Energy Use – Heating System Replacement[3]	14	(445)	(412)	93%
Extra Energy Use –Water Heater Fuel Switch[3]	103	(3,040)	(9,744)	321%
ENERGY STAR Lighting/ Refrigerator[2]	1,879	(3,081)	0	0%
Extra Energy Use – Heating System Fuel Switch[3]	242	(22,740)	(24,089)	106%
Totals	**--**	**267,035**	**172,455**	**65%**

[1] These measures were not included in the final regression model; for most measures, there were no homes with these measures in the final regression model. A realization rate of 1.00 was assumed. These measures have a very small impact on the overall program savings.

[2] The Program tracking data included assumed extra use for refrigerators and lighting in many homes. These measures were included in an interim model, and no extra use was found.

[3] Negative savings occur when efficiency measures are more efficient overall but the savings are created in part by moving use from one fuel to another, generating savings of one fuel type while causing extra use in the other. For example, natural gas furnaces or oil boilers could be replaced by electric heat pumps for both heating and cooling, creating additional electric use, a reduction in natural gas use and an improvement in overall efficiency.

Envelope

Envelope measures, including insulation, air sealing, and window and door replacements, account for almost three-quarters of the claimed natural gas savings and are a very strong contributor to the final natural gas realization rate.[51] The realization rate for these measures was found to be 53%. It is not uncommon to find that engineering estimates of heating related measures overstate the actual savings. Sometimes participants will increase their thermostat settings when they can improve the comfort level without generating excessively high heating bills. The recent impact evaluation of NYSERDA's EmPower program also found a low realization rate for these types of measures. Reviewing methods for estimating savings for envelope measures may be a worthwhile approach for program staff to improve their program reported savings in order to increase realization rates in future evaluations.

Heating System Replacement

Heating system replacements account for about 26% of the Program reported savings. The realization rate from the measure-level modeling is 101%, indicating that the method used by program staff to estimate savings for these measures is reasonably accurate.

Programmable Thermostats

As discussed above, savings from programmable thermostats are difficult to estimate in a billing model due to the high variability of the measure performance due to behavioral issues, *e.g.*, some participants may be setting the thermostat back manually prior to the installation and may actually see an increase in use, some may not use the programmable features of the thermostat correctly and the measure may operate as intended in other homes.[52] The realization rate from the billing analysis shows a 68% realization rate for natural gas savings from programmable thermostats. This is consistent, or even higher, than impact evaluations of other programs similar to HPwES.

Measures Excluded from the Billing Model

As with the electric model, there are a few measures that were not included in the natural gas model due to the small number of homes with the measure, low savings per project or other issues. In these cases, evaluators recommend that the measure-level realization rates from the model should not be used for either program or policy changes without further investigation. The natural gas measures in this category are water heater fuel switch, heating system conservation, heating system fuel switch, and extra use from lighting, refrigerators and other measures.

4.3.3 Evaluated Program Savings

Total evaluated program savings were based on the results from the billing model. Program savings were augmented to include savings for measures that were not included in the regression model; these excluded measures were assumed to have a realization rate of 1.0. These measures account for less than 1% of the total program reported electric savings and 9% extra usage of the total program reported natural gas savings.

[51] It was not possible to develop separate estimates of savings for the various types of envelope measures, such as wall insulation, attic insulation, window replacements or air sealing.

[52] The recent impact evaluation of the EmPower program found that setback behavior affected the ability to estimate savings from heating related measure in a billing model. In the restricted billing analysis, the additional information about setback behavior from the participant survey was included in the model with the following results: "The savings from heating measures are less variable and substantially higher (by 80%) for the 25% of respondents who reported that they set the thermostat at one temperature and leave it, in comparison to those who either reported some type of setback (manual or programmed) or did not provide a valid response to the question." NYSERDA *2007-2008 EmPower New York℠ Program Impact Evaluation Report*, prepared for NYSERDA by Megdal & Associates, April, 2012, Appendix D.

4.4 DEMAND (KW) SAVINGS

A kW to kWh factor was used to calculate the annual kW savings at system peak from the 2007-2008 HPwES program. This was done as described in the Methods section. The annual kW savings from the 2007 and 2008 HPwES program is 1.19 MW.

4.5 SUMMARY OF GROSS PROGRAM SAVINGS

The program annual achieved kWh and MMBtu savings for PY2007-2008 were estimated from the full billing models. The realization rate was 35% and 65% for the electric and natural gas savings, respectively. These results are based on all homes with sufficient billing records.

Average household savings were compared to the pre-installation average annual use of homes in the billing model, as shown in Table 4-5. This analysis indicates that HPwES participants that adopted electric saving measures saved approximately 4% of their total electric use and those undertaking natural gas measures saved approximately 16% of their natural gas energy use.

Table 4-5. Comparison of Annual Consumption and Evaluated Program Savings for Participants

	Before Program Participation	After Program Participation	Evaluated Program Savings	
Annual Consumption and Savings	Average Pre-Retrofit Consumption	Average Post-Retrofit Consumption	Annual Savings per Home	% of Pre-Installation Annual Consumption
Annual Electric Consumption and Savings (kWh)	8,700a	8,271c	315	4%
Annual Natural Gas Consumption and Savings (therms)	1,055b	917d	173	16%

a This average has a sample size, n, of 27,421 pre-installation bills.

b This average has a sample size, n, of 13,845 pre-installation bills.

c This average has a sample size, n, of 27,104 post-installation bills.

d This average has a sample size, n, of 13,710 post-installation bills.

4.6 NET-TO-GROSS EFFECTS

This section covers components of the impact evaluation that are required to produce the final evaluated net savings estimates for the HPwES, *i.e.*, free ridership (FR), spillover (SO) rates and net-to-gross (NTG) ratio. The NTG effects were estimated from surveys of participating homeowners and contractors and non-participating and formerly-participating contractors (see Appendices B, C, and D). The survey instruments and methods were consistent with the methods used in prior HPwES evaluations.

4.6.1 Free Ridership Analysis

The evaluated free ridership rate for HPwES' program years 2007 and 2008 found through this impact evaluation is 20%. The foundation of the homeowner's self-report FR estimate is the direct FR. As described in Section 3: Methods, this estimate is created by combining responses to questions on distinct elements of free ridership: likelihood of adoption, the quantity or proportion of savings

influenced by the Program, and the influence of the Program on the timing of the installation, *i.e*., whether the participant completed the installation earlier than he or she would have in the absence of the Program. The average of this intermediate homeowner FR is 35%.

The distribution for the FR estimates is fairly polarized, clustered around 0% and 100% and then lower proportions throughout the 0 to 100% range. Table 4-6 demonstrates this distribution. The direct FR estimate for homeowners has a median of 23%, with 26% of the homeowners reporting 0% FR and 7% reporting 100%. For participating contractors, the direct FR estimate was 14% while the median was 5%.

Table 4-6. Distribution of Free Ridership Estimates from Participating Homeowners and Contractors

	Participating Homeowners (n = 74)	Participating Contractors (n = 51)
Direct FR Average	35%	
Direct FR Median	23%	
FR (Share of Projects) Average		14%
FR (Share of Projects) Median		5%
Percent at 0% FR	26%	14%
Percent at 100% FR	7%	0%

The homeowner direct FR estimates were then compared to their influence score created from the average of their responses to the three program influence questions. FR upper and lower bounds were assigned to each possible influence score. If the homeowner direct FR estimate fell below the lower or above the upper bounds of FR based on their average influence score, the household FR estimate from that respondent was adjusted upward or downward to the edge of those bounds. The homeowner FR rate adjusted consistency is 31%.

To calculate the Program level FR, the individual FR estimates from each respondent were weighted by program reported savings. This weighted FR estimate is 25% and 14% for participating homeowners and contractors, respectively. The last stage of the free ridership algorithm averaged the FR estimate from participating homeowners with the FR estimate from participating contractors. The combined program free ridership is 20%, as detailed in Table 4-7.

Table 4-7. Overall Free Ridership Rates

Participant Group	Savings Weighted Free Ridership Rate	Number of Respondents
Participating Homeowners	25%	74
Participating Contractors	14%	51
Overall	20%a	--

a This value was rounded from 19.5% to 20%.

The "Assisted" component of the HPwES program is designed for low-to-moderate income households and offers additional subsidies for improvements to income-qualified households. Households with up to 80% of area median income, or 80% of state median income, are eligible.[53]

The Impact Evaluation Team calculated free ridership for participating homeowners in the assisted and market rate components separately. As seen in Table 4-8, a comparison of these components demonstrates that respondents in the Assisted HPwES category indicate a significantly lower FR rate of 19% when compared to 30% for respondents in the market rate group. This difference is statistically significant at the 90% confidence level. The 19% FR for the Assisted HPwES component compares to the pilot FR rate determined for NYSERDA's low income EmPower Program of 17%.[54]

Table 4-8. Free ridership by Market Group from Participating Homeowner Surveys

Market Group	Free Ridership Rate	Number of Respondents (n = 76)
Market Rate	30%	52
Assisted	19%	24

The Economy and Self-Reported Free Ridership

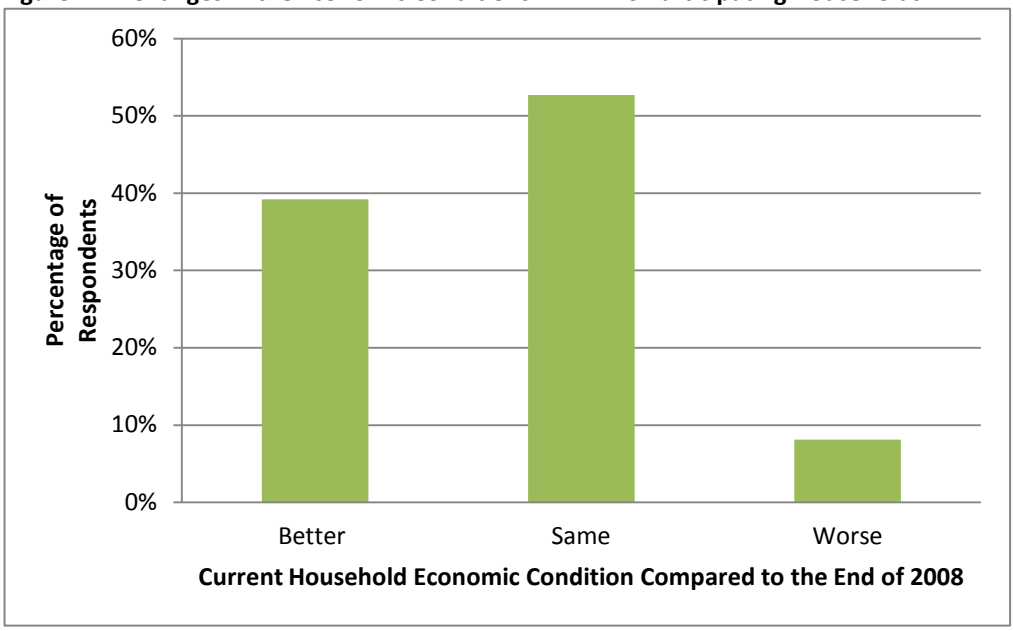
The impact evaluation surveys were conducted during the summer and fall 2011. The impact evaluation covers 2007-2008 HPwES participants, a period which includes the start of the recent recession. To assess whether recent changes in personal economic conditions may have colored respondents' perception of their decision-making process, several questions about household economic conditions were added to the surveys. Overall, the results of this analysis show no clear relationship between the household economic conditions and self-reported FR.

The initial question asked participants whether their household economic situation had improved (significantly better or somewhat better), not changed (the same), or diminished (somewhat worse or significantly worse) today as compared to the end of 2008. Over a third (38%) of survey respondents reported an improved household economic condition, more than four times as many as reported their household's economic condition was worse**.**

[53] In comparison, eligibility for the federally-funded Weatherization Assistance Program and NYSERDA's low-income residential program, EmPower is based on 60% of state median income.

[54] *2007-2008 EmPower New York[SM] Program Impact Evaluation Report*, prepared for NYSERDA by Megdal & Associates, April, 2012, pp. 4-14.

Figure 4-1. Changes in the Economic Conditions in HPwES Participating Households



This evaluation did not find a clear relationship between the change in household economic conditions and the self-reported FR, as shown in Table 4-9**.** The households with improved economic status reported a FR of 26% and those with no change had a FR of 28%. Due to the fact that there were very few respondents in the "somewhat worse" and "significantly worse" categories, the comparison between those with improved and worsened economic conditions is not statistically significant.

Table 4-9. Changes in the Economic Conditions and Self-Reported Free Ridership Rates

Current Economic Status Compared to End of 2008	Free Ridership Rate	Number of Respondents (n = 74)
Significantly Better	26%	9
Somewhat Better	15%	20
The Same	28%	39
Somewhat Worse	5%	3
Significantly Worse	50%	3

Participants were also asked if they had experienced a major drop in income any time between 2006 and 2009. Only 26% reported a major drop in income. Free ridership levels were stable across households that did and did not report a major drop in income (24% and 25%, respectively).

As the final survey question in this series, participants were asked to identify the number of adults in the household who were not employed and not looking for work, including individuals who were retired or not seeking work due to a disability. In fact, retirees could be expected to comprise most of these individuals not employed and not seeking work. Again no relationship was found between self-reported FR and presence of adults who were not employed or seeking work. Table 4-10 shows the FR rate by the number of adults who were not employed. This analysis indicates that the FR is not related to the number of non-working adults in the household.

Table 4-10. Free Ridership among Adults Not Employed or Looking for Work

Number of Adults Not Employed and Not Seeking Employment (# of Respondents, Percent of Households)	Free Ridership Rate
None, all adults in household either employed or seeking work (39, 51%)	25%
One (16, 21%)	18%
Two (19, 25%)	25%
Three (2, 3%)	29%

4.6.2 Spillover

Spillover (SO) is defined as energy efficiency savings that are induced by the Program, but are not directly included in program savings. In general there are three potential types of spillover: participant inside spillover, participant outside spillover (spillover from participant actions outside the Program home or building, such as in their parent's or child's home) and non-participant spillover (such as a neighbor taking energy efficiency actions based upon what they learned about energy savings from the Program participant).

Inside Spillover (ISO)

The survey of participating home owners included questions to estimate participant SO inside the participant's home, *i.e.*, inside spillover. Nine respondents, or 12%, of the surveyed participating homeowners reported that participation in HPwES led them to install measures to obtain additional electric savings. Over half of those with electric SO savings said the amount of savings they obtained were less than what they achieved through the Program. The other survey respondents with electric spillover were equally split between those reporting higher SO savings than achieved from program measures and those reporting that the SO and program savings were about the same.

A slightly greater proportion (13%), or 10 survey respondents, reported that their participation in the Program induced them to add measures that saved natural gas. Of the 10 survey respondents with natural gas inside spillover, six reported achieving savings that were lower than, or equal to, their program reported savings while four had savings that were higher than the natural gas savings through the Program. Table 4-11 presents these findings.

Table 4-11. Participating Homeowner Inside Spillover and Inside Spillover Savings per Spillover Household Compared to Program Savings

Spillover Savings Compared to Project Savings	# of Respondents with kWh SO (n = 76)	# of Respondents with Natural Gas SO (n = 76)	% of Respondents with kWh SO	% of Respondents with Natural Gas SO	% of All Survey Respondents
No Inside Spillover	64	63			84%
Don't Know	3	3			4%
Spillover Savings Lower than HPwES Project	5	3	56%	30%	
Savings Same as HPwES Project	2	3	22%	30%	
Savings Higher than HPwES Project	2	4	22%	40%	
Homeowners with Inside Spillover[1, 2]	**9**	**10**			**12%**

[1] This line only includes respondents who provided a valid response the question about comparing spillover to program savings.

[2] Natural gas spillover measures could include any natural gas efficiency measures they add after their HPwES participation. They could have small savings such as from an added water pipe wrap or large savings such as replacing the furnace with an ENERGY STAR furnace after program participation (as could be the case if the participant does not have the funds, even with the incentive, to take this action at the time of program participation).

Spillover is based on respondents' estimates of the SO installations and the share of the savings attributable to the Program. As discussed in Section 3.7.2, the SO rates are calculated by combining the responses by fuel type, converting all savings to source MMBtu for electricity and natural gas MMBtu, and then estimating an overall value for both fuels. The ISO savings are then divided by the Program reported savings to calculate the ISO rate.

Table 4-12 shows that the spillover rates for natural gas and electricity were 16% and 5%, respectively. The spillover rate for natural gas (16%) is the major contributor to the overall spillover rate due to the higher potential MMBtu savings from natural gas measures. Overall spillover was calculated as 14%.

Table 4-12. Participating Homeowner Spillover Estimate by Fuel Type and Overall Spillover Estimate

Type of Spillover	Spillover Rate	Number of Respondents (Used to Derive Spillover Rate)
Electric	5%	9
Natural Gas	16%	10
Overall	14%	24

Outside Spillover

Outside Spillover (OSO) occurs when participating contractors or homeowners decide to install efficiency measures in non-program homes as a result of their participation in the Program. The OSO measurement for this HPwES impact evaluation was derived from responses from a survey of participating contractors. (The Participating Contractor Survey is provided as Appendix C.) Just under half, 23 or 45%, of the participating contractors reported they had no OSO. Most of these contractors

completed all of their home improvement projects through HPwES. More participating contractors claimed electric OSO than gas OSO (26 and 23 contractors, respectively).

Over half of the SO savings are from projects that save less than the HPwES participating homes. Only 14% of the natural gas SO projects had greater savings per project than the participating projects. Table 4-13 details these results.

Table 4-13. Participating Contractor Outside Spillover Savings Compared to Program Savings

Spillover savings compared to Project Savings	# of Respondents with kWh SO (n = 51)	# of Respondents with Natural Gas SO (n = 51)	% of Respondents with kWh SO	% of Respondents with Natural Gas SO	% of All Survey Respondents
No Outside Spillover	25	28			45%a
Don't Know	7	2			
SO Savings Lower than HPwES Project	10	12	53%	57%	
Savings Same as HPwES Project	4	6	21%	29%	
Savings Higher than HPwES Project	5	3	26%	14%	
Contractors with Outside Spillover	**26**	**23**			**55%a**

a There were 28 participating contractors with spillover, 21 participating contractors who reported generating both electric and natural gas spillover savings due to the Program, five contractors with electric spillover only and two cases with natural gas spillover only.

Table 4-14 shows that the OSO rates for electric and natural gas are relatively similar from participating contractors, at 16% and 13% respectively, although two more respondents reported natural gas spillover (23) than electric spillover (26). While the electric SO rate is slightly higher, electric savings represent a smaller proportion of the total program savings in MMBtus, and the overall OSO rate from participating contractors was 14%.[55] Table 4-14 presents the OSO rates.

[55] It is only a coincidence that participant ISO and participating contractor OSO are both 14%. The participant ISO measured 13.6% and the participating contractor OSO measured 13.8%.

Table 4-14. Participating Contractor Outside Spillover Rates by Fuel Type and Overall

Type of Spillover	Spillover Rate	Number of Respondents with Spillover (n)
Electric	16%	26
Natural Gas	13%	23
Overall	14%	28a

a Twenty-one of the contractors surveyed claimed both natural gas and electric spillover. Five contractors reported only electric spillover and two reported only natural gas spillover. The total number of contractors with responses that were used to calculate the overall spillover rate is 21 plus 5 plus 2, or 28.

Non-Participant Spillover

The Non-Participant Spillover (NPSO) estimate was based on self-reports regarding the impact of the Program on the installation of high efficiency measures installed by the non-participating contractors. The estimation does not include any broader market effects that the Program may create by changing the way the market operates, the attitudes of customers due to NYSERDA or program specific marketing, or the availability of high efficiency measures in the marketplace. To be included in the NPSO calculations, non-participating contractors had to show awareness of, and have some familiarity with, the HPwES program. These contractors were asked about the proportion of their home improvement projects that contain each high efficiency measure and the influence by HPwES on these installations.

In response to the question about their familiarity with the HPwES program, only 8% of non-participating contractors had not heard of the Program. Another 18%, had heard of, but were not familiar with, the HPwES program and thus could not have been influenced by the Program.

Overall, 74% of the non-participating contractor respondents reported some level of familiarity with the Program. These non-participating contractors were asked about the influence the HPwES had on the proportion of their home improvement jobs that contained high efficiency measures, by measure. Table 4-15 presents the numbers and percentages for each of the awareness and familiarity responses offered in the survey.

Table 4-15. Awareness and Familiarity of Home Performance with ENERGY STAR Program from the Non-participating Contractor Survey

State of Awareness/ Familiarity with Home Performance with ENERGY STAR	Number of Non-Participating Contractor Respondents (n=82)	% of Respondents
Had not heard of HPwES	7	8%
Heard of but unfamiliar with HPwES	15	18%
Slightly familiar with HPwES	17	21%
Somewhat familiar with HPwES	25	31%
Extremely familiar with HPwES	18	22%

The survey also covered the proportion of savings (by fuel type) that could be reasonably attributed to the HPwES program. The NPSO was calculated from the following inputs:

- the number of home improvement jobs conducted by the respondent
- the proportion of projects that contained a specific high efficiency measure

- proportion of savings (by fuel type) that could be attributed to the HPwES program

The NPSO estimates were calculated by fuel type and overall. The Program reported energy savings per project by fuel type (with electric savings converted to MMBtu) for the high efficiency measures were used to calculate the NPSO from the survey responses for each non-participating contractor.

The electric SO and natural gas SO in MMBtu were summed to provide the overall SO estimate. The NPSO estimates were divided by the Program savings (by fuel type where appropriate) to create the NPSO rates.

The formula for deriving the NPSO requires four stages. These are provided as the next few paragraphs. All savings are in MMBtu with the electric converted to MMBtu with source conversion rate.

$n\hat{}_{SO}n\hat{}_{SO}$ (C, F) = $\sum_{n=1}^{n}(\sum_{k=1}^{k} U_{kn} * \left(\frac{SP_k}{JP_k}\right))(\sum_{n=1}^{n}(\sum_{k=1}^{k} U_{kn} * \left(\frac{SP_k}{JP_k}\right))$(C, F)

(1)

where

C is category of non-participant with 1 = Formerly-participating contractor (FP) and 2 = Never participated contractor (NvP),

F is fuel type with 1 = Electric E and 2 = Natural gas (NG), and

(C, F) is by C and F, *i.e.*, there are 4 outcomes (Y) one for each combination of C and F. The combinations are: FP-E = FP for electric, NvP-E = NvP for electric, FP-NG = FP for natural gas, NvP-NG = NvP for natural gas.

n is those in the sample,

k is the vector of measures*, i.e.*, each measure in a measure-by-measure basis,

P stands for program,

S_k is the savings in MMBtu for measure k,

J_k is the number of projects for measure k,

$n\hat{}_{SO}n\hat{}_{SO}$ (C, F) is the estimated survey spillover in MMBtus by C and F.

