New Hampshire ENERGY STAR Homes Program Impact Evaluation (2014–2015)

Final Report

December 7, 2017

Prepared for

Liberty Utilities

New Hampshire Electric Cooperative

Eversource NH

Unitil

New Hampshire Public Utilities Commission

Prepared by

ERS

120 Water Street, Suite 350

North Andover, MA 01245

Phone: 978-521-2550

NOTICE

This report was prepared by ERS in the course of performing work contracted for and sponsored by the New Hampshire Public Utilities Commission ("PUC") and Eversource, Unitil, Liberty Utilities, and the New Hampshire Electric Co-op (NHEC), hereinafter referred to as the "Utilities." The opinions expressed in this report do not necessarily reflect those of the PUC, the Utilities, or the State of New Hampshire, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, the PUC, the Utilities, the State of New Hampshire, 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 PUC, the Utilities, the State of New Hampshire, 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 constrained, described, disclosed, or referred to in this report.

ABSTRACT

This report describes the impact and process evaluation of the New Hampshire utilities (the "Utilities") ENERGY STAR Residential New Construction Program (the "Program") conducted by ERS (the "Evaluation Team"). This study represents the first evaluation of the Program.

To assess the overall administration of the Program and its impact and benefits on various stakeholders, interviews were conducted with the Utilities, participating builders and HVAC contractors, Home Energy Rating System (HERs) energy auditors, and homeowners. The impact and process evaluation found a program that is well run from an administrative standpoint and is valued by stakeholders and participants, with those surveyed giving the Program high marks. The on-site inspections and homeowner interviews largely revealed participant homes whose physical characteristics aligned with the inputs of the utility-generated energy models and homeowners who were happy with their ENERGY STAR homes.

The process evaluation interviews confirmed that parts of the HVAC contractor market are reluctant to comply with the ENERGY STAR v3.0 requirements for design and administrative tasks, which has impacted the ability of some builders to register the homes with the Program. While it was not specifically researched, the process evaluation also noted evidence of spillover. Interviews with builders and HVAC contractors indicated that their experience participating in the Program has raised their levels of performance in all of the homes that they build, not just homes that participate in the Program. Several builders and HVAC contractors stated that they build their homes to ENERGY STAR standards, regardless of whether the home is a participant.

The Program faces a substantial challenge in terms of realized energy savings resulting from the performance of the nonparticipant population. The Evaluation Team performed a billing analysis of a sample of participant and nonparticipant homes built during the evaluated period which showed that the actual measured energy consumption of the participant and nonparticipant populations was very similar. Based on the existence of IECC 2009 as state code, and the findings of the impact, process, and user-defined reference home (UDRH) review, the evaluation determined the evaluated results by re-estimating

the savings for a large sample of project using the as-built REM/Rate[1] models with an IECC 2009 based UDRH.

This report presents the results of the impact analysis in terms of energy consumption and savings. Process evaluation findings are used in conjunction with the engineering analysis results and REM/Rate modeling to provide a comprehensive view into the performance of the Program. This report also provides recommendations that seek to improve program effectiveness.

[1] REM/Rate is a residential energy modeling software program used to estimate energy consumption, and to generate Home Energy Ratings System (HERS) ratings. The software is widely used and is compliant with ENERGY STAR and IECC requirements.

ACKNOWLEDGMENTS

This final report was prepared by the Impact Evaluation Team, led by ERS with Nick Collins as the project manager. The Impact Evaluation Team wishes to acknowledge the significant contributions and valuable suggestions provided by Thomas Belair of Eversource, Mary Downes of Unitil, Tina Poirier of Liberty Utilities, and Carol Woods of NHEC, and the input of the Utilities Program and evaluation staff.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1: EXECUTIVE SUMMARY

This report describes the impact and process evaluation of the New Hampshire utilities ("Utilities") 2014–2015 ENERGY STAR Residential New Construction Program ("Program"). This report provides a description of the Program, details the process and impact evaluation approach and methods, and provides the findings and recommendations of the evaluation activities.

The objective of the impact evaluation was twofold: a) to provide a process evaluation to assess the efficiency of program delivery and b) to estimate the evaluated savings for the Program, which includes electric and thermal savings. The process evaluation used stakeholder and customer interviews and the results of on-site inspections to assess current delivery methods and to identify improvements. The evaluated savings were informed by a population-level utility analysis on participant homes and on a control group of nonparticipant homes built during the same period. This approach was used to assess not only the performance of the participant homes but also the relative performance of nonparticipant homes. The impact findings were ultimately determined through an analysis of a sample of participant REM/Rate models with a revised user defined reference home (UDRH).

Overall, the process evaluation found that the Utilities' management of the Program is effective, leaving only modest opportunities for improvement of the current delivery model. The Program has reached about half of the multifamily homes built in this period and about 5% of single-family homes. The state's largest builders are active participants and supporters of the program. Field inspections verified that built homes are accurately represented in the savings models delivered as part of the applications. The evaluators also applaud the cooperation across program administrators. The Program does face challenges retaining HVAC contractors, due to the perceived burden of design and administrative tasks required of the HVAC contractors as part of ENERGY STAR v3.0 (although general contractors do *not* perceive an undue burden).

The program participant homes were built as represented in program documentation and, on-average, performed as modeled and therefore the program reported savings are accurate relative to the program defined user defined reference home (UDRH). On-site inspections confirmed that homes were built as designed and revealed only minor differences (primarily differences in thermostat set-points) between as-built conditions and the program design documents. Utility bill disaggregation performed on a small sample of inspected homes found that while individual home energy consumption varied, on average the electrically and fossil fuel heated homes total energy consumption was within 4% of what was predicted by the Program.

While the Program has done a commendable job promoting, facilitating, and validating the construction of ENERGY STAR v3.0 homes, the larger issue facing the Program is the apparent widespread adoption of efficient construction practices across the market. Although the research in this study does not answer every question that arises from these unexpected results, the weight of the evidence from the stakeholder interviews, the billing analysis, the on-site inspections, and other analysis is that the Program has done its job; however, the residential new construction market has evolved since the program UDRH was last updated in 2008. The billing analysis, along with contractor reporting, present convincing evidence that the playing field shifted beneath the Program and nonparticipant homes have improved beyond the baseline assumptions embedded in the Program savings estimates. This state of the market has likely been influenced by the adoption of IECC 2009 as the state wide minimum residential building code, and by program activity both past and present, although program attribution was not researched in this study. Substantial spillover was found in the Massachusetts residential new construction programs.[2]

While the billing analysis is strong evidence for a shift in baseline, it does not define the baseline. The limitations of the billing analysis included a relatively high attrition rate and unaccounted-for participation in other programs within the non-participant population. Based on the existence of IECC 2009 as state code, and the findings of the impact, process, and UDRH review, the evaluation based the evaluated results on an IECC 2009 based UDRH. The savings generated through this method are summarized in Table 1-1 and represent the evaluated realization rates for the Program.

[2] http://ma-eeac.org/wordpress/wp-content/uploads/Residential-New-Construction-Net-Impacts-Report-1-27-14.pdf

Table 1-1. ENERGY STAR Homes Program Evaluated Savings - IECC 2009 UDRH (2014–2015)

Statewide Energy Savings	Program Primary Tracking Savings	Realization Rate	Evaluated Savings	Relative Precision (90% CI)
Primary electric energy (kWh/yr)	2,781,796	57%	1,578,256	13%
Primary natural gas (MMBtu/yr)	3,718	24%	881	11%
Ancillary electric energy (kWh/yr)	87,606	57%	49,935	13%
Ancillary natural gas (MMBtu/yr)	6,131	24%	1,471	11%
Ancillary propane (MMBtu/yr)	11,874	24%	2,849	11%
Ancillary fuel oil (MMBtu/yr)	446	24%	107	11%
Ancillary wood (MMBtu/yr)	731	24%	175	11%

The program administrators and the Public Utility Commission must interpret the findings and decide on their next steps considering the interests of its rate payers, the citizens of New Hampshire, and the community that have built their livelihoods in this market. Options include revising the UDRH to acknowledge the improved performance of the non-participant market, transitioning the Program to ENERGY STAR v3.1 which has more stringent performance and eligibility requirements, or to aggressively move to a net zero energy (NZE) ready design. The NZE path can produce per-home savings similar to the current program design and is not at risk of market practices overtaking the program in the foreseeable future. The program administrators should consider revising the UDRH to IECC 2009 to align with established code and better than anticipated non-participant performance. Given that the State of New Hampshire has previously considered advancing the state wide code to IECC 2015, the Program should be prepared to further refine project eligibility requirements to achieve even greater performance as codes and the market continue to advance.

1.1 APPROACH

This section summarizes the approaches and methods used for the impact and process evaluation. Further detail on the methods is provided in Section 3.

1.1.1 Impact Evaluation

The impact evaluation was based on applying an IECC 2009 baseline to a sample (n=150) of participant REM/Rate modeling files. The on-site inspections and a comparison of select sites modeled and billed energy usage demonstrates that the buildings are performing as predicted by the program models.

However, program savings depend on the baseline as embodied by the UDRH. A billing analysis had been envisioned as the method for determining program savings by comparing the normalized energy usage of participating and nonparticipating homes. This approach was selected because it inherently accounts for new construction standard practices, since the nonparticipants will embody typical construction practices in the residential new construction market. A billing analysis also appeared feasible since the ex-ante savings estimates indicated that nonparticipants should use approximately 30%–50% more than participants, which is sufficiently large to be detectable in a monthly billing analysis.

Participants (P) were identified by program tracking data. Nonparticipants (NP) were identified from a data set purchased from the Warren Group[3], a respected provider of New England real estate sales and ownership data gathered through community websites and directly from authorities. The data set from the Warren Group included about two-thirds of multifamily and one-third of the single-family homes built in this time frame, as inferred by state permitting records. The representation was further eroded because of billing data attrition. Since the final dataset incompletely captured the market, a concern naturally arises of potential bias. While, further analysis confirmed that the nonparticipant sample was well matched to the participants by community, as well as by year built and home square footage (as further confirmed by the Evaluation Team through a search of tax records), the relatively small number of sites in the final billing analysis and questions about participation rates in other incentive programs led to the conclusion that the billing analysis should not be the sole determinant of the evaluation baseline.

Based on the existence of IECC 2009 as state code, and the findings of the impact, process, and UDRH review, IECC 2009 was selected as the evaluation baseline. The program savings were estimated by leveraging the sample of homes described in Section 1.1.3 to model program impacts using IECC 2009 as the UDRH.

1.1.2 Process Evaluation

The process evaluation was designed to answer the questions posed in the original RFP:

- Are the Program Administrators (PAs), builders, and contractors delivering and receiving program benefits?
- Are the savings estimation methods appropriate?

[3] http://www.thewarrengroup.com/ http://www.thewarrengroup.com/

- Are the builders delivering on the recommendations of the HERS raters?
- Are there marketing recommendations?
- Are there process recommendations?

Research conducted for the process evaluation consisted primarily of interviews with the Utilities, participant homeowners, participating builders and HVAC contractors, and HERS raters. The process evaluation was also informed by the findings and observations of the impact evaluation team.

1.1.3 User-Defined Reference Home

The scope of the evaluation includes a review of the existing user-defined referenced home (UDRH) that is used by the Utilities as the baseline home against which the participant homes' performance is compared. Each participant home is modeled in REM/Rate software to estimate proposed energy consumption. Within REM/Rate, the as-built home is compared to alternate baseline performance values for systems such as envelope insulation and infiltration, and mechanical system efficiency. The source of the baseline values is the UDRH. There are two UDRH files: one for electrically heated homes (e.g., air or ground source heat pumps), and one for fossil fuel-heated homes (natural gas, oil, or propane). This approach allows a proposed participant home to be compared to the same home built to theoretically lower standards of efficiency. The Utilities only use the REM/Rate modeling to estimate savings associated with building enclosure (envelope), HVAC, and domestic hot water (DHW) measures. Energy savings associated with lighting and appliances are calculated separately in a prescriptive fashion and are added to the REM/Rate generated savings to arrive at the total claimed savings for a given home. The 2014–2015 UDRH was initially defined in 2007 and updated in 2008 and has not been updated since IECC 2009 became the mandatory statewide code in 2010.

In order to assess the impact of an advancing baseline, the evaluators obtained a statistical sample of 150 participants REM/Rate modeling files from the Utilities and compared each of the as-built homes against alternate IECC 2009, IECC 2015, and ENERGY STAR v3.1 baseline models. The details of this process and findings are provided in Sections 3 and 4.

1.2 FINDINGS AND RECOMMENDATIONS

The key impact evaluation finding of this study is that market practices have caught up with the New Hampshire residential new construction program, diminishing the difference between participant and nonparticipant electricity and natural gas energy use. This assessment is supported by the results of the

billing analysis, the findings from the process evaluation, and additional ad hoc analysis conducted to further explore this finding.

1.2.1 Impact Evaluation

The impact results by utility are presented in Table 1-2.

Table 1-2. Program Impacts by Utility

By Utility Energy Savings	Eversource		NHEC		Liberty		Unitil	
	Tracking	Evaluated	Tracking	Evaluated	Tracking	Evaluated	Tracking	Evaluated
Primary tracking electric energy (kWh/yr)	2,299,816	1,310,895	229,370	130,740	16,080	9,165	236,530	134,822
Primary natural gas (MMBtu/yr)	N/A	N/A	N/A	N/A	1,729	415	1,989	477
Ancillary electric energy (kWh/yr)	N/A	N/A	N/A	N/A	24,435	13,876	63,171	36,007
Ancillary natural gas (MMBtu/yr)	6,131	1,471	N/A	N/A	N/A	N/A	N/A	N/A
Ancillary propane (MMBtu/yr)	9,281	2,227	434	104	1,103	265	1,056	253
Ancillary fuel oil (MMBtu/yr)	446	107	N/A	N/A	N/A	N/A	N/A	N/A
Ancillary wood (MMBtu/yr)	612	147	N/A	N/A	N/A	N/A	120	29

As noted, the primary finding of the impact evaluation is the movement of the market to a more efficient baseline. The primary recommendation resulting from the impact analysis is that the requirements of the Program should be advanced to ensure that participant homes are built in a manner that is superior to the NP population and current statewide building energy code.

1.2.2 Process Evaluation

As the ERS team conducted interviews and mined the program data, there were certain recurring themes that presented themselves. These themes have been organized into five key findings that incorporate all the data collected throughout the evaluation effort:

1. The ENERGY STAR label is the trusted key to the Program's identity, but it comes with some challenges.
2. Benefits, motivations, requirements, and costs differ dramatically among the Program's major actors.
3. Barriers to HVAC contractor participation represent a major impediment to the Program’s growth.

4. The Program primarily relies direct outreach through Utility staff and HERS raters to recruit builders, supplemented by utility-sponsored training and some traditional marketing techniques.
5. Overall, the Program management is effective, with a few opportunities for small internal tweaks.

Section 5 provides additional details on the findings and recommendations resulting from the process evaluation.

1.2.3 UDRH Review

The REM/Rate baseline analysis of 150 participant homes demonstrated that homes modeled using an IECC 2009 (current state code) baseline performed nearly identically to homes modeled using an ENERGY STAR v3.0 minimums baseline (the 2014–2015 program minimum performance threshold). The scope of the evaluation did not include an assessment of code enforcement or a direct assessment of the physical characteristics of NP homes, but the impact, process, and UDRH review findings strongly suggest that NP homes, as a population, are performing at or above the levels associated with IECC 2009. Based on the existence of IECC 2009 as state code, and the findings of the impact, process, and UDRH review, the evaluation recommendation is that IECC 2009 be used as the UDRH going forward.

The review of the current UDRH against IECC 2009 found that the roof/ceiling insulation values prescribed in the UDRH were far less than required by code during the period of review (2014-2015). The UDRH assumes ceiling insulation values of R-17, while IECC 2009 requires ceiling insulation values of R-49.

SECTION 2: INTRODUCTION

This section presents a program description and a summary of previous evaluations.

2.1 PROGRAM DESCRIPTION

The New Hampshire utilities ENERGY STAR New Construction Program encourages New Hampshire builders and new home buyers to participate in energy efficient practices in new home and gut rehab construction projects. It does this by providing cash incentives and technical assistance to offset the upfront costs and technical barriers associated with meeting ENERGY STAR v3.0 requirements. The Program provides:

- Coverage of all technical guidance and support costs paid directly to the ENERGY STAR contractor responsible for the construction of the home
- Free light-emitting diode (LED) lamps
- A $25 rebate for each approved ENERGY STAR fixture
- A $25 rebate for each ENERGY STAR qualified refrigerator, clothes washer, and clothes dryer
- Performance-based cash incentives up to $4,000 per single-family home/townhouse based on REM/Rate modeled Home Energy Rating System (HERS) Target Index[4] (including lighting and appliances)
- Performance-based cash incentives up to $1,000 per unit in multifamily buildings based on REM/Rate modeled HERS Target Index[5]

The Utilities' Program has been recognized by ENERGY STAR as a Partner of the Year every year since 2013.

The Utilities' contract with two primary HERS raters to implement the Program on their behalf, guiding builders and homeowners through the design and construction process, conducting inspections, and preparing and submitting much of the paperwork required to verify compliance with Program requirements.

[4] The HERS Target Index is a standard by which a home's energy efficiency is measured.

[5] Ibid

The Utilities primarily use direct outreach to builders, coupled with utility-sponsored technical training and some traditional marketing methods to recruit builders into the Program.

2.1.1 Summary of Program Tracking Savings

This section provides a summary of the claimed savings for Program years 2014–2015. These values represent the data set of record and were established in concert with the Utilities at the onset of the evaluation activities. Table 2-1 provides a summary of Program-claimed savings.