$N\hat{}_{SO}N\hat{}_{SO}$ (C, F) = ($n\hat{}_{SO}(n\hat{}_{SO}$ (C, F))/ n) * N (C)

(2)

where

$N\hat{}_{SO}N\hat{}_{SO}$ (C, F) is the estimated population spillover (by C and F).

$n\hat{}_{SO}n\hat{}_{SO}$ (C, F) is the estimated survey spillover (by C and F)

a, b, c, d, e, h are sample dispositions which are by C, where a = Out of business, b = Not eligible, not qualified, c = No working telephone number after look-ups by survey implementation firm, d = Respondent never available, answering machine but known eligible, e = Broke-off or refused, h = Unknown eligibility

Assume overall not eligible is those likely out of business and contacted and not qualified = a + b + c with percent overall not eligible = (a + b + c)/ (a + b + c + d + e + h) = % not eligible

Assume those not reached have same percent not eligible as others then population (by C) then N (C) = n + ((d * (1 - % not eligible)) + e

SO (C, F) =

$N\hat{}_{SO}N\hat{}_{SO}$ (C, F)/ program reported savings
(3)

where SO is the spillover rate.

HPwES NPSO =

($N\hat{}_{SO}$($N\hat{}_{SO}$ FP-E + $N\hat{}_{SO}N\hat{}_{SO}$ NvP-E + $N\hat{}_{SO}N\hat{}_{SO}$ FP-NG + $N\hat{}_{SO}N\hat{}_{SO}$ NvP-NG)/ program reported savings

HPwES NPSO = ($\sum_{C1_{F1}}^{C2_{F2}} N\hat{}_{SO}$)/($\sum_{C1_{F1}}^{C2_{F2}} N\hat{}_{SO}$)/program reported savings (4)

HPwES NPSO is the Program non-participant spillover rate.

As seen in Table 4-16, the electric spillover rate is twice as high as the natural gas spillover rate, 107% compared to 53%. The non-participating contractors' spillover savings was derived from 30 and 29 respondents for electric and gas respectively. The smaller proportion of program savings for electricity (in MMBtu), as compared to natural gas, results in an overall NPSO rate that is much closer to the natural gas rate than the electric NPSO rate. The overall NPSO rate is 66% and is based upon information from 35 responding non-participating contractors (43% of those surveyed).

Table 4-16. Non-Participant Spillover by Fuel Type

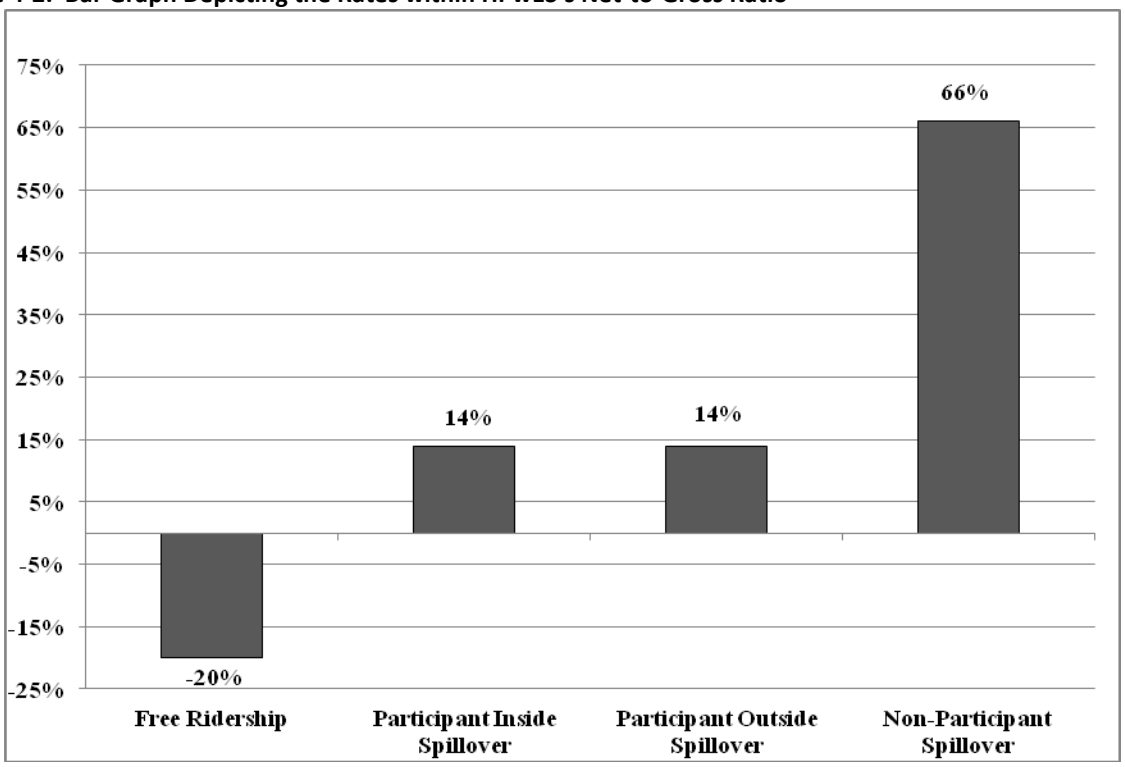
Type of Spillover	Spillover Rate	Number of Non-participant Respondents With Spillover
Electric	107%	30
Natual Gas	53%	29
Overall	66%	35

4.6.3 Net-to-Gross Ratio

The FR rate and SO rate are combined to produce a net-to-gross (NTG) ratio that is applied to evaluated gross savings to produce net savings.

Figure 4-2 presents the NTG components on a bar graph with the 20% free ridership rate and positive spillover rates of 14% inside, 14% outside and 66% non-participant spillover rate. The FR is negative as it represents a reduction in savings since these savings would be expected to accrue in the absence of the Program, and all of the SO rates are positive, reflecting the increase in savings as participating and non-participating contractors expand the use of efficient equipment and practices as an indirect result of program activities. The combined SO is greater than the FR rate. This makes the NTGR greater than one.

Figure 4-2. Bar Graph Depicting the Rates within HPwES's Net-to-Gross Ratio



The NTGR is calculated according to the following formula:

NTGR = 1- FR + (ISO + OSO + NPSO)

HPwES NTGR = 1 – 0.195 + (0.136 + 0.138 +0.66) = 1.74

The overall NTGR for this program is 1.74.

4.7 NET IMPACTS

Combining the evaluated savings with the NTGR provides the net savings estimates. Each component of the net annual electric and fossil fuel savings is provided in Table 4-17. The table shows that the net annual electric savings from the HPwES program for PY 2007 and 2008 is 2,735,471 kWh per year. The associated kW coincident peak savings is 2.06 MW. The net natural gas savings from the HPwES program for PY 2007 and 2008 is 296,410 MMBtu per year. The 90% confidence interval (CI) on the realization rate for natural gas is plus or minus 7.2%. The CI on the electric realization rate is plus/minus 22.1%. The high degree of variability in the electric model is partially due to the low magnitude of the saving. However, the electric savings are only a small part of the overall savings. When the electric savings are converted to source MMBtu and combined with the natural gas savings, they account for less than 1% of aggregated savings. The relative precision of the aggregated savings is about 7% at the 90% confidence level.

Table 4-17. Summary of 2007-2008 Program Reported and Evaluated Savings

	Annual Electric Savings (MWh[1]/Yr)	Summer Peak Demand Savings (MW)[2]	Annual Savings for Non-Electric Fuels[3] (MMBtu/Yr)
NYSERDA Program Reported Savings	4,545		353,890
Realization Rate	35%		65%
Evaluated Savings[4]	1,582	1.19	230,029
Net-to-Gross Ratio	1.74	1.74	1.74
Net Impact	2,753	2.07	400,250

[1] A megawatt-hour is 1,000 kilowatt-hours.

[2] Program goals were established in energy savings (kWh and MMBtu) and demand savings are not estimated by the Program. The evaluated demand savings are calculated by applying the kW/kWh ratio developed by measure from NYSERDA's Deemed Savings Database to the evaluated energy savings.

[3] The realization rate from the impact evaluation of natural gas is used as the realization rate for the other non-electric fuels. Non-natural gas fuel savings includes oil, propane, kerosene, wood and pellets. Two-thirds of non-electric savings are from natural gas.

[4] The 90% confidence interval on the realization rate is plus or minus 7.2% for natural gas and 22.1% for electricity. The confidence band on the realization rate reflects variability in the models, not sampling precision, as no sampling was conducted for this analysis. All homes with sufficient billing records were included in the models. Most of the Program savings (with electric savings converted to MMBTus) are the natural gas savings so that the overall precision is 7%.

4.8 EARLY REPLACEMENT VERSUS RETROFIT

The participating homeowner survey collected data from the participants on the age of replaced equipment and the reasons for replacement. These questions were asked for specific replacement measures (*e.g.*, refrigerators and freezers, appliances, heating system fuel switches, water heater fuel switches, and cooling systems) in the study sample. This component of the survey was designed to investigate the prevalence of early replacement of major equipment as compared to replacement at time of failure.

4.8.1 Age and Condition of Original Equipment

The NTG survey inquired about the age, condition, size, and features of original equipment as well as the size and features of the new replacements. Some of the findings are discussed below.

- Overall, a third of participants (35%) replaced measures that were working but said that the measure would need to be replaced in the next couple of years.
- Over half (53%) of the participants reported having replaced equipment that was 20 years or older. Among replaced heating systems, 60% were 20 years or older.
- More than half (58%) of the heating systems required frequent maintenance or were going to need to be replaced in the next few years. Thirty-six percent of respondents who replaced their heating equipment said it was in reasonable condition and they did not expect it to quit in the next few years.
- More than half (56%) of the water heaters were 20 years or older. Half of the replaced water heaters had required frequent maintenance and would need to be replaced in the next couple of years.

Table 4-18 highlights the reported condition of original household equipment by measure.

Table 4-18. Condition of Original Equipment as Reported by Participants

Measure	It had failed or was about to fail	Required frequent maintenance or old and needed to be replaced in couple of years	It was in reasonable condition and not expected to quit in the next few years	Totals
Heating System	1	11	7	19
Water Heater	3	6	3	12
Heating System Fuel Switch	0	4	1	5
Water Heater Fuel Switch	0	0	2	2
Cooling System	2	0	0	2
Totals	**6**	**21**	**13**	**40**

These inquiries were also made of participating and non-participating contractors and the results are relatively consistent with participant reports that the replaced equipment was often older than the normal manufacturer's claim of expected useful life. Seventy-nine percent (79%) of the participating contractors and 66% of the non-participating contractors reported that half or more of the original removed appliances were 12 years old or older.[56] Forty-five percent (45%) of the participating contractors and 16% of the non-participating contractors reported that half to all of the removed appliances (refrigerators, freezers, or clothes washers) were replaced with ENERGY STAR® ones.

Having older equipment does not necessarily mean that this equipment would have been replaced before the customer felt it absolutely had to be. The life expectancy for a natural gas boiler as the heating system, for example, is given by manufacturers and plumbers as 10 to 15 years. However, the survey responses show the existing equipment was significantly older than that.

The effective useful life (EUL) is an important estimate given its use in program benefit-cost analyses and subsequent policy decisions. The EUL is generally accepted as the estimated median life, with 50% of the products failing before the median life and 50% of the equipment lasting beyond the EUL age. The EUL as a median does not indicate the actual life expectancy of those units that survive past the median date. Any estimate of life expectancy may include equipment that fails in the first couple years due to substandard assembly or manufacturing, suggesting that the average life expectancy for heating equipment that has lasted more than five years may be quite a bit higher.[57]

This conceptual framework could help explain why most of the equipment being replaced through the HPwES program is much older than the average life expectancy[58] and may have important implications for appropriate policy assumptions of expected useful life for benefit-cost analyses as it affects lifetime savings for savings estimation.

[56] Participating homeowners' surveys provide that 83% of their replaced equipment was 12 years old or older.

[57] Comparisons of human life expectancy provide an example of this concept. Infant mortality rate is a significant contributor to lower life expectancy in the developing world and a comparison of life expectancies for those surviving to age five are much more similar between developed and developing countries than estimates of life expectancy from birth. Similarly, demographers examining how life expectancy differs by race in the U.S. often compare white male versus black male life expectancy for those surviving past their 30th birthday. The difference in life expectancy at birth for white U.S. males and black U.S. males is 5.8 years and drops to 5.2 years once they have reached 30 years old.

[58] This suggests that future studies on the age, condition and decisions to replace equipment with and without efficiency programs should include testing this hypothesis.

4.8.2 Replacement Size and Features

Thirteen of the participating homeowners surveyed reported replacing equipment that was in reasonable condition. Of these, 38% reported downsizing their equipment. Among the replaced equipment in reasonable condition, there were two respondents with feature upgrades and two additional respondents obtained replacements that included the same features as the original equipment.

Seven respondents reported the replaced heating systems were in reasonable condition and these included two that were bigger than the prior equipment and two that were downsized.

Of all the equipment replaced, regardless of the condition of the prior equipment, 80% of the efficient upgrades were not the same size as the existing equipment. Most of existing units (75%) were smaller than the efficient equipment. Sixty-four percent of the efficient equipment included additional features, and 36% contained the same features as the old equipment.

In contrast, 70% of participating contractors reported that half or more of their equipment replacement sizes and features were the same as the original equipment. The equipment replacements made by non-participating contractors are very different as only 19% of these respondents reported that half or more of their refrigerator, freezer or clothes washer replacements were the same sizes and features as the prior equipment.[59]

4.9 PROGRAM IMPACTS ON PARTICIPATING CONTRACTORS

Participating contractors were asked a series of questions to investigate the non-energy impacts of sales and profitability to these contractors due to the Program. These questions are close to the end of the Participating Contractor Survey and this survey is provided as Appendix C.

Fifty-one percent of surveyed participating contractors reported an increase in sales revenues due to the HPwES program. On average, sales revenues went up $110,000 per year, while the average contractor experienced an increase of $57,000 (the median increase in sales revenues).[60]

Over a third, or 19 respondents, of surveyed participating contractors experienced increased profits due to participating in the Program.[61] The median value of the profit increase for participating contractors is $12,000 per year.

[59] Most non-participating contractors (22%) reported that appliance replacements were both upsized and upgraded.
[60] Three participating contractors had sales revenue decreases which averaged $200,000.
[61] Two respondents experienced reduced profits due to the Program, averaging about $15,000.

CONCLUSIONS AND RECOMMENDATIONS

This section covers conclusions of this impact evaluation and recommendations for the Program and future evaluations. The recommendations provided are based upon the findings of this impact evaluation and the Impact Evaluation Team did not assess the steps or resources needed to undertake them.

5.1 PROGRAM CONCLUSIONS AND RECOMMENDATIONS

5.1.1 Energy Savings

The billing analysis provided reliable savings estimates for the energy benefits associated with the HPwES program. Overall, the natural gas realization rate was estimated at 65%, while the electric realization rate was found to be 35%. The low realization rates for some measures, such as lighting and water heater fuel switch for electric savings and envelope (insulation, air sealing, windows and doors) and programmable thermostats for natural gas savings, indicate the Program should review and update the process for calculating savings. The Impact Evaluation Team understands that this process is already in progress.

Recommendation: Examine methods for estimating claimed lighting and water heater fuels switch for electricity savings and envelope measures and programmable thermostats natural gas claims should be examined.

5.1.2 Program Data Issues

The project data obtained from the Program database proved difficult to use. Specifically, it was a challenge to identify and aggregate key fields and ensure that projects, measures and billing data were properly assigned to participant homes. The measure description was a lengthy character field with the quantity installed embedded in it. In many cases, there were multiple records for a single measure and no clear key to ensure that the components of the measure could be correctly matched. An example is fuel switching, where the replacement equipment was recorded as one measure and the removal of the existing heater was a second measure. Energy savings were recorded in a variety of units, even within a single fuel type (such as natural gas).

In addition, within the time frame of this evaluation it was not possible to obtain utility billing records for a substantial proportion of participants due to the absence of correct utility account numbers associated with the HPwES projects. Some of the inconsistencies found in the Program data suggest that the Quality Control process for the Program database was not sufficient to identify these issues, at least for the Program as implemented during 2007 and 2008.

It would also be useful for program data to include the age of equipment that was replaced. While the participant survey was used to obtain this information, evaluators understand that this information is available to the Program. If so, it is likely that the Program data may be more reliable as it was presumably obtained at the time of the installation and it would be readily available for all participants and major measures.

There was very little data on the participant homes in the Program database, such as house type, ownership status and number of occupants. The absence of this information made it impractical to assess whether there may be systematic differences between participants that were included in the billing or survey analysis and the full program population.

Recommendations:

Consider database and data collection enhancements to the Program tracking database as described below. This list of potential enhancements is lengthy and may require substantial time and resources to implement. The items below are listed in order of importance.

- *Continue to improve methods to increase the reliability of the utility identification and account numbers.*
- *In the measure tracking file, modify the measure codes and descriptions to clearly define the measures in a way that they can be easily and accurately categorized (lighting fixture, CFLs, dishwasher, refrigerator, freezer, attic insulation, wall insulation, air sealing, foundation insulation, etc.).*
- *Establish a single unit for tracking measure-level energy savings for each fuel type.*
- *Add a numeric field in the measure tracking file for the installed quantity for each measure.*
- *Add a field to the measure tracking system to connect multiple records associated with the same measure, particularly for fuel switching.*
- *Add error checking to ensure that both negative and positive savings are correctly recorded for fuel switching measures. For example, switching water heating from electric to natural gas should have a record to reflect the electric savings and a second one for the natural gas extra use, or extra fields should be added to the measure tracking file to allow direct entry of both positive savings and extra use in the same record.*
- *Ensure data integrity by improving quality control and error checking procedures for the Program database.*
- *Consider adding more detailed household information to the primary program database, such as house type, ownership status, number of occupants, adults and adults 65 and older living in the home most of the year, age of house, presence of central air-conditioning, approximate age of equipment replaced, rather than keeping this data only in the database maintained by the implementation contractor.*
- *Continue efforts to collect more information on customer decision-making regarding equipment and the age of the existing equipment replaced through the Program.*

5.2 EVALUATION CONCLUSIONS AND RECOMMENDATIONS

5.2.1 Billing Data Issues

One impediment to conducting the billing analysis was the difficulty in obtaining utility billing data for participants. This type of analysis relies on including as much of the population as possible in the regression models. No billing data was available for 47% of homes with electric savings and 66% of homes with natural gas savings. Increasing the percentage of participants with complete billing history will support future evaluations and the additional billing data would improve the confidence in the results from the modeling.

Due to time, confidentiality, and transaction process limitations, some utilities provided only a subset of the requested fields. Critical data, such as whether a reading was estimated or an actual read were missing. Consistent inclusion of all the data required for a billing analysis would improve the overall results of future evaluations. Finally, each utility provided the billing records in their own data structures, requiring many hours of data manipulation to put them together in one data set. In some instances, data was provided in multiple formats by a single utility.

The Impact Evaluation Team understands NYSERDA Evaluation and Program staffs are actively engaged with the DPS and each of the utilities to access and collect participant utility billing data on a routine basis. The effort is critical to the validity of future evaluations.

Recommendations:

- *Continue efforts with the utilities to ensure that billing data is complete, useful and properly interpreted. It is important to understand the data contained in the variables, yet data dictionaries have seldom been provided to NYSERDA.*
- *Some suggestions for NYSERDA are listed below:*
  - *Expand the sample size of participants that are sent to each utility to ensure that billing records are not missed due to being assigned to the wrong utility.*
  - *Continue efforts to work with the utilities and DPS to develop an efficient process to make a higher proportion of high quality billing and consumption data available for use in evaluations.*
- *Some suggestions for the DPS and New York utilities are listed below:*
  - *Develop a process to store participant billing records for a specified period rather than allowing older data to be placed in archives on the utilities' regular schedule.*
  - *Work with NYSERDA and the utilities' evaluators to develop a standard way to provide billing data to both NYSERDA and the utilities' evaluators, placing the billing data provided for NYSERDA and utility evaluations on the same footing.*

5.2.2 Energy Change Survey

The Energy Change Survey was used to develop the restricted models. These models supported the ability of the full regression models to obtain reliable savings.

Recommendation: Supporting billing analyses with a telephone survey to assess changes in energy use may not be necessary in the future. The results of the Energy Change survey conducted in this evaluation support the use of the full regression model including all participants with sufficient billing data over the smaller sample of survey respondents used in the restricted model. If an Energy Change survey is used in the future, efforts to lessen the lag time between project completion and survey fielding will help increase data reliability.

5.2.3 Non-Participating Contractor Surveys

Completing the surveys with non-participating contractors proved quite difficult. Completing the required 70 surveys involved a sample of 800 and a $100 incentive; the final cooperation rate was 45% and the response rate was 17%.

Recommendation: Paying $100 incentives to non-participating contractors to complete the survey should be included in the initial evaluation design, the work plan and the evaluation budget.

5.2.4 NTG Evaluation

The NTG survey found participant spillover to be significantly greater than free ridership. Non-participating contractor spillover was found to be 66%. Non-participating and formerly-participating contractor spillover analysis was not included in prior HPwES NTG estimations. The size of this impact means it is important to continue to measure non-participant spillover for HPwES. While the sample size for the HPwES SO analysis was larger than in the other NYSERDA impact evaluations being completed in 2012, the potential size of the impact suggests that improvements and verification efforts should be added to future NTG HPwES impact evaluations. To increase the reliability of the net to gross evaluation, new evaluation designs and verification follow-ups should be explored and implemented.

Recommendations:

- *Continue to include non-participant spillover studies when measuring net effects for HPwES in future impact evaluations. Surveys used to gather data for SO estimation should be designed to meet quotas for the number of respondents reporting SO.*
- *Design future SO evaluations with full consideration to conducting related market effects studies and follow-up verification studies. This approach may mean staging different research elements relating to participant ISO, participating vendor SO, and NPSO, within a context of market change and program-induced market effects. Significantly more resources will be needed to conduct this level of research into SO and market effects.*
- *Design additional evaluation research to increase the number, depth and breadth of validity checks for the NPSO analysis, as this spillover component reflects efficiency efforts in the larger market and has a multiplier effect in the calculations.*

5.2.5 Early Equipment Replacement

The issues surrounding early replacement of equipment appear to be more complicated than initially anticipated, since some of the information could be interpreted in more than one way. It is possible that the advanced age of the existing equipment is evidence that consumers will not replace an expensive item until absolutely necessary unless they are provided with a financial incentive. However, it is also possible that the fact that the existing equipment is old and required frequent maintenance demonstrates that they would have replaced it in the next few years anyway, without another impetus. The survey did not provide insight into this critical issue and further research in this area is recommended.

Recommendation:

Develop and implement an enhanced evaluation design to learn more about the decision-making process for replacing major equipment. The criteria for replacing old equipment, probably by level of cost, should be investigated and be able to ascertain the importance of different criteria in different circumstances. Specific hypotheses to be tested should be developed to better ensure that results or a combination of results can be interpreted in only one way and are worded such that they are meaningful to program and policy decisions. It is important to avoid the issue discovered and discussed above that was learned in this pilot where important information is gathered but not enough to properly interpret what was found. Flip points, Analytical Hierarchical Process and other decision-making perspectives should be explored and data gathered to have multiple types of analyses used for a more in-depth understanding of decision-making.

5.2.6 Non-Energy Impacts

This impact evaluation explored an alternative method for examining non-energy impacts then the more expensive but abstract methods used by NYSERDA in prior NEI measurement. The NEI questions were asked of the participants based upon measures they had received through the Program. The total sample sizes for each measure then were found to be small.

Recommendation:

Future evaluations desiring to gather information on NEIs need to include measure quotas in its survey and sampling design and evaluation cost estimates.

5.3 CONCLUSIONS

The evaluation consisted of a rigorous analysis with multiple components. The evaluated gross program savings were estimated through a billing analysis of all participants with complete and reliable billing data, and both internal and external validation was conducted to ensure that the results were within a reasonable range. The validations included implementation of an Energy Change Survey and the associated restricted billing analysis to inform the billing analysis, a review of alternative models to incorporate external influences into the billing regression and an assessment of the validity of the model.

All of these supplemental activities support the use of the results from the full billing model. The realization rates of 35% and 65% for electric and natural gas savings, respectively, were applied to estimate total program verified savings.

In addition, a study of net effects was conducted which included an analysis of non-participant spillover. The FR rate was estimated at 20%, inside spillover was 14%, participant outside spillover was 14% and the non-participant spillover rate was 66%. Combining these NTG components resulted in an overall NTGR of 1.74.

A new element of the NTG survey included questions to assess whether the economic upheaval of the last four years may have had an impact on self-reports of free ridership. The survey responses do not demonstrate that the recent economic uncertainty affected the self-reports of free ridership.

PARTICIPATING HOMEOWNERS ENERGY CHANGE SURVEY

New York Home Performance and Assisted Home Performance Program with ENERGY STAR® Impact Evaluation 2010/2011 Participating Homeowners Survey – Energy Change Version

Final 9/16/2011

May I speak to **[NAME]**?

Hello 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 participated in NYSERDA's Home Performance with ENERGY STAR® Program. Our records indicate that a contractor participating in NYSERDA's Home Performance Program installed energy efficiency measures in your home in **[COMPLETEDT_YEAR]**. We're calling today to ask you some questions about your experience with this Program to help us evaluate how the Program might serve people better. We sent you a letter recently telling you that we would be calling and explaining the research we are doing. Your responses to this survey will be kept confidential to the extent permitted by law.

[IF NECESSARY:] The New York Home Performance with ENERGY STAR Program encourages contractors and homeowners to install energy efficient products, utilize program services, and promote a whole-house approach to ensure that homes are as energy efficient as possible. As you may recall, the Comprehensive Home Assessment (or CHA) is performed by a contractor participating in NYSERDA's Home Performance with ENERGY STAR program. The contractor comes to your home and completes the CHA by conducting an inspection of the living space, attic, and basement or crawl space. The contractor also performs a number of tests using special equipment including a blower door. The assessment usually takes one to three hours. At the end of the assessment, the contractor makes recommendations about things that you could do to improve the energy efficiency, comfort, and safety of your home.

Our records show that you received a Comprehensive Home Assessment (CHA) by a contractor participating in NYSERDA's Home Performance with ENERGY STAR program sometime in **[COMPLETEDT_YEAR]**. **[IF NECESSARY:]** You were selected as part of a carefully designed sample and your feedback about this Program is very important to future planning for energy efficiency programs in the State.

SCREENER FOR PARTICIPANT STILL LIVING IN TREATED RESIDENCE

PART1. Do you still reside at the home where, in 2007, 2008, or 2009, you installed measures with the assistance of the Home Performance Program?

1. YES
2. NO **[THANK AND TERMINATE]**

96 REFUSED **[THANK AND TERMINATE]**

97 DON'T KNOW **[THANK AND TERMINATE]**

PART2. Were you living at the same address in **[YEAR1]**?

1. YES

NO [THANK AND TERMINATE]

96 REFUSED **[THANK AND TERMINATE]**

97 DON'T KNOW **[THANK AND TERMINATE]**

SCREENER FOR CONTACT

SCR1. I have you as the contact for the project. Are you the person in your home we should speak to regarding participation in NYSERDA's Home Performance with ENERGY STAR Program and the energy efficiency actions taken?

1. YES **[GO TO M1]**
2. NO
96 REFUSED **[THANK AND TERMINATE]**
97 DON'T KNOW

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 REFUSED **[THANK AND TERMINATE]**
97 DON'T KNOW **[THANK AND TERMINATE]**

SCHEDULE ANOTHER TIME FOR INTERVIEW IF NECESSARY

This survey will take about 15 minutes to complete.

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

NOW IS NOT A CONVENIENT TIME TO TALK, SCHEDULE A FOLLOW-UP DATA AND TIME, AND RECORD IT BELOW.]

APPOINTMENT DATE AND TIME: _____

PROGRAM RECALL

GENERAL INSTRUCTIONS:

Your opinions about NYSERDA's Home Performance with ENERGY STAR Program are important to this research effort. If we ask you a question you aren't sure you can answer, your best guess or even a rough judgment is fine. If you have no idea whatsoever, you can just indicate that you don't know and we will move on.

In this survey, I will be asking you to remember if you made any changes to your household that affects your energy use. It may help to think about major changes that occurred in the last four years. The events that would help most would be those that are important to you.

I would also like to ask you to remember in what season and year you made a change.

M1. In what year did you receive a Comprehensive Home Assessment through NYSERDA's Home Performance with ENERGY STAR Program?

1. **[RECORD YEAR]**

96 REFUSED

97 DON'T KNOW

M2. I'm going to read you a list of measures that were installed through NYSERDA's Home Performance with ENERGY STAR Program according to our records. For each one, please tell me if that measure was actually installed or not. **[READ SM1-SM13 IF measure1-13 IN SURVEY SAMPLE FILE]**

TABLE 1.

SURVEY_MEASURE
SM1. [ADDED INSULATION]
SM2. [INSTALLED CFLs OR HIGH EFFICIENCY LIGHTING FIXTURES]
SM3. [Installed an Efficient Refrigerator or Freezer]
SM4. [INSTALLED HIGH EFFICIENCY APPLIANCE] *(e.g.*, clothes washer, dishwasher)
SM5. [INSTALLED HEATING OR COOLING SYSTEM CONSERVATION MEASURES]
SM6. [REPLACED THE HEATING SYSTEM]
SM7. [replaceD the hot water heater]
SM8. [INSTALLED HOT WATER CONSERVATION MEASURES] **such as low flow showerhead, wrapped the tank, or insulated the pipes**
SM9. [Installed a Programmable Thermostat]
SM10. [REPLACED HEATING SYSTEM USING A DIFFERENT FUEL**]**
SM11. [REPLACED HOT WATER HEATER USING A DIFFERENT FUEL**]**
SM12. [REPLACED COOLING SYSTEM]
SM13. [REPLACED WINDOWS OR DOORS]

1. YES

2. NO

96 REFUSED

97 DON'T KNOW

[IF SM2 ASK M3-M4, OTHERWISE GO TO NEXT SECTION]

M3. As part of NYSERDA's Home Performance with ENERGY STAR, how many compact fluorescent bulbs were installed in your home?

1. **[RECORD NUMBER]**

96 REFUSED

97 DON'T KNOW

M4. As part of your program participation, how many high efficiency compact fluorescent fixtures were installed in your home? These fixtures require special pin-based bulbs. I am only asking about hardwired fixtures that take CFL pin-based bulbs, **NOT** plug-in lamps or fixtures that take standard screw in bulbs.

1. **[RECORD NUMBER]**

96 REFUSED

97 DON'T KNOW

HEATING SYSTEM

[YEAR1=THE CALENDAR YEAR PRIOR TO THE PROGRAM; YEAR2=CALENDAR YEAR AFTER ALL MEASURES WERE INSTALLED. SUMMERYEAR1=CALENDAR YEAR THAT INCLUDES THE SUMMER MONTHS (JUNE TO AUGUST) OF THE YEAR PRIOR TO THE PROGRAM; WINTERYEAR1A & WINTERYEAR1B= CALENDAR YEARS THAT INCLUDE THE WINTER MONTHS (NOVEMBER TO MARCH) OF THE YEAR PRIOR TO THE PROGRAM. SUMMERYEAR2 AND WINTERYEAR2, WINTERYEAR2A & WINTERYEAR2B ARE DEFINED IN THE SAME WAY.]

The next set of questions is about your heating system and how you use it. We are particularly interested in changes between the year prior to your participation in the Program and the year following the installation of measures – that would be between **[INSERT YEAR1]** and **[INSERT YEAR2]**.

HS1a. What is the primary fuel you use to heat your home? **[READ LIST, RECORD ALL THAT APPLY]**

1. Natural Gas, not Propane

2. Electricity

3. Oil

95. OTHER (Specify:_____)

96 REFUSED

97 DON'T KNOW

HS1b. Are you using the same heating fuel now as you were in during the winter of **[WINTERYEAR1A/ WINTERYEAR1B]**?

1. YES **[GO TO HS2]**

2. NO

96 REFUSED **[GO TO HS2]**

97 DON'T KNOW **[GO TO HS2]**

HS1c. What was the primary fuel used to heat your home in **[WINTERYEAR1A/ WINTERYEAR1B]**? **[READ LIST, RECORD ONE]**

1. Natural Gas, not Propane
2. Electric
3. Oil
95. OTHER (Specify:_____)
96 REFUSED
97 DON'T KNOW

[SKIP TO HS2 IF HS1a=HS1c]

HS1d. In what season and year did you change your primary heating fuel? **[IF RESPONDENT PROVIDES A DATE THAT IS BEFORE YEAR1, PLEASE PROBE FOR ANY CHANGES WITHIN THE PERIOD OF INTEREST THAT IS YEAR1 FORWARD. IF THE ONLY CHANGE IS BEFORE YEAR1, THEN CHOOSE OPTION 2 BELOW. PLEASE NOTE THAT, UNLIKE LATER QUESTIONS, THE OPENING QUESTION WAS ABOUT THE HEATING SYSTEM CURRENTLY IN USE, SO EVEN CHANGES AFTER YEAR 2 MAY BE RELEVANT.]**

1. RECORD SEASON

   [1=FALL; 2 =WINTER; 3=SPRING; 4 =SUMMER]
96. REFUSED
97. DON'T KNOW

1. RECORD YEAR
2. OUTSIDE OF PERIOD, BEFORE YEAR1 **[GO TO HS2]**
96. REFUSED
97. DON'T KNOW

HS1e. Did you change your primary heating fuel through NYSERDA's Home Performance with ENERGY STAR Program?

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

HS2. How do you control your primary heating system? Do you… **[READ LIST, RECORD ONE RESPONSE]**

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 REFUSED

97 DON'T KNOW

HS3a. Comparing the winter of **[WINTERYEAR2A/WINTERYEAR2B]** to the winter of **[WINTERYEAR1A/WINTERYEAR1B]**, did you change the way you use your primary heating system?

1. YES

2. NO **[GO TO HS4a]**

96 REFUSED **[GO TO HS4a]**

97 DON'T KNOW **[GO TO HS4a]**

HS3b. Would you say that you used the heating system a lot less, somewhat less, somewhat more, or a lot more in **[WINTERYEAR2A/WINTERYEAR2B]** than in **[WINTERYEAR1A/WINTERYEAR1B]**? **[RECORD ONE]**

1. A LOT LESS

2. SOMEWHAT LESS

3. SOMEWHAT MORE

4. A LOT MORE

96 REFUSED

97 DON'T KNOW

HS4a. Did you use a different supplemental heating system, such as a wood stove or portable heaters, in **[WINTERYEAR2A/WINTERYEAR2B]**?

1. YES

2. NO **[GO TO HS5a]**

96 REFUSED **[GO TO HS5a]**

97 DON'T KNOW **[GO TO HS5a]**

HS4b. What type of supplementary heat did you use to heat your home during the winter of **[WINTERYEAR2A/WINTERYEAR2B]**? **[READ ALL AND RECORD ALL THAT APPLY]**

1. Natural gas, such as a gas space heater, fireplace, cooking stove or oven **[DISTINGUISH BETWEEN NATURAL GAS AND PROPANE]**

2. Electric portable heaters, electric baseboard, or other electric heaters

3. Wood, such as wood stove or fireplace

95. OTHER (Specify: _____)

96 REFUSED

97 DON'T KNOW

HS4c. Which of the following best describes how you used the supplemental heat in **[WINTERYEAR2A/WINTERYEAR2B]**? **[READ LIST, RECORD ONE]**

1. 10 days or less
2. 11-30 days
3. 31-60 days
4. More than 60 days

96 REFUSED

97 DON'T KNOW

HS4d. Comparing the winter of **[WINTERYEAR2A/WINTERYEAR2B]** to the winter of **[WINTERYEAR1A/WINTERYEAR1B]**, did you change the way you use your supplemental heating system? **[READ LIST, RECORD ONE]**

1. No, I used the supplemental heat about the same **[GO TO HS5a]**
2. Yes, I did not use the supplemental heat at all in **[WINTERYEAR1A/WINTERYEAR1B] [GO TO HS5a]**
3. Yes, I used a different type of supplemental heat in **[WINTERYEAR1A/WINTERYEAR1B]**
4. Yes, I used the supplemental heat a lot less [**GO TO HS5a]**
5. Somewhat less in **[GO TO HS5a]**
6. Somewhat more in **[GO TO HS5a]**
7. Or a lot more in **[WINTERYEAR2A/WINTER2B]** than in **[WINTERYEAR1A/WINTERYEAR1B] [GO TO HS5a]**

96 REFUSED **[GO TO HS5a]**

97 DON'T KNOW **[GO TO HS5a]**

HS4e. What type of supplementary heat did you use to heat your home during the winter of **[WINTERYEAR1A/WINTERYEAR1B]**? **[READ ALL AND RECORD ALL THAT APPLY]**

1. Natural gas, such as a gas space heater, fireplace, cooking stove or oven **[DISTINGUISH BETWEEN NATURAL GAS AND PROPANE]**
2. Electric portable heaters, electric baseboard, or other electric heaters

95. OTHER (Specify:_____)

96 REFUSED

97 DON'T KNOW

HS5a. What fuel do you use to heat your water? **[READ ALL AND RECORD ONE]**

1. Natural Gas, not propane
2. Electric
3. Solar with electric back up
4. Solar with natural gas back up
95. OTHER (Specify:_____)
96 REFUSED
97 DON'T KNOW

HS6b. Are you using the same fuel to heat your water now as you were in **[YEAR1]**?

1. YES **[GO TO NEXT SECTION]**
2. NO
96 REFUSED **[GO TO NEXT SECTION]**
97 DON'T KNOW **[GO TO NEXT SECTION]**

HS6c. What fuel did you use to heat your water in **[YEAR1]**? **[READ LIST, RECORD ONE]**

1. Natural Gas, not propane
2. Electric
3. Solar and Electric
4. Solar and Natural Gas
95. OTHER (Specify:_____)
96 REFUSED **[GO TO NEXT SECTION]**
97 DON'T KNOW **[GO TO NEXT SECTION]**

HS6d. In what season and year did you install the new water heater? **[IF RESPONDENT PROVIDES A DATE THAT IS BEFORE YEAR1, PLEASE PROBE FOR ANY CHANGES WITHIN THE PERIOD OF INTEREST, YEAR1 TO YEAR2. IF THE ONLY CHANGE IS BEFORE YEAR1, THEN CHOOSE OPTION 2 BELOW. PLEASE NOTE THAT, UNLIKE LATER QUESTIONS, THE INITIAL QUESTION WAS ABOUT THE WATER HEATING SYSTEM CURRENTLY IN USE, SO EVEN CHANGES AFTER YEAR 2 MAY BE RELEVANT]**

1. RECORD SEASON

   [1=FALL; 2 =WINTER; 3=SPRING; 4 =SUMMER]
96. REFUSED
97. DON'T KNOW

1. RECORD YEAR
2. OUTSIDE OF PERIOD, BEFORE YEAR1 **[GO TO NEXT SECTION]**
96. REFUSED
97. DON'T KNOW

HS6e. Was the new water heater installed through NYSERDA's Home Performance with ENERGY STAR Program?

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

COOLING SYTEMS

CL1. Did you have a working central air conditioning system in **[SUMMERYEAR2]**?

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

CL2. How many working room or window A/C units were in use in your home during the summer of **[SUMMERYEAR2]**?

1. **[RECORD NUMBER OF UNITS]**

94 NONE
96 REFUSED
97 DON'T KNOW

[IF CL1=2 AND CL2=94, SKIP TO CL4]

CL3. Which of the following best describes how you used the air conditioning in **[SUMMERYEAR2]**? **[READ LIST, RECORD ONE]**

1. Not at all
2. 10 days or less
3. 11-30 days
4. 31-60 days
5. More than 60 days

96 REFUSED

97 DON'T KNOW

CL4. Comparing **[SUMMERYEAR2]** to **[SUMMERYEAR1]**, did you change the way you use the air conditioning?

1. YES
2. NO **[GO TO NEXT SECTION]**

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

CL5. Would you say that you ... **[READ LIST, RECORD ONE RESPONSE]**

1. Did not use air conditioning at all in **[SUMMERYEAR1]**?
2. Used the air conditioning at lot less,
3. Somewhat less,
4. Somewhat more,
5. Or a lot more in **[SUMMERYEAR2]** than in **[SUMMERYEAR1]**?

96 REFUSED

97 DON'T KNOW

APPLIANCES

AP1. I'm going to read you a list of appliances. For each one, please tell me, between **[YEAR1]** and **[YEAR2]**, did you add or replace this appliance on your own, ***not through NYSERDA's Home Performance with ENERGY STAR Program***. We are only interested in appliances that use either natural gas or electricity and were not replaced through the Program.

[IMPORTANT - DOES NOT COUNT IF THE APPLIANCE USES ANY FUEL OTHER THAN NATURAL GAS OR ELECTRICITY, OR IF IT WAS INSTALLED AS A PROGRAM MEASURE - PLEASE CLARIFY IF NECESSARY]

[READ LIST, RECORD AS MANY AS APPLY]

a. Central air conditioner
b. Room or wall air conditioner
c. Dishwasher
d. Clothes washer
e. Refrigerator/Freezer
f. Extra refrigerator
g. Heated waterbed
h. Electric heater
i. Gas heater, not propane

j. Jacuzzi or hot tub

k. Any other appliances I haven't mentioned? (Specify: _____)

l. Stove

1 YES

2 NO

96 REFUSED

97 DON'T KNOW

[FOR EACH APPLIANCE IDENTIFIED IN AP1, ASK AP2 AND AP3 IN SEQUENCE THEN GO TO NEXT MEASURE AND ASK AP2 AND AP3]

AP2. Was the **[APPLIANCE AS LISTED IN AP1]** a new addition to your home or did it replace an existing one?

1. New addition to home

2. Replaced an existing one

96 REFUSED

97 DON'T KNOW

AP3. In what season and year did you install the new **[APPLIANCE AS LISTED IN AP1]**? **[IF RESPONDENT PROVIDES A DATE THAT IS BEFORE YEAR1 OR AFTER YEAR2, PLEASE PROBE FOR ANY CHANGES WITHIN THE PERIOD OF INTEREST, YEAR1 TO YEAR2. IF THE ONLY CHANGE IS OUTSIDE OF THE PERIOD (EITHER BEFORE YEAR1 OR AFTER YEAR2), THEN CHOOSE OPTION 2 BELOW.**

1. RECORD SEASON

[1=FALL; 2 =WINTER; 3=SPRING; 4 =SUMMER]

96. REFUSED

97. DON'T KNOW

1. RECORD YEAR

2. OUTSIDE OF PERIOD, BEFORE YEAR1

96. REFUSED

97. DON'T KNOW

OCCUPANCY AND SCHEDULE

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 between **[YEAR1]** and **[YEAR2].**

SCH1a. The next question is about how many people live in your home most of the year. Do not include anyone who just visits or who may be away at college or deployed by the military for most of

the year. Include all members of your household whether or not they are related to you. How many people, including yourself, currently live in your home year-round?

1. **[RECORD NUMBER]**

96 REFUSED **[SKIP TO SCH2a]**

97 DON'T KNOW **[SKIP TO SCH2a]**

SCH1b. Thinking back to **[YEAR1]**, how many people including yourself were living in your home?