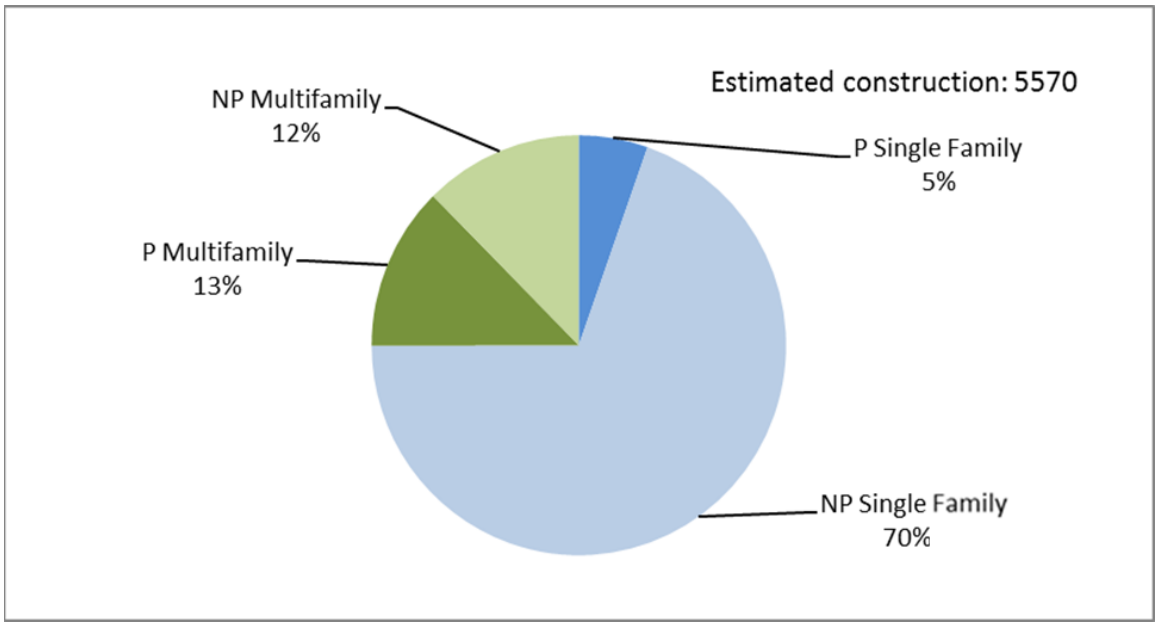
Table 2-1. Program Tracking Savings

Segment	# of Locations	# of Homes	Tracking Primary Annual Electric Savings (kWh)	Tracking Auxiliary Annual Electric Savings (kWh)	Tracking Primary Annual Natural Gas Savings (MMBtu)	Tracking Auxiliary Annual Natural Gas Savings (MMBtu)	Tracking Auxiliary Annual Propane Savings (MMBtu)	Tracking Auxiliary Annual Fuel Oil Savings (MMBtu)	Tracking Auxiliary Annual Wood Savings (MMBtu)
Single Family	**282**	**300**	**1,672,661**	**19,450**	**1,194**	**1,056**	**9,731**	**95**	**294**
Electric	265	279	1,672,661	0	0	1,056	9,731	95	294
Eversource	216	230	1,308,509	0	0	1,056	7,935	95	174
Liberty	6	6	4,535	0	0	0	306	0	0
NHEC	18	18	229,370	0	0	0	434	0	0
Unitil	25	25	130,247	0	0	0	1,056	0	120
Natural gas	17	21	0	19,450	1,194	0	0	0	0
Liberty	6	10	0	2,139	309	0	0	0	0
Unitil	11	11	0	17,311	884	0	0	0	0
Multifamily	**43**	**703**	**1,109,135**	**68,156**	**2,525**	**5,075**	**2,142**	**351**	**438**
Electric	21	633	1,109,135	0	0	5,075	2,142	351	438
Eversource	17	516	991,307	0	0	5,075	1,345	351	438
Liberty	1	62	11,545	0	0	0	797	0	0
Unitil	3	55	106,283	0	0	0	0	0	0
Natural gas	22	70	0	68,156	2,525	0	0	0	0
Liberty	20	34	0	22,296	1,420	0	0	0	0
Unitil	2	36	0	45,860	1,105	0	0	0	0
Total	**325**	**1,003**	**2,781,796**	**87,606**	**3,718**	**6,131**	**11,874**	**446**	**731**

The program has captured approximately 20% of the residential construction market[6], with the largest penetration rate in the multifamily market as illustrated in Figure 2-1.

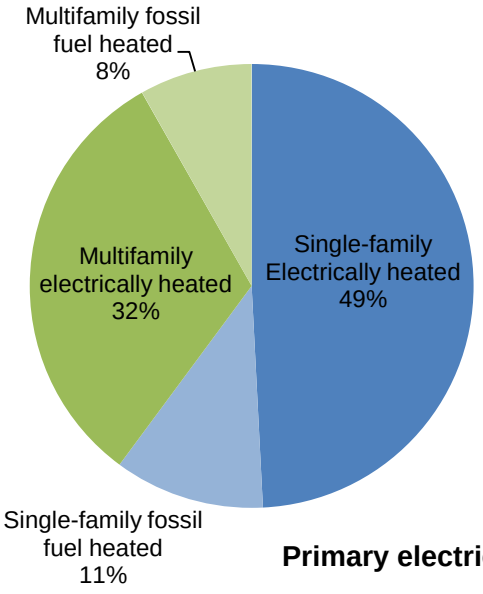
[6]Based on a tabulation of NH permits adjusted for build-out. https://www.census.gov/construction/bps/stateannual.html

Figure 2-1. Program Dwelling Unit Market Share



While almost twice as many multifamily units participated as single-family, more than half of the primary electric savings claimed came from single-family homes, as illustrated in Figure 2-2. The single-family homes are projected to save about twice as much electricity (14,559 kWh per electrically heated home) as a multifamily unit (3,796 kWh per electrically heated home). It is clear from the figure that most of the claimed savings came from electrically heated homes utilizing air and ground source heat pump technology. As would be expected, program savings for electrically heated homes (14,559 kWh per single-family home) is much larger than the electricity savings for a fossil fuel home (1,644 kWh per single-family home).

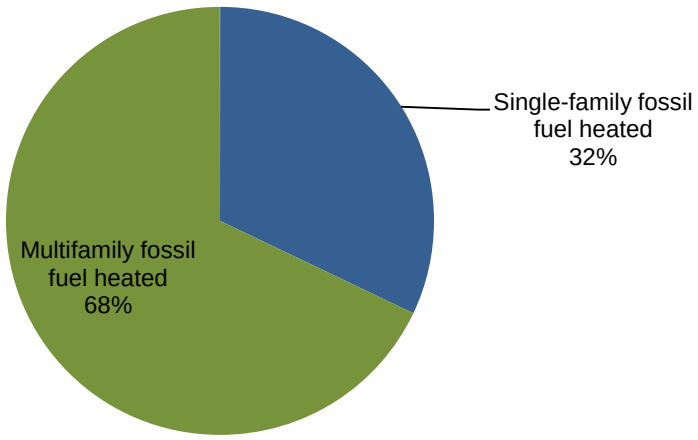
Figure 2-2. Primary Electric Tracking Savings by Unit Type



Primary electric savings: 2,781,796 kWh

Figure 2-3 shows the division of primary tracking natural gas savings. Here it is clear that most of the program savings are realized by multifamily units.

Figure 2-3. Primary Natural Gas Tracking Savings by Unit Type



Primary natural gas savings: 3,178 MMBtu

2.2 PREVIOUS EVALUATIONS

The Program has not undergone any previous evaluations.

SECTION 3: METHODS

This section discusses in detail the methods used in conducting the impact and process evaluations. The overall evaluation consisted of four separate efforts.

1. Utility billing data analysis, the primary method of determining program impact
2. On-site visual inspections and interviews of a sample of participant (P) homes to inform impact and process evaluation tasks
3. UDRH model review through REM/Rate batch analysis
4. Process evaluation activities that centered on interviews with various groups of stakeholders

This methods section will begin with a discussion of the data sources and data acquisition common to all four components.

3.1 DATA SOURCES AND ACQUISITION

The program evaluation relied on multiple data sources, which are summarized in Table 3-1, below.

Table 3-1. Data Sources

Data type	Source	Use	Issues and Challenges
Program tracking data	Each utility provided a uniquely structured set of participant data (four for electric accounts and two for natural gas accounts).	Source of P information for sample frame and billing population. Source of Data Set of Record.	Missing key fields in some cases
		Source of information on participating builders for the purpose of process interviews	
Nonparticipant data	Warren Group data for new residential construction in 2014–2015 period	Source of NP homes sample and initial assessment of size (in sq ft) and HVAC equipment type	Market coverage and NP representation in program participant communities, limited HVAC data
Program project REM/Rate files	Each utility provided project specific REM/Rate files for each site sampled project. The data files came from the HERS raters that generated the file, as the Utilities generally do not keep copies of the actual REM/Rate files.	Source of system-level details for confirmation during site inspection and for use within the utility data analysis. REM/Rate modeling files used in batch UDRH analysis.	Some files were missing key data that prevented successful modeling in REM/Rate.
Building area (sq ft) and HVAC type	Tax assessor records, Zillow.com, Trulia.com	Source for all home building area (sq ft) and HVAC system types for NP	
Weather data	National Oceanic and Atmospheric Administration's (NOAA) data on historic hourly average outside air temperatures across relevant NH weather stations	Used to weather-normalize the historic utility data	Less than 1% of the data was missing.
	NOAA typical meteorological data (TMY3) used to generate weather-normalized typical annual energy use	Used to generate the HDD and CDD (which were later used as independent variables in regression model)	
Customer billing data	Each utility provided a uniquely structured set of participant data (six sources).	Impact evaluation weather-normalized annual consumption (NAC)	Each utility's billing data was structured uniquely. Indications of different meter read types (actual, estimated, etc.) were not clear in all cases. The categorization of energy use and generation for homes with solar PV and net metering was not clear in all cases. Data was not available or not provided for all requested customer accounts.

3.1.1 Program Tracking Data

Each utility provided its own program tracking spreadsheet, each with a variety of fields and formats. Eversource tracked the largest amount of data, with approximately 200 tracked fields. Unitil and NHEC both tracked over 50 fields, while Liberty tracked less than 20. Table 3-2 lists some of the fields that were used to build the master data set.

Table 3-2. Utility Tracking Data Breakdown

	Utility			
Tracking Data Field	**Eversource**	**Liberty**	**NHEC**	**Unitil**
Claimed utility service	Yes	Yes	Yes	Yes
Program year	Yes	Yes	Yes	Yes
Building type	Yes	Yes	Yes	Yes
New/renovation	Yes	No	No	Yes
Square footage	Yes	Yes	Yes	Yes
Heating system type	Yes	No	Yes	No
Heating fuel	Yes	No	Yes	Yes
Photovoltaic system	Yes	No	Yes	No

3.1.2 Nonparticipant Data

The nonparticipant population was established by purchasing a commercially available data set of new construction projects in New Hampshire for Program years 2014–2015 from The Warren Group[7]. The Warren Group researches and compiles real estate records throughout New England for use in business, marketing, and other purposes. The evaluators' research indicated that The Warren Group had the most complete and most accessible list of new construction records for the period of review. However, there was a concern using this data set, since it did not completely capture the market, missing both nonparticipants and participant homes.

Collecting residential construction data is challenging. The most reliable US Census data is for building permits, which leads and usually exceeds actual construction build and occupancy. This data indicates that about 5,500 units were built in the 2014–2015 study period in New Hampshire, while the Warren Group data set contained about 2,200 units.

An additional concern was that the Warren Data contained few participant homes. This was puzzling, because the homes that were included in the Warren Group data were constructed in the 2014–2015

[7] http://www.thewarrengroup.com/ http://www.thewarrengroup.com/

period as confirmed by tax and online real estate records[8], as were the program participants, also confirmed in the tax and real estate records.

Further discussions with a Warren Group representative provided some answers. The Warren Group collects data from sales deeds and mortgages, as well as property ownership data obtained from tax assessor records on a regular basis; however, the "year completed" is a value that may not be immediately updated in property records. Indeed, the Warren Group provided a refresh of the 2014–2015 data set in August 2017, a year after the first data set, and the total number of homes in that refresh is within 10% of the market size predicted by permits. Since contractors are highly motivated to report a completed home to the Program (to receive payment), the complete date for participation occurs ahead of property records. This explains underreporting of participants and nonparticipants in the data set.

Since the Warren Group data does not represent all of the market, communities with systematically different inspection and recording practices that could be correlated with better code enforcement might be overly represented in the data. However, the Warren Group homes were distributed through communities accounting for 92% of New Hampshire's population, and a community bias was not evident. The evaluators concluded that the Warren database represented a significant sample of new construction homes that were built in the 2014–2015 period and would serve the purpose of establishing a nonparticipant sample. Appendix A includes a table with the counts of the participants (P) and nonparticipants from the Warren Data (NPs) used in this analysis. Additional comparisons were conducted of the P and NP homes included in the final billing analysis; these are described in Section 3.2.2.

Although the Program tracking data included building area data for P homes, the information was taken from the REM/Rate files. REM/Rate has a unique method for calculating building area, which is reportedly based on exterior dimensions of the home and not the interior occupied space. The Warren data for NP homes uses a more traditional real estate method that considers the interior occupied space. Because the impact analysis considers building area as one of the independent variables, it is important that the method by which building area is calculated be consistent, so neither the REM/Rate nor Warren Data could serve that purpose. The evaluators instead looked up all P and NP homes through online tax assessor databases or online real estate services in order to have a consistent and like source for building area information for both P and NP populations. The same source was used to determine NP heating

[8] Online real estate records as viewed on Zillow.com or Trulia.com.

system type. On average, the REM/Rate square-footage estimates were larger than the tax record estimates by up to 35%.

Utility Data

In concert with the development of the population data sets, utility data for regulated fuels[9] was requested for all identified participants and nonparticipants. Billing data was provided by each utility for P and NP homes within their given territory and were compiled and cross-referenced by the evaluators to align with each home, as the addresses were frequently inconsistent and required computer code-based and manual matching.

The format of the billing data was unique to each utility and had to be extracted and mapped to a uniform format for use in the analysis. The billing data was calendarized, such that each billing period was disaggregated into an average consumption per day in the billing period and each day was assigned an average heating degree day (HDD) and cooling degree day (CDD) value derived from historical weather data.

Unregulated fuels, such as propane, oil, and wood, are supplied to homeowners by individual fuel dealers, and that data does not exist in a single repository as the regulated fuel data does. Evaluations have historically struggled with the acquisition of unregulated fuel data for several reasons[10], as follows:

- Obtaining billing records requires extensive cooperation from participants and fuel dealers.
- Fuel deliveries may not occur on a regular basis and the fuel tank may not be filled to capacity during a given delivery.

Given the known challenges, limited success, and costs associated with attempting to acquire unregulated fuel data, the natural gas realization rates were used as a proxy for unregulated fuel realization rates. This approach is common; the Maine, Vermont, and New York TRMs all assume no efficiency difference between natural gas and deliverable fuel equipment for measures that include fossil fuel savings. Assuming a similar savings between fossil fuels is also supported by research. Two major national

[9] Regulated fuels include electricity and natural gas. Unregulated fuels include propane, oil, and wood.

[10] *Home Performance with ENERGY STAR: Unregulated Fuels Impact Evaluation (2011–2013),* November 2016. ERS and West Hill Energy and Computing for NYSERDA.

evaluations of the Weatherization Assistance Program (WAP) concluded that the deliverable fuel savings are essentially equivalent between natural gas and other fuel savings. A study of NYSERDA's Home Performance with ENERGY STAR program included an unregulated fuel billing analysis. The unregulated fuel (oil and propane) realization rates were similar to the natural gas realization rates. Although natural gas is more available in urban and suburban areas than it is in rural areas, which could introduce systematic differences in usage between populations served by natural gas and those served by propane or oil, the evidence indicates that the outcomes will be similar for natural gas and other fuels.

Weather Data Set

The hourly average outside air temperature across eight weather stations in NH was extracted from the National Oceanic and Atmospheric Administration (NOAA) website. A small number of data points (less than 1% of the overall population) were missing and linear interpolation between the two nearest points was carried out to estimate the missing values.

The HDD and CDD were calculated for each hour using a base temperature of 65°F. For each billing period, the total HDD and CDD were calculated by summing the hourly degree days within the given period. When the billing period was calendarized to daily data, each day was assigned an average HDD and CDD derived from the NOAA weather data.

Participant Population

The participant population was established through the utility tracking data for Program years 2014–2015. The tracking data included information on the location of the home, and the physical characteristics of the home, such as heating system type and building area. Since the definition of home area varies (as discussed above), the evaluators also researched tax and Zillow records to populate heating system and building area for consistency between the P and NP populations.

Master Data Set

Once the original data sets were collected, they were compiled into one master data set. This master list included all participant and nonparticipant sites, along with key characteristics about the building as determined from Program files and from online tax assessor and real estate records, as previously discussed.

3.2 BILLING ANALYSIS

Several factors led to the selection of billing analysis as the method for evaluating the program savings. A primary reason for using billing analysis was to test an underlying assumption of the Program that

nonparticipant building construction followed older code practices. If the program assumption was correct, the billing analysis would demonstrate that nonparticipants consumed approximately 30%–50% more energy than an ENERGY STAR equivalent home. A building modeling approach could not test this assumption without extensive and cost-prohibitive nonparticipant on-site research to verify baseline building characteristics. A billing analysis was also feasible given the large expected level of savings and the large number of participants. Finally, a billing analysis would properly account for interactive savings between measures (i.e., a higher efficiency boiler, reduces potential insulation savings), and ENERGY STAR homes entail numerous interactive measures.

The final billing models were statistically characterized and precisions were calculated to reflect how well each of the models estimated the actual usage for each home.

3.2.1 Billing Analysis Model

The billing analysis approach was straightforward. For each fuel, homes were grouped by home type (single-family, multifamily) and for electric savings by heating system type (electric or fossil fuel heat) and then further segmented into participants and nonparticipants. Participant and nonparticipant models (or equations) were created for each group using a linear regression where home size (area) and weather conditions (historical HDD and CDD) are the independent variables and monthly usage is the dependent variable. The final program savings were calculated as the difference between the sums of each participant's usage, calculated using both the P and NP models.

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

$$C_{it} = \alpha + x_i\beta + y_{it}\,\gamma_{HDD} + z_{it}\,\gamma_{CDD}$$

$$with\ error\ term{:}\ \varepsilon_i$$

where,

C_{it} = The daily consumption for the home *i* in period *t*, expressed in kWh or therms

α = The intercept (or error) for accounting for baseload and unexplained difference in use between homes associated with the number of occupants, appliance holdings, and lifestyle

x_j = The independent variables (sq ft) for household *i*

β = The slope coefficients that quantify the average influence of the home area variable on monthly consumption

z_{it} and y_{it} = The independent variables reflecting weather impacts (HDD and CDD) for household *i* in period *t*

$\gamma_{HDD, CDD}$ = The slope coefficients that quantify the average influence of modeled program-related effect on consumption

ε_i = The error term that accounts for the difference between the model estimate and actual consumption for household *i* across the billed period

3.2.2 Mitigating Model Bias

In addition to conducting the analysis in a manner that met precision targets, the evaluation carefully considered potential sources of bias and methods for mitigating them. One source of bias is attrition, which is the removal of sites from the billing models due to insufficient or irregular data. A second source of bias can be introduced if the nonparticipant and participant populations vary systematically in some dimension that is not captured by the models.

The following aspects of the analysis were designed to minimize bias:

- **Common independent variable sources** – The two key independent variables of area of the home and HVAC type were gathered or confirmed from tax records for both participant and nonparticipant data to ensure that the definitions were consistently applied to both populations.
- **Analysis method** – Participant and nonparticipant models were developed (by heating fuel type and single-family vs. multifamily) group and then applied to each participant in the modeled population. This ensures that the final results reflect the location (for weather), size, home type (single/multifamily), and heating system type for the participant population and does not bias the results for differences between P and NP due to size or location.
- **Attrition** – Bills were excluded from the models using consistent criteria for both the participants and nonparticipants.

Bias is discussed further in the following sections.

Comparison of P and NP Populations

The P and NP populations were initially compared to see how similar or dissimilar they might be. The modeling approach assumes a linear relationship between building size and consumption, for example, which is likely valid if the two populations are similar in size. Three tables compare the P and NP

populations in their respective groups. In addition to presenting the average areas and weather (average HDD and CDD), the tables present the number of P and NP sites that are in each group and also the number of sites that were included in the billing analysis. The average annual usage is the non-weather normalized, actual billed usage for each group.

Table 3-3 compares the electric program's single-family home populations. The P and NP groups are very similar. The billing analysis models also include over half of the sites in each subpopulation, although the electrically heated P group only has 20 participants.