1. **[RECORD NUMBER]**

96 REFUSED **[SKIP TO SCH2a]**

97 DON'T KNOW **[SKIP TO SCH2a]**

[ASK SCH1c IF SCH1a NOT EQUAL TO SCH1b]

SCH1c. In what season and year did the size of your household change? Let's start in the beginning of **[YEAR1]** and go to **[YEAR2]**. Please tell me how the size of your household changed and when it happened each time there was a change. **[RECORD FOR EACH CHANGE IN OCCUPANCY, UP TO 5 CHANGES, ONLY RECORD CHANGES DURING THE PERIOD OF INTEREST, FROM YEAR1 TO YEAR2.]**

1. RECORD SEASON

[1=FALL; 2 =WINTER; 3=SPRING; 4 =SUMMER]

94. NO MORE CHANGES

96. REFUSED

97. DON'T KNOW

1. RECORD YEAR

2. OUTSIDE OF PERIOD, BEFORE YEAR1

96. REFUSED

97. DON'T KNOW

Change in number of occupants: _____ **[EX, -1 FOR ONE FEWER OCCUPANT IN COMPARISON TO THE NUMBER OF OCCUPANTS IN YEAR1.]**

96. REFUSED

97. DON'T KNOW

SCH2a. Thinking back to **[SUMMERYEAR1]**, approximately how many weeks were all occupants away from the home for any reason during the summer months of June, July and August? **[READ LIST, RECORD ONE RESPONSE]**

1. None
2. Less than a week.
3. 1-2 weeks
4. 3-4 weeks
5. 5-6 weeks
6. More than 6 weeks

96 REFUSED **[GO TO SCH3a]**

97 DON'T KNOW **[GO TO SCH3a]**

SCH2b. Was there a change in your schedule or the number of weeks when no one was at home during the summer months in **[SUMMERYEAR2]**? **[READ LIST, RECORD ONE RESPONSE]**

1. No, no change in schedule. **[GO TO SCH3a]**
2. Yes, less time away in **[SUMMERYEAR2]**.
3. Yes, more time away in **[SUMMERYEAR2]**. **[GO TO SCH2d.]**

96 REFUSED **[GO TO SCH3a]**

97 DON'T KNOW **[GO TO SCH3a]**

SCH2c. Was the time away during **[SUMMERYEAR2]** shorter by… [**READ LIST, RECORD ONE RESPONSE**]

1. Less than a week **[GO TO SCH3a]**
2. 1 to less than 2 weeks **[GO TO SCH3a]**
3. 2 to less than 3 weeks **[GO TO SCH3a]**
4. 3 weeks or more **[GO TO SCH3a]**

96 REFUSED **[GO TO SCH3a]**

97 DON'T KNOW **[GO TO SCH3a]**

SCH2d. Was the time away during **[SUMMERYEAR2]** longer by… **[READ LIST, RECORD ONE RESPONSE]**

1. Less than a week
2. 1 to less than 2 weeks
3. 2 to less than 3 weeks
4. 3 weeks or more

96 REFUSED

97 DON'T KNOW

SCH3a. During **[WINTERYEAR1A/WINTERYEAR1B]** approximately how many weeks were all occupants away from the home for any reason during the winter **[EMPHASIZE "WINTER"]** months of November through March? **[READ LIST, RECORD ONE RESPONSE]**

1. None
2. Less than a week.
3. 1-2 weeks
4. 3-4 weeks
5. 5-6 weeks
6. More than 6 weeks

96 REFUSED **[GO TO SCH4a]**

97 DON'T KNOW **[GO TO SCH4a]**

SCH3b. Was there a change in your schedule or the number of weeks when no one was at home during the winter months of **[WINTERYEAR2A/WINTERYEAR2B]**? **[READ LIST, RECORD ONE RESPONSE]**

1. No, no change in schedule. **[GO TO SCH4a]**
2. Yes, less time away in **[WINTERYEAR2/WINTERYEAR2B]**.
3. Yes, more time away in **[WINTERYEAR2/WINTERYEAR2B]**. **[GO TO SCH3d]**

96 REFUSED **[GO TO SCH4a]**

97 DON'T KNOW **[GO TO SCH4a]**

SCH3c. Was the time away during **[WINTERYEAR2A/WINTERYEAR2B]** shorter by… **[READ LIST, RECORD ONE RESPONSE]**

1. Less than a week, **[GO TO SCH4a]**
2. 1 to less than 2 weeks, **[GO TO SCH4a]**
3. 2 to less than 3 weeks, **[GO TO SCH4a]**
4. 3 weeks or more **[GO TO SCH4a]**

96 REFUSED **[GO TO SCH4a]**

97 DON'T KNOW **[GO TO SCH4a]**

SCH3d. Was the time away during **[WINTERYEAR2A/WINTERYEAR2B]** longer by… **[READ LIST, RECORD ONE RESPONSE]**

1. Less than a week,
2. 1 to less than 2 weeks
3. 2 to less than 3 weeks
4. 3 weeks or more

96 REFUSED

97 DON'T KNOW

SCH4a. Did your household have a change in day-to-day schedule between **[YEAR1]** and **[YEAR2]**?

1. YES
2. NO **[GO TO SCH5a]**

96 REFUSED **[GO TO SCH5a]**

97 DON'T KNOW **[GO TO SCH5a]**

SCH4b. How did the schedule change? Were you… **[READ LIST, RECORD ONE]**

1. at home more in **[YEAR2]**
2. at home less in **[YEAR2]**

95. OTHER (Specify:_____)

96 REFUSED

97 DON'T KNOW

SCH5a. Comparing **[YEAR1]** to **[YEAR2]**, were there any other major changes in your household that affected your natural gas use.

1. YES
2. NO [**GO TO SCH6a**]

96 REFUSED **[GO TO SCH6a]**

97 DON'T KNOW **[GO TO SCH6a]**

SCH5b. In [**YEAR1**], did you use a lot more natural gas, somewhat more, somewhat less, or a lot less than in **[YEAR2]**? **[READ LIST, RECORD ONE]**

1. A LOT MORE
2. SOMEWHAT MORE
3. SOMEWHAT LESS
4. A LOT LESS

96 REFUSED **[GO TO SCH6a]**

97 DON'T KNOW **[GO TO SCH6a]**

SCH5c. What was the reason for the change in natural gas use? **[RECORD ALL THAT APPLY]**

2. REMOVAL/ADDITION/CHANGE IN USE OF FURNACE OR HEATER
3. REMOVAL/ADDITION/CHANGE WINDOWS OR DOORS

4. REMOVAL/ADDITION/CHANGE INSULATION OR SEALING
5. CHANGE IN HH SCHEDULE OR HH COMPOSITION
95. OTHER (Specify:_____)
96 REFUSED
97 DON'T KNOW

SCH6a. Comparing **[YEAR1]** to **[YEAR2]**, were there any other major changes in your household that affected your electric use?

1. YES
2. NO **[GO TO NEXT SECTION]**

96 REFUSED **[GO TO NEXT SECTION]**
97 DON'T KNOW **[GO TO NEXT SECTION]**

SCH6b. In **[YEAR1],** did you use a lot more electricity, somewhat more, somewhat less, or a lot less than in **[YEAR2]**? **[READ LIST, RECORD ONE]**

1. A LOT MORE
2. SOMEWHAT MORE
3. SOMEWHAT LESS
4. A LOT LESS

96 REFUSED
97 DON'T KNOW

SCH6c.What was the reason for the change in electric use? **[RECORD ALL THAT APPLY]**

2. REMOVAL/ADDITION/CHANGE IN USE OF FURNACE OR HEATER
3. REMOVAL/ADDITION/CHANGE WINDOWS OR DOORS
4. REMOVAL/ADDITION/CHANGE INSULATION OR SEALING
5. CHANGE IN HH SCHEDULE OR HH COMPOSITION
6. REMOVAL/ADDITION/CHANGE IN USE OF ELECTRONIC DEVICES
7. REMOVAL/ADDITION/CHANGE IN USE OF LIGHTS
8. REMOVAL/ADDITION/CHANGE IN USE OF AC OR FANS
95. OTHER (Specify:_____)

96 REFUSED
97 DON'T KNOW

DEMOGRAPHICS

Finally, 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 evaluation team in any way that identifies you or your household.

D1. The next question is about how many **adults** live in your home most of the year. Do not include anyone who just visits or who may be away at college or deployed by the military for most of the year. Include all members of your household whether or not they are related to you. How many people, including yourself, currently live in your home year-round?

1. **[RECORD NUMBER]**

96 REFUSED

97 DON'T KNOW

[READ D2-D6 AS 1 QUESTION. MAKE SURE SUM OF D2-D6=D1.]

D2. Including yourself, how many of these **adults [EMPHASIZE ADULTS]** are employed or self-employed full-time?

1. **[RECORD NUMBER]**
96. REFUSED
97. DON'T KNOW

D3. How many of these adults are employed or self-employed part-time?

1. **[RECORD NUMBER]**
96. REFUSED
97. DON'T KNOW

D4. How many of these adults are temporarily unemployed?

1. **[RECORD NUMBER]**
96. REFUSED
97. DON'T KNOW

NOTE THERE IS NO QUESTION D5

D6. How many of these adults are not employed and not seeking work, including those not seeking work because they are retired or disabled?

1. **[RECORD NUMBER]**
96. REFUSED
97. DON'T KNOW

D7a. Would you say the total combined income of all members of your household over the past 12 months was under or over $50,000? **[READ LIST, RECORD ONE]**

1. UNDER $50,000
2. $50,000 OR MORE **[GO TO D7c]**

96 REFUSED **[GO TO CLOSING]**

97 DON'T KNOW **[GO TO CLOSING]**

D7b. Please stop me when I read the range that contains the total combined income of all members of your household over the past 12 months. **[READ LIST, RECORD ONE]**

1. Less than $15,000
2. $15,000 to less than $25,000
3. $25,000 to less than $35,000
4. $35,000 to less than $50,000

96 REFUSED **[GO TO CLOSING]**

97 DON'T KNOW **[GO TO CLOSING]**

[ASK D7c IF D7a = 2]

D7c. Please stop me when I read the range that contains the total combined income of all members of your household over the past 12 months. **[READ LIST, RECORD ONE]**

1. $50,000 to less than $75,000
2. $75,000 to less than $100,000
3. $100,000 to less than $150,000
4. $150,000 to less than $200,000
5. $200,000 or more

96 REFUSED

97 DON'T KNOW

CONFIRM RESPONDENT NAME AND IF RESPONDENT IS CONTACT FROM THE SAMPLE OR OTHER HOUSEHOLD HEAD.

CLOSING:

Those are all the questions I have for you. Thank you so much for taking the time to go through this survey. The information you provided will be very helpful in evaluating and improving the program.

PARTICIPATING HOMEOWNERS NET-TO-GROSS SURVEY

New York Home Performance and Assisted Home Performance Program with ENERGY STAR® Impact Evaluation 2010/2011 Participating Homeowners Survey – NTG & NEI Version

FINAL 9/9/2011

May I speak to **[NAME]**?

Hello 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 participated in NYSERDA's Home Performance with ENERGY STAR® Program. Our records indicate that a contractor participating in NYSERDA's Home Performance with ENERGY STAR Program installed energy efficiency measures in your home in **[COMPLETEDT_YEAR]**. We're calling today to ask you some questions about your experience with this program to help us evaluate how the Program might serve people better. We sent you a letter recently telling you that we would be calling and explaining the research we are doing. Your responses to this survey will be kept confidential to the extent permitted by law.

[IF NECESSARY:] The New York Home Performance with ENERGY STAR Program encourages contractors and homeowners to install energy efficient products, utilize Program services, and promote a whole-house approach to ensure that homes are as energy efficient as possible. As you may recall, the Comprehensive Home Assessment (or CHA) is performed by a participating Home Performance with ENERGY STAR contractor who comes to your home and completes a visual inspection of the living space, attic, and basement or crawl space. The contractor also performs a number of tests using special equipment including a blower door. The assessment usually takes one to three hours. At the end of the assessment, the contractor makes recommendations about things that you could do to improve the energy efficiency, comfort, and safety of your home.

Our records show that you received a Comprehensive Home Assessment by a participating Home Performance with ENERGY STAR contractor sometime in **[COMPLETEDT_YEAR]**.

[IF NECESSARY:] You were selected as part of a carefully designed sample and your feedback about this Program is very important to future planning for energy efficiency programs in the State.

SCREENER FOR CONTACT

SCR1. I have you as the contact for the project. Are you the person in your home we should speak to regarding participation in the Home Performance with ENERGY STAR Program and the energy efficiency actions taken?

1. YES **[GO TO REP1]**
2. NO

96 REFUSED **[THANK AND TERMINATE]**

97 DON'T KNOW

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 REFUSED **[THANK AND TERMINATE]**

97 DON'T KNOW **[THANK AND TERMINATE]**

SCHEDULE ANOTHER TIME FOR INTERVIEW IF NECESSARY

This survey will take about 20 minutes to complete.

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

NOW IS NOT A CONVENIENT TIME TO TALK, SCHEDULE A FOLLOW-UP DATA AND TIME, AND RECORD IT BELOW.]

APPOINTMENT DATE AND TIME:_____

NOTE TO PROGRAMMER: Please use the table below to drive insertion text for all occurrences of **[DESC_]** and **[MEAS_]**. Insert the corresponding description under the Meas_, Desc_, (and for FR9 only) Desc_FR9 columns based on which variables under "measure_in_survey" = 1 in the sample file.

For example, consider a respondent where msr_HSFS and msr_DHWFS both = 1 in the sample frame (and no other variables from the "measure_in_survey" list equal to 1). Then in REP1, both "Replaced heating system using a different fuel" and "Replaced hot water heater using a different fuel" would be inserted at every **[DESC_]**.

measure_in_survey	Meas_	Desc_	Desc_FR9
msr_a	Insulation	Added insulation	insulation
msr_b	Lighting	Installed CFLs or high efficiency lighting fixtures	CFLs or high efficiency lighting fixtures
msr_c	Refrigerator or Freezer	Replaced a refrigerator or freezer with an ENERGY STAR one	
msr_d	Appliance	Installed an ENERGY STAR appliance	
msr_e	Heating or Cooling conservation measure	Added heating or cooling conservation measures	Heating or cooling conservation measures
msr_f	Heating System	Replaced the heating system with an ENERGY STAR one	
msr_g	Hot water heater	Replaced the hot water heater with an ENERGY STAR one	
msr_h	Hot water conservation measure	Installed hot water conservation measures	Hot water conservation measures
msr_i	Heating system fuel source	Replaced heating system using a different fuel	
msr_j	Thermostat	Installed a programmable thermostat	
msr_k	Hot water heater	Replaced hot water heater using a different fuel	
msr_l	Cooling system	Replaced the cooling system with an ENERGY STAR one	
msr_m	Windows or Doors	Replaced windows or doors with ENERGY STAR ones	ENERGY STAR windows or doors

GENERAL INSTRUCTIONS:

The opinions of Program participants are important to this research effort. If we ask you a question you aren't sure you can answer, your best guess or even a rough judgment is fine. If you have no idea whatsoever, you can just indicate that you don't know and we will move on.

[READ TO ALL]

As you may recall, the Comprehensive Home Assessment (or CHA) is performed by a certified contractor who comes to your home and completes a visual inspection of the living space, attic, and basement or crawl space. The contractor also performs a number of tests using special equipment. The assessment usually takes one to three hours. At the end of the assessment, the contractor makes recommendations about things that you could do in your home to improve energy efficiency, comfort and safety.

EARLY REPLACEMENT VERSUS RETROFIT

[ASK REP1-REP5 IF msr_c = 01 OR msr_d = 01 OR msr_f = 01 OR msr_g = 01 OR msr_k = 01 OR msr_i = 01 OR msr_l = 01, ELSE SKIP TO NEXT SECTION]

[FOR EACH OF THE MEASURES LISTED ABOVE, ASK REP1 – REP5 IN SEQUENCE, THEN GO TO NEXT MEASURE AND ASK REP1 – REP5.]

REP1. Our records show that you **[DESC_]** through the Program in **[COMPLETEDT_YEAR]**. To the best of your recollection, how old was the original equipment prior to when you **[DESC_]** through the Program? **[FOR EACH APPLICABLE MEASURE, RECORD AGE IN YEARS OR ORIGINAL INSTALL DATE]**

Age in years ***or*** Original installation date

SURVEY_MEASURE1 1. _____ (number of years) 2. _____ (MMYYYY)

96 REFUSED

97 DON'T KNOW

94 WASN'T INSTALLED, DIDN'T GET THIS MEASURE/ITEM **[LOOP BACK TO REP1 FOR THE NEXT ELIGIBLE MEASURE]**

REP2. Which of the following best describes the condition of the original equipment that was replaced?

1. It had failed or was about to fail.
2. It worked but was old and would probably need to be replaced in next couple of years anyway.
3. It required frequent maintenance.
4. It was in reasonable condition and not expected to quit in the next few years.
95. Other (specify:_____)
96 REFUSED
97 DON'T KNOW

[ASK REP3-REP5 IF REP2 = 4 or 95]

REP3. Is your **[MEAS_]** about the same size as your old equipment?

1. YES **[GO TO INSTRUCTIONS BEFORE REP5]**
2. NO
96 REFUSED **[GO TO INSTRUCTIONS BEFORE REP5]**
97 DON'T KNOW **[GO TO INSTRUCTIONS BEFORE REP5]**

REP4. Is your **[MEAS_]** smaller or larger than your old equipment?

1. SMALLER
2. LARGER
96 REFUSED
97 DON'T KNOW

[ASK REP5 IF msr_d = 01 OR msr_f = 01 OR msr_c = 01 OR msr_l = 01; ELSE SKIP TO NEXT SECTION]

REP5. Does your **[MEAS_]** have approximately the same features, more features or fewer features than the equipment it replaced?

1. SAME
2. MORE
3. FEWER
96 REFUSED
97 DON'T KNOW

AID TO ACCURATE RECALL

In this survey, I will be asking you to remember how you made decisions several years ago about improving the energy efficiency of your home. It may help to think about major changes that occurred in the last four years. The events that would help most would be those that are important to you. When answering these questions, I would like you to try to remember how you were actually thinking just prior to your participation in the Home Performance with ENERGY STAR Program.

A1. Is your household's economic situation significantly better, somewhat better, the same, somewhat worse, or significantly worse today than at the end of 2008?

1. SIGNIFICANTLY BETTER
2. SOMEWHAT BETTER
3. THE SAME
4. SOMEWHAT WORSE
5. SIGNIFICANTLY WORSE

96 REFUSED

97 DON'T KNOW

[IF 'THE SAME' TODAY (A1=3) GO TO FR1a, OTHERWISE READ: Please try to answer the next few questions thinking back to [YEAR1].].

FREE RIDERSHIP

FR1a. Did you have specific plans to install or add the energy efficiency improvements provided by the Home Performance with ENERGY STAR Program prior to the Comprehensive Home Assessment?

1. YES
2. NO **[GO TO FR2]**

96 REFUSED

97 DON'T KNOW

FR1b. What were you planning to do regarding energy efficiency before the Comprehensive Home Assessment? **[PROBE AS NECESSARY TO CAPTURE TIMING, QUANTITY, AND EFFICIENCY, AS WELL AS PRIOR BUDGETING.]**

1. [RECORD VERBATIM]

96 REFUSED

97 DON'T KNOW

FR1c. **[BASED ON RESPONSES TO FR1b, FILL IN A "0 TO 4" SCORE INDICATING THE EXTENT TO WHICH RESPONDENT WAS ALREADY PLANNING TO INSTALL THE ENERGY EFFICIENCY MEASURES. DO NOT ASK RESPONDENT DIRECTLY.]**

[GUIDELINES FOR ASSIGNING HIGH-EFFICIENCY PROJECT PLANNING SCORE]

SCORE	EXTENT OF PLANNING
0	NO PLANS FOR HIGH-EFFICIENCY EQUIPMENT; RESPONDENT MAY HAVE CONSIDERED ALTERNATIVE TECHNOLOGY OPTIONS, BUT DID NOT EXPLICITLY CONSIDER HIGH EFFICIENCY.
1	INITIAL STEPS TOWARD CONSIDERATION OF HIGH EFFICIENCY SUCH AS REQUESTING INFORMATION ON OR DISCUSSING, IN GENERAL, HIGH EFFICIENCY OPTIONS WITH VENDORS OR CONTRACTORS.
2	IN-DEPTH DISCUSSION OR CONSIDERATION OF SPECIFIC TYPES OF HIGH EFFICIENCY EQUIPMENT (E.G., LIGHTING, HVAC, APPLIANCES), INCLUDING THEIR POSITIVE AND NEGATIVE ATTRIBUTES AND COSTS.
3	IDENTIFICATION OF SPECIFIC EQUIPMENT MANUFACTURERS AND MODELS, INCLUDING ASSESSMENT OF THEIR RELATIVE COSTS AND PERFORMANCE CHARACTERISTICS.
4	HIGH EFFICIENCY EQUIPMENT AND DESIGNS FULLY SPECIFIED AND EXPLICITLY SELECTED AND PLANS TO ACCOMMODATE ANY INCREASE IN COSTS TO OBTAIN HIGH EFFICIENCY.

96 REFUSED

97 DON'T KNOW

FR1d. Now I would like you to think about your plans for improving the efficiency of your home, and please consider the costs of the changes you made through the Home Performance with ENERGY STAR Program and what those costs would have been without the Program. Which of the following statements best describes your plans to install high efficiency equipment or improvements to your home? **[READ LIST]**

0. I had not considered the efficiency level of my home and had no plans for improving the efficiency of my home.

1. I had gathered some information on high efficiency or discussed it with friends or family.

2. I had one or more in-depth discussions with knowledgeable people or had received an analysis about specific high efficiency equipment or improvements.

3. I had considered specific high efficiency equipment and improvement options, including a comparison of costs and performance for these items.

4. I had already picked out the specific high efficiency equipment or improvements we wanted, and we were prepared to pay the full cost of these items.

96 REFUSED

97 DON'T KNOW

FR2. Did your participation in the Home Performance with ENERGY STAR Program in any way influence the type or efficiency level of the equipment or the amount of high efficiency equipment that is in your home compared to what you would have now without the Program?

1. Yes

2. No, all the same equipment would have been installed at the same high efficiencies.

   [GO TO FR5]

96 REFUSED **[GO TO INSTRUCTIONS BEFORE FR4]**

97 DON'T KNOW **[GO TO INSTRUCTIONS BEFORE FR4]**

FR3. Would you have <u>installed any</u> of the new equipment provided by Home Performance with ENERGY STAR without the Program?

1. YES
2. NO **[GO TO FR5]**

96 REFUSED

97 DON'T KNOW

[ASK FR4a IF FR2 = 1 AND FR3 = 1, 96, 97]

FR4a. In what ways did NYSERDA's Home Performance with ENERGY STAR Program influence your decision to have high efficiency measures or equipment put into your home? (Be sure to identify specific measures/equipment.)