Table 3-3. Comparison of Single-Family Electric Program P/NP with Bills

Single-Family Electric Program	Electrically Heated		Fossil Fuel Heated	
	P	NP	P	NP
Number of homes	94	20	185	410
Average sq ft	2,484	2,740	2,200	2,262
Average tracking savings, kWh	14,559	N/A	1,644	N/A
Homes with valid bills	52	12	106	276
Average annualized kWh use	15,404	13,491	7,573	7,159
Average HDD	7362	6954	6874	6731
Average CDD	652	720	715	766

Table 3-4 compares the electric program multifamily populations, which shows more divergence between the P and NP groups and a lower fraction of the sites captured in the billing models, two factors that contributed to the poorer precision results for multifamily.

Table 3-4. Comparison of Multifamily Electric Program P/NP

Multifamily Electric Program	Electrically Heated		Fossil Fuel Heated	
	P	NP	P	NP
Number of homes	232	67	401	74
Number of locations	4	4	16	9
Average sq ft	998	1,075	1,545	2,147
Average tracking savings, kWh	3,796	N/A	570	N/A
Homes with valid bills	127	24	92	24
Number of locations	3	2	9	6
Average annualized kWh use	6,784	9,122	6,156	5,033
Average HDD	6453	6964	6477	6661
Average CDD	826	697	819	777

Table 3-5 compares the natural gas program groups, which show more divergence between the P and NP groups and a lower fraction of the sites captured in the billing models. However, the natural gas models perform better, which partially compensates for the relatively small populations.

Table 3-5. Comparison of Natural Gas Program P/NP

	Single Family		Multifamily	
Natural Gas Programs	**P**	**NP**	**P**	**NP**
Number of homes[11]	21	1007	70	159
Number of locations[12]	N/A	N/A	21	19
Average sq ft	2004	2491	659	1674
Average tracking savings, MMBtu	57	N/A	36	N/A
Homes with valid bills	15	177	35	9
Number of locations	N/A	N/A	5	2
Average annualized MMBtu use	61	72	25	36
Average HDD	6966	6607	6450	6542
Average CDD	706	790	827	798

Other Potential Systematic Differences

In the previous section, the Ps and NPs were compared by average square-footage and average HDD/CDD. This section examines potential differences between Ps and NPs due to community differences. If, for example, all of the Ps were in communities without building inspections and all of the NPs were in communities with inspections, the impact of the program could be masked. This is an especially important consideration because the nonparticipant population is a sub-sample of the new construction market and the overlap in communities between Ps and NPs was reduced due to billing attrition. The results in this section compare the weather-normalized annual consumption (NAC) of single-family homes for various groupings of the communities, based on the following segmentation:

- **Population density –** The communities were ordered by population size and stratified such that each stratum contained about a third of the population[13]. Nine communities were in the highest-density population stratum (Manchester, Nashua, Concord, Derry, Dover, Rochester, Salem, Merrimack, and Hudson). These communities may have more resources to enforce codes.

[11] For multifamily, "number of homes" indicates the number of individual units and "number of locations" indicates the number of multifamily buildings.

[12] Ibid

[13] http://newhampshire.hometownlocator.com/census/sorted-demographics.cfm

- **Average income –** The communities were ordered by average income and stratified such that each stratum contained about one-third of the communities. Wealthier communities may have more resources to enforce code or their residents may build larger homes.

Table 3-6 compares the P and NP normalized annual electric consumption of fossil fuel-heated homes. Fossil fuel-heated homes are the largest group and therefore are the most useful for comparing performance across communities. The average EUI for the NPs remains consistently at 3.5 kWh/sq ft ±9%. The population density does not bear out a hypothesis that rural communities do a poorer job of inspecting homes because the NP EUIs are stable across location, community size, and income; if anything, smaller communities perform better.

Table 3-6. Fossil Fuel-Heated Homes: Average NACs by Community Grouping with Valid Bills

Fossil Fuel-Heated Homes		Count		Average Electric NAC (kWh)		Average EUI (kWh/sq ft)	
Category	**Location**	**P**	**NP**	**P**	**NP**	**P**	**NP**
Population density	High	5	110	13,705	6,935	3.4	3.7
	Medium	62	83	7,479	8,112	3.9	3.4
	Low	39	83	7,582	7,793	3.6	3.7
Income	Lower	3	35	5,581	6,692	3.1	3.8
	Mid	31	113	8,313	7,166	3.1	3.7
	Upper	72	128	7,687	8,117	4.1	3.4
Average		106	276	7,810	7,547	3.8	3.6

Table 3-7 includes homes with bills that did not pass all the screening criteria, which increased the communities represented in the data. The average EUIs are similar between the groups with and without billing screens and do not lead to different conclusions.

Table 3-7. Fossil Fuel-Heated Homes: Average NACs by Community Grouping Failing Some Billing Screens

Fossil Fuel Heat Homes		Count		Average Electric NAC (kWh)		Average EUI (kWh/sq ft)	
Category	**Location**	**P**	**NP**	**P**	**NP**	**P**	**NP**
Population density	High	11	181	10,773	7,091	3.4	3.8
	Medium	78	166	7,384	7,593	3.8	3.3
	Low	68	191	8,721	7,544	3.9	3.5
Income	Lower	10	71	4,621	6,343	2.6	3.5
	Mid	51	228	9,405	6,963	3.8	3.5
	Upper	96	239	7,934	8,146	4.0	3.6
Average		**157**	**538**	**8,201**	**7,407**	**3.8**	**3.5**

The Evaluation Team concludes that the NP population is not dominated by high-performance communities that could skew the baseline to be lower than low-performance communities with high levels of participation. At one level the data indicates the opposite, as the high population density communities have higher NP EUIs and the lowest rates of participation.

Attrition in the Billing Models

A source of potential bias is that homes evaluated within the billing model may differ from homes that were excluded from the model because the billing data was inadequate or suspect or an independent parameter was missing (such as square footage). The process of cleaning billing data resulting in participant attrition may introduce bias if the households removed from the analysis have specific sets of characteristics that are associated with energy savings. The potential for attrition-related bias is dependent upon the methods chosen to remove homes from the model and the methods used to conduct the analysis.

The potential for the introduction of bias is discussed for each stage of the billing data cleaning process, which ultimately determined the accounts included in the billing analysis and those that were excluded. Note that the causes for attrition are not mutually exclusive, and so the five data cleaning stages shown in Table 3-8 represent the order in which they were addressed in the analysis.

Table 3-8. Billing Analysis Attrition Sources

Total Sites	Single-Family Electric	Single-Family Gas	Multifamily Electric	Multifamily Gas
Population (P/NP requested)	274 / 1007	26 / 583	733 / 159	324 / 150
Sites with billing data available	237 / 602	17 / 202	434 / 142	152 / 67
Sites with HVAC system data	797	214	493	170
Sites with square footage data	797	211	493	166
Sites with non-negative billing data	227 / 545	17 / 193	358 / 138	105 / 64
Sites with acceptable R2	171 / 368	16 / 177	306 / 129	85 / 49
Sites with greater than 9 months of bills	446	192	267	44
Final P/NP in billing analysis	118/327	15/177	219/48	35/9

The first stage of cleaning screened out those P and NP records where a billing account could not be located in the PA billing systems. The evaluators worked closely with the PAs to use participant tracking and Warren Group addresses and names to find a matching account in the PA customer billing systems. Of the 3,256 original requests, bills were acquired for 62% of the P records and 53% of the NP records.

The second and third stage removed accounts that were missing square footage or HVAC system type. As noted previously, the evaluators used tax or real estate records to define or confirm home area and system type. Very few single-family homes were dropped at this stage (5%) because of the alternate sources available; however, multifamily records are not recorded in a similar way in tax or real estate records.

This stage was the largest source of attrition for multifamily accounts with 18% of the records dropped at this stage.

The fourth stage of cleaning eliminated accounts with billing anomalies, defined as accounts with poor correlation with weather data or negative bills. A quantity of accounts (25, or 3%) were dropped from the single-family electric model for having negative bills; in other models this attrition stage led to a negligible drop. A poor R square (R^2) reflects a poor correlation between the energy consumption and weather data. Numerous R^2 criteria were tested at this stage to select the appropriate R^2 threshold (below which accounts will be dropped). An R^2 threshold of 30% and 60% was chosen for electric and natural gas accounts, respectively. It was noted that these thresholds lead to a stable aggregate model, which further leads to stable savings calculations.

A few outliers (less than 1% of all records) were also dropped at this stage, such as records with unusually high consumption values, and were dropped, as those values appeared erroneous. In these instances, the single outlier month was dropped, not the entire account. Excess consumption, missing reads, and/or large gaps may indicate infrequent meter reads (where the utilities relied on estimated consumption) or simple clerical errors at the utility. It is likely that this type of error in the billing data is random and would not be expected to introduce bias into the billing analysis since it is not believed to be systematic.

The last stage of cleaning involved removing any accounts that did not have a sufficient number of bills. While the goal was to have 12 months of billing data, the threshold for this study was set to nine bills to allow for the inclusion of a larger number of accounts, while still providing sufficient coverage of the seasonal weather variance experienced in New Hampshire. Overall, an average of 18 months of bills was available for each account included in the analysis, and 80% of accounts in the final analysis had a full year or more of data.

The number of accounts included in the final analysis was lower than planned, particularly for the multifamily natural gas program. The biggest source of attrition was the lack of active billing accounts for P and NP sites. Both the evaluators and the PAs worked diligently to link a P/NP site to an account in the billing system by attempting to match the source address with an address in the billing system. Many of the multifamily sites were excluded from the analysis because the end uses included in the bills[14] were not

[14] Multifamily units may be served by common equipment or by equipment dedicated to a single unit.

clear, or because the area of the buildings or units could not be determined. A census of Ps and NPs was attempted; however the fraction of homes included in the analysis is summarized in Table 3-9. Except for the multifamily fossil fuel-heated homes, a majority of participant homes was included in the final regression models (and all homes were modeled to determine a final realization rate). The retention fractions of the NP groups were mixed, with a significant portion of the electric program sample included in the final model, although there was low representation in the natural gas models and that affected precision.

Table 3-9. Fraction of Accounts Included in Final Model

	P	NP
Electric Program		
Single-family electrically heated	55%	60%
Single-family fossil fuel-heated	57%	67%
Multifamily electrically heated	55%	36%
Multifamily fossil fuel-heated	23%	32%
Natural Gas Program		
Single-family	71%	18%
Multifamily	50%	6%

3.2.3 Calculation and Application of Realization Rates

Multiple iterations of the models were run using different attrition tests. The criteria for excluding outlier or anomalous accounts were analyzed to include as many accounts as possible while maintaining stable results. Once the optimum criteria had been established, the final P and NP models were run for each of the 1,357 participants using that participant's square footage and typical meteorological year (TMY3) HDD and CDD data. The realization rate for any given group was calculated as the sum of the P modeled usage (of all modeled participants) divided by NP modeled usage for all modeled participants. The group realization rate was then applied to the group's tracking savings.

The multifamily and single-family natural gas realization rates were applied to the tracking savings estimates of ancillary fossil fuels.

The precision of the estimate was reviewed by examining how well the models predicted the actual billed usage of the members in the group. Propagation of error methods was then used to calculate the precision of the savings estimate, which includes uncertainty in both the P and NP usage.

3.2.4 Model Precision

The impact results are based on normalized billing models with statistical results illustrated in Table 3-10.

Table 3-10. Impact Evaluation Utility Analysis Precision Results by Program Sub segment

Analysis Subgroup	Average NP Annual Use	Average Primary Program Tracking Savings	Average Evaluator Modeled Annual Use	Average Modeled Savings	RR%	Mean Relative Precision (90%)	Error Relative to Tracking
Single-family, electric Electric heat – kWh	13,491	14,559	14,726	-2,282	-15%	83%	16%
Single-family, electric Fossil fuel heat – kWh	7,159	1,644	1,675	-379	-23%	54%	20%
Multifamily, electric Electric heat – kWh	9,122	3,796	4,021	2364	59%	29%	19%
Multifamily, electric Fossil fuel heat – kWh	5,033	570	886	-1068	-21%	41%	75%
Electric total						**43%**	**11%**
Single-family, gas Fossil fuel heat – MMBtu	72	57	73	11	15%	22%	6%
Multifamily, gas Fossil fuel heat – MMBtu	36	36	27	13	48%	64%	35%
Natural gas total						**46%**	**25%**

The precision results of the impact analysis did not meet the relative precision targets of ±10% at the 90% confidence interval. While the uncertainty relative to the mean savings is large, the uncertainty relative to the tracking savings is on target for electric savings (±11 %), with possible realization rates falling between 8% to 14% in the 90% confidence interval. The natural gas program results are less certain, with realization rates falling between 13% and 63% in the 90% confidence interval.

The billing analysis would have been strengthened by the inclusion of more accounts in the final models. Additional accounts would have improved precision and lessened concerns about bias, particularly with the multifamily group. However, the tracking savings predicted that the participants should have outperformed the nonparticipants by a large margin, which should be discernible within the utility analysis even with the smaller population counts.

As expected, none of the sub segments met a relative precision target sufficiently robust (a relative precision better than ±20%) to warrant the application of a unique realization rate to that sub segment.

3.3 PROCESS EVALUATION METHODS

The main sources of data for the process evaluation were primary data collection activities, including in-depth interviews and surveys. The team collected perspectives from some stakeholders and beneficiaries of the Program's activities. The types of entities interviewed and number of complete interviews are shown in Table 3-11.

Table 3-11. Process Evaluation Data Collection

Type	Number of Interviews	Number of People Interviewed
Utility program administrator	4	6
NH Public Utilities Commission staff	1	2
HERS Raters	3	4
Home builders	7	7
Former home builders	2	2
HVAC contractors	4	4
Former HVAC contractors	2	2
Homeowner/home builder	4	4
Interview total	**27**	**31**
Onsite surveys: homeowners/tenants	34	34
Data collection total	**61**	**65**

In addition to these interviews, the process evaluation team also gained data from several other sources, including:

- A review of Program documents, including training materials and marketing
- A review of the Program tracking data
- Informal interviews with the impact evaluation team to assess their interactions with the Program, the data, and any learning from site visits

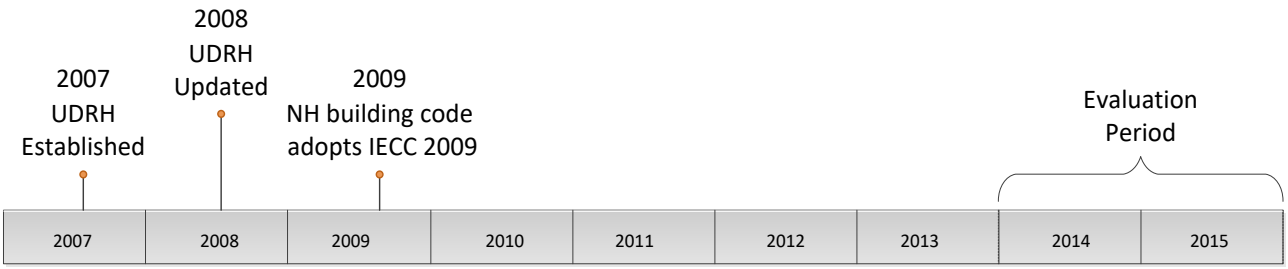
Findings gathered from the synthesis of this data are presented in Section 5.

3.4 UDRH REVIEW METHODS

The evaluation team was tasked with reviewing the current UDRH to identify parameters for potential revision, and to estimate the potential impact of revisions to the UDRH related to energy savings. The UDRH review was informed by the results of the utility analysis, the process evaluation interviews with builders, HVAC contractors, and HERS raters, and the current statewide residential building code.

The current UDRH was developed in 2007 with the most recent updates occurring in 2008. The UDRH was developed through a stakeholder review process where code and perceived existing building practices were reviewed and a consensus was reached for the input values of the various systems that are modeled in REM/Rate. There are in fact two UDRH models: one for fossil fuel-heated homes, and one for electrically heated homes. Figure 3-1 presents a timeline with UDRH and NH building code updates noted.

Figure 3-1. UDRH and Code Adoption Timeline



As the utility billing analysis progressed it became apparent that the P and NP populations were performing in a very similar manner, and the savings that were anticipated by the Program were not being achieved at the meter. Simultaneously, process evaluation interviews with builders, HVAC contractors, and HERS raters all suggested that NP homes were being built to higher standards than anticipated in the UDRH. While neither code compliance nor code enforcement was a focus of this evaluation, IECC 2009 was in effect as the statewide residential building code for 4 years prior to the Program review period (2014–2015) and the measured performance of the NP population supports the premise that NP homes were built to higher performance levels then indicated in the UDRH. Analysis was conducted to identify a baseline that better reflected the market practices.

The evaluators randomly sampled 150 P homes and received the original REM/Rate files from the HERS raters for these homes. The sampled homes were a mix of single-family and multifamily. Table 3-12 summarizes the sampled group.

Table 3-12. Sample of P Homes Used in UDRH Modeling Review

Unit Type	Count of REM/Rate Files Reviewed
Apartment, end unit	30
Apartment, inside unit	41
Multifamily, whole building	4
Single-family detached	71
Townhouse, end unit	4
Total	**150**

Each REM/Rate file was used in conjunction with REM/Design v15.1 to the sample of P homes against multiple baselines. The analysis allows for the P home to be redesigned within REM/Design to match the requirements of various codes, such as IECC 2009. This process was driven entirely by the REM/Design software; the evaluators did not alter or modify any of the original modeling files. Each home within the batch analysis was modeled to comply with:

- **The as-built conditions –** This reflects the original REM model as submitted by the HERS rater to the utility at project completion. ENERGY STAR v3.0 is the minimum threshold for eligibility, and many of the P homes exceed the minimum requirements of ENERGY STAR v3.0.
- **ENERGY STAR v3.0 –** Each home was redesigned within REM/Design to meet ENERGY STAR 3.0 minimums.
- **ENERGY STAR v3.1 –** Each home was redesigned within REM/Design to meet ENERGY STAR 3.1 minimums.
- **IECC 2009 –** Each home was redesigned within REM/Design to meet IECC 2009 minimums.
- **IECC 2015 –** Each home was redesigned within REM/Design to meet IECC 2015 minimums.

The modeling runs were then exported to a Microsoft Access database and Microsoft Excel for review and analysis. The results for this review are presented in Section 6.

3.5 On-Site Methodology

This section discusses the methodology of the on-site activities.

3.5.1 Overview

On-site visual inspections were planned to assess the veracity of input values used in the final REM/Rate model and to interview the homeowner on their use of and satisfaction with the home. Metering of end uses was not part of the scope of work and no metering of subsystems was performed.

A random sample was selected from projects with billing data (about 53% of the projects). and was further segmented to provide coverage of each utility and for single-family and multifamily building types. The sample was designed to meet ±10 relative precision in the 90% confidence interval using modeled energy savings as the target variable. The sampling precision is somewhat irrelevant, as the information gathered during the site visits does not influence the results of the impact evaluation, which are based on the billing analysis. The sample resulted in a target of 47 home visits, 19 multifamily and 28 single-family.