1. [RECORD VERBATIM]

96 REFUSED

97 DON'T KNOW

FR4b. **[BASED ON RESPONSE TO FR4a, FILL IN A "0 TO 4"SCORE INDICATING THE EXTENT TO WHICH THE PROGRAM INFLUENCED THE DECISION TO INSTALL HIGH EFFICIENCY MEASURES OR EQUIPMENT. DO NOT ASK RESPONDENT DIRECTLY. "0" INDICATES THAT THE PROGRAM HAD NO INFLUENCE; "4" INDICATES THAT THE PROGRAM WAS THE PRIMARY REASON THAT HIGH EFFICIENCY MEASURES WERE INSTALLED.]**

[GUIDELINES FOR ASSIGNING PROGRAM INFLUENCE SCORE]

SCORE	CHARACTERIZATION OF PROGRAM INFLUENCE
0	NO INFLUENCE ON THE DECISION TO INSTALL HIGH-EFFICIENCY EQUIPMENT. ALL EQUIPMENT WOULD HAVE BEEN INSTALLED AT THE SAME EFFICIENCIES EVEN WITHOUT THE PROGRAM.
1	PROGRAM HELPED IN MAKING FINAL DECISION ON EQUIPMENT THAT HAD ALREADY BEEN THOROUGHLY CONSIDERED.
2	PROGRAM LENT CREDIBILITY TO THE DECISION TO INVEST IN HIGH EFFICIENCY AND/OR IT PROVIDED INFORMATION THAT HELPED EXPAND THE QUANTITY, SCOPE, OR EFFICIENCY OF THE EQUIPMENT.
3	PROGRAM IDENTIFIED A SIGNIFICANT NUMBER OF SPECIFIC HIGH EFFICIENCY OPTIONS THAT WERE INSTALLED BUT THAT HAD NOT PREVIOUSLY BEEN CONSIDERED AND/OR PROGRAM WAS A MAJOR DRIVER BEHIND A SIGNIFICANT INCREASE IN THE QUANTITY, SCOPE, OR EFFICIENCY OF HIGH-EFFICIENCY EQUIPMENT.
4	PROGRAM WAS THE PRIMARY REASON THAT HIGH EFFICIENCY EQUIPMENT WAS INSTALLED IN THE PROJECT.

96 REFUSED

97 DON'T KNOW

FR5. On a scale of 0 to 4, where 0 is "not at all important" and 4 is "very important," how important was your participation in the Home Performance with ENERGY STAR Program in having energy efficiency measures installed in your home?

0. NOT AT ALL IMPORTANT
1.
2.
3.
4. VERY IMPORTANT
96 REFUSED
97 DON'T KNOW

[FOR EACH OF THE PARTICIPANT'S ENERGY SAVING MEASURE DESCRIPTION (msr_a – msr_m), ASK FR6 – FR9 IN SEQUENCE THEN GO TO NEXT MEASURE AND ASK FR6 – FR9]

Now I'd like to talk specifically about the decisions you made concerning the [**MEAS_]** you received with the Program's assistance.

[ASK FR6 and FR7 IF msr_b = 01OR msr_c = 01 OR msr_d = 01 OR msr_f = 01 OR msr_g = 01 OR msr_l = 01 OR msr_m = 01]

FR6. If you had not participated in the Home Performance with ENERGY STAR Program, would you have changed your **[MEAS_]**?

[NOTE THAT THESE DO NOT HAVE TO BE "ENERGY EFFICIENT" MEASURES/ EQUIPMENT.]

1. YES **[GO TO FR7]**
2. NO **[ENTER 0% FOR THE CATEGORY IN THE FREE RIDERSHIP VALUE COLUMN IN TABLE 1 BELOW (FR) AND MOVE ON TO THE NEXT SURVEY_MEASURE]**

96 REFUSED **[MOVE ON TO THE NEXT MEASURE]**

97 DON'T KNOW **[MOVE ON TO THE NEXT MEASURE]**

[ASK FR7 FOR ALL MEASURES]

FR7. Within how many months and years of when you participated in the Home Performance with ENERGY STAR Program would you have been likely to make these improvements if you had not participated in the Program? For example, if you would have installed the item at the same time as occurred through the Program, then your answer would be zero; if you would have installed it a year and a half later, then your answer would be 1 year and 6 months.

1. [RECORD YEARS LATER, RECORD MONTHS LATER]

93 DO NOT UNDERSTAND THE QUESTION

96 REFUSED

97 DON'T KNOW

[ASK FR8 FOR ALL MEASURES]

FR8. What is the likelihood that you would have **[DESC_]** (of the same high level of efficiency) if you had not participated in the Home Performance with ENERGY STAR Program?

1. Definitely would **not** have installed equipment of the same high level of efficiency

2. Definitely **would** have installed equipment of the same high level of efficiency anyway
3. **May have** installed equipment of the same high level of efficiency, even without the comprehensive home assessment **[GO TO FR8a]**

96 REFUSED

97 DON'T KNOW

AUTOFILL INSTRUCTIONS

[FR8a1 = 0 IF FR8 = 1]

[FR8a1 = 100 IF FR8 = 2]

[ASK FR8a1 IF FR8 = 3]

FR8a. With what percent likelihood would you have **[DESC_]** if you had not participated in the Home Performance with ENERGY STAR Program or had its Comprehensive Home Assessment?

[SHORTER VERSION TO USE AFTER SECOND DESC_: With what percent likelihood would you have **[DESC_]** if you had not participated in the Program?

1. **[RECORD PERCENTAGE]**

93 **DO NOT UNDERSTAND THE QUESTION**

96 REFUSED

97 DON'T KNOW

99 NOT APPLICABLE

[ASK FR9 IF msr_a = 01 OR msr_b = 01 OR msr_e = 01 OR msr_h = 01 OR msr_m = 01]

FR9. What share or percentage of the **[DESC_FR9_]** would you have installed without the Program and its Comprehensive Home Assessment?

[SHORTER VERSION TO USE AFTER SECOND DESC_FR9_: What share or percentage of the **[DESC_FR9_]** would you have installed without the Program?

TABLE 1.

[FILL IN EITHER THE "LIKELIHOOD" VALUE OR THE "SHARE OF MEASURES" VALUE OR BOTH VALUES FOR EACH RELEVANT MEASURE CATEGORY.

IF RESPONDENTS ASK FOR THE TIMEFRAME, USE THE TIMEFRAME SPECIFIED ABOVE IN QUESTION FR6 .

THEN ENTER THE APPROPRIATE FREE RIDERSHIP VALUE (FR), WHICH WILL BE ONE OF THE FOLLOWING, DEPENDING ON THE NATURE OF THE PROJECT AND THE RESPONSES:

1) **THE SINGLE VALUE FOR "LIKELIHOOD" OR "SHARE OF MEASURES" IF ONLY ONE IS ENTERED;**
2) **THE PRODUCT OF THE TWO, IF APPROPRIATE (E.G., IF THERE IS A 50% LIKELIHOOD THAT 75% OF THE MEASURES WOULD HAVE BEEN INSTALLED, AND RESPONDENT DEFINITELY WOULDN'T HAVE DONE THE FINAL 25%)**

SURVEY_MEASURE	FR6. WOULD HAVE INSTALLED IN FORESEEABLE FUTURE [YES = 1, NO = 2, REFUSED = 96, DON'T KNOW = 97]	FR7. WITHIN ____ YEARS OF PARTICIPATION [ENTER # OF YEARS REFUSED = 96, DON'T KNOW = 97]	FR8. LIKELIHOOD THAT EQUIPMENT…		FR9. SHARE OF MEASURES THAT…	FR. [ENTERED BY CALCULATION OF FR8*FR9 WHERE FR8=1 IF NOT ASKED AND FR9=1 IF NOT ASKED]
	NO FR=0%		…WOULD HAVE BEEN INSTALLED (AT HIGH EFFICIENCY) WITHOUT THE COMPREHENSIVE HOME ASSESSMENT			FREE RIDERSHIP VALUE
msr_a:. [ADDED INSULATION]	FR6a	FR7a	FR8a	and/or	FR9a	FR_a
msr_b: [INSTALLED CFLs OR HIGH EFFICIENCY LIGHTING FIXTURES]	FR6b	FR7b	FR8b	and/or	FR9b	FR_b
msr_c:. [Installed an ENERGY STAR Refrigerator or Freezer]	FR6c	FR7c	FR8c	and/or	FR9c	FR_c
msr_d: . [INSTALLED ENERGY STAR APPLIANCE] *(e.g.*, clothes washer, dishwasher)	FR6d	FR7d	FR8d	and/or	FR9d	FR_d
msr_e: [INSTALLED HEATING OR COOLING SYSTEM CONSERVATION MEASURES]	FR6e	FR7e	FR8e	and/or	FR9e	FR_e

[FILL IN EITHER THE "LIKELIHOOD" VALUE OR THE "SHARE OF MEASURES" VALUE OR BOTH VALUES FOR EACH RELEVANT MEASURE CATEGORY.

IF RESPONDENTS ASK FOR THE TIMEFRAME, USE THE TIMEFRAME SPECIFIED ABOVE IN QUESTION FR6 .

THEN ENTER THE APPROPRIATE FREE RIDERSHIP VALUE (FR), WHICH WILL BE ONE OF THE FOLLOWING, DEPENDING ON THE NATURE OF THE PROJECT AND THE RESPONSES:

1) **THE SINGLE VALUE FOR "LIKELIHOOD" OR "SHARE OF MEASURES" IF ONLY ONE IS ENTERED;**
2) **THE PRODUCT OF THE TWO, IF APPROPRIATE (E.G., IF THERE IS A 50% LIKELIHOOD THAT 75% OF THE MEASURES WOULD HAVE BEEN INSTALLED, AND RESPONDENT DEFINITELY WOULDN'T HAVE DONE THE FINAL 25%)**

SURVEY_MEASURE	**FR6. WOULD HAVE INSTALLED IN FORESEEABLE FUTURE [YES = 1, NO = 2, REFUSED = 96, DON'T KNOW = 97]**	**FR7. WITHIN ____ YEARS OF PARTICIPATION [ENTER # OF YEARS REFUSED = 96, DON'T KNOW = 97]**	**FR8. LIKELIHOOD THAT EQUIPMENT…**	**FR9. SHARE OF MEASURES THAT…**		**FR. [ENTERED BY CALCULATION OF FR8*FR9 WHERE FR8=1 IF NOT ASKED AND FR9=1 IF NOT ASKED]**
	NO FR=0%		**…WOULD HAVE BEEN INSTALLED (AT HIGH EFFICIENCY) WITHOUT THE COMPREHENSIVE HOME ASSESSMENT**			**FREE RIDERSHIP VALUE**
msr_f: [REPLACED THE HEATING SYSTEM WITH AN ENERGY STAR ONE]	FR6f	FR7f	FR8f	and/or	FR9f	FR_f
msr_g: [replaceD the hot water heater WITH AN ENERGY STAR ONE]	FR6g	FR7g	FR8g	and/or	FR9g	FR_g
msr_h: INSTALLED HOT WATER CONSERVATION MEASURES] **such as low flow showerhead, wrapped the tank, or insulated the pipes**	FR6h	FR7h	FR8h	and/or	FR9h	FR_h
msr_i:[Installed a Programmable Thermostat]	FR6i	FR7i	FR8i	and/or	FR9i	FR_i

[FILL IN EITHER THE "LIKELIHOOD" VALUE OR THE "SHARE OF MEASURES" VALUE OR BOTH VALUES FOR EACH RELEVANT MEASURE CATEGORY.

IF RESPONDENTS ASK FOR THE TIMEFRAME, USE THE TIMEFRAME SPECIFIED ABOVE IN QUESTION FR6 .

THEN ENTER THE APPROPRIATE FREE RIDERSHIP VALUE (FR), WHICH WILL BE ONE OF THE FOLLOWING, DEPENDING ON THE NATURE OF THE PROJECT AND THE RESPONSES:

1) **THE SINGLE VALUE FOR "LIKELIHOOD" OR "SHARE OF MEASURES" IF ONLY ONE IS ENTERED;**
2) **THE PRODUCT OF THE TWO, IF APPROPRIATE (E.G., IF THERE IS A 50% LIKELIHOOD THAT 75% OF THE MEASURES WOULD HAVE BEEN INSTALLED, AND RESPONDENT DEFINITELY WOULDN'T HAVE DONE THE FINAL 25%)**

SURVEY_MEASURE	**FR6. WOULD HAVE INSTALLED IN FORESEEABLE FUTURE [YES = 1, NO = 2, REFUSED = 96, DON'T KNOW = 97]**	**FR7. WITHIN ____ YEARS OF PARTICIPATION [ENTER # OF YEARS REFUSED = 96, DON'T KNOW = 97]**	**FR8. LIKELIHOOD THAT EQUIPMENT…**	**FR9. SHARE OF MEASURES THAT…**		**FR. [ENTERED BY CALCULATION OF FR8*FR9 WHERE FR8=1 IF NOT ASKED AND FR9=1 IF NOT ASKED]**
	NO FR=0%		**…WOULD HAVE BEEN INSTALLED (AT HIGH EFFICIENCY) WITHOUT THE COMPREHENSIVE HOME ASSESSMENT**			**FREE RIDERSHIP VALUE**
msr_j: [REPLACED HEATING SYSTEM USING A DIFFERENT FUEL**]**	FR6j	FR7j	FR8j	and/or	FR9j	FR_j
msr_k: . [REPLACED HOT WATER HEATER USING A DIFFERENT FUEL**]**	FR6k	FR7k	FR8k	and/or	FR9k	FR_k
msr_l: [REPLACED COOLING SYSTEM WITH AN ENERGY STAR ONE]	FR6l	FR7l	FR8l	and/or	FR9l	FR_l
msr_m: [REPLACED WINDOWS OR DOORS WITH ENERGY STAR ONES]	FR6m	FR7m	FR8m	and/or	FR9m	FR_m

SPILLOVER

SO1. Did your experience with the Program cause you to install any additional energy efficiency products to save **gas**?

1. NO **[GO TO SO4]**
2. YES **[GO TO SO2]**

96 REFUSED **[GO TO SO4]**

97 DON'T KNOW **[GO TO SO4]**

SO2. Would you estimate the energy savings from these extra **gas** efficiency measures to be less than, similar to, or more than the savings from the energy efficient **gas** measures installed through the Home Performance with ENERGY STAR Program?

1. Less than the savings from the energy efficiency measures installed through the program.
2. Similar to the savings from the energy efficiency gas measures installed through the program. **[SKIP TO SO3]**
3. More than the savings from the energy efficiency gas measures installed through the program.

96 REFUSED **[SKIP TO SO3]**

97 DON'T KNOW **[SKIP TO SO3]**

SO2a. The energy savings from these extra gas measures are about what percent of the gas savings from the Program measures? **[READ IF NECESSARY:** If the savings from the additional measures are about a quarter of the savings you are achieving from the Program measures, then the percentage would be 25%.]

1.____ [RECORD PERCENTAGE > 100 IF SO2=3, PERCENTAGE <100 IF SO2=1]

93 DO NOT UNDERSTAND QUESTION

96 REFUSED

97 DON'T KNOW

SO3. What share of the **gas** savings from these extra measures can reasonably be attributed to the influence of the Program?

1. [RECORD PERCENT, ACCEPT 100% OR LESS]

96 REFUSED

97 DON'T KNOW

SO4. Did your experience with the Program cause you to install any additional energy efficiency products at your home to save **electricity?**

1. NO **[GO TO N1]**
2. YES **[GO TO SO5]**

96 REFUSED **[GO TO N1]**

97 DON'T KNOW **[GO TO N1]**

SO5. Would you estimate the energy savings from the extra **electric** efficiency measures to be less than, similar to, or more than the savings from the energy efficiency **electric** measures installed through the program?

1. Less than the savings from the energy efficiency electric measures installed through the Program.
2. Similar to the savings from the energy efficiency electric measures installed through the program. **[SKIP TO SO6]**
3. More than the savings from the energy efficiency electric measures installed through the program.

96 REFUSED **[SKIP TO SO6]**

97 DON'T KNOW **[SKIP TO SO6]**

SO5a. The energy savings from these extra electric measures are about what percent of the electric savings from the Program measures? **[READ IF NECESSARY:** If the savings from the additional measures are about a quarter of the savings you are achieving from the Program measures, then the percentage would be 25%.]

1. [RECORD PERCENTAGE > 100 IF SO5=3, PERCENTAGE < 100 IF SO5=1]

93 DO NOT UNDERSTAND THE QUESTION

96 REFUSED

97 DON'T KNOW

SO6. What share of the **electric** savings from these extra measures can reasonably be attributed to the influence of the Program?

1. [RECORD PERCENTAGE, ACCEPT 100% OR LESS]

96 REFUSED

97 DON'T KNOW

ENERGY EFFICIENCY ENVIRONMENT

EE1. On a scale of 0 to 4, where 0 is "Not at all" and 4 is "Very often," in the past 6 months, how often have you heard or read about things that you could do to reduce energy use in your home? This could include purchasing energy efficient appliances, light bulbs, or changing behaviors.

0. NOT AT ALL
1.
2.
3.
4. VERY OFTEN
96 REFUSED
97 DON'T KNOW

EE2. In the last couple of years, would you that say your familiarity with energy efficient products and equipment has …? **[READ LIST AND RECORD ONE RESPONSE]**

5. Increased significantly
4. Increased somewhat
3. Stayed the same
2. Decreased somewhat
1. Decreased significantly
96 REFUSED
97 DON'T KNOW

[ASK EE3 IF EE2 =4, 5, OTHERWISE GO TO NEXT SECTION.]

EE3. How much of your increased familiarity with energy efficiency is due to your Comprehensive Home Assessment? **[READ LIST]**

4. All of it
3. Most of it
2. A small part, or
1. None of it
96 REFUSED
97 DON'T KNOW

[ASK EE4 IF EE3<3, OTHERWISE GO TO NEXT SECTION]

EE4. To what do you attribute your increased familiarity with energy efficiency?

1. [RECORD VERBATIM]

NON-ENERGY IMPACTS

[ASK N1 – N2 IF msr_b = 01]

N1. Are you replacing light bulbs more frequently, less frequently or with the same frequency as you did before participating in the Program?

1. MORE
2. SAME **[GO to the INSTRUCTION BEFORE N3]**
3. LESS

96 REFUSED **[GO TO THE INSTRUCTION BEFORE N3]**

97 DON'T KNOW **[GO TO THE INSTRUCTION BEFORE N3]**

N2. How many **[IF N1 = 01 SHOW** "more"**; IF N1 = 03 SHOW** "fewer"] bulbs do you use per year?

1. [RECORD NUMBER]

96 REFUSED

97 DON'T KNOW

[ASK N3 – N6 IF msr_d = 01]

N3a. Did you install a high efficiency clothes washer through the Home Performance with ENERGY STAR Program?

1. YES
2. NO **[GO TO N7]**

96 REFUSED **[GO TO N7]**

97 DON'T KNOW **[GO TO N7]**

N3b. In an average week, how many loads of laundry are washed in your clothes washer?

1. 1 or less loads per week
2. 2 to 4 loads per week
3. 5 to 9 loads per week
4. 10 to 15 loads per week
5. More than 15 loads per week

96 REFUSED

97 DON'T KNOW

N4. Does your household use more or less laundry detergent with the efficient clothes washer than your old washer?

1. MORE **[GO TO N5]**
2. SAME **[GO TO N7]**
3. LESS **[GO N6]**

96 REFUSED **[GO TO N7]**

97 DON'T KNOW **[GO TO N7]**

N5. In comparison to your old washer, are you now using ....

1. Less than twice the amount of detergent as was required by your old washer?
2. About twice as much detergent as was required by your old washer?
3. More than twice the amount of detergent as was required by your old washer?

96 REFUSED

97 DON'T KNOW

[ASK N6 IF N4 =3, OTHERWISE GO TO N7]

N6. In comparison to your old washer, are you now using ....

1. Less than half the amount of detergent than required by your old washer
2. About half the amount of detergent required by your old washer
3. More than half the amount of detergent than required by your old washer

96 REFUSED

97 DON'T KNOW

[ASK N7 – N8 IF msr_i = 01]

N7. How many times did you repair your heating system during **[YEAR1]**?

1. [RECORD NUMBER]

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

N8. How many times did you repair your heating system during **[YEAR2]**?

1. [RECORD NUMBER]

96 REFUSED

97 DON'T KNOW

RECESSION EFFECTS

R1. Did anyone in your household experience a major drop in income sometime between 2006 and 2009?

1. YES
2. NO **[GO TO NEXT SECTION]**
96 REFUSED **[GO TO NEXT SECTION]**
97 DON'T KNOW **[GO TO NEXT SECTION]**

R2. Was there more than one person in your household who experienced this type of income loss?

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

[ASK R3 IF R1 = 1]

R3. In what year and season between 2006 and 2009 did the loss of income begin?

1. [RECORD YEAR, RECORD SEASON]
96 REFUSED
97 DON'T KNOW

[ASK R4 IF R2 = 1]

R4. In what year and season between 2006 and 2009 did your household experience the second drop in income?

1. [RECORD YEAR, RECORD SEASON]
96 REFUSED
97 DON'T KNOW

DEMOGRAPHICS

Finally, 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 evaluation team in any way that identifies you or your household.

SCH1a. Next we want to know many people live in your home most of the year. Do not include anyone who just visits or who may be away at college or deployed by the military for most of the year. Include all members of your household whether or not they are related to you. How many people, including yourself, currently live in your home year-round?

1 [RECORD NUMBER]

96 REFUSED

97 DON'T KNOW

D1b. How many adults, persons over 21, live in your home most of the year?

1. [RECORD NUMBER]

96 REFUSED

97 DON'T KNOW

[READ D2-D6 AS 1 QUESTION. STOP WHEN SUM OF ADULT COUNT = VALUE IN D1b; MAKE SURE SUM OF D2-D6 = D1b]

D2. Including yourself, how many of these **adults** are employed or self-employed full-time?

1. [RECORD NUMBER]

96 DON'T KNOW

97 REFUSED

D3. How many of these adults are employed or self-employed part-time?

1 [RECORD NUMBER]

96 DON'T KNOW

97 REFUSED

D4. How many of these adults are temporarily unemployed?

1 [RECORD NUMBER]

96 DON'T KNOW

97 REFUSED

D6. How many of these adults are not employed and not seeking work including those not seeking work because they are retired or disabled?