3.5.2 Recruiting On-Sites

Recruiting consisted of an advance letter sent by the Utilities (or by the evaluators on behalf of the utility) followed by telephone calls and emails where email addresses were available for the targeted homes. There were two occasions where homeowners offered to contact their neighbors to encourage their participation in neighborhoods with more than one targeted home. The evaluators did not request this peer-to-peer outreach but did accept it when it was offered. Gift cards were offered to encourage participation, although many homeowners chose not to accept, even when they permitted the inspection.

The evaluators ultimately contacted or attempted to contact 98 homes, and were able to complete site visits at 30 homes before schedule and budget constraints curtailed the on-site activities. Further information on outreach and dropped sites is provided in Section 6.

3.5.3 On-Site Activities

The on-site activities consisted of a visual inspection of physical systems and a homeowner interview. The visual inspection was performed to verify the input values used in the submitted REM/Rate file and the homeowner interview sought to characterize the occupant experience with the home, their use of the home, any changes made to the home since its construction, and to identify any unusual or large plug loads that may impact energy use.

A report detailing the physical systems as modeled for the inspected home was generated in REM/Design directly from the REM/Rate modeling file and was used as the primary data collection tool for comparing model inputs to on-site observations. A 12-question survey was fielded as part of the homeowner interview, although discussions were not limited to those items found on the survey instrument.

The observations and findings related to the site inspections are provided in Section 6.

SECTION 4: IMPACT EVALUATION RESULTS, FINDINGS, AND RECOMMENDATIONS

The section presents the results and findings from the impact evaluation.

4.1 STATEWIDE ENERGY SAVINGS RESULTS

Table 4-1 summarizes both primary (incented fuel) and ancillary energy (non-incented fuel) savings impact evaluation results.

Table 4-1. ENERGY STAR Homes Program Impact Evaluation Results (2014–2015)

Statewide Energy Savings	Program Primary Tracking Savings	Realization Rate	Evaluated Savings	Relative Precision (90% CI)
Primary electric energy (kWh/yr)	2,781,796	57%	1,578,256	13%
Primary natural gas (MMBtu/yr)	3,718	24%	881	11%
Ancillary electric energy (kWh/yr)	87,606	57%	49,935	13%
Ancillary natural gas (MMBtu/yr)	6,131	24%	1,471	11%
Ancillary propane (MMBtu/yr)	11,874	24%	2,849	11%
Ancillary fuel oil (MMBtu/yr)	446	24%	107	11%
Ancillary wood (MMBtu/yr)	731	24%	175	11%

The precision results of the impact analysis fell slightly short of the precision targets of ±10% at the 90% confidence interval.

The contributions of the single-family and multifamily homes to the final evaluated savings are illustrated for the electric program and the gas program in Table 4-2 and Table 4-3, respectively. Note that since the

same realization rate is applied to each fuel type, the subsector contribution to savings is a function of tracking savings.

4.1.1 Single-Family Savings Results

The single-family results are presented in Table 4-2.

Table 4-2. Single-Family Savings Results

Single-Family	Electric Program Homes			Natural Gas Program Homes		
	Program-Tracking Savings	Statewide Realization Rate	Evaluated Savings	Program-Tracking Savings	Statewide Realization Rate	Evaluated Savings
Total number of homes constructed (P and NP)	1,286	N/A	N/A	1,028	N/A	N/A
Number of P homes	279	N/A	N/A	21	N/A	N/A
Primary electric energy (MWh/yr)	1,673	57%	954	N/A	N/A	N/A
Primary natural gas (MMBtu/yr)	N/A	N/A	N/A	1194	24%	286
Ancillary natural gas (MMBtu/yr)	1,056	24%	253	0	57%	0
Ancillary propane (MMBtu/yr)	9,731	24%	2335	0	N/A	0
Ancillary fuel oil (MMBtu/yr)	95	24%	23	0	N/A	0
Ancillary wood (MMBtu/yr)	294	24%	71	0	N/A	0

4.1.2 Multifamily Savings Results

The multifamily results are presented in Table 4-3.

Table 4-3. Multifamily Results

Multifamily	Electric Program Homes			Natural Gas Program Homes		
	Program-Tracking Savings	Statewide Realization Rate	Evaluated Savings	Program-Tracking Savings	Statewide Realization Rate	Evaluated Savings
Total number of homes constructed (P and NP)	792	N/A	N/A	229	N/A	N/A
Number of properties	20	N/A	N/A	21	N/A	N/A
Number of P homes	633	N/A	N/A	N/A	N/A	N/A
Primary electric (MMBtu/yr)	1,109	57%	632	N/A	N/A	N/A
Primary natural gas (MMBtu/yr)	N/A	N/A	N/A	2,525	24%	606
Ancillary electric energy (MWh/yr)	5,075	57%	2892	68	57%	39
Ancillary propane (MMBtu/yr)	2,142	24%	N/A	N/A	24%	N/A
Ancillary fuel oil (MMBtu/yr)	351	24%	N/A	N/A	24%	N/A
Ancillary wood (MMBtu/yr)	438	24%	N/A	N/A	24%	N/A

4.1.3 Program Savings by Program Administrator

The program savings by program administrator were calculated by applying the fuel realization rate to the utility tracking savings. The statistics did not support reporting precision by individual utility. Program savings by utility are summarized in Table 4-4.

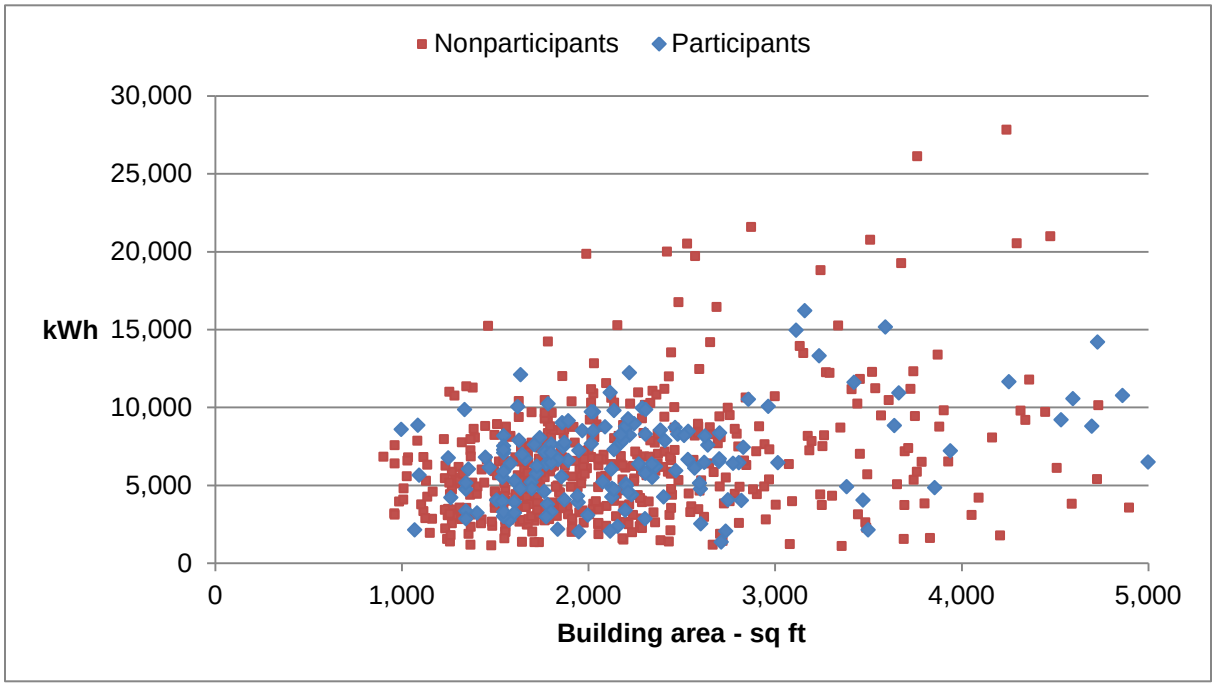
Table 4-4. Program Savings by Utility

By Utility Energy Savings	Eversource		NHEC		Liberty		Unitil	
	Tracking	Evaluated	Tracking	Evaluated	Tracking	Evaluated	Tracking	Evaluated
Primary tracking electric energy (kWh/yr)	2,299,816	1,310,895	229,370	130,740	16,080	9,165	236,530	134,822
Primary natural gas (MMBtu/yr)	N/A	N/A	N/A	N/A	1,729	415	1,989	477
Ancillary electric energy (kWh/yr)	N/A	N/A	N/A	N/A	24,435	13,876	63,171	36,007
Ancillary natural gas (MMBtu/yr)	6,131	1,471	N/A	N/A	N/A	N/A	N/A	N/A
Ancillary propane (MMBtu/yr)	9,281	2,227	434	104	1,103	265	1,056	253
Ancillary fuel oil (MMBtu/yr)	446	107	N/A	N/A	N/A	N/A	N/A	N/A
Ancillary wood (MMBtu/yr)	612	147	N/A	N/A	N/A	N/A	120	29

4.2 ADDITIONAL OBSERVATIONS

An observation made during the utility analysis that is worthy of further discussion is the large variability in energy use for homes of any given size. Figure 4-1 plots the billed electric energy use for fossil fuel heated P and NP homes for all accounts with 12 months of billing data between 4/1/15 and 3/31/16.

Figure 4-1. Plot of Billed Annual kWh from 4/1/15-3/31/16 vs. Building Area for P and NP Homes Using Fossil Fuel Heat



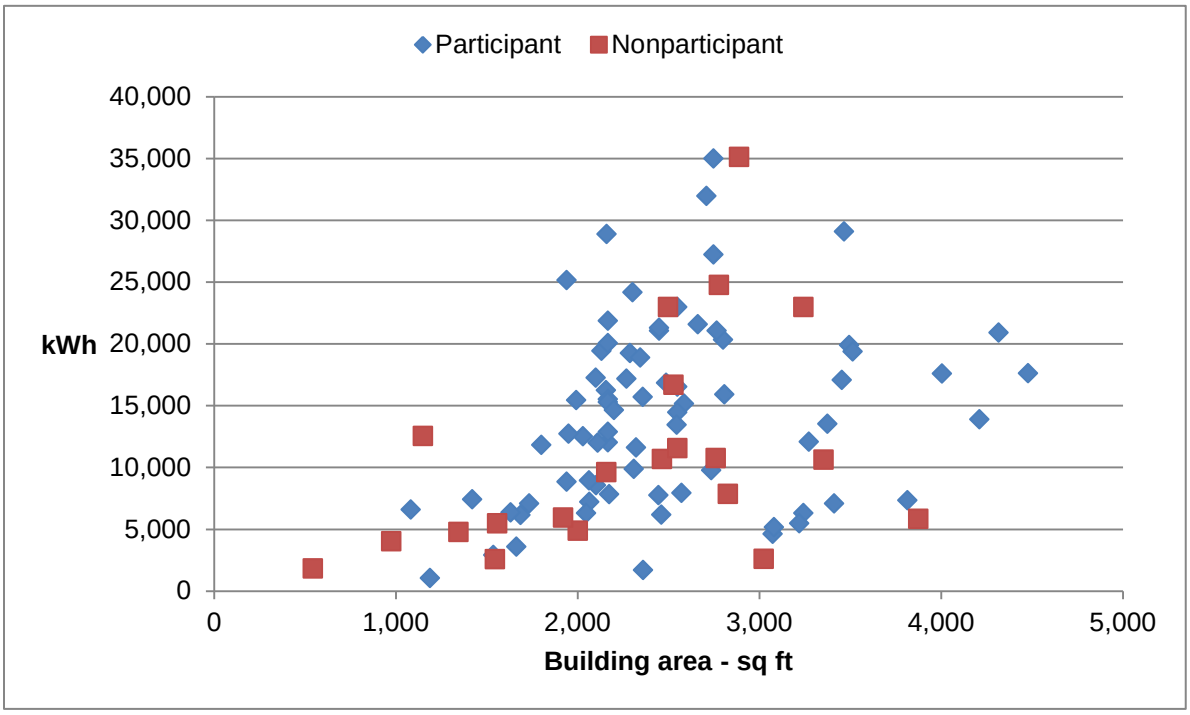
Within the building area range of 2,000 to 2,500 ft^2 for P homes, annual kWh use ranges from approximately 2,300 kWh to 12,600 kWh. For NP homes, an even greater variance can be observed with a low of approximately 2,000 kWh per year to a high of over 20,000 kWh per year. This type of variance is not uncommon for residential energy use[15]. So, while the Program is facilitating the construction of energy efficient homes (discussed further in Section 6), there is substantial variation in actual energy use

[15] As noted by Robert Kasman, "All [evaluation] methodologies are challenged if large behavioral variation exists. Variations of usage of 3x to 6x are common, and as much as 100x have been observed in residential projects." See Kasman, Robert, *Lessons Learned in Selecting Impact Evaluation Methodologies: Metering, Modeling, or Billing Analysis?* 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

due to factors beyond the control of the Utilities, primarily the occupant characteristics and their use of the home.

Figure 4-1 above also provides visual representation of the findings of the utility analysis and supporting statistics: the P and NP populations are nearly indistinguishable from the standpoint of energy consumption. Both P and NP markers are widely scattered and occupy the same territory on the plot. Although there are fewer data points, plotting the data for electrically heated homes provides a similar outcome, as shown in Figure 4-2.

Figure 4-2. Plot of Annual kWh vs. Building Area for P and NP Homes Using Electric Heat



4.3 RECOMMENDATIONS

The recommendations associated with the impact evaluation concern both the UDRH and the Program requirements for eligibility. The evaluators recommend adopting IECC 2009 as the UDRH, which is discussed in detail in Section 6, and increasing the HERS index score required for qualify as a participant in the Program.

SECTION 5: PROCESS EVALAUATION RESULTS, FINDINGS, AND RECOMENDATIONS

As the ERS team conducted interviews and mined the program data, there were certain recurring themes that presented themselves. These themes were organized into six key findings that incorporate all the data collected throughout the evaluation effort:

1. The ENERGY STAR label is the trusted key to the Program's identity, but it comes with some challenges.
2. Benefits, motivations, requirements, and costs differ dramatically among the Program's major actors.
3. Barriers to HVAC contractor participation represent a major impediment to the Program's growth.
4. The Program uses mostly direct outreach to recruit builders, supplemented by utility-sponsored training and some traditional marketing techniques.
5. Overall, the Program management is effective, with a few opportunities for small internal tweaks.
6. The Program will need to expand under EERS, but there are mixed opinions on how to do so.

This section is arranged along these six findings, with subsections for each containing all of the relevant data and further information. These sections also include associated recommendations with thoughts on how to implement them, as well as potential benefits of making the program change. Overall, the evaluation found that the utilities' management of the Program is effective, with small opportunities for improvement. The bigger issues faced by the Program are considering updates to ensure that the Program results in energy savings above the state's current baseline (as detailed in the impact evaluation findings) and overcoming challenges with the ENERGY STAR requirements for certain stakeholders in order to increase participation.

5.1 ENERGY STAR FRAMEWORK

Finding #1: The ENERGY STAR label is the trusted key to the Program's identity, but it comes with some challenges.

The Utilities adopted the EPA's ENERGY STAR Homes program nearly 20 years ago and have certified more than 6,600 homes through the Program over the last decade.[16] Utilizing the ENERGY STAR framework for the new construction program provides several benefits. The label itself is nationwide, easily recognizable, and trusted by homeowners. The ENERGY STAR label also benefits builders and HVAC contractors via the certification, which is a major motivator for companies that want to differentiate themselves from their competition and demonstrate that they build quality homes and systems. From a program design perspective, since the framework, requirements, and all associated components (like the certifications) have already been designed, it allows the utility to proceed straight to implementation. Because of the nationwide reach, it also provides a platform where New Hampshire can be recognized at a national scale for their efforts. NHSaves has received a Partner of the Year award from the EPA every year since 2013, of which they are justifiably proud. Chinburg Properties, an ENERGY STAR certified builder that has participated in the NHSaves program for years, also received the Partner of the Year Award in 2016.

While the ENERGY STAR Program is recognizable, the one-size-fits-all-states design also creates challenges and prevents the Utilities from making changes to the requirements to meet their unique needs. Climate variations across the country lead to different practices in building design, which is especially true for HVAC equipment design and sizing. Two builders and HVAC contractors commented on the fact that the stringent sizing requirements for cooling were designed for hotter climate zones, where some of the biggest home building markets can be found, but these do not accommodate colder markets. One home builder commented that the heating and cooling sizing for heat pumps was not appropriate for the Northeast since heat pumps are generally sized for the heating load, which often leads to an oversized unit for the cooling load that the ENERGY STAR program penalizes them for.

The EPA updates the requirements periodically to respond to increases in the general market's efficiency (i.e., due to code improvements). The changes are beneficial, as they continue to push the market towards the best building practices and ensure that the label and its participants continue to maintain an "elite" status, one of the major motivators for builders and HVAC contractors to participate. The most recent major update was Version 3.0, which went into effect in 2012. Similar to what happens after a state adopts a stricter energy code, the requirements become more challenging for the participants to meet, which was certainly the case with the Version 3 update.

[16] New Hampshire CORE Energy Efficiency Team profile on the ENERGY STAR website: https://www.energystar.gov/about/content/new_hampshire_core_energy_efficiency_team

The Version 3 changes – which included more stringent technical and administrative/reporting requirements – have become a focal point of dissatisfaction for many participants. In particular, the increased requirements on the HVAC contractors (which will be covered in Section 5.3) were deemed by many to be too onerous, and consequently many contractors left the Program, sometimes pulling their builders out as well. One interviewee stated that the Version 3.0 update "slowed down the appetite for [ENERGY STAR] homes" based on the perception that the program was much more challenging now. In response to the requirements, Massachusetts' Mass Save and Connecticut's Energize CT both pulled out of ENERGY STAR to instead include an above-code option for residential new construction.

The nationwide program requirements can also be prescriptive. This makes the program far more accessible and scalable, but the participants sometimes think that the specific requirements are too strict. These perceptions must be considered in context, as the Program's incentives are provided to offset some of the extra effort required to build a high-performance house and meet the requirements. Some of the requirements that builders and HVAC contractors were unhappy with included:

- A prohibition on oversizing heating or cooling equipment to meet a customer's comfort requirements
- The inability to size HVAC to accommodate for extra square footage from future additions to a home
- Challenges with sizing heat pumps to heating vs. cooling loads (see home builder comment above)
- A perception that large homes over a certain square footage are penalized within the program
- Kitchen ventilation requirements that are hard to meet without over-ventilating

These, as with most of the requirements, are mostly out of the control or influence of the Utilities (although the Program team continues to meet regularly with the EPA to provide feedback). These challenges are balanced with the benefits provided by the ENERGY STAR framework. At this time, NHSaves still considers the benefits as outweighing the costs – although the utilities, HERS raters, builders, and HVAC contractors have all noted in some way that they continue to monitor the Program and weigh the costs and benefits of participation.

5.2 STAKEHOLDER PARTICIPATION EXPERIENCE

Finding #2: Benefits, motivations, requirements, and costs differ dramatically among the Program's major actors.

The ENERGY STAR framework is complex in terms of the number of different stakeholders that are involved in each new construction project. Each of those actors, while they have some requirement placed

on them by ENERGY STAR, also have very different goals or motivations that can impact how they interact with the program. Likewise, the costs and benefits are not spread equally across those stakeholders. This ties in to one of the major research questions presented by the NHSaves team, which was, "Are the utilities, home builders, and HVAC contractors delivering and receiving the benefits of the program?" Table 5-1 provides a view of these differences across three factors: benefits delivered (essentially the requirements), benefits received, and costs incurred.

Table 5-1. Benefit/Cost Matrix

	Benefits Delivered	Benefits Received	Costs Incurred
Utility	● Incentives ● Trainings ● Contracted HERS rater ● Outreach and education	● Energy savings towards program and utility goals ● Customer relationship with the utility ● National recognition by EPA ● Contributing to moving the housing market towards efficient design	● Incentive costs ● Additional training costs ● Program staff time
HERS Rater	● Outreach and education ● Home rating services ● Recommendations on building systems ● Final home certification	● Payment for 3 steps of process ● HERS rating work ● Lead generation (through outreach) ● Trust of builders, HVAC contractors, and other industry partners	● HERS Rater Certification: $1,200–$2,500 ● Annual HERS Fee: $250–995/year ● REM/Rate per project fee ● Cost of annual continuing education units (CEUs) ● Time spent with builders who do not complete participation ● Additional time spent with contractors for education or tracking down reports
Builder	● Home that meets ES standards ● Any necessary reporting	● Program incentive – up to $4000 per home ● HERS rater services for free (value of $1300) ● Certification as a distinguishing characteristic, proof to customers of home quality ● Additional selling point to customers ● Education on best practices	● Additional cost of more efficient materials ● Extra time spent to ensure that homes meet requirements ● Additional cost of certified HVAC system ● Additional cost to find a certified HVAC contractor (if needed)
HVAC Contractor	● HVAC system that meets Program standards ● All necessary reporting	● Ability to work on certified homes with builders ● Certification as a distinguishing characteristic, proof to customers of home quality ● Pass-through of incentive/ability to charge more for system	● ES certification costs: $600–$900 ● AE/ACCA annual fees: $600–$800) ● Extra cost of HVAC system ● Extra time for sealing to ES requirement ● Extra administrative time for reporting
Homeowner	● Demanding a certified home that the utilities can claim savings on ● Moving the market by purchasing a certified home	● Home that meets Program standards ● Energy bill savings ● Peace of mind on quality, savings, comfort, durability, value	● Incremental cost of home

While the benefits are often substantial enough drivers to keep the entity participating in the Program, they are harder to quantify than the costs. The costs, meanwhile, are fairly concrete and can vary widely by participant. One of the major costs that differ most between stakeholders is EPA's ENERGY STAR certification requirements, which vary greatly and are generally seen as burdensome.

- **HERS raters** have the strictest requirements, which are justifiable, as they are ultimately responsible for certifying performance and compliance and therefore must be experts on all aspects of the Program requirements and efficient building practices. They are seen as a resource and are often called upon to provide education to participants. HERS raters are certified by the national organization Residential Energy Services Network (RESNET) and are required to complete a 5- to 8-day course, earn 80% or better on the final exam, obtain a recertification each year, and complete 18 continuing education units (CEUs) every 3 years.
- **Builders** must complete a free, online, 1-hour course. This is a relatively low barrier to entry, which is important since some homeowners may be acting as their own general contractor and will not have the expertise, patience, or need to go through a more rigorous certification. However, this does mean that first-time builders often rely heavily on the HERS rater to provide additional education.
- **HVAC contractors** have numerous requirements that are frequently described as a major barrier to entry and continued participation (discussed more in Section 5.3). Certification is managed by two national organizations, Air Conditioning Contractors of America (ACCA) and Advanced Energy (AE). To be certified an HVAC contractor must attend in-person training or take an online course, pass a 100-question exam, and renew their credentials annually. The requirements under ACCA and AE are similar; however, the annual fees and guidance provided differ slightly between organizations.

While certification may represent an initial hurdle to entry, it is a key part of the ENERGY STAR Program to ensure the quality of certified homes. As with other costs, the requirements are balanced by the benefits received by participating in the Program and the incentives the Program offers to directly overcome some of the costs.

Participant Feedback

During the interviews and surveys, the stakeholders and homeowners were invited to provide their perspectives on their experience with the Program. This included everything from how they initially heard

about the Program, why they were motivated to participate, what the certification process looked like, whether there were any challenges, how they interacted with the other stakeholders, how satisfied they were with the Program overall, and more. Many of these topics are discussed in other findings where they are most relevant. For the sake of completeness, however, takeaways not included in other sections are described here, including stakeholder and homeowner motivations, characteristics of builders and HVAC contractors, and satisfaction.

Motivations and Goals

Stakeholders who were interviewed offered their perspectives on their motivation to participate in the Program:

- **HERS rater** – Raters tended to focus on an overall desire to move the market towards deeper levels of efficiency and to improve building practices. Additionally, they are looking to gain additional HERS rating work, perform the home rating process as efficiently as possible, move homes into the ENERGY STAR program so that they can be rated, and develop builder/contractor relationships.
- **Builder** – Six builders (including two former participants) stated some variation on the desire to be an energy-conscious builder and improve their building practices. Two builders consider participation in the program to be "one of their tools to sell homes." One builder became involved with the program when asked to participate by their client, a homeowner. Other motivations that contribute to their participation include minimizing callbacks, distinguishing themselves from other builders, and being able to build a better-quality home – with the overall goal of building and selling enough homes each year to meet the company's needs.
- **HVAC contractor** – The six HVAC contractors interviewed were split evenly when asked what their primary motivation was to participate in the program. Three contractors prioritized the participation because it distinguished from them other contractors, and the other three contractors were primarily motivated to participate in order to build better-quality home. Other motivations include being able to generate business and minimizing callbacks.
- **Homeowner/home builder** – The four homeowners who were also acting as the general contractor for their home were also evenly split: two said that the incentive made the additional quality feasible, and the other two wanted to learn how to build a higher-quality, more comfortable, more efficient, and more cost-effective home. All were looking to minimize the costs of building, owning, and maintaining their homes.
- **Homeowner motivations –** Nearly two-thirds of the 30 homeowners/tenants surveyed during site visits stated that energy efficiency factored in to their decision when purchasing/renting the

home. Nearly the same amount (59%) stated that the ENERGY STAR certification was very important in their decision. Over half of respondents saw the cost savings as a major benefit, with a comfortable and tight home referenced as the second-most important benefit. However, there were five respondents (15%) who thought that their home wasn't actually more efficient – it just cost more to build.

- **Builder and contractor characteristics** – The Program's participants come from different segments of the industry and locations. Six of the nine builders and four of the six HVAC contractors interviewed have participated with the Program through multiple utilities, as well as in multiple energy efficiency programs with the Utilities. All but one of the builders had been participating in the Program for 10 years or more (some since the advent of the Program), whereas the homeowner/home builders were all first-time builders/participants. Six builders build solely custom homes and one builds spec homes for developers. The characteristics of the builders' clientele also vary substantially, ranging from retirees to individuals looking to downsize from their previous home, and from organizations like Habitat for Humanity to developers.
- **Program satisfaction –** The Program received high marks from the participants, even from those who are no longer participating in the Program. On a scale of 0 to 10, with 10 being very satisfied with the Program, builders answered between 7 and 10, HVAC contractors between 7 and 9, and homeowners/home builders between 9 and 10. Interestingly, the highest rating from a builder came from a company that left the Program due to an inability to find a certified HVAC contractor to work with.

Overall, the stakeholders and homeowners were very positive about their experiences in the program; almost all participants mentioned that the program runs efficiently and that the Utilities' management of the Program is very effective. Program participants also said that they were provided with enough information when starting off, and one builder described the requirements as "fairly painless."

Participant Suggestions

Participants were also active in providing suggestions for the Program. While all stakeholders provided high satisfaction ratings for the Program, they recommended a variety of possible revisions. The 17 participants (builders, HVAC contractors, and homeowner/home builders) interviewed offered a total of 23 suggestions, which fell into five categories, as shown in Table 5-2 below.

Table 5-2 provides a description of each category and the number of responses for the interviews.

Table 5-2. Participant Suggestion Types and Descriptions

Category	Number	Description
HVAC requirements	7 (30%)	Participants thought that the program requirements for HVAC were too strict. Some of the specific suggestions included: • Allow for different requirements based on climate zone. • Eliminate the HVAC certification requirement, or choose between the HVAC certification requirement and the HVAC inspection requirement. • Make the certification process easier/the program guidelines less strict. • Allow for some oversizing of heating and cooling equipment to meet the customer's comfort requirements or plans for future additions.
Education and Program awareness	6 (26%)	Participants provided a variety of perspectives on how marketing could be done to increase education and program awareness. Specific suggestions included: • Spend more time marketing the Program and its benefits to homeowners, especially those considering building their own homes. • Partner with municipalities to have them promote the Program locally. • Ensure that participants are up to date with program standards. • Produce an easy-to-find checklist and provide videos to show building techniques and best practices for participants. • Consider training collaboration opportunities between the HERS raters and HVAC contractors.
Project management	5 (22%)	Participants commented on opportunities for communication, feedback, and reporting. Some of the specific suggestions included: • Have the HERS raters communicate more with HVAC contractors early in the process. • Create a forum for participants to share feedback on the Program, the certification process, and building practices. • Create a checklist for all parts of the program so that participants are aware of all requirements (application, reports, etc.). • Decrease the reporting requirements on HVAC contractors, or hire a HERS rater to do some of the paperwork.
Program structure	4 (17%)	Participants provided several comments related to the program's structure and management. Some of the specific suggestions included: • To allow for more certainty for planning purposes, alter the funding model so that there is not a gap of several months where no homes can apply if funding is exhausted before the end of the year. • Create an "ENERGY STAR-plus" option to promote building a house above and beyond the current efficiency requirements. • Should program requirements change again, requiring even more rigorous certification, inspections, or documentation, consider ways to spread the increased compliance requirement deadlines over time rather than all at once (to essentially spread incremental costs over a greater period). • Increase the incentives to increase participation.
Other	1 (4%)	One builder asked if the utility could prioritize ENERGY STAR homes in the queue to receive new electricity and gas service.
	23 (100%)	

Several of the participants' suggestions are requests to decrease some of the program's requirements, which is understandable from their perspective but not possible to directly address without putting the Program out of its compliance with the ENERGY STAR framework (although indirect means of circumventing the barriers are still within the control of the program, as discussed more in Recommendation #1 below). The program requirements exist to ensure that homes are being built to a high level of quality and efficiency, and while the customer would prefer if they could receive the incentive with minimal additional effort, the goal of the program is to push the market, and that takes effort.

However, some of the requests, particularly around education and marketing, are within the control of the NHSaves team. The most relevant recommendations are covered in subsequent sections.

5.3 HVAC CONTRACTOR PROGRAM ROLE

Finding #3: HVAC contractor participation represents a major barrier to the Program's growth.

One of the most visible challenges the Program faces concerns the requirements for HVAC contractors, which became evident very early in the evaluation process. Since HVAC equipment is a significant part of a home's energy use, there are strict requirements for HVAC systems under the program, including that any house installing a forced air/ducted system requires an ENERGY STAR-certified HVAC contractor. The certification process, as described in Section 5.2, is fairly involved. In addition, the Version 3.0 updates added several requirements to the HVAC contractors' scope of work in terms of building practices and reporting. After the Version 3.0 update, many HVAC contractors started dropping out of the program, sometimes bringing builders with them.

The evaluation team interviewed four certified HVAC contractors, as well as two who had formerly participated in the Program, to assess the barriers they faced. Several other stakeholders, including builders, also commented on the feedback they had received from HVAC contractors. Ten barriers were cited in the interviews, shown in Table 5-3. Interestingly, no two contractors identified the same barrier as their biggest challenge.

Table 5-3. HVAC Contractor Barriers to Participation

#	Type	Description
Certification Requirements		
1	Certification requirements	As discussed in Section 5.2, HVAC contractors have a demanding certification process that includes taking an initial exam, renewing their credentials annually, and paying certification fees.
2	Membership fees	There is a one-time participation fee at the time of certification ($600 to $900) and an annual membership fee ($600 to $800). The fees may have decreased somewhat, as the numbers listed on the ACCA and Advanced Energy websites are lower than the numbers provided through interviews.
3	Annual certification renewal	HVAC contractors must "conduct an annual reevaluation of compliances with the QA [17]
Program Requirements		
4	QA requirement	The certifying organization (ACCA or Advanced Energy) may also run a desk review or some percentage of each contractor's paperwork. It appears that these requirements may have been relaxed somewhat, according to contractors, which they appreciated.
5	Paperwork and reporting	ENERGY STAR adds documentation requirements on top of the contractor's work. The amount of paperwork required by the Program, especially since the Version 3 update, was frequently mentioned in the interviews. In particular, the pre-installation checklists and the final design report were mentioned as onerous to document, even if the contractor was already doing the work. A few contractors either charge their builders extra for the added scope of work that is the paperwork or are looking for ways to have another party (such as the HERS rater) complete the checklists and report.
6	Design requirements	The Program has some prescriptive requirements regarding equipment sizing that HVAC contractors feel are too strict (i.e., the system cannot be oversized for an owner's comfort requirements or to accommodate for future home additions).
Costs vs. Benefits		
7	Lack of benefits	There are not many major benefits to being an ENERGY STAR certified HVAC contractor besides the ability to participate in the Program ("pay to play"). The only other identified benefit is that the certification sets the contractor aside as a high-quality contractor. If there was more of a benefit to balance out the costs, the Program would seem more appealing.
8	Lack of incentives	The Program incentive is generally paid to the builder, not the HVAC contractor, and as the incentive amount has decreased over time (and some HVAC-related incentives have also been discontinued or decreased) while requirements have increased, they feel squeezed to complete the jobs.
9	Additional time/cost	HVAC contractors mentioned the additional time spent on-site (and therefore additional cost), including for testing, follow-up site visits, and meeting all program requirements. The extra time to seal the ductwork was mentioned in particular. One HVAC contractor estimated that it cost $1,500 more per home for the HVAC system to be certified as ENERGY STAR.

[17] ACCA, "Contractor Requirements," accessed from their resources page here: http://www.acca.org/qa/resources.

#	Type	Description
Management		
10	Communication from HERS raters	Some contractors complained that they did not hear from the HERS rater early enough in the process or enough throughout and received comments and recommendations too late. Additionally, they wanted additional guidance on all of the paperwork requirements (especially when those requirements change, as with the transition to version 3.0).

HVAC contractors who remained in the Program cited similar barriers; however, they noted that the ability to work with certain builders, the education provided on how to build a better-quality system and the differentiation that the ENERGY STAR HVAC certification provides within the market are enough to convince them to stay in the Program. Of the four participating contractors interviewed, two said that the primary benefit was the education and two said the differentiation within the market was the primary benefit. Most feel somewhat neutral about participating. However, some felt that their work on ENERGY STAR jobs was overall break-even, and half said they design to a similar standard regardless of Program participation, just without the extra reporting requirements and costs (two HVAC contractors interviewed self-reported that they build almost 100% of their homes to ENERGY STAR standards, but not all are certified; one contractor has 10%–20% of his homes certified through the Program, and one has 5% certified).[18] HVAC contractors who had left the program said that the costs outweighed the benefits. Interestingly, despite the barriers, all six contractors gave the Program high marks; on a scale from 0 to 10, the two former participants rated the Program as a 7, and the current participants gave between 8 and 9.

These barriers and contractors' perceptions of them have had considerable impacts on the Program, as contractors have pulled out of the Program, new contractors have been unwilling to consider certification, builders are opting to install non-ducted HVAC systems to circumvent the lack of certified HVAC contractors, and participants continue to grapple with certain requirements.

Program participation – The lack of HVAC contractors can affect the ability of builders to participate in the Program. There are several reasons for this. First, builders often have existing relationships with their HVAC contractors, and if the HVAC contractor no longer chooses to participate, they may pull the

[18] Note that these are self-reported numbers to the question "What percentage of your homes are built to ENERGY STAR standards, and what percentage go on to be certified through the ENERGY STAR program?" Respondents may have interpreted "ENERGY STAR standard" in different ways, however.

builder out of the Program with them. Second, there are no certified contractors in the northern and western areas of the state, meaning that builders in those areas who want to build houses with ducted systems must pay more to have a non-local contractor work on the home, or they cannot participate in the Program at all. Both builders who formerly participated in the Program left because they could not find a certified HVAC contractor to work with; both stated that they would rejoin if they could find one. One of the builders even asked about the ability of his company to become certified in the ENERGY STAR HVAC requirements instead of the contractor.

Program pipeline – Given the perceptions of the Program requirements and barriers, it is very difficult to convince new HVAC contractors to become certified. Builders noted that recruiting new contractors has been difficult because the certification requirements are a major barrier to entry. One builder mentioned that they are aware of many HVAC contractors who are capable of building to ENERGY STAR but will not go through the process of enrolling in the Program.

Market for HVAC – Due to the difficulty of finding a certified HVAC contractor, some builders have changed their practices and moved towards ductless systems, which do not require a certified contractor. Out of the seven participating builders interviewed, three use ductless systems to avoid having a certified ENERGY STAR contractor, while the remaining four have certified HVAC contractors whom they work with.

Logistics – HERS raters noted that the reporting requirements often hold up the overall program process and add additional costs and administrative tasks. Contractors dislike the checklists and design reports and may not fully understand all of the requirements (or forget about them); the HERS raters sometimes must track down the reports or require additional data from the contractors. One rater said that receiving all of the documentation from the HVAC contractor is one of the more challenging and frustrating parts of their process.

The Utilities have been monitoring the situation for the past several years and have shared many of their concerns with the EPA, the Agency that created and oversees the ENERGY STAR program, including the ENERGY STAR residential new construction program. In response to concerns from program administrators around the country, the EPA has adjusted and relaxed some of the reporting requirements in subsequent updates. To date, the utilities have noted that they have still been able to meet their goals despite the challenges; however, they are concerned that they may not be able to sustain a program expansion under the 2018 Energy Efficiency Resource Standard (EERS) with the current project pipeline. They will need to recruit additional builders and contractors, which will mean overcoming some of the barriers described. This may involve re-engaging former participants, who will be reluctant to consider it given their past experiences, and reaching out to new HVAC contractors, who may balk at the considerable certification and

project documentation requirements. It will be important to convince both groups that there is a major benefit to participating in the Program, and that the benefit is enough to overcome the costs.

Several stakeholders requested that the Program drop the certification requirements for HVAC contractors altogether. This is not in the power of the Utilities to do without removing the Program from complying with the nationwide ENERGY STAR Program, nor is it necessarily advisable, as these requirements exist to ensure performance and quality. It will also remove the largest benefit cited by current participants, which is the certification as a designation of being a quality contractor. Instead, the Program can work to creatively overcome some of the existing barriers, as discussed in the following section.

Recommendations

ERS has developed one recommendation relating to the findings in this section.

Recommendation #1: Use outreach, education, and targeted incentives to overcome some of the major barriers to HVAC contractor participation.