1 [RECORD NUMBER]

96 DON'T KNOW

97 REFUSED

D7a. Would you say the total combined income of all members of your household over the past 12 months was under or over $50,000? **[READ LIST, RECORD ONE]**

1. UNDER $50,000
2. OVER $50,000 **[GO TO D7c]**

96 REFUSED **[THANK RESPONDENT FOR THEIR TIME AND END INTERVIEW]**

97 DON'T KNOW **[THANK RESPONDENT FOR THEIR TIME AND END INTERVIEW]**

D7b. Please stop me when I read the range that contains the total combined income of all members of your household over the past 12 months. **[READ LIST, RECORD ONE]**

1. Less than $15,000
2. $15,000 to less than $25,000
3. $25,000 to less than $35,000
4. $35,000 to less than $50,000

96 REFUSED **[THANK RESPONDENT FOR THEIR TIME AND END INTERVIEW]**

97 DON'T KNOW **[THANK RESPONDENT FOR THEIR TIME AND END INTERVIEW]**

[ASK D7c IF D7a = 2]

D7c. Please stop me when I read the range that contains the total combined income of all members of your household over the past 12 months. **[READ LIST, RECORD ONE]**

1. $50,000 to less than $75,000
2. $75,000 to less than $100,000
3. $100,000 to less than $150,000
4. $150,000 to less than $200,000
5. $200,000 or more

96 REFUSED

97 DON'T KNOW

Thank you for your time!

PARTICIPATING CONTRACTORS NET-TO-GROSS SURVEY

NYSERDA Home Performance with ENERGY STAR® and Assisted Home Performance with ENERGY STAR® Programs Participating Contractors Survey

Draft 5/22/2011 Revised with CM edits 2nd Revision 6/28/2011

Post-Pretest Comments 07/15/2011 M&A QC/Revised 7/22/11
Revision 8/10/2011 for CATI programming

ASK TO SPEAK WITH NAMED SAMPLE MEMBER. WHEN PERSON COMES TO THE PHONE OR IF PERSON ANSWERING PHONE ASKS WHAT THIS IS ABOUT, READ:

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

We are researching a small carefully designed sample of contractors that participated in the NYSERDA Home Performance with ENERGY STAR® Program. Because we are only talking to a few people, your participation in this evaluation is very important to us. The information you provide will be used to assess program accomplishments and improve NYSERDA's programs. Your responses to this survey will be kept confidential to the extent permitted by law.

[IF NECESSARY:] The NYSERDA Home Performance with ENERGY STAR Program encourages contractors and homeowners to install energy efficient products, utilize program services, and promote a whole-house approach to ensure that homes are as energy efficient as possible.

[IF ASKED WHY ALL RESPONSES CAN NOT BE MAINTAINED AS CONFIDENTIAL:] The NYS Freedom of Information Law, Public Officers law, Article 6, provides for public access to information NYSERDA possesses. Although Public Officers Law, Section 87(2)(d) provides for exceptions to disclosure for records or portions thereof, NYSERDA cannot guarantee the confidentiality of any information submitted.

SCREENER FOR CONTACT

SCR1. Our records indicate that your firm completed one or more Home Performance projects between 2007 and 2009. Are you the best person to speak to about the firm's participation in the Home Performance with ENERGY STAR Program and the home improvement practices of your firm that could affect energy usage?

1. YES **[GO TO SCR2]**
2. NO
96 REFUSED
97 DON'T KNOW

[IF 2] Who at your company can best speak about energy related issues for Home Performance projects?

[IF 96 OR 97] Is there someone else at your company that might be able to help our research for NYSERDA with this survey?

[RECORD THE NAME AND NUMBER OF THE NEW CONTACT PERSON BELOW, AND THEN FOLLOW UP WITH HIM OR HER.]

1. NEW CONTACT NAME AND PHONE NUMBER:

Name: _____

Phone: (___) _____ Extension: _____

[ONCE CORRECT PERSON IS ON THE LINE, REINTRODUCE, SCR1 AND CONTINUE.]

SCR2. This survey will take about 20 to 30 minutes to complete. Could you spare the time now, or is there a more convenient time I could call you back?

1. YES – AVAILABLE NOW **[CONTINUE]**
2. NOT AVAILABLE **[ARRANGE CALLBACK]**
96 REFUSED **[THANK AND TERMINATE]**

[IF YES BUT NOW IS NOT A CONVENIENT TIME TO TALK, SCHEDULE A FOLLOW-UP DATA AND TIME, AND RECORD IT BELOW.]

APPOINTMENT DATE AND TIME: _____

GENERAL INSTRUCTIONS:

The judgment of program participants is important to this research effort. We are looking for best estimates and opinions as a starting point for characterizing participating projects and assessing the

accomplishments of the Home Performance with ENERGY STAR Program. If you have an opinion or even a rough judgment regarding the answer to a question, please provide it as an estimate for the question. If you have no idea whatsoever, you can just indicate that you don't know and we'll move on.

S1a. First, just to double check, our records show that your firm had customers who participated in the 2007, 2008, or 2009 Home Performance with ENERGY STAR Program. Is this correct?

1. YES
2. NO **[THANK AND TERMINATE]**
96 REFUSED **[THANK AND TERMINATE]**
97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

[ASK S1b IF MarketAssist = Both; OTHERWISE, GO TO THE INSTRUCTION BEFORE S1c]

S1b. Our records also show that for 2007 through 2009 your firm's participating customers in NYSERDA's Home Performance with ENERGY STAR Program included both participants who did and did not receive the additional assistance available for those with more limited income. Is this correct?

1. YES **[GO TO S2]**
2. NO **[GO TO S1f]**
96 REFUSED **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING**
97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

[ASK S1c IF MarketAssist = Assisted; OTHERWISE, GO TO THE INSTRUCTION BEFORE S1d]

S1c. Our records also show that for 2007 through 2009 your firm's participating customers in NYSERDA's Home Performance with ENERGY STAR Program were all income qualified for the additional assistance component of the Program and did receive higher financial incentives than non-assisted participants. Is this correct?

1. YES **[GO TO S2]**
2. NO **[GO TO S1e]**
96 REFUSED **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING**
97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

[ASK S1d IF MarketAssist = Market]

S1d. Our records also show that for 2007 through 2009 your firm's participating customers in NYSERDA's Home Performance with ENERGY STAR Program did not include any participants that received the additional assistance available for those with more limited income. Is this correct?

1. YES **[GO TO S2]**
2. NO **[GO TO S1e]**

96 REFUSED **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING**

97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

S1e. Did your firm's 2007, 2008, and 2009 participating customers include some participants with and some without the additional assistance for those with more limited income?

1. YES **[GO TO S2]**
2. NO

96 REFUSED **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING**

97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

S1f. Were all of your firm's 2007 through 2009 participating customers market rate participants who did not receive additional incentives? Or, were they all income qualified for the additional assistance component of the Program?**]**

1. ALL MARKET RATE PARTICIPANTS **[GO TO S2]**
2. ALL ASSISTED PARTICIPANTS **[GO TO S2]**

96 REFUSED **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

97 DON'T KNOW **[ASK FOR ANOTHER RESPONDENT AT COMPANY AND START AT BEGINNING]**

S2. What is your firm's core area of expertise or role in home improvements? Would you say it is …?

1. HVAC contractor
2. Lighting contractor
3. Siding, window and door sales and installation
4. Insulation or air sealing contractor
5. General contractor
6. Builder
7. Developer

95 OTHER (SPECIFY:_____)

S3. How many residential home improvement jobs did your firm do between 2007 and 2009? Please include both those submitted through the Home Performance with ENERGY STAR Program and those not part of the Program.

_____[RECORD NUMBER OF HOMES]

96 REFUSED

97 DON'T KNOW

EARLY REPLACEMENT versus RETROFIT

This set of questions concerns any existing refrigerators, freezers or clothes washers that were removed and replaced with ENERGY STAR models through the 2007, 2008, and 2009 Home Performance with ENERGY STAR Program.

REP1. To the best of your recollection, did any of your 2007, 2008, or 2009 customers replace existing appliances with ENERGY STAR versions through Home Performance with ENERGY STAR Program? The appliances we are interested in are refrigerators, freezers, or clothes washers.

1. YES

2. NO **[GO TO REP5]**

96 REFUSED **[GO TO REP5]**

97 DON'T KNOW **[GO TO REP5]**

REP2. To the best of your recollection, what portion of the appliances replaced through the 2007-2009 program were 12 years or older? We understand that contractors may not know exact ages of equipment that was replaced but we would just like your best guess. Would you say it was….

1. None

2. Less than half, but not zero

3. Half

4. More than half, but not all

5. All

96 REFUSED

97 DON'T KNOW

REP3. Thinking about the appliances that your company replaced, what portion were **[INSERT ITEM]?** Would you say it was….

a. In need of replacement because they had already failed or were failing

b. Nearing the end of their life with an expected remaining life of less than 3 years

c. In reasonable condition and not expected to fail

1. None
2. Less than half, but not zero
3. Half
4. More than half, but not all
5. All

96 REFUSED

97 DON'T KNOW

[IF REP3c=1, GO TO REP5]

REP4. Now thinking only about the new appliances that replaced units that were in reasonable condition, what portion of these new units were **[INSERT ITEM]?** Would you say it was….

a. Approximately the same size and had the same features as the units being replaced

b. Significantly larger or had additional features, such as through the door ice, than the units being replaced

c. Smaller or had fewer features than the units being replaced

1. None
2. Less than half, but not zero
3. Half
4. More than half, but not all
5. All

96 REFUSED

97 DON'T KNOW

REP5. Now, thinking about all the equipment change outs made through your 2007 to 2009 Home Performance projects, please tell me what percentage of change outs made by participating customers fall into one of three categories:

Would have been replaced with a high efficiency one in next few years

Would have been replaced with a new standard efficiency one in next few years

Would not have been replaced in the near future

We are interested in what you think the customer would have done if incentives had not been available through the Home Performance with ENERGY STAR Program. Please be sure to provide percentages totaling 100% for each equipment type. Answer none if none of your customers made appliance replacements of this type of equipment.

What percentage of the **[EQUIPMENT]** do you think…**[READ ALL, THEN RECORD]**

[IF NECESSARY: What percentage of the **[EQUIPMENT]** change outs made by participating Home Performance customers between 2007 and 2009 do you think …]

[EQUIPMENT: domestic hot water heaters]

a. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO REP5d]**
96 REFUSED **[GO TO REP5d]**

97 DON'T KNOW

b. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

c. Would not have been replaced in the near future

1. _____**[RECORD PERCENT[ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

[EQUIPMENT: furnaces]

d. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO REP5g]**
96 REFUSED **[GO TO REP5g]**

97 DON'T KNOW

e. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

f. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

[EQUIPMENT: central air conditioners]

g. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO REP5j]**
96 REFUSED **[GO TO REP5j]**

97 DON'T KNOW

h. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

i. Would not have replaced the central air conditioner in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

[EQUIPMENT: refrigerators]

j. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO REP5m]**
96 REFUSED **[GO TO REP5m]**

97 DON'T KNOW

k. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

l. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

[EQUIPMENT: freezers]

m. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO REP5p]**
96 REFUSED **[GO TO REP5p]**

97 DON'T KNOW

n. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

o. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

[EQUIPMENT: clothes washers]

p. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NONE **[GO TO FR1]**
96 REFUSED **[GO TO FR1]**

97 DON'T KNOW

q. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

r. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<=100%]

FREE RIDERSHIP

For the next several questions, I'll ask you about the homes that your company has worked on in New York State, excluding Long Island.

FR1. **[[IF Num_Homes = 1]** Our records show that between 2007 and 2009 your firm had **[NUM_HOMES]** home that had a Comprehensive Home Assessment and took action through the Home Performance with ENERGY STAR Program.**]**

[[IF Num_Homes > 1] Our records show that between 2007 and 2009 your firm had **[NUM_HOMES]** homes that had Comprehensive Home Assessments and took actions through the Home Performance with ENERGY STAR Program.**]**

Approximately what percentage of all your residential improvement projects would you say this represents?

1. _____[RECORD PERCENT [ACCEPT 0-100]]

96 REFUSED

97 DON'T KNOW

FR2. From 2007 to 2009, did your firm do home improvements that increased energy efficiency, beyond that caused by replacing old equipment with new standard equipment?

[IF NECESSARY: by standard equipment replacements, we mean new equipment that meets minim required energy codes, but is not designated as high efficiency or does not carry the ENERGY STAR® rating.**]**

1. YES

2. NO

96 REFUSED

97 DON'T KNOW

[ASK FR3 IF FR2 = 1 AND FR1_1<100%]

FR3. From 2007 to 2009, how many homes that did NOT participate in the Home Performance with ENERGY STAR Program did projects to increase energy efficiency beyond that achieved through replacing old equipment with new standard equipment?

1. _____[RECORD NUMBER OF HOMES]

96 REFUSED

97 DON'T KNOW

[ASK IF FR3_1>0]

FR4. NYSERDA's Home Performance with ENERGY STAR Program could contribute to the number of homes making similar improvements in several ways. This could be through what you offered to customers, how you were able to market items to customers or what customers wanted or were willing to buy. Do you think the Program influenced the number of nonparticipating homes in 2007 to 2009 making energy efficiency improvements similar to those in the Home Performance with ENERGY STAR Program?

1. YES

2. NO

96 REFUSED

97 DON'T KNOW

[FOR EACH msr FROM SURVEY SAMPLE FILE, ASK FR5-FR8 IN SEQUENCE THEN GO TO NEXT msr AND ASK FR5-FR8]

We are going to be asking about residential improvement jobs in New York State, not including Long Island.

FR5. Our records also show that you have **[DESC_A]** through the Home Performance with ENERGY STAR Program. What percent of all your 2007 to 2009 residential improvement jobs included this efficiency improvement? Please include both those submitted through the Program and those not part of the Program.

[SHORTER VERSION TO USE AFTER FIRST msr: Our records also show that you have **[DESC_A]**. What percent of all your 2007 to 2009 residential improvement jobs included **[DESC_B]**?**]**

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

FR6. Were all of your **[DESC_B]** conducted through the Home Performance with ENERGY STAR Program?

1. YES **[GO TO FR8]**

2. NO

96 REFUSED

97 DON'T KNOW

FR7. What percent of your residential improvement jobs that **[DESC_A]** were program participants or had received a Home Performance Comprehensive Home Assessment? **[IF NECESSARY:** Please provide a value between 0% and 100%.**]**

[FR6 CAN BE LESS THAN 100% WHILE FR7 IS 100% AS FR7 INCLUDES THOSE WITH CHA's BUT DID NOT COMPLETE PROGRAM PARTICIPATION BY INSTALLING THROUGH THE PROGRAM.]

1. _____**[RECORD PERCENT [VALID RANGE: 0-100%]]**

96 REFUSED

97 DON'T KNOW

FR8. Thinking about those projects that participated in the Program, what share of the **[DESC_B]** would you estimate would have occurred without the Home Performance with ENERGY STAR Program and its Comprehensive Home Assessment? Please provide a percentage.

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

Table 1: Percent of Projects with High Efficiency Equipment and Program Influence

SURVEY_MEASURE DESCRIPTION	DESC_A	DESC_B	FR5. % PROJECTS THAT INCLUDE EFFICIENCY MEASURE/ACTION 0%=NONE 100%=ALL PROJECTS	% EFFICIENT PROJECTS THAT ARE IN PROGRAM FR6.	FR7.	FR8. % OF PROJECT HOMES THAT WOULD HAVE USED HIGH EFFICIENCY MEASURE W/O PROGRAM
msr_a	[ADDED **INSULATION]**	**[INSULATION MEASURES]**	FR5a.	FR6a.	FR7a.	FR8a.
msr_b	**[**INSTALLED **CFLs OR HIGH EFFICIENCY LIGHTING FIXTURES]**	**[CFL OR HIGH EFFICIENCY LIGHTING FIXTURES]**	FR5b.	FR6b.	FR7b.	FR8b.
msr_c	**[**INSTALLED AN ENERGY STAR REFRIGERATOR OR FREEZER]	**[ENERGY STAR REFRIGERATORS OR FREEZERS]**	FR5c.	FR6c.	FR7c.	FR8c.
msr_d	[INSTALLED **AN ENERGY STAR APPLIANCE [IF NECESSARY: such as a clothes washer or dishwasher)]]**	**[ENERGY STAR APPLIANCES]**	FR5d.	FR6d.	FR7d.	FR8d.
msr_e	**[**INSTALLED **HEATING OR COOLING SYSTEM CONSERVATION MEASURES [IF NECESSARY: such as duct sealing, HVAC pipe or duct insulation, new ventilation fan]]**	**[HEATING OR COOLING SYSTEM CONSERVATION MEASURES]**	FR5e.	FR6e.	FR7e.	FR8e.
msr_f	**[REPLACED A HEATING SYSTEM WITH AN ENERGY STAR ONE]**	**[ENERGY STAR HEATING SYSTEMS]**	FR5f.	FR6f.	FR7f.	FR8f.
msr_g	**[replaceD A hot water heater TO AN ENERGY**	**[ENERGY STAR HOT WATER HEATERS]**	FR5g.	FR6g.	FR7g.	FR8g.

SURVEY_MEASURE DESCRIPTION	DESC_A	DESC_B	FR5. % PROJECTS THAT INCLUDE EFFICIENCY MEASURE/ACTION 0%=NONE 100%=ALL PROJECTS	% EFFICIENT PROJECTS THAT ARE IN PROGRAM		FR8. % OF PROJECT HOMES THAT WOULD HAVE USED HIGH EFFICIENCY MEASURE W/O PROGRAM
				FR6.	FR7.	
	STAR ONE]					
msr_h	**[**INSTALLED HOT WATER CONSERVATION MEASURES [IF NECESSARY: **such as low flow showerhead, wrapped the tank, or insulated the pipes]]**	**[HOT WATER CONSERVATION MEASURES]**	FR5h.	FR6h.	FR7h.	FR8h.
msr_i	**[Installed a Programmable Thermostat]**	**[PROGRAMMABLE THERMOSTATS]**	FR5i.	FR6i.	FR7i.	FR8i.
msr_j	**[**REPLACED A HEATING SYSTEM USING A DIFFERENT FUEL]	**[HEATING SYSTEM REPLACEMENTS USING A DIFFERENT FUEL]**	FR5j.	FR6j.	FR7j.	FR8j.
msr_k	**[**REPLACED A HOT WATER HEATER USING A DIFFERENT FUEL]	**[HOT WATER HEATER REPLACEMENTS USING A DIFFERENT FUEL]**	FR5k.	FR6k.	FR7k.	FR8k.
msr_l	**[**REPLACED A COOLING SYSTEM WITH AN ENERGY STAR ONE]	**[ENERGY STAR COOLING SYSTEMS]**	FR5l.	FR6l.	FR7l.	FR8l.
msr_m	**[**REPLACED WINDOWS OR DOORS FOR ENERGY STAR]	**[ENERGY STAR WINDOWS OR DOORS]**	FR5m.	FR6m.	FR7m.	FR8m.

[ASK FR9 IF S1b=1 or S1e=1]

FR9. Is there any difference in these answers between the participating customers in the Assisted Home Performance with ENERGY STAR component and the market rate participants that do not receive additional assistance?

[IF NECESSARY: That is, any difference between these two types of participating customers in the number of homes that would have installed the high efficiency measure without the Program.**]**

1. YES
2. NO [GO TO NEXT SECTION]

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

[ASK FR10 IF FR9 = 1]

FR10. How likely would the assisted program participants be to adopt efficiency measures without the Program compared to the market rate (non-assisted) program participants? Would they be one-quarter, one-half, the same, two times, or four times as likely?

1. ONE-QUARTER
2. ONE-HALF
3. THE SAME
4. 2 TIMES
5. 4 TIMES

96 REFUSED [GO TO NEXT SECTION]

97 DON'T KNOW **[GO TO NEXT SECTION]**

[ASK FR11 IF FR8=1 FOR AT LEAST ONE msr IN TABLE 1]

FR11. To make sure that I correctly understood what you are saying, earlier you said that **[FR8_PERCENT RESPONSE FOR THE msr FROM TABLE 1 THAT HAS THE GREATEST SAVINGS FOR THAT RESPONDENT]** percent of those **[DESC_B]** would have occurred without the program. Does this mean that **[FR11 CALCULATION]** would be the approximate percentage of Assisted program participants that would do this same action without the program and that **[FR8_PERCENT]** would be the percentage of Market Rate non-assisted participants that would do this without the program?

FR10 RESPONSE	FR11 CALCULATION
1	0.25*FR8_PERCENT
2	0.50*FR8_PERCENT

3	**1*FR8_PERCENT**
4	**2*FR8_PERCENT**
5	**4*FR8_PERCENT**

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

[IF FR11 = 2 THEN RE-ASK FR10 AND CORRECT]

OUTSIDE SPILLOVER

[IF FR1 = 100% THEN GO TO NEXT SECTION]

Now, I'd like to ask some questions about your firm's experience and interaction with energy efficiency as a result of your participation in NYSERDA's Home Performance with ENERGY STAR Program. Please consider your non-program residential improvement jobs in New York State, not including Long Island, during the 2007 to 2009 time frame.

OSO1. Did your firm offer or implement additional energy efficiency measures on jobs that did not receive support from the Home Performance with ENERGY STAR or any other NYSERDA program?

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

OSO2. Did additional measures at these non-program homes save natural gas?

1. YES
2. NO [GO TO OSO6a]

96 REFUSED [GO TO OSO6a]

97 DON'T KNOW **[GO TO OSO6a]**

OSO3. About how many other residential homes, which did not participate in NYSERDA programs, saved natural gas due to your participation in this Program?

1. _____[RECORD NUMBER OF HOMES]

96 REFUSED

97 DON'T KNOW

OSO4a. On average, would you estimate the natural gas savings from these non-program homes to be less than, similar to, or more than **[Avg_MMBTU FOR THIS RESPONDENT]** million BTU, the average natural gas savings from your firm's Home Performance with ENERGY STAR projects?

[INTERVIEWER NOTE: For contractors with more than one HPwES 2007 to 2009 participating home, this number is the average natural gas savings across **all** their HPwES homes.**]**

LESS THAN [GO TO OSO4b]

2. SIMILAR TO **[GO TO OSO5]**
3. MORE THAN **[GO TO OSO4c]**

96 REFUSED **[GO TO OSO5]**

97 DON'T KNOW **[GO TO OSO5]**

For this series of questions we are looking for savings "on average" (not in aggregate) across the many homes that might be affected.

[ASK OSO4b IF OSO4a = 1]

OSO4b. Of the non-program homes that saved natural gas, what proportion of the savings seen in program homes would have occurred? For example, if non-program homes saved ¼ the amount of gas saved through the Home Performance Program then the savings would be 25%.

1. _____**[RECORD PERCENT [ACCEPT 0-99]]**

96 REFUSED

97 DON'T KNOW

[ASK OSO4c IF OSO4a = 3]

OSO4c. Of the non-program homes that saved natural gas, what proportion of the savings seen in program homes would have occurred? For example, if the same actions are taken in a non-program home twice as big then savings would be 200%.

1. _____**[RECORD PERCENT [ACCEPT >100]]**
96 REFUSED
97 DON'T KNOW

OSO5. To the best of your knowledge, what percentage of the savings from natural gas measures at these non-program homes would you say are due to your experience with the Home Performance with ENERGY STAR Program?

1. _____**[RECORD PERCENTAGE [ACCEPT 0-100]**]
96 REFUSED
97 DON'T KNOW

OSO6a. Did additional measures at non-program homes save electricity?

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

OSO6b. About how many other residential homes that did not participate in NYSERDA programs, saved electricity due to your participation in this Program?

1. _____[RECORD NUMBER OF HOMES]
96 REFUSED
97 DON'T KNOW

OSO7a. On average, would you estimate the electricity savings from these other non-program homes to be less than, similar to, or more than **[Avg_KWH FOR THIS RESPONDENT] kilowatt hours**, the average electricity savings from your firm's Home Performance with ENERGY STAR projects?

1. LESS THAN **[GO TO OSO7b]**
2. SIMILAR TO **[GO TO OSO8]**
3. MORE THAN **[GO TO OSO7c]**
96 REFUSED **[GO TO OSO8]**
97 DON'T KNOW **[GO TO OSO8]**

For this series of questions we are looking for savings "on average" (not in aggregate) across the many homes that might be affected.

[ASK OSO7b IF OSO7a = 1]

OSO7b. Of the non-program homes that saved electricity, what proportion of the savings seen in program homes would have occurred? For example, if non-program homes saved ¼ the amount of electricity saved through the Home Performance Program then the savings would be 25%.

1. _____**[RECORD PERCENT [ACCEPT 0-99]]**

96 REFUSED

97 DON'T KNOW

[ASK OSO7c IF OSO7a = 3]

OSO7c. Of the non-program homes that saved electricity, what proportion of the savings seen in program homes would have occurred? For example, if the same actions are taken in a non-program home twice as big then savings would be 200%.

1. _____**[RECORD PERCENT [ACCEPT >100]]**

96 REFUSED

97 DON'T KNOW

OSO8. To the best of your knowledge, what percentage of the savings from the electricity measures at these non-program homes would you say are due to your experience with the Home Performance with ENERGY STAR Program?

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

NON-ENERGY IMPACTS

N1. Excluding the Program incentive payments, did your annual 2007-2009 sales revenue change because of your firm's participation in the Home Performance with ENERGY STAR Program?

1. YES

2. NO **[GO TO NEXT SECTION]**

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

N2. Excluding the amount received from the Program's financial incentives, has your firm's sales revenue increased, stayed the same, or has it decreased between 2007-2009 due to your program participation?

1. INCREASED **[GO TO N3]**
2. SAME **[GO TO N5]**
3. DECREASED **[GO TO N3]**

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

N3. About how many **[USE "MORE" if N2=1, USE "LESS" if N2=3]** dollars were you receiving per year in 2007-2009 sales revenue?

1. _____**[RECORD DOLLARS]**

96 REFUSED

97 DON'T KNOW

N4. Did this change in sales in 2007-2009 impact profit (over what otherwise would have occurred, such as changes in the economy)?

1. YES
2. NO **[GO TO NEXT SECTION]**
3. CAN'T TELL WITH SO MANY OTHER THINGS CHANGING **[GO TO NEXT SECTION]**

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

N5. Excluding the receipt of program financial incentives, has profitability increased or decreased in 2007-2009 due to your program participation?

[IF NEEDED: Profitability is increased by the Program if there are actual profit increases, or decreases in losses, that are due to program participation.**]**

1. INCREASED
2. SAME **[GO TO NEXT SECTION]**
3. DECREASED

96 REFUSED [**GO TO NEXT SECTION]**

97 DON'T KNOW **[GO TO NEXT SECTION]**

N6. About how many dollars **[USE "MORE" if N5=1, USE "LESS" if N5=3]** per year in 2007-2009 profits occur due to your Program participation?

1. _____**[RECORD DOLLARS]**

96 REFUSED

97 DON'T KNOW

FIRMOGRAPHICS

Finally, I have a few general questions about your business. We are interested in responses that relate to all periods of time (to include during your program participation).

Z1. Approximately what percentage of your New York State residential home improvement projects are in…**[READ ALL, THEN RECORD]**? Please be sure that your percentages add up to 100%.

a. _____% New York City area, excluding Long Island **[IF NEEDED:** Utility service area of ConEd]

b._____% Long Island

c. _____% Upstate New York

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 3 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2 OPTIONS, VERIFY SUM<=100%]

1. **[RECORD PERCENTAGES [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

Z2. Considering New York State except for Long Island, what percentage of your residential projects fall into the following categories **[READ ALL, THEN RECORD]**? Please be sure that your percentages add up to 100%.

a._____% New Homes

b._____% Additions

c._____% Renovation or remodeling projects

d._____% Replacement or installation of specific equipment, windows or insulation

e._____% Other types of jobs (specify: _____)

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 5 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2-4 OPTIONS, VERIFY SUM<=100%]

1. **[RECORD PERCENTAGES [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

Z3. What percentage of the residential jobs you work on in New York State, excluding Long Island, are…**[READ ALL, THEN RECORD]**?

a._____% Single family detached homes

b._____% Single family attached homes (town homes, row houses)

c._____% Apartment buildings with 5 or more units

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 3 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2 OPTIONS, VERIFY SUM <=100%]

1. **[RECORD PERCENTAGES [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

Z4. Approximately how many employees currently work for your company at all of your New York locations?

1. _____[RECORD NUMBER OF EMPLOYEES]

96 REFUSED

97 DON'T KNOW

Z5. What is the approximate dollar value of your company's annual sales? **[IF NECESSARY:** You are allowed to refuse this question.**]**

1. _____[RECORD DOLLARS]

96 REFUSED

97 DON'T KNOW

[ASK IF Z5=96 or 97]

Z6. If you prefer, let me read you some dollar ranges. Please select the one that contains your company's annual sales.

1. $250,000 or less
2. $250,001 - $500,000
3. $500,001 - $1,000,000
4. $1,000,001 - $2,000,000
5. $2,000,001 - $5,000,000
6. $5,000,001 or more

96 REFUSED

97 DON'T KNOW

Those are all the questions I had. Thank you very much for your time!

NON-PARTICIPATING CONTRACTORS NET-TO-GROSS SURVEY

NYSERDA Home Performance with ENERGY STAR® and Assisted Home Performance with ENERGY STAR® Programs Non-Participating and Formerly Participating Contractors Survey

FINAL as Revised for CATI Programming 10/13/2011

ASK TO SPEAK WITH NAMED SAMPLE MEMBER. WHEN PERSON COMES TO THE PHONE OR IF PERSON ANSWERING PHONE ASKS WHAT THIS IS ABOUT, READ:

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

We are researching a small carefully designed sample of contractors that conduct residential home improvement projects. Because we are only talking to a few people, your participation in this evaluation is very important to us. As a token of our appreciation for your time, NYSERDA has authorized a $100 incentive payment for those who qualify for and complete the survey. The information you provide will be used to assess program accomplishments and improve NYSERDA's programs. Your responses to this survey will be kept confidential to the extent permitted by law.

[IF ASKED WHY ALL RESPONSES CAN NOT BE MAINTAINED AS CONFIDENTIAL: The NYS Freedom of Information Law, Public Officers law, Article 6, provides for public access to information NYSERDA possesses. Although Public Officers Law, Section 87(2)(d) provides for exceptions to disclosure for records or portions thereof, NYSERDA cannot guarantee the confidentiality of any information submitted.**]**

SCREENER FOR CONTACT

SCR1. Does your firm do residential home improvement jobs for 1 to 4 family residences in New York State, not including Long Island?

1. YES
2. NO **[GO TO SCR1 TERMINATION SCRIPT]**
96. REFUSED **[GO TO SCR1 TERMINATION SCRIPT]**
97. DON'T KNOW **[GO TO SCR1 TERMINATION SCRIPT]**

[SCR1 TERMINATION SCRIPT: This survey targets contractors who work on 1-4 family homes in New York State but outside of Long Island. Thank you for your time.**] [TERMINATE]**

SCR2. Are you the best person to speak to about your firm's residential home improvement jobs, the types of improvements made that could affect energy usage?

1. YES
2. NO **[SEE [IF 2] BELOW]**

96 REFUSED **[SEE [IF 96 OR 97] BELOW]**

97 DON'T KNOW **[SEE [IF 96 OR 97] BELOW]**

[IF 2] Who at your company can best speak about your firm's home improvement jobs?

[IF 96 OR 97] Is there someone else at your company that might be able to help our research for NYSERDA with this survey?

[RECORD THE NAME AND NUMBER OF THE NEW CONTACT PERSON BELOW, THEN FOLLOW UP WITH HIM OR HER.]

NEW CONTACT NAME AND PHONE NUMBER:

Name: _____

Phone: (___) _____ Extension: _____

[ONCE CORRECT PERSON IS ON THE LINE, REINTRODUCE, SCR1 AND CONTINUE.]

SCR3. This survey will take about 15 to 20 minutes to complete. Could you spare the time now, or is there a more convenient time I could call you back?

1. YES – AVAILABLE NOW **[CONTINUE]**
2. NOT AVAILABLE **[ARRANGE CALLBACK]**

96 REFUSED **[THANK AND TERMINATE]**

[IF YES BUT NOW IS NOT A CONVENIENT TIME TO TALK, SCHEDULE A FOLLOW-UP DATA AND TIME, AND RECORD IT BELOW.]

APPOINTMENT DATE AND TIME: _____

GENERAL INSTRUCTIONS:

Information from contractors such as you is important to this research effort. We are looking for best estimates and opinions as a starting point for characterizing residential home improvements that affect energy usage. If you have an opinion or even a rough judgment regarding the answer to a question, please provide it as an estimate for the question. If you have no idea what-so-ever, you can just indicate that you don't know.

S1. This survey is asking questions of contractors that have not **[EMPHASIZE NOT]** had home projects in 2007 or after that participated in NYSERDA's Home Performance with ENERGY STAR® Program. Just to double check, did your firm have projects participating in the NYSERDA Home Performance or Assisted Home Performance with ENERGY STAR Program in 2007 or after?

[IF NECESSARY: The New York Home Performance with ENERGY STAR program encourages contractors and homeowners to install energy efficient products, utilize program services, and promote a whole-house approach to ensure that homes are as energy efficient as possible.**]**

1. NO PROJECTS IN EITHER HOME PERFORMANCE WITH ENERGY STAR OR ASSISTED HOME PERFORMANCE WITH ENERGY STAR
2. YES, WE HAD PROJECTS IN 2007 OR AFTER THAT PARTICIPATED IN HOME PERFORMANCE WITH ENERGY STAR OR ASSISTED HOME PERFORMANCE WITH ENERGY STAR **[THANK AND TERMINATE]**

96 REFUSED **[TERMINATE]**

97 DON'T KNOW [ASK FOR ANOTHER RESPONDENT AT COMPANY]

S2. What is your firm's core area of expertise or role in home improvements? Would you say it is …**[READ LIST]**

1. HVAC contractor
2. Lighting contractor
3. Siding, Windows and doors sales and installation
4. Insulation or air sealing contractor or sales and installation
5. General contractor
6. Builder
7. Developer

95 OTHER (SPECIFY:_____)

96 REFUSED

97 DON'T KNOW

S3. How many residential home improvement jobs did your firm do in 2007, 2008 and 2009?

1. _____[RECORD NUMBER OF HOMES [ACCEPT >0]]

94 NONE [THANK AND TERMINATE]

96 REFUSED

97 DON'T KNOW

SPILLOVER & AWARENESS SCREENER

SOSC1. There are energy efficiency programs in New York that target homeowners and contractors and promote a variety of high efficiency equipment and actions. How much influence did energy efficiency programs in New York have on the types of equipment installed in your firm's residential improvement jobs since 2007? Would you say a great deal, some, only a little or none?

1. A GREAT DEAL
2. SOME
3. ONLY A LITTLE

94 NONE

96 REFUSED

97 DON'T KNOW

SOSC2. The New York Home Performance with ENERGY STAR program encourages contractors and homeowners to install energy efficient products, utilize program services, and promote a whole-house approach to ensure that homes are as energy efficient as possible. Prior to hearing this description, would you say you . . . **[READ LIST. ALLOW 1 RESPONSE. STOP WHEN RESPONSE SELECTED.]**

94 Had not heard of the Program **[GO TO NPSO1]**,

1. Had heard of the Program but are not at all familiar with it **[GO TO NPSO1]**,
2. Are slightly familiar with the program,
3. Are somewhat familiar with the program, or
4. Are extremely familiar with the program?

96 REFUSED

97 DON'T KNOW

SOSC3. How much influence did NYSERDA's Home Performance with ENERGY STAR program have on the types of equipment installed in your firm's residential improvement jobs since 2007? Would you say a great deal, some, only a little or none?

1. A GREAT DEAL
2. SOME
3. ONLY A LITTLE

94 NONE

96 REFUSED

97 DON'T KNOW

NON-PARTICIPANT SPILLOVER

We are going to be asking about your residential improvement jobs in New York State, not including Long Island.

[IF (SOSC1 = 94, 96 OR 97) AND (SOSC2 = 94, 96, OR 97): FOR EACH MEASURE FROM TABLE 1, ASK NPSO1 AND NPSO2 IN SEQUENCE THEN GO TO NEXT MEASURE AND ASK NPSO1 AND NPSO2]

[IF (SOSC1 = 1, 2 OR 3) OR (SOSC2 = 1, 2, 3 OR 4): FOR EACH MEASURE FROM TABLE 1, ASK NPSO1-NPSO6 IN SEQUENCE THEN GO TO NEXT MEASURE AND ASK NPSO1-NPSO6]

NPSO1. What percent of your 2007 to 2009 home improvement jobs included **[MEASURE]**?

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

NPSO2. What percent of your 2010 to present home improvement jobs included **[MEASURE]**?

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[IF NPSO1_PERCENT=0 AND NPSO2_PERCENT=0 FOR [MEASURE] GO TO NPSO1 FOR NEXT MEASURE]

[GO TO NPSO5 IF MEASURE FROM TABLE 1 IS b OR c]

NPSO3. What percent of the **natural gas** savings from your firm's **[MEASURE]** can reasonably be attributed to the influence of **all** energy efficiency programs in New York? **[IF NECESSARY:** Please be sure to provide a percentage between 0% and 100%.]

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[ASK NPSO4 IF TYPE=1 OR (SOSC2 = 2, 3 OR 4)]

NPSO4. What percent of the **natural gas** savings from your firm's **[MEASURE]** can reasonably be attributed to the influence of NYSERDA's Home Performance with ENERGY STAR Program?

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR BOTH NPSO3 AND NPSO4, VERIFY NPSO4_PERCENT<=NPSO3_PERCENT. IF NOT, READ: Your response about the influence of this program should not exceed your response about the influence of all energy efficiency programs in the state. Let's go back. **[RETURN TO NPSO3 AND ASK AGAIN]]**

NPSO5. What percent of the **electricity** savings from your firm's **[MEASURE]** can reasonably be attributed to the influence of **all** energy efficiency programs in New York? **[IF NECESSARY:** Please be sure to provide a percentage between 0% and 100%.]

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[ASK NPSO6 IF TYPE=1 OR (SOSC2 = 2, 3, OR 4)]

NPSO6. What percent of the **electricity** savings from your firm's **[MEASURE]** can reasonably be attributed to the influence of NYSERDA's Home Performance with ENERGY STAR Program?

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR BOTH NPSO5 AND NPSO6, VERIFY NPSO6_PERCENT<=NPSO5_PERCENT. IF NOT, READ: Your response about the influence of this program should not exceed your response about the influence of all energy efficiency programs in the state. Let's go back. **[RETURN TO NPSO5 AND ASK AGAIN]]**

Table 1: Percent of Projects with High Efficiency Equipment and Program Influence

MEASURE	NPSO1. % OF 2007-2009 JOBS THAT INCLUDE EFFICIENCY MEASURE/ ACTION	NPSO2. % OF 2010-2011 JOBS THAT INCLUDE EFFICIENCY MEASURE/ ACTION	NPSO3. % GAS SAVINGS ATTRIBU-TABLE TO EE PROGRAMS IN NEW YORK	NPSO4. % GAS SAVINGS ATTRIBU-TABLE TO HPwES PROGRAM	NPSO5. % ELECTRIC SAVINGS ATTRIBU-TABLE TO EE PROGRAMS IN NEW YORK	NPSO6. % ELECTRIC SAVINGS ATTRIBU-TABLE TO HPwES PROGRAM
a. Added insulation	NPSO1a.	NPSO2a.	NPSO3a.	NPSO4a.	NPSO5a.	NPSO6a.
b. Installation of CFLs or high efficiency lighting fixtures	NPSO1b.	NPSO2b.	NPSO3b.	NPSO4b.	NPSO5b.	NPSO6b.
c. Installation of ENERGY STAR® refrigerators or freezers	NPSO1c.	NPSO2c.	NPSO3c.	NPSO4c.	NPSO5c.	NPSO6c.
d. Installation of ENERGY STAR clothes washers or dishwashers	NPSO1d.	NPSO2d.	NPSO3d.	NPSO4d.	NPSO5d.	NPSO6d.
e. Installation of heating or cooling system conservation measures [IF NECESSARY: such as duct sealing, HVAC pipe or duct insulation, new ventilation fan]	NPSO1e.	NPSO2e.	NPSO3e.	NPSO4e.	NPSO5e.	NPSO6e.
f. Replacement of heating systems with ENERGY STAR systems	NPSO1f.	NPSO2f.	NPSO3f.	NPSO4f.	NPSO5f.	NPSO6f.
g. Replacement of hot water heaters with ENERGY STAR ones	NPSO1g.	NPSO2g.	NPSO3g.	NPSO4g.	NPSO5g.	NPSO6g.
h. Installation of hot water conservation measures [IF NECESSARY: such as low flow showerhead, wrapped the tank, or insulated the pipes]	NPSO1h.	NPSO2h.	NPSO3h.	NPSO4h.	NPSO5h.	NPSO6h.
i.Installation of Programmable Thermostats	NPSO1i.	NPSO2i.	NPSO3i.	NPSO4i.	NPSO5i.	NPSO6i.
j. Replacement of heating systems using a different fuel	NPSO1j.	NPSO2j.	NPSO3j.	NPSO4j.	NPSO5j.	NPSO6j.

MEASURE	NPSO1. % OF 2007-2009 JOBS THAT INCLUDE EFFICIENCY MEASURE/ ACTION	NPSO2. % OF 2010-2011 JOBS THAT INCLUDE EFFICIENCY MEASURE/ ACTION	NPSO3. % GAS SAVINGS ATTRIBU-TABLE TO EE PROGRAMS IN NEW YORK	NPSO4. % GAS SAVINGS ATTRIBU-TABLE TO HPwES PROGRAM	NPSO5. % ELECTRIC SAVINGS ATTRIBU-TABLE TO EE PROGRAMS IN NEW YORK	NPSO6. % ELECTRIC SAVINGS ATTRIBU-TABLE TO HPwES PROGRAM
k. Replacement of hot water heaters using a different fuel	NPSO1k.	NPSO2k.	NPSO3k.	NPSO4k.	NPSO5k.	NPSO6k.
l. Replacement of cooling systems with ENERGY STAR ones	NPSO1l.	NPSO2l.	NPSO3l.	NPSO4l.	NPSO5l.	NPSO6l.
m. Replacement of windows with ENERGY STAR windows	NPSO1m.	NPSO2m.	NPSO3m.	NPSO4m.	NPSO5m.	NPSO6m.

EARLY REPLACEMENT versus RETROFIT

This set of questions concerns any existing refrigerators, freezers or clothes washers that were removed and replaced with ENERGY STAR® models.

REP1a. Did your 2007 to 2009 home improvement jobs include any appliance replacements?

1. YES
2. NO **[GO TO Z1]**
96 REFUSED **[GO TO Z1]**
97 DON'T KNOW **[GO TO Z1]**

REP1b. To the best of your recollection, did any of your 2007 through 2009 customers replace existing appliances with ENERGY STAR® versions? The appliances we are interested in are refrigerators, freezers, or clothes washers.

1. YES
2. NO **[GO TO REP5]**
96 REFUSED **[GO TO REP5]**
97 DON'T KNOW **[GO TO REP5]**

REP2. To the best of your recollection, what portion of the appliances replaced in 2007 through 2009 were 12 years or older? We know that contractors will not know exact ages of the equipment. We just want your best guess. Would you say it was…**[READ LIST]**

1. None

2. Less than half, but not zero
3. Half
4. More than half, but not all
5. All
96 REFUSED
97 DON'T KNOW

REP3. Thinking about the appliances that your company replaced, what portion were **[INSERT ITEM]?** Would you say it was…**[READ LIST]**

a. In need of replacement because they had already failed or were failing
b. Nearing the end of their life with an expected remaining life of less than 3 years
c. In reasonable condition and not expected to fail

1. None
2. Less than half, but not zero
3. Half
4. More than half, but not all
5. All
96 REFUSED
97 DON'T KNOW

REP4. Now thinking only about the new appliances replacing units that were in reasonable condition, can you tell us what portion of the new units were **[INSERT ITEM]?** Would you say it was…**[READ LIST]**

a. Approximately the same size and had the same features as the units being replaced
b. Significantly larger or had additional features, such as through the door ice, than the units being replaced
c. Smaller or had fewer features than the units being replaced

1. None
2. Less than half, but not zero
3. Half
4. More than half, but not all
5. All
96 REFUSED
97 DON'T KNOW

REP 5. Now, thinking about all the appliance change outs made through your 2007 through 2009 home improvement projects, we are going to ask what percentage of change outs fall into one of three categories for each appliance type. The categories are:

Would have been replaced with a high efficiency one in next few years

Would have been replaced with a new standard efficiency one in next few years

Would not have been replaced in the near future

Please be sure to provide percentages totaling 100% for each appliance type. Answer "no change out of this type" if none of your customers made appliance replacements of this type of equipment.