To increase program participation the Utilities will need to provide HVAC contractors more tangible benefits to becoming an ENERGY STAR-certified contractor. To re-engage former participating HVAC contractors and to bring new contractors into the Program, the utilities should design a targeted campaign, which can include:

- **Outreach to HVAC contractors** specifically to discuss the program benefits, including the value of having the HVAC system's installation quality assured by the HERS rater's performance testing and the distinguishing designation of being an ENERGY STAR certified contractor. Other methods of outreach can also be used to raise awareness of the Program among the HVAC community. The direct dialogue will also build trust between the contractors and the utilities and will demonstrate that the utilities recognize and are attempting to mitigate the issues faced by the HVAC contractors.
- **Education** – Develop HVAC training programs that focus on the benefits of using more efficient practices as a way of engaging contractors. In-person sessions would be best to allow for face-to-face interaction and the ability for new contractors to gain perspectives and tips on best practices from those who are currently in the Program.
- **Targeted incentives** – Direct monetary incentives are a tool to overcome cost-related barriers. However, because incentives will potentially reduce the program's cost-effectiveness, they should be carefully considered. Such incentives could be used in three ways:

1. Pay for or partially offset certification cost (akin to how the utilities sponsored an in-person three-day certification training several years ago)
2. Pay for or partially offset the annual certification fee
3. Provide a small per-home incentive directly to the HVAC contractor

Since some of the largest barriers raised by the HVAC contractors were the time and cost associated with the HVAC certification and the ultimate home certification, the Utilities should use tactics that are most appropriate and effective in overcoming these barriers. The utilities can also consider the remaining barriers and assess which ones are most likely to decrease due to a utility intervention.

5.4 MARKETING AND OUTREACH

Finding #4: The Program uses mostly direct outreach to recruit builders, supplemented by utility-sponsored training and some traditional marketing techniques.

The ENERGY STAR Program team uses mostly direct one-on-one outreach to promote the offerings with some other marketing techniques. Education – ensuring that potential and active participants have a strong understanding of good efficient building practices as well as the Program requirements – also is very important for a program as complex as ENERGY STAR. This section provides a background on the methods used to market the program as well as education for builders.

Methods

The Program uses mostly direct communication to recruit participants and build relationships with them, which is very effective for this industry. Outreach is generally directed towards the builders, who are the stakeholders ultimately responsible for filling out the application and ensuring that the home can meet the Program's requirements. Both the utilities and the HERS raters are active in reaching out to builders. Some of their methods for generating leads for new builders include:

- ❑ Exhibitions at home shows
- ❑ Energy code training (discussed more below)
- ❑ Visits to homes under construction to speak with contractors, determine the builder responsible and attempt to contact them, or even tape a business card and a note to the house frame if no one is there
- ❑ Visits to town offices to review new building permits and any contact information
- ❑ Visits or calls to real estate offices to discover any new homes on the market

- Standing monthly calls with the builder community to share program updates and gather information about the market

In addition, the utilities do have some more traditional marketing materials that provide information on the program more generally to customers (and potential homeowners). These materials include:

- Flyers, including project case studies
- Brochures discussing the incentives
- Yard signs for newly certified ENERGY STAR homes
- YouTube videos on the program and on home case studies
- Short write-ups in utility newsletters and bill inserts

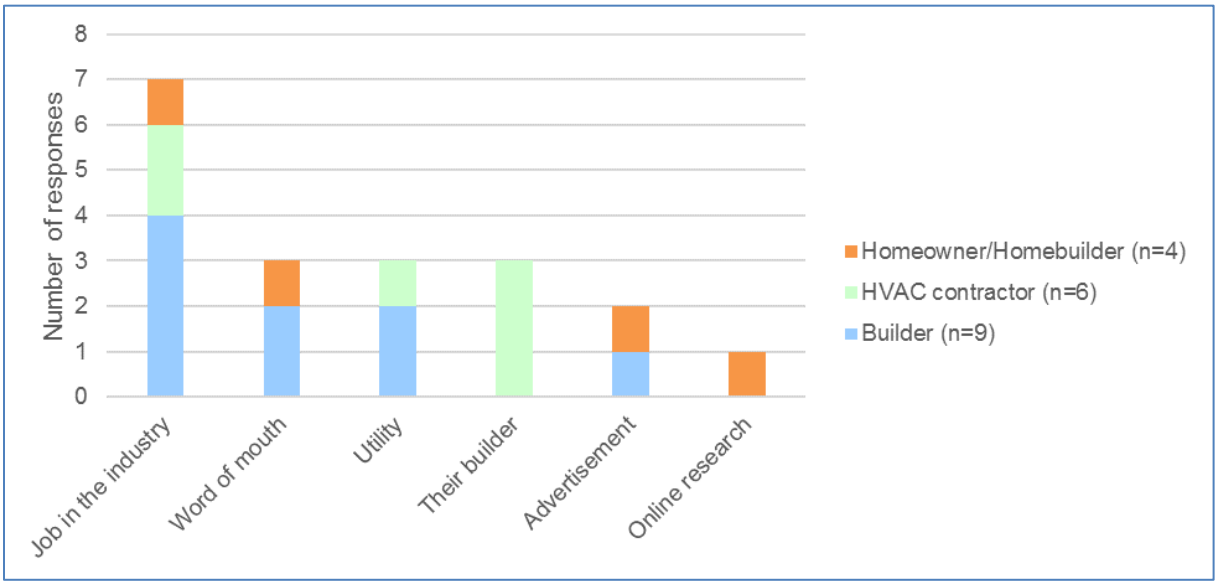
The overall Program strategy is very strongly geared towards recruiting builders, which does leave an opportunity for greater targeting of HVAC contractors (discussed in Section 5.3 above). One of the more challenging subgroups to reach and make aware of the program offerings is homeowners who are acting as the general contractor to build their own home (referred to throughout the report as homeowner/home builders). As many of these customers have not built a home before – or have built very few – they are harder to reach through the methods the utilities and HERS raters use to recruit builders. They also require more upfront education, which is discussed more below.

Outreach to the general homeowner population is achieved through write-ups in utility newsletters and bill inserts and by providing information on the NHSaves website, but it is less of a priority than reaching the builder population. Targeting this population would be a long-term way of driving participation by increasing the awareness and subsequently the demand for efficient homes; it is discussed more in subsequent recommendations.

Awareness

Participants reported a variety of methods that first alerted them to the presence of the Program, as shown in Figure 5-1.

Figure 5-1. Program Awareness Source – Stakeholders

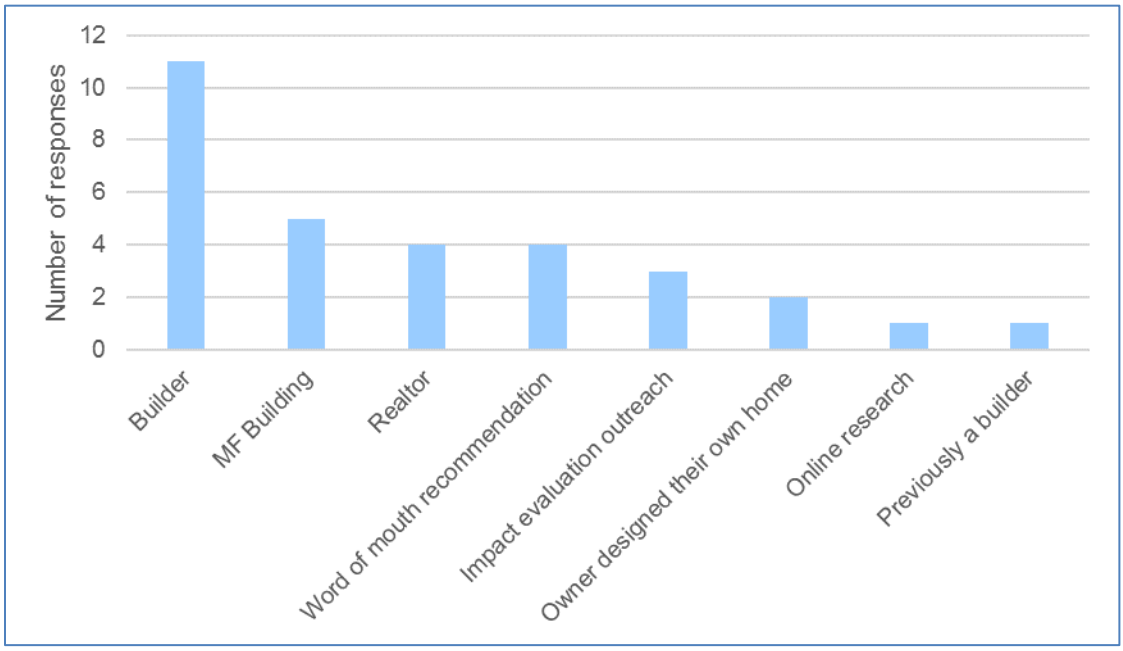


[1]Note: Builder and HVAC contractor populations include current participants and former participants (n=2 former participants for each).

A total of seven stakeholders (37%) became aware of the Program through previous work in the field, such as working for a builder, contractor, or supplier who built ENERGY STAR homes or components for one, or an energy efficiency course they had enrolled in. A word-of-mouth recommendation, a direct introduction by the utility, or a request to participate by the HVAC contractor's builder were the next most common sources, reaching 16% of interviewees each. Traditional advertising (i.e., through a bill insert) was cited by two participants.

The impact evaluation team also surveyed homeowners and tenants in ENERGY STAR homes on how they first became aware that their home or building was ENERGY STAR certified. The responses are shown in Figure 5-2.

Figure 5-2. Home Certification Awareness Source – Homeowners/Tenants



The most common way that the homeowner learned that their home was ENERGY STAR certified was through their builder – either in conversations when designing the home, on the builder's literature, or on the construction contract. Tenants in multifamily buildings generally heard about the certification when visiting the building. Three homeowners were unaware that their home was ENERGY STAR certified until the evaluators called to schedule a site visit. Note that three of the 31 respondents said that they were already aware of the ENERGY STAR certification and requested it for their home ("Owner designed their own home" and "Previously a builder").[19]

Education

Utility-sponsored education – such as the HERS rater-led code training – represents a way for the utilities to both market the ENERGY STAR program and educate builders about efficient building practices. There have been several one-off training opportunities offered as well, such as an on-site training/walk-through of participating ENERGY STAR homes, and a utility-sponsored HVAC certification where the utilities paid for Advanced Energy to provide the class in person in New Hampshire.

[19] The survey form did not assess what the original awareness source was for these three individuals.

There are varying levels of awareness of utility-sponsored training among the builders and HVAC contractors, and several felt that more frequent training sessions should be offered. Two-thirds (66%) of the nine builders interviewed said they had participated in at least one training session. HVAC contractors, on the other hand, had much lower attendance; only one of the six interviewed had participated in a utility-sponsored training session and two said they were unsure. The trainings were seen to be useful by those who had attended. One builder commented that one of the training sessions had discussed the program guidelines after the Version 3.0 updates and he had found that very valuable. Several of the builders commented on the frequency – one said that training had been offered more frequently in the past, and another thought he had been dropped from a distribution list since there had not been any recently.

The need for education is particularly important for any first-time builder, which can either be a builder working on their first ENERGY STAR home, or a homeowner who is acting as their own general contractor but who may not be as well versed in building practices – or as easily reached by the program's marketing and outreach.[20] Because these builders are starting at a lower level of awareness with regard to program requirements, education for first-time home builders takes substantial effort from the HERS raters, beyond what they typically anticipate and budget for. HERS raters noted that the process of educating a new builder can take twice as many hours per project than educating a builder with a few certified homes. Builders generally thought that they received enough information when they started participating in the program, including all four of the homeowner/home builders interviewed, mostly due to the effort put in by HERS raters and occasionally the utility. However, four builders and two HERS raters noted that the program and its requirements are rather confusing for a first-time builder, and having clear documentation like checklists would be beneficial.

Recommendations

ERS has developed four recommendations related to marketing feedback, most with the goal of creating additional marketing collateral and improving the methods that have already been developed.

[20] One of the homeowner/home builders illustrated this challenge in particular: "I didn't know about the program until I was two-thirds done [with the construction]. When I found the program [through an insert on one of my utility bills], I jumped on it to get some tips. It would have been helpful to be able to ask questions about energy efficient homes. For example, I didn't know about closed cell insulation. I was researching everything myself."

Recommendation #2: Consider other ways to use marketing collateral to supplement direct outreach, including online communication, press releases, and additional builder materials.

Other forms of marketing that the Program should take into consideration include:

- **Online communication** – If the utility has e-billing or sends out email newsletters, include a small insert on the ENERGY STAR program with the e-bill insert or mention it in the newsletter. Include embedded videos or links to the YouTube channel, as well as case studies.
- **Press releases –** Employ positive program interactions to work with the utility's marketing department and generate press releases. For example, the utility could use a press release to celebrate a Habitat for Humanity house participating in the program, which would generate good publicity for the Program, the utility overall, the builder, and the organization. This can also be done for something like a low-income multifamily building.
- **Additional builder materials –** Ensure that builders, HVAC contractors, architects, and other key groups have brochures on hand that they can provide to interested customers. It could also be helpful to create a "marketing kit" for builders that would include brochures, a summary on the Program that each can include on their website, and links to how to get the ENERGY STAR logo on the website. Only three of the seven participating builders interviewed advertised the ENERGY STAR Program on their website, and increasing exposure online could allow more builders, contractors, and homeowners to recognize the program.

Recommendation #3: Survey builders and HVAC contractors on the effectiveness of utility-sponsored training and what topics they would find most valuable.

Utility-sponsored training is valuable to both the participants and to the utilities – the participants receive no-cost or low-cost education and an opportunity to network with others attending, and the utilities get the opportunity to raise awareness of the program and to be seen as an ally, expert, and advisor. In designing future training sessions, it would be useful to first see what worked from previous sessions and what would be most valuable going forward. Builders had a fairly high participation rate in training sessions, while HVAC contractors did not. This provides an opportunity to target and interact more with HVAC contractors (which is also considered in Recommendation #1).

The Program should conduct a survey that includes both certified and uncertified builders/HVAC contractors, and those who have and have not previously participated in training. For prior attendees, the survey should collect feedback about the experience; for non-attendees it should determine what barriers

precluded them from doing so. For both, ask about what topics in the building world they are most interested in (or concerned about), and what kinds of utility-sponsored training they would be interested in. After the survey, consider opportunities to offer more training as a way of increasing awareness of efficient building practices and the Program at the same time. Finally, ensure that all interested and/or relevant parties receive notifications, through several media, if possible.

Recommendation #4: Develop materials to reach and educate first-time home builders and homeowner/home builders.

The program already provides resources for program participants to aid them in the Program's process, but many first-time home builders and homeowner/home builders have been unaware that those resources existed, or are unaware of their location. The program could provide several materials online to reach and educate these participants, such as:

- **FAQ list** – Create a document that lists some common questions that participants have when learning about the program and starting off. The answers could also call their attention to other available program resources.
- **Checklist** – Develop a checklist for builders that lay out all of the requirements in an easily understood format. One stakeholder envisioned this as a list that describes key steps to take and things to remember, as well as mistakes to avoid.
- **Brief training video**– Consider creating a short online training video for first-time builders, separate from the official ENERGY STAR certification. This would provide a visual version of the checklist or FAQ list to show tips when starting out, describe resources available to the builders, and answer some common questions.

Providing a little more information upfront, or resources that can be easily sent to potential participants, may decrease the amount of time the HERS raters spend bringing new participants up to speed.

There is also a longer-term question of how best to reach these first-time builders and homeowner/home builders, which were raised by multiple stakeholders, who wished that there was broader market awareness. The Program should consider developing an outreach plan to architects, real estate agents, and local energy committees or other municipal groups as a first step to create additional channels where first-time builders might hear about the program. Outreach to these entities will have the additional benefit of reaching prospective homeowners as well and adding allies who can market the Program.

Recommendation #5: Perform cross-marketing to owners of, or tenants in, ENERGY STAR homes to alert them to other program offerings and energy efficient behaviors.

Owners and tenants of homes or buildings certified by the Program had high awareness that they were in an ENERGY STAR home. However, there is an opportunity to ensure that the remaining owners and tenants are aware and know the benefits (such as the number who were unaware that the home was ENERGY STAR-certified until the evaluators called to schedule a site visit). This increases awareness overall, helps bolster the public perception of the ENERGY STAR brand, and creates an opportunity for word-of-mouth referrals.

There is an additional benefit to the utility to take the opportunity to alert the new owner or tenant of other energy efficiency offerings and behaviors. For example, the Program can send out a mailing to the address a few months after a home is complete that says "Congratulations on your ENERGY STAR home! Here are some ways to make the most out of your efficient home." The mailing can then include descriptions of other NHSaves programs, tips on energy-saving behaviors, and other ways to get involved. This has the added benefit of helping to build the utility's relationship with the customer. A more advanced version of this would be to produce a home energy report that benchmarked the home's energy usage against other ENERGY STAR customers and other local homes, similar to the Home Energy Report pilot that Eversource ran in 2014 in New Hampshire.

5.5 PROGRAM MANAGEMENT

Finding #5: Overall, the Program management is effective, with a few opportunities for small internal tweaks.

Given the complexities of the ENERGY STAR Homes platform and the fact that the Program consists of four different utilities, it is not simple to execute. It takes effort to ensure that there is enough communication between the utilities as well as between the various stakeholders (utility, HERS rater, builder, HVAC contractor), and that the Program team has developed formal and informal methods to good effect. The formal methods largely consist of standing meetings between the utilities and other key groups, as follows:

- **Program utilities (monthly)**: Each month, the program managers from each of the four utilities call in to discuss topics such as where they are with respect to goals and spending. They may also work through any questions or challenges that the Program is experiencing.
- **HERS raters (weekly to monthly)**: Depending on the utility, there may be weekly or monthly check-ins with the HERS raters; there is generally also more informal communication on a day-to-day basis.

- **Builders (monthly)**: There is a standing monthly meeting for builders where the utilities can present information on the Program, code, etc., and gather information on what is happening in the market.
- **Other states – Eversource (monthly)**: Eversource spans three states (MA, CT, and NH), and all three have residential new construction programs (although of the three, NH is the only that has remained in the ENERGY STAR Homes framework). The program managers talk monthly about lessons learned, challenges, or market trends.
- **EPA (quarterly)**: The four utilities and HERS raters have had several calls with the EPA to provide the team running the national ENERGY STAR Homes framework with information about how the program is run in practice in NH. The calls have largely centered on the challenges engaging the HVAC contractor community after the Version 3 changes.

The effort put in by the Utilities shows that most of the builders and some of the HVAC contractors knew the utility program manager(s) by name. Since two of the four program managers are also certified as HERS raters, they are also seen out in the field helping the program HERS raters with the final inspections and blower door tests. The more active HERS raters also provides code training and is involved in other NH programs, and so they too are easily recognizable in the industry. There are only two places where stakeholders commented that they wished there was more communication: the Utilities and HERS raters would both like to know what the homeowners thought of the house after they moved into the certified home, and several of the HVAC contractors wanted more communication from the HERS rater early in the process.

For the most part, the program processes, reporting, and updates are well done and consistent across all utilities. There is a uniform application that streamlines the process, and the HERS raters have a standard report that they provide after each home is certified. There are some differences by utility and HERS rater for informal status updates and formal project reporting, and some Utilities and HERS raters indicated that the reporting structure was not as beneficial as they would like in a few key ways. For example, one of the HERS raters noted that in addition to the final report, two utilities have them duplicate some of the information into their own data tracking templates, which adds administrative time; the other HERS raters sent in only the final report. On the other hand, some of the utilities felt that they did not receive enough communication or updates from the HERS raters, such as a quick email to alert the utility that a project was about to be inspected or had completed certification.

Each utility tracking system provides varying levels of visibility into projects in progress, and may or may not be easily exportable into aggregated savings values, contact information, or other key fields. This

created challenges for the impact evaluation team when merging and comparing participation information across the four utilities. There were also differences in how multifamily buildings were tracked (i.e., on the building or unit level). Perhaps most importantly, there is no overlap on participation tracking. If a customer receives electric and gas service from different utilities and participates with the electric utility, then the gas utility has no record of that participation within their tracking data. This creates a challenge in terms of collecting the customer's tracking and billing data.

Recommendations

ERS has developed two recommendations related to the findings in this section.

Recommendation #6: Devote part of a monthly meeting with all utilities and the HERS raters to discussing expectations for uniform project reporting and frequency of updates from HERS raters.

Some of the utilities and HERS raters noted that the reporting structure could be improved. The utilities should discuss and arrive at a consensus in terms of what information they need from the HERS raters for formal reporting and use that to design a uniform reporting template. For informal updates, the utilities can also discuss the types of information they receive from the HERS raters throughout the process, which likely varies by utility and the utility's involvement.

Recommendation #7: Harmonize participation information across electric and gas utilities to improve overall program project tracking.

Where possible, there should instead be attempts to collect and share data with evaluators in similar formats. One of the challenges that affect both the evaluators and the Utilities themselves is the issue of how to track participant overlap so that the Utilities are not targeting the same customers – and are aware of all participants in their own service territory. Given that each of the utilities has a different tracking system, the mechanism by which this is achieved will vary for each, but it could be as simple as a separate tab in an Excel spreadsheet or a checkbox on a DSM system that notes that the home is a participant through one of the other utilities.

5.5.1 Future Growth Opportunities

Finding #6: The Program will need to expand under EERS, but there are mixed opinions on how to do so.

Program Year 2017 is considered a transition year to bridge the old program cycle with the state's new Energy Efficiency Resource Standard (EERS), which starts in 2018 and increases each utility's overall

efficiency goals from 0.6 to 0.8% of sales to 1.0 to 1.3% of sales. This will also nearly triple the budgets for energy efficiency programming. Each utility will determine how best to scale its current programs or new offerings to meet the increase in goals. The ENERGY STAR Homes program at each utility may also be expanded to contribute to those goals, which comes with both opportunities and challenges, as discussed in both the process and impact sections of this report.

The single largest challenge is the one detailed by the impact evaluation. Although the program is claiming savings based on the User-Defined Reference Home (UDRH) baseline uploaded into the REM/Rate model, the baseline is old (developed in 2007 and last revised in 2008) and does not consider the 2010 implementation of IECC 2009 as the statewide residential code. The impact analysis showed that the energy consumption of nonparticipant homes was largely indistinguishable from the energy consumption of participant homes, and that the weather-normalized energy consumption of both participant and nonparticipant homes varied widely for any given home size. While the impact evaluation has recommendations for adjustments to the UDRH and for future program design considerations (as discussed elsewhere in this report), the Program will need to take stock of the existing new construction market and set both the baseline and the requirements appropriately to push the market forward and generate a cost-effective program.

The qualitative or quantitative analysis of occupant behavior was not part of the scope of work of this evaluation, but it is believed to be an underlying cause of the variability of energy use for any given size home within both the participant and nonparticipant populations.[21] The impact evaluation analysis did not consider behavior impacts on energy usage, which may be a factor if owners of ENERGY STAR homes are shown to use their homes differently than nonparticipants or be subject to snapback.[22] There was very high awareness among the 34 homes visited by the impact evaluation team that the home was ENERGY STAR certified – 79% of owners or tenants were aware that the home was certified when they purchased

[21] As noted by Robert Kasman, "All [evaluation] methodologies are challenged if large behavioral variation exists. Variation of usage of 3x to 6x are common, and as much as 100x have been observed in residential projects." See Kasman, Robert, *Lessons Learned in Selecting Impact Evaluation Methodologies: Metering, Modeling, or Billing Analysis?* 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

[22] Snapback refers to changes in behavior or use patterns after the installation of an energy efficient technology. In this case, the awareness of an energy efficient home may cause the occupants to be less proactive with energy efficient behaviors, believing that this effort is no longer necessary since the home itself is more efficient.

it or signed the lease. Although this information is speculative, it could indicate the potential for snapback. The interviews also asked a series of questions about whether the occupant had seen changes in electric bills, gas bills, the comfort of their home, and maintenance costs from previous homes. While this information is anecdotal, the results are thought-provoking: 43% of occupants noticed a decrease in electric bills from the previous home, but 36% noticed an increase. On the other hand, while only half of the occupants had gas service, 82% noticed a decrease in gas bills. The team could not verify characteristics of the previous houses (such as square footage and whether it was electrically heated), and so there are several factors that could be at play, but on the surface these results support the results of the billing analysis. Additionally, 79% of the occupants said that the comfort of their home had increased, and 56% said their maintenance costs had decreased (one respondent said the costs had increased – the remainder said no change).

Due to the challenges associated with recruiting and retaining HVAC contractors, the Utilities believe that there are homes that could be participating in the Program, but because the HVAC contractor does not want to get certified, the home cannot participate. The interview data seems to support this: of the nine builders the evaluation team interviewed, all said that at least 90% of their homes are certified, and the remainder are built to ENERGY STAR standards but are not certified.[23] This includes the two former participants, who could not find HVAC contractors and therefore cannot certify their homes – they both noted that all of their homes are built to ENERGY STAR standards regardless.[24]

The story is different for HVAC contractors. Two said that 100% of their systems are built to ENERGY STAR standards, but fewer than half of those homes are certified through the program. The other two noted that a very small fraction of their work is on ENERGY STAR certified homes – 10%–20% for one and 5% for the other. For the two former participants, one stated that 100% of their systems were built to the ENERGY STAR standard although none were certified, and the other said that almost none of their

[23] Note that these are self-reported numbers to the question "What percentage of your homes are built to ENERGY STAR standards, and what percentage go on to be certified through the ENERGY STAR program?" Respondents may have interpreted "ENERGY STAR standard" in different ways.

[24] Given such high responses from the builders, it is also appropriate to ask whether the utilities' Program and incentives are actually pushing the builders to be more efficient, or whether the houses would be built to that level and result in savings nonetheless. HVAC contractors, on the other hand, appear to require that extra push.

systems were required by clients to achieve the ENERGY STAR level. However, those responses also indicate that builders would already be building to ENERGY STAR levels, regardless of the Program requirements and the incentives offered, and gives credence to the premise that the market has moved to a more efficient baseline. One builder explicitly asked if the program could add a tier beyond ENERGY STAR homes for builders who were ready to take the next steps. However, the same does not seem to be true for the community of HVAC contractors, who need the extra push to build to that level.

The Program is left with a challenge: How does it increase the amount of savings generated by the program, given these findings? The first step must be updating the baseline to ensure that it reflects the market (as discussed in Section 6), and confirming that the Program requirements will lead to savings over that baseline (if the Program only acts to increase the number of homes without confirming that they will generate savings over current practice in the nonparticipant market, there will be no benefit – multiplying large numbers of homes by zero savings will still result in zero savings). Once this has been done, the Program has three options, all of which may be valuable:

1. **Increase the savings generated per home.** The Program can add higher tiers with appropriate incentives to encourage higher levels of energy efficiency.
2. **Increase the number of homes certified through the Program.** The Program can increase the pipeline of homes built to ENERGY STAR (the Program team currently estimates that 13% of new homes in New Hampshire are built with the ENERGY STAR certification).
3. **Conduct additional research to determine spillover –** Massachusetts has identified significant spillover in its new construction program which could be directly tied to current program activity.

Many of the previous recommendations in Section 5 are geared towards the second option: building a pipeline by overcoming or bypassing some of the challenges experienced by the HVAC contractor community, finding ways to reach the first-time builders and homeowner/home builders, and increasing homeowners' awareness of the program and energy efficiency to increase the demand. Regarding the first option, the Program is running a "Drive to Net Zero Home Competition" for homes completed by November 2017. Rather than being a separate program, the competition offers the potential for additional funding in the form of three prizes for homes built through the ENERGY STAR Homes program that have extremely low HERS scores and renewable technologies. Homes are judged on their HERS indices, lowest cost per square foot, estimated annual operating costs, and technological innovation. Learnings from this experience can be used to guide the utilities' next steps towards increasing the savings gained per home. Other recommendations for this goal are described below.

Recommendations

ERS has developed two recommendations related to the findings in this section.

Recommendation #8: Consider a program design update that creates additional tiers for above ENERGY STAR and zero net energy (ZNE) ready homes.

Comments from some builders, participation within the ZNE competition this year and experiences from other states show that some segments of the market may be ready to continue moving toward higher levels of efficiency. Promoting deep savings in new construction is also a way for the program to gain more savings per home. The Program should consider adding a tier that is beyond ENERGY STAR (such as the requirements for Version 3.1) and a ZNE-ready tier. At a minimum, the requirements will both include more aggressive HERS target scores for participating homes; the Program may also include additional measure-level requirements as appropriate.

At this point, the evaluation team does not recommend dropping out of the ENERGY STAR framework given the benefits provided, but an increase in the required performance of participant homes will be necessary to overcome the energy performance of the nonparticipant population (driven at least in part by the current building code, IECC 2009). However, the utilities should continue to monitor the situation, as there are concerns that the federal government will attempt to discontinue or privatize the ENERGY STAR brand.

Recommendation #9: Consider additional studies to provide a more complete picture of the market for new homes in New Hampshire.

Additional data can help the Program determine the best way to proceed to ensure a Program design that yields defensible savings over the current nonparticipant market. There are two studies that can provide valuable information, although their benefits must be weighed carefully against the costs:

1. **Market baseline study –** Based on the utility data analysis discussed in Section 4, nonparticipant homes perform similarly to participant homes in terms of weather-normalized energy consumption. While the evaluators were able to determine the relative performance on the participant and nonparticipant populations, examining the characteristics and driving forces behind nonparticipant energy consumption was not part of the impact evaluation scope of work. The Program should consider a study that explores how homes are being built in New Hampshire and how practices differ across the state. With New Hampshire considering an update to the energy code, the best timing of a study of this kind may be shortly after the new code is introduced.

2. **Behavioral study –** The substantial variability in weather-normalized energy use for both participant and nonparticipant homes of a given size strongly suggests that occupant behavior and characteristics are a major influence in overall energy use, particularly in electric energy use. A behavioral study may reveal opportunities for education and interventions through other residential programs to ensure the materialization and persistence of savings generated as part of the Program. This type of study may best be conducted in conjunction with a broader market study at a relatively small incremental cost.

A market baseline study can be used to inform future Program design or revisions related to target Program performance values and UDRH characteristics. A behavioral study, while it is less of an immediate need, will provide information on how the homes are used that can help in designing incentives and other efforts to ensure that the homes are operating as efficiently as possible. Moreover, it can provide the opportunity for the utility to build relationships with those customers.

5.6 CONCLUSION

The process evaluation's findings resulted in nine recommendations listed at the end of each of the six major findings. NHSaves may choose to implement as many as it deems appropriate after considering them and the role of the program in its portfolio. The recommendations can be broken into four major categories, which may be helpful in analyzing the costs and benefits of each, as shown in Table 5-4.

Table 5-4. Process Evaluation Recommendations by Type

Recommendation #	Finding #	Description
Program Design *(Goal: Increase savings per home)*		
5	4	Perform cross-marketing to owners of, or tenants in, ENERGY STAR homes to alert them to other program offerings and energy efficient behaviors.
8	6	Consider a program design update that creates additional tiers for above ENERGY STAR and zero net energy (ZNE) ready homes.
9	6	Consider additional studies to provide a more complete picture of the market for new homes in New Hampshire.
Barriers to Participation *(Goal: Increase participation)*		
1	3	Use outreach, education, and targeted incentives to overcome some of the major barriers to HVAC contractor participation.
Awareness and Outreach *(Goal: Increase participation)*		
2	4	Consider other ways to use marketing collateral to supplement direct outreach, including online communication, press releases, and additional builder materials.
3	4	Survey builders and HVAC contractors on the effectiveness of utility-sponsored training and what topics they would find most valuable.
4	4	Develop materials to reach and educate first-time home builders and homeowner/home builders.
Program Efficiency *(Goal: Reduce administration time/cost)*		
6	5	Devote part of a monthly meeting with all utilities and the HERS raters to discuss expectations for uniform project reporting and frequency of updates from HERS raters.
7	5	Harmonize participation information across electric and gas utilities to increase transparency while also ensuring that no double-counting is occurring.

Overall, the Program is well run, with a large part of that due to how active the utilities and HERS raters are in the market and in all the methods used to communicate and coordinate their efforts. The Program's major challenge has been reaching the HVAC contractor community, given the requirements. The impact evaluation showed another challenge: low savings due to the similar and highly variable performance of both participant and nonparticipant homes, resulting in two populations (participant and nonparticipant) that are virtually indistinguishable in terms of energy use. The nine recommendations offered in this section provide a set of suggestions geared toward helping the Program overcome these challenges. The Program will need to consider ways to increase the amount of savings per home, and once it has confirmed that these homes generate savings above the baseline will want to continue to increase participation to achieve greater levels of savings. The Program is well placed to continue to build both supply and demand for efficient homes in New Hampshire and to contribute to meeting the increase in savings goals under the new EERS.

SECTION 6: SITE INSPECTION, REM/RATE, AND UDRH FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The following sections discuss the findings related to the UDRH review and REM/Rate modeling, and the observations made during the visits to participant homes.

6.1 On-Site Activity Findings

As discussed in Section 3.5.2, outreach was conducted to 98 participant sites in an attempt to complete 47 site visits. Ultimately, the evaluation team completed 30 site visits. Table 6-1 provides a summary of the results of the outreach efforts.

Table 6-1. Outreach Status

Outreach Status	Count
Complete	30
Contact unresponsive	9
Dropped	39
Recruiting in progress	20
Total	**98**

"Contact unresponsive" indicates sites where the contact information appeared invalid (phone numbers no longer in service). "Dropped sites" indicates sites that received a minimum of six attempts at contact via phone and email (where available) conducted at different times during different days of the week, or sites where contact was made and the homeowner declined participation. "Recruiting in progress" indicates sites where outreach was ongoing but a minimum of six attempts had not yet been completed when outreach activities were curtailed due to schedule. Basic information on the homes where site visits were completed is provided in Table 6-2.

Table 6-2. Characteristics of Completed Site Visits

Multifamily		**8**
Eversource		*7*
Heating fuel	Electric	3
	LP	3
	NG	1
Liberty		*1*
Heating fuel	NG	1
Single Family		**22**
Eversource		*9*
Heating fuel	Electric	4
	LP	5
Liberty		*2*
Heating fuel	LP	1
	NG	1
NHEC		*7*
Heating fuel	Electric	7
Unitil		*4*
Heating fuel	LP	2
	NG	2
Total		**30**

Findings from the site visits are objective in terms of what could be visually confirmed relating to the construction of the home and its alignment with the construction details included in the REM/Rate file, but they are also subjective as they relate to the homeowners' views concerning their motivations and impressions of owning an ENERGY STAR home. The differences between REM/Rate parameters and what was observed on-site are provided in Table 6-3.

Table 6-3. Differences between REM/Rate Values and Site Observations

Finding	Frequency
Thermostat settings different from model	8
Basement slab covering different from model	8
Lighting technology different from model (less efficient than modeled)	4
DHW technology different from model	4
Oven fuel different from model	2
Number of bedrooms different from model	2
Heating system capacity different from model	2
Cooling system capacity different from model	2
Cooling SEER different from model	2
Heating system type different from model	2
Exterior door type different from model	1
HSPF different from model	1
Number of stories different from model	1
DHW tank size different from model	1
Dryer fuel different from model	1
Basement conditioning different from model	1
Added a hot tub after construction	1
Added an additional heat pump after construction	1
Makes use of supplemental electric resistance space heaters	1

In addition to the observations noted in Table 6-3 above, two homeowners noted that after moving into the home they became suspicious of envelope performance due to observations made during cold weather (in one example, areas of the roof where snow melted, adjacent to other areas where snow did not melt). Both homeowners investigated and discovered that large areas of insulation were missing within the envelope construction. In both cases the homeowners reported that the builder quickly investigated and corrected the situation, and the homeowners were satisfied with the outcome.

The homeowners were surveyed on their experience with the home, which is discussed in Section 5 above. Additional insights are provided below.

The homeowners were asked what role ENERGY STAR certification and energy efficiency played in their decision to purchase an ENERGY STAR home, and they were asked what they felt the benefit of owning an ENERGY STAR home was. The results are provided in Table 6-4.

Table 6-4. Participant Homeowner Survey Responses

Question	Survey Response	%
ENERGY STAR certification factored in to the decision to purchase the home	Yes	59%
	No	41%
Energy efficiency played a role in deciding to purchase the home	Yes	62%
	No	38%
The value of owning an ENERGY STAR home	Lower utility costs	55%
	Increased comfort	20%
	Environmental stewardship	15%
	No benefit	10%

Approximately 60% of the homeowners surveyed stated that the ENERGY STAR certification and a desire for energy efficiency were significant factors in purchasing the home. Conversely, 40% indicated that the ENERGY STAR label and an energy efficient home were either nice to have but not a major factor in the purchase or were not a factor at all in the purchasing decision. It is interesting to note that 90% of respondents saw benefits to owning an ENERGY STAR home, even if their purchase was not initially motivated by the ENERGY STAR label.

Conclusions

The evaluators observed well-built homes that were largely occupied by satisfied individuals with an interest in energy efficiency. With few exceptions, the homeowners were very pleased with their purchase. Their awareness of energy efficient behaviors varied, and numerous occupants expressed a desire to find new ways to operate the home more efficiently.

While the review of model inputs to in situ systems or conditions yielded few major discrepancies, there were numerous instances of small differences between REM/Rate input values and actual conditions.

As shown in Table 6-3 above, basement slabs modeled as covered with a carpet were often in fact bare slab, and actual thermostat settings varied substantially from what was observed on-site. These minor discrepancies should be considered in the context of their impact on the HERS index score. While thermostat setting may be irrelevant in the context of calculating savings between two theoretical homes (the UDRH and the as-built design) since both models include setback thermostats with the same settings, it is not clear what impact those settings have on the HERS index score, which is a qualifying component of the Program. The thermostat settings within the REM/Rate models are generally much more aggressive than what was observed on-site. The impact is that heating systems and cooling systems (where installed) are likely to run more frequently than estimated in the model, as homeowners generally condition their homes to the same approximate temperature in heating and cooling seasons. As an example, changing the

set points in REM/Rate for one 1,600 sq ft home with fossil fuel heating from the modeled values of 68°F and 78°F for heating and cooling, respectively, to 70°F for both heating and cooling (more in line with on-site observations) increases total modeled annual energy use by 6% and may impact the HERS index score that is used in part to determine eligibility.