What percentage of the **[EQUIPMENT]** do you think…**[READ ALL, THEN RECORD]**

[IF NECESSARY: What percentage of the **[EQUIPMENT]** change outs made by your customers between 2007 and 2009 do you think …]

[EQUIPMENT: domestic hot water heaters]

a. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO REP5d]**
96 REFUSED **[GO TO REP5d]**

97 DON'T KNOW

b. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**
96 REFUSED **[GO TO REP5d]**
97 DON'T KNOW

c. Would not have been replaced in the near future

1. _____**[RECORD PERCENT[ACCEPT 0-100]]**

96 REFUSED
97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

[EQUIPMENT: furnaces]

d. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO REP5g]**
96 REFUSED **[GO TO REP5g]**

97 DON'T KNOW

e. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED **[GO TO REP5g]**

97 DON'T KNOW

f. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

[EQUIPMENT: central air conditioners]

g. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO REP5j]**
96 REFUSED **[GO TO REP5j]**

97 DON'T KNOW

h. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED **[GO TO REP5j]**

97 DON'T KNOW

i. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

[EQUIPMENT: refrigerators]

j. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO REP5m]**
96 REFUSED **[GO TO REP5m]**

97 DON'T KNOW

k. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED **[GO TO REP5m]**

97 DON'T KNOW

l. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

[EQUIPMENT: freezers]

m. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO REP5p]**
96 REFUSED **[GO TO REP5p]**

97 DON'T KNOW

n. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED **[GO TO REP5p]**

97 DON'T KNOW

o. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

[EQUIPMENT: clothes washers]

p. Would have been replaced with a high efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

94 NO CHANGE OUTS OF THIS TYPE **[GO TO NEXT SECTION]**
96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW

q. Would have been replaced with a new standard efficiency one in next few years

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED **[GO TO NEXT SECTION]**

97 DON'T KNOW

r. Would not have been replaced in the near future

1. _____**[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: IF PERCENTS RECORDED FOR ALL 3 OPTIONS, VERIFY SUM=100%; IF PERCENTS RECORDED FOR ONLY 2 OF 3 OPTIONS, VERIFY SUM<100%]

FIRMOGRAPHICS

Finally, I have a few general questions about your firm. We are interested in responses that currently describe your business.

Z1. Approximately what percentage of your New York State residential home improvement projects are in…**[READ ALL, THEN RECORD]**? Please be sure that your percentages add up to 100%. **[VERIFY THAT THE SUM OF THE PERCENTAGES TOTAL 100%]**

a._____% New York City area, excluding Long Island [**IF NEEDED:** Utility service area of ConEd**]**

b._____% Long Island

c._____% Upstate New York

1. _____ **[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 3 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2 OPTIONS, VERIFY SUM<100%]

Z2. Considering New York State except for Long Island, what percentage of your residential projects fall into the following categories **[READ ALL, THEN RECORD]**? Please be sure that your percentages add up to 100%.

a._____% New Homes

b._____% Additions

c._____% Renovation or remodeling projects

d._____% Replacement or installation of specific equipment, windows or insulation

e._____% Other types of jobs (specify: _____)

1. _____ **[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 5 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2-4 OPTIONS, VERIFY SUM<100%]

Z3. What percentage of the residential jobs you work on in New York State, excluding Long Island, are…**[READ ALL, THEN RECORD]**?

a._____% Single family detached homes

b._____% Single family attached homes (town homes, row houses)

c._____% Apartment buildings with 5 or more units

1. _____ **[RECORD PERCENT [ACCEPT 0-100]]**

96 REFUSED

97 DON'T KNOW

[PROGRAMMER: VERIFY 100% TOTAL IF PERCENTS RECORDED FOR ALL 3 OPTIONS; IF PERCENTS RECORDED FOR ONLY 2 OPTIONS, VERIFY SUM <100%]

Z4. Approximately how many employees currently work for your company at all of your New York locations?

1. _____[RECORD NUMBER OF EMPLOYEES]

96 REFUSED

97 DON'T KNOW

Z5. What is the approximate dollar value of your company's 2010 annual sales? **[IF NECESSARY:** You are allowed to refuse this question.**]**

1. _____[RECORD DOLLARS]

96 REFUSED

97 DON'T KNOW

[ASK IF Z5=96 OR Z5=97]

Z6. If you prefer, let me read you some dollar ranges. Please select the one that contains your company's 2010 annual sales. **[READ LIST]**

1. $250,000 or less
2. $250,001 - $500,000
3. $500,001 - $1,000,000
4. $1,000,001 - $2,000,000
5. $2,000,001 - $5,000,000
6. $5,000,001 or more

96 REFUSED

97 DON'T KNOW

Those are all the questions I had. Now, I just need to confirm your contact information so that we can send the $100 incentive payment.

Z7. Please spell your name as it should be written on the check.

[IF NECESSARY: The check can be made out to you personally or to your company, whichever you prefer.**]**

[FOR INTERVIEWER REFERENCE: THE ORIGINAL CONTACT FOR THIS RECORD WAS [CONTACT_NAME] AND COMPANY WAS [COMPANY_NAME]]

1. _____[RECORD NAME FOR CHECK]

96 REFUSED

Z8. What is the mailing address where we should send the check?

[FOR INTERVIEWER REFERENCE: THE ORIGINAL ADDRESS ON THIS RECORD WAS [ADDRESS], [CITY], [STATE] [ZIP]]

1. _____**[RECORD ADDRESS FOR CHECK]**

96 REFUSED

Z9. What is the best phone number to reach you in case we need to reconfirm this information?

[FOR INTERVIEWER REFERENCE: THE ORIGINAL PHONE NUMBER ON THIS RECORD WAS [PHONE]]

1. _____**[RECORD PHONE FOR CHECK]**

96 REFUSED

The check will be sent out in the next few weeks. Thank you very much for your time!

SUMMARY OF ENERGY CHANGE SURVEY RESPONSES

The following tables reflect the responses for various sections of the Energy Change survey. Respondents were asked to recall the measures which were installed. They were also asked about the use of primary and supplemental heating systems and cooling systems, whether they added or replaced various appliances and about changes in schedule or occupancy during the Program years 2007 and 2008.

Table E-1. Respondent Recollection of Measures Installed

Respondent Recollection of Measures Installed	Measure Installed (Program)	Measure Installed (Respondent)	Measure Not Installed (Respondent)	Don't Know/ Refused
Insulation	411	397	13	1
CFLs or High Efficiency Fixtures	280	217	60	3
ENERGY STAR Refrigerator/Freezer	36	35	1	0
ENERGY STAR Appliance	32	27	4	1
Heating or Cooling Conservation	39	23	12	4
Heating System Replacement	213	210	2	1
ENERGY STAR Hot Water Heater	98	95	3	0
Hot Water Conservation Measures	7	5	2	0
Programmable Thermostat	194	186	8	0
Heating System Fuel Switch	8	8	0	0
Hot Water Heater Fuel Switch	7	7	0	0
ENERGY STAR Cooling System	79	78	1	0
ENERGY STAR Windows or Doors	236	225	11	0
Total	**1,640**	**1,513**	**117**	**10**

Table E-2: Respondent Recollection of CFLs and Fixtures Installed

Lighting Measure	Number of Homes (Program)	Number Installed (Program)	Number Installed (Respondent)	Number of Homes (Respondent)	Don't Know/ Refused
CFLs	20	146	133	13	1
Fixtures	166	3,364	49	121	7
Total	**186**	**3,510**	**182**	**134**	**8**

Table E-3: Primary Heating Fuel

Primary Heating Fuel for Home Heating	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=698)
Natural Gas	649	92.84%	92.97%
Electric	12	1.71%	1.72%
Other	37	5.29%	5.30%
Don't Know/Refused	1	0.14%	.

Note: Thirteen respondents indicated switching to natural gas or electric fuel.

Table E-4: Control of Primary Heating System

Method of controling primary heating system	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=693)
Set at one temperature	106	15.16%	15.30%
Manually adjust	202	28.89%	29.14%
Program thermostat	385	55.07%	55.55%
Don't Know/Refused	6	0.85%	.

Table E-5: Difference in Use of Primary Heating System

Changes in Use	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=665)
No Change	555	79.39%	83.45%
Use a lot less	36	5.15%	5.41%
Use somewhat less	53	7.58%	7.97%
Use somewhat more	10	1.43%	1.50%
Use a lot more	11	1.57%	1.65%
Don't Know/Refused	34	4.86%	.

Table E-6: Supplemental Heating System

Supplemental Heat Fuel Type	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=696)
None	581	83.11%	83.47%
Natural Gas	40	5.72%	5.75%
Electric	46	6.58%	6.61%
Other Fuel	29	4.14%	4.17%
Don't Know/Refused	3	0.42%	.

Table E-7: Use of Supplemental Heating System

Frequency of Supplemental Heating Use	Number of Homes	Percent of Homes (n=115)	Adjusted Percent of Homes (n=113)
Minimal (10 days or less)	15	13.04%	13.27%
Low (11 to 30 days)	18	15.65%	15.93%
Moderate (31 to 60 days)	24	20.86%	21.24%
High (more than 60 days)	56	48.69%	49.55%
Don't Know/Refused	2	1.73%	.

Table E-8: Change in Use of Supplemental Heating System

Changes in Use	Number of Homes	Percent of Homes (n=115)	Adjusted Percent of Homes (n=115)
No Change	75	65.21%	65.21%
Did not use supplemental heat at all in Season 1	15	13.04%	13.04%
A lot less in Season 2 than in Season 1	4	3.47%	3.48%
Somewhat less	13	11.30%	11.30%
Somewhat more	2	1.73%	1.74%
A lot more in Season 2 than in Season 1	6	5.21%	5.22%

Table E-9: Fuel to Heat Water

Fuel Type	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=687)
Natural Gas, not Propane	619	88.55%	90.10%
Electric	46	6.58%	6.70%
Solar with Natural Gas Backup	3	0.42%	0.44%
Other	19	2.71%	2.77%
Don't Know/Refused	12	1.71%	.

Note: 11 respondents indicated changing fuel to heat water.

Table E-10: Hot Water Fuel Switch

Fuel Switch Description	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=687)
Gas to Electric	2	18.18%	20.00%
Electric to Gas	4	36.36%	40.00%
Electric to Other	3	27.27%	30.00%
Other to Gas	1	9.09%	10.00%
Don't Know/Refused	1	9.09%	.

Note: Seven out of eleven respondents indicated that the change was a result of the HPwES Program.

Table E-11: Working Central Air Conditioning

Did you have a working central air conditioning system?	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=696)
Yes	445	63.66%	63.93%
No	251	35.90%	36.06%
Don't Know/Refused	3	0.42%	.

Table E-12: Room Air Conditioning

Was a room air conditioner installed?	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=694)
Yes	228	32.61%	32.85%
No	466	66.66%	67.14%
Don't Know/Refused	5	0.71%	.

Table E-13: Current Air Conditioning

Type of Air Conditioning	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=699)
None	90	12.87%	12.88%
Either Central or Room A/C	545	77.96%	77.97%
Both Central and Room A/C	64	9.15%	9.16%

Table E-14: Use of Air Conditioning

Frequency of Air Conditioning Usage	Number of Homes	Percent of Homes (n=612)	Adjusted Percent of Homes (n=559)
Not at all	8	1.14%	1.43%
10 days or less	77	11.01%	13.77%
11-30 days	194	27.75%	34.70%
31-60 days	158	22.60%	28.26%
More than 60 days	122	17.45%	21.82%
Don't Know/Refused	53	7.58%	.
Not Applicable	87	12.44%	.

Table E-15: Change in Use of Air Conditioning

Changes in Use	Number of Homes	Percent of Homes (n=699)	Adjusted Percent of Homes (n=675)
No Change	591	84.54%	87.55%
Did not use at all in season 1	10	1.43%	1.48%
Use the air conditioning a lot less	20	2.86%	2.96%
Somewhat less	29	4.14%	4.30%
Somewhat more	15	2.14%	2.22%
A lot more in season 2 than season 1	10	1.43%	1.48%
Don't Know/Refused	24	3.43%	.

Table E-16: Added or Replaced Appliances

Appliance Type	Added	Replaced	Don't Know/ Refused
Central A/C	23	25	0
Room A/C	13	17	0
Dishwasher	8	46	0
Clothes Washer	1	71	0
Refrigerator/Freezer	7	72	1
Extra Refrigerator	9	8	0
Heated Waterbed	0	1	0
Electric Heater	9	2	0
Gas Heater	1	8	0
Jacuzzi or Hot Tub	1	2	0
Other Appliance	7	64	0
Stove	3	25	0
Total Number of Homes with Change(s)	**82**	**341**	**1**

Table E-17: Change in Summer Vacation

Duration of Summer Vacation	Less Time Away	More Time Away
Less than a week	15	3
1 to less than 2 weeks	10	13
2 to less than 3 weeks	1	4
3 weeks or more	4	4
Total	**30**	**24**

Table E-18: Change in Winter Vacation

Duration of Winter Vacation	Less Time Away	More Time Away
Less than a week	6	3
1 to less than 2 weeks	3	15
2 to less than 3 weeks	2	5
3 weeks or more	3	5
Total	**14**	**28**

Table E-19: Other Changes in Schedule

Schedule Changes	Number of Homes
No Change	633
At home more in 2008	33
At home less in 2008	20
Don't Know/Refused	3
Total	**689**

Table E-20: Changes in Energy Usage

Change in Use	Gas	Electric	Total
No Change	638	641	1,279
A lot less in Year1	12	6	18
Somewhat less in Year1	24	18	42
Somewhat more in Year1	7	20	27
A lot more in Year1	4	6	10
Don't Know/Refused	14	8	22
Total	**699**	**699**	**1,398**

MEMORANDUM OF RESULTS FROM 2012 SUPPLEMENTAL HPWES BILLING ANALYSIS

Megdal & Associates

M E M O R A N D U M

To: NYSERDA

From: Kathryn Parlin, WHEC, Steve Doyle, and Lori Megdal, Megdal & Associates, LLC

Subject: Results of HPwES 2009-2011 Preliminary Billing Analysis

Date: July 10, 2012; Revised July 24, 2012

The purpose of this memo is to describe the results of the preliminary billing analysis conducted for HPwES using the recent program and billing data. This billing analysis was conducted on a short time line and there was insufficient time to perform the extensive review as is done for more comprehensive evaluation studies. This memo covers both the natural gas and electric savings.

Billing data for this analysis was provided by three natural gas utilities: National Fuel, NYSEG and RG&E. The total number of homes with bills and the number included in the regression model are provided below. Data from the other utilities was unavailable in the required time frame for this analysis.

Table 20: HPwES Home with Natural Gas Billing Data

Utility	National Fuel	NYSEG	RG&E	Total
Number of Participating Homes with Billing Data	1,522	650	2,558	4,730
Number of Homes in the Model	916	217	1,023	2,156
% of Homes with Billing Data Included in the Model	60%	33%	40%	46%

For the electric model, only NYSEG and RG&E provided billing records.

Table 21: HPwES Home with Electric Billing Data

Utility	NYSEG	RG&E	Total
Number of Participating Homes with Billing Data	1,099	1,671	2,770
Number of Homes in the Model	329	929	1,258
% of Homes with Billing Data Included in the	30%	56%	45%

Model			

Homes were removed from the analysis for the following reasons:

- Homes did not have at least 9 months of billing data before and after program participation (covering both winters)
- Projects had total natural gas savings less than 1.0 MMBtu or 50 kWh per year, as these savings would be likely to be too small to find in a billing analysis
    - This criteria also resulted in the removal of a few homes with fuel switching to natural gas from alternative fuels, resulting in increased consumption of natural gas
- Billing data could not be interpreted (particularly an issue for the utilities that provided the raw meter data)
- A few homes were removed due to key fields that were found to be missing in the process of preparing the billing data for the regression; these issues can be corrected in the next round

A brief description of the analysis method is provided below, followed by the results and next steps in the analysis.

Method

A fixed effects regression model with customer specific intercepts was used to estimate the savings. This modeling approach compares the pre- and post-installation by household and accounts for the house-specific characteristics, including individual consumption patterns.

Due to time constraints, savings were estimated only at the household level and the model included only participants. Weather effects were included as predictor (independent) variables and the response (dependent) variable was the daily energy consumption. The model was a generalized linear model with customer-specific intercept of the form shown in the equation below.

$$C_{it} = \alpha_i + \tau_t + \sum_{j=1}^{p} x_{ijt}\beta_j + \sum_{k=1}^{q} z_{ikt}\gamma_k + \varepsilon_{it}$$

where

Cit is the monthly consumption for the household i in period t, expressed in monthly kWh per day,

α_i is the "customer-specific" intercept (or error) for household *i*, accounting for unexplained difference in use between households associated with the characteristics of the house (size, orientation, number of windows, age), number of occupants, appliance holdings and lifestyle,

τ_t is the "time-specific" error for period *t*, reflecting the unexplained difference in use between time periods,

x_{ijt} are the predictor variables reflecting the installation of measures for end use *j* for household *i* in period *t*; in the natural gas model, savings from both base and heating measures were estimated; for the electric model, only base savings were estimated as few heating sensitive measures were installed

β_j are the slope coefficients that quantify the average influence of modeled efficiency measure *j* on monthly consumption,

p is the total number of end uses with energy efficiency measures included in the model (p=2 for natural gas - heating and base use, p=1 for electric - base use only)

z_{it} are the predictor variables reflecting non-program related effect *k* (such as weather impacts) for household *i* in period *t,*

γ_k represents the slope coefficients that quantify the average influence of modeled non-program related effect *k* on monthly consumption,

q is the total number of non-program related effects included in the model (q=1 for natural gas - heating degree days and q=2 for electric - heating and cooling degree days), and

ε_{it} is the error term that accounts for the difference between the model estimate and actual consumption for household *i* in period *t.*

The model used dummy variables, in which the *x's* for the installed measures are one or zero to indicate the installation and the coefficients reflect the program savings. The heating savings for natural gas were normalized using several years' of NOAA weather data.

This analysis was completed within a short time period and, consequently, it was not as extensive as other evaluations based on billing analysis conducted for NYSERDA. Some of the differences between a more extensive analysis and the current analysis are described briefly below.

- a more extensive analysis is likely to incorporate strategies to assess the impacts of widespread changes in energy consumption due to market effects, such as increased use due to wider saturation of electronics or decreased use due to economic factors
- full scale evaluations typically include a more thorough data cleaning process and would be designed to try to include billing data from as many of the utilities with participating homeowners as possible

Results

The estimators from both regression models were highly significant, and the R-squared for the models were 0.69 for natural gas and 0.73 for electric. The billing analysis results are provided below.

Table 3: Electric and Natural Gas Savings and Realization Rates

Household Savings	Electric Savings per Home (kWh/Year)	Natural Gas Savings per Home (MMBtu/Year)
Average Verified Savings for Homes in the Model	324	18.8
Average Program Savings for Homes in the Model	702	25.8
Realization Rate	46%	73%

To develop a single realization rate for the program, it is necessary to convert the electric savings to MMBtu. There are two approaches to making this conversion:

- source MMBtu reflects the total energy required to generate the electricity and
- site MMBtu reflects the participant's savings at the home

The overall program blended savings and realization rates were calculated both ways, as shown in Table 4 below.

Table 4: Overall Program Savings and Realization Rates

Household Savings	Total Savings per Home (Site MMBtu/Year)	Total Savings per Home (Source MMBtu/Year)
Average Verified Savings for Homes in the Model	19.9	22.0
Average Program Savings for Homes in the Model	28.2	32.8
Realization Rate	71%a	67%b

a The standard site conversion factor of 3,412 Btu/kWh was applied to the kWh savings to calculated the total program MMBtu savings.

b The source factor of 9,949.2 Btu/kWh was applied. This value was provided by NYSERDA.

Since the electric savings are relatively small in comparison to the natural gas savings, the blended realization rate is closer to the natural gas realization rate.

The Impact Evaluation Team did some research into evaluations of similar programs to provide context for the results of this analysis. The MassSAVE program in Massachusetts is similar to NYSERDA's HPwES in that it covers many of the same measures included in HPwES; however, the program is delivered directly by the utilities rather than through home performance contractors. The impact evaluation for program year 2006 found that the realization rates of 0.76 for natural gas and 0.47 for electricity.[62]

Wisconsin's targeted Home Performance with Energy Star program includes the same range of measures as NYSERDA's program and also has a similar delivery mechanism. Wisconsin's program was evaluated for program year 2004 and the evaluation was updated in 2009, although the results were still primarily based on the billing analysis conducted for program year 2004. The impact evaluation results indicate the realization rates were 0.44 and 0.54 for natural gas and electricity, respectively, when compared to the savings reported for program year 2004.[63]

Principle Analyst: Kathryn Parlin, West Hill Energy and Computing, Inc., with assistance from Steve Doyle, Megdal & Associates

[62] *MassSAVE Final Summary QA/QC and Impact Study Report.* Prepared for Bay State Gas, Berkshire Gas, Cape Light Compact, KeySpan Energy Delivery, National Grid, NSTAR Electric and Gas Corporation, Unitil/Fitchburg Gas and Electric, New England Gas Company and Northeast Utilities/Western Massachusetts Electric. Prepared by RLW Analytics, Middletown, CT. April 8, 2008. Tables 6 and 7 on pdf pages 19 and 20 (report pages 11 and 12). http://www.env.state.ma.us/dpu/docs/electric/08-46/82908nsteera6s9.pdf

[63] Memorandum titled "Recommendations for Targeted Home Performance with Energy Star Energy Impacts" from PA Consulting Group to Oscar Bloch, Public Service Commission of Wisconsin. June 28, 2009. http://www.focusonenergy.com/files/Document_Management_System/Evaluation/Recommendations_for_Targeted_Home_Performance_with_ENERGY_STAR_Energy_Impacts_-_Revised_Final_v2.pdf