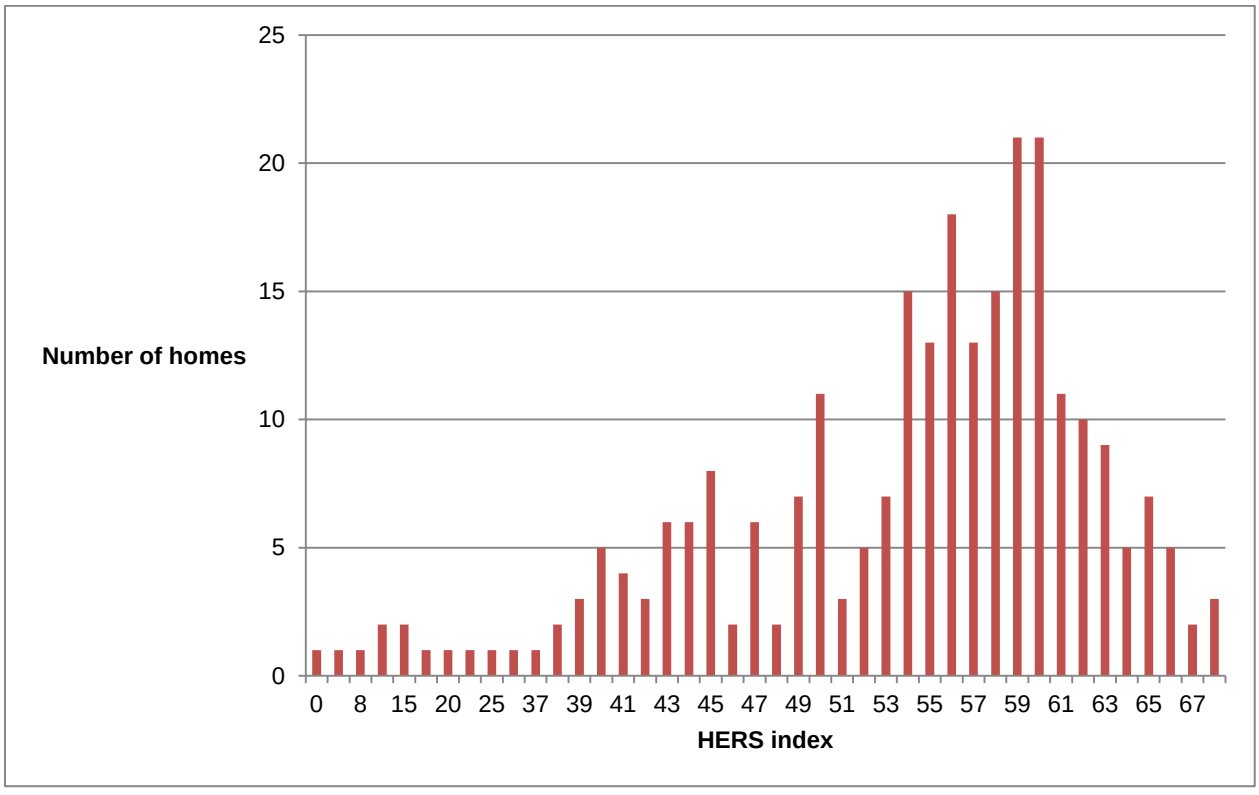
6.2 REM/Rate Modeling and UDRH Findings

This section presents findings and recommendations separately for the REM/Rate modeling and UDRH research but combines the conclusions and recommendations into a single section since they are closely related.

6.2.1 REM/Rate Modeling Findings and Conclusions

The average HERS index of the participant homes is 49. Figure 6-1 plots the modeled HERS values of the participant homes.

Figure 6-1. Participant HERS Index Frequency



While most participant homes achieved a modeled HERS index greater than 49, a substantial number of participants achieved HERS values less than 49, including single-family and multi-family dwellings.

Per the modeling, the as-built participant homes outperform all other design standards considered. This indicates that participant homes in general are exceeding the minimum requirements of ENERGY STAR v3.0. Further breaking down the participant models into categories associated with the sponsoring utility presents another interesting observation. Table 6-5 compares the modeled performance of the participant homes relative to IECC 2009, broken down by sponsoring utility.

Table 6-5. Utility-Level Comparison of Modeled As-Built Performance of Participant Homes

Building Type	Number of Sites	Utility	Heating Fuel Type	Building Reference	Average Consumption (MMBtu/yr)	% Savings Compared to 2009
Single-family detached	33	Unitil	All	Design	71.19	12%
Single-family detached	4	Liberty	All	Design	95.12	25%
Single-family detached	26	Eversource	All	Design	76.73	28%
Single-family detached	8	NHEC	All	Design	48.42	34%

Of note is the relative performance of the homes built in NHEC's territory. Per the modeling, the NHEC homes are built to higher levels of performance than the other utilities. While this model-level observation is limited to the sampled projects, this observation is supported by both interviews with HERS raters and observations made on-site by the evaluation team.

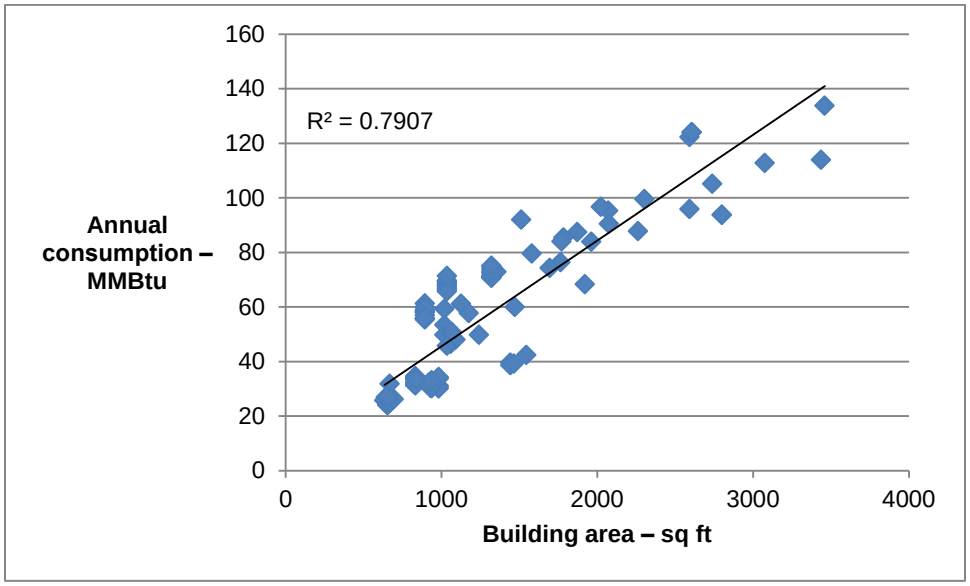
One of the large HERS raters noted that there is more of a "niche market" in the northern counties with more custom homes and that ENERGY STAR homes in that area are "more committed." On-site activities also noted homes in NHEC territory with thicker walls and homeowners who played a greater role in the design and construction of their home, with a specific aim towards maximizing energy efficiency for long-term ownership.

An additional finding resulting from the REM/Rate modeling review is the strong relationship between building area and energy consumption within the participant models. Figure 6-2 plots the annual energy consumption in MMBtu for all participant homes[25], single and multifamily, within the sample of

[25] Three large multifamily buildings were excluded from the plot to preserve the scale and readability of the figure. The large multifamily buildings that were excluded for visual purpose do follow the same trend and do not impact the R^2 value presented.

REM/Rate files reviewed. Total energy consumption is expressed in MMBtu in REM/Rate and allows for a direct comparison of site-level energy between homes regardless of heating fuel.

Figure 6-2. Comparison of REM/Rate Annual Energy Use to Building Area



Note the R^2 value of 0.79; this indicates that for these homes the building area is closely correlated to annual energy use. This is an inherent function of the modeling software. Compare this to the plot in Figure 4-1 in Section 4.2 above. The plot in Figure 4-1 compares actual energy use (from utility data) of participant homes to building area. The R^2 of the participant plot in Figure 4-3 is 0.1 (not shown in the plot), meaning that in reality there is very little correlation between building area and annual energy use. This further illustrates the issue of variability in energy use that is attributable to factors beyond Program control, i.e., occupant characteristics and behavior.

6.2.2 UDRH Findings

As previously discussed, participant homes were modeled using REM/Design analysis to assess the impact of energy use and potential program savings of UDRH home revision. These modeling runs were performed using as-built system parameters, and for minimum design criteria associated with ENERGY STAR v3.0, IECC 2009, IECC 2015, and ENERGY STAR v3.1. The result of the analysis for all 150 sampled REM/Rate files is presented in Table 6-6. The average annual consumption of the as-built conditions can be compared to the consumption of alternate design or baseline standard. The column IECC 2009 in the far-right column illustrates the impact of revising the UDRH to IECC 2009, and of aligning the Program requirements to that of the alternate design standard (IECC 2015, ENERGY STAR v3.1, etc.).

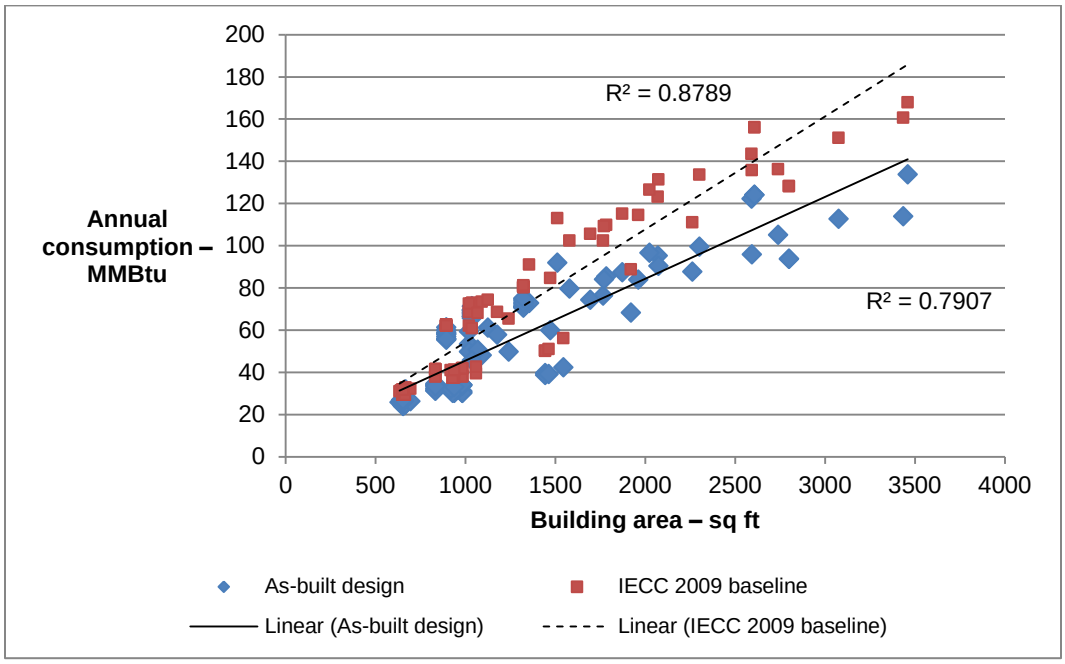
Table 6-6. Comparison of REM/Rate Output for Various Design Standards

Design Standard	Notes	Average Modeled Consumption (MMBtu/yr)	% Savings Compared to IECC 2009
IECC 2009	Adopted by NH in 2009	93.96	0%
ENERGY STAR v3.0	Current program threshold	92.29	2%
IECC 2015	Under consideration for adoption in NH	81.91	13%
ENERGY STAR v3.1		81.04	14%
Design standard	As built- conditions	**73.33**	**22%**

Two major observations can be made from the results of this modeling exercise. The first is that a revision of the UDRH to align with IECC2009 will result in very little savings (2%) when compared to ENERGY STAR v3.0, the current threshold for Program participation. The requirements of IECC 2009 and ENERGY STAR v3.0 are very similar and result in buildings that perform in a like fashion, per the REM/Rate modeling.

Figure 6-3 further illustrates this point by showing the modeled as-built annual consumption and the modeled IECC 2009 consumption against building area.

Figure 6-3. As-Built and IECC 2009 Modeled Energy Consumption vs. Building Area



The strong model correlation between building area and energy consumption is again evident. This plot also indicates that the Program participant homes as modeled outperform the same homes built to IECC 2009 minimums.

The Program currently requires homes to meet or exceed the standards of ENERGY STAR v3.0. However, the REM/Rate modeling suggests there may only be a 9% savings improvement on average between homes built to IECC 2009 and ENERGY STAR v3.0. However, ENERGY STAR identifies expected savings of 22%-27%. This can be seen in an October 2016 cost-and-savings paper released by ENERGY STAR that compares the energy savings and incremental cost between a theoretical homes built to IECC 2009 and ENERGY STAR v3.0 standards[26]. A summary table from this ENERGY STAR paper is presented in Figure 6-4.

Figure 6-4. ENERGY STAR Comparison of IECC 2009 and ENERGY STAR v3.0 Energy Use and Incremental Costs

					2009 IECC	ENERGY STAR Version 3					
#	CZ	Location	Found.	HVAC Equipment Type	Annual Purchased Energy Costs	Annual Purchased Energy Costs	Annual Purchased Energy Savings		Total Upgrade Cost	Monthly Purchased Energy Savings	Monthly Mortgage Upgrade Cost	Net Cash Flow
1	1	Miami, FL	Slab	Elec. Air-Source HP	$1,885	$1,571	$294	16%	$1,463	$25	$8	$17
2	1	Miami, FL	Slab	Gas Furnace / Elec. AC	$1,750	$1,462	$288	16%	$1,517	$24	$8	$16
3	2	Tampa, FL	Slab	Elec. Air-Source HP	$1,912	$1,638	$276	14%	$1,463	$23	$8	$15
4	2	Tampa, FL	Slab	Gas Furnace / Elec. AC	$1,782	$1,496	$285	16%	$1,517	$24	$8	$16
5	3	Fort Worth, TX	Slab	Elec. Air-Source HP	$2,322	$1,821	$502	22%	$1,696	$42	$9	$33
6	3	Fort Worth, TX	Slab	Gas Furnace / Elec. AC	$2,069	$1,709	$360	17%	$1,750	$30	$9	$21
7	4	St. Louis, MO	Bsmt.	Elec. Air-Source HP	$2,823	$2,359	$464	16%	$1,589	$39	$9	$30
8	4	St. Louis, MO	Bsmt.	Gas Furnace / Elec. AC	$2,215	$1,852	$362	16%	$1,915	$30	$10	$20
9	5	Indianapolis , IN	Bsmt.	Elec. Air-Source HP	$3,080	$2,347	$732	24%	$2,059	$61	$11	$50
10	5	Indianapolis , IN	Bsmt.	Gas Furnace / Elec. AC	$2,295	$1,824	$471	21%	$2,117	$39	$11	$28
11	6	Burlington, VT	Bsmt.	Elec. Air-Source HP	$3,760	$2,732	$1,028	27%	$2,155	$86	$12	$74
12	6	Burlington, VT	Bsmt.	Gas Furnace / Elec. AC	$2,438	$1,902	$535	22%	$2,117	$45	$11	$33
13	7	Duluth, MN	Bsmt.	Gas Furnace / Elec. AC	$2,843	$2,142	$701	25%	$2,117	$58	$11	$47

Rows 11 and 12 in the above table represent climate zone 6, a close analog to NH weather conditions. Savings data is not presented in terms of units of energy but in terms of energy cost savings. Figure 6-4 shows a projected energy cost savings in climate zone 6 for electrically heated and fossil fuel-heated homes of 27% and 22%, respectively.

The report goes on to explain that a portion of the savings attributable to the ENERGY STAR program is not captured in REM/Rate modeling, which includes a requirement for Grade I insulation, while IECC

[26] https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf

2009 only requires Grade II insulation. Grade I and Grade II are definitions used to describe the quality and completeness of insulation installation in terms of voids, compression, and cavities. The ENERGY STAR paper claims an additional 5% savings from the requirement for Grade I insulation that is not captured in the REM/Rate model. Further, ENERGY STAR notes that there is additional 6.9% savings in home with electric heat pumps that is not captured by REM/Rate due to the ENERGY STAR requirement for HVAC commissioning. For homes with electric heat pumps, these two additional sources of claimed savings total to approximately 12% of the total claimed savings and are not reflected in REM/Rate modeling. Where IECC 2009 exists as code, this presents a challenge to programs using ENERGY STAR v3.0 as qualifying criteria because programs cannot rely solely on the Fuel Summary Report from REM/Rate to capture all savings claimed by the ENERGY STAR program. The Executive Summary of the ENERGY paper concludes with the following:

"*Despite the fact that many of the items in the ENERGY STAR Checklists are required by code, EPA believes that their inclusion provides significant benefits: code often allows these items to be traded off for other improvements, while the Checklists help ensure that these details are included in every home to consistently deliver a complete thermal enclosure system, complete HVAC system, and complete water management system; the ENERGY STAR Checklists consolidate critical code-required details in a relatively concise format that improves compliance; the ENERGY STAR Checklists provide a consistent set of building-science details from which to educate and train partners; and many of the items on the ENERGY STAR Checklists are required to be third-party verified by a Home Energy Rater, whereas most jurisdictions do not require such oversight*."

6.2.3 Conclusion and Recommendations

The UDRH review went beyond the scope of reviewing and providing recommendations; it also revealed trends and observations that can inform future program design. The primary observations are as follows:

- The evaluators recommend that the UDRH be revised to IECC 2009 as it represents the current code in NH and provides an established baseline from which comparisons can be made. As stated by ENERGY STAR[27], "*…code is a well-defined baseline from which costs and savings can be*

[27] ENERGY STAR, *Cost & Savings Estimates ENERGY STAR Certified Homes, Version 3 (Rev.08)*. October 1, 2016.

consistently evaluated. In contrast, standard practice often varies from code-minimum requirements (both below-code and above-code) and is therefore difficult to consistently benchmark against...most utility-sponsored programs are not able to claim savings for improvements from below-code to code-minimum practices. Therefore, estimating the incremental costs and savings only for the above-code measures of the ENERGY STAR v3 program requirements makes the analysis more relevant to utility sponsors and partners that wish to improve practices above code."

This recommendation is further supported by the results of the utility analysis (Section 4), which demonstrate that the nonparticipant population is performing near the level of the participant homes.

- Although it is not specific to the UDRH itself, the UDRH review and batch analysis also revealed that adopting IECC 2009 as the UDRH will require raising the requirements of the Program to ensure project savings above IECC 2009, and a cost-effective Program. This is discussed further in Section 7.
- The current UDRH ceiling/attic insulation values are substantially less then what is required by IECC 2009. The UDRH assumes ceiling/attic insulation values of R-17 while IECC 2009 requires R-49. This is a significant source of discrepancy between the modeled performance of participant homes based on UDRH requirements versus IECC 2009 requirements.
- Heat pump performance – IECC 2009 requires that air-source heat pumps have a heating season performance factor (HSPF) of 8.2 or greater. Energy v3.0 and v3.1 require a HSPF of 9.5, which represents approximately 15% better heating season performance. A review of residential air-source heat pumps within the AHRI directory for actively sold models indicates that there are many models available with HSPFs in excess of 9.5. Program may want consider a custom requirement for air source heat pumps that is in excess of the ENERGY v3.0 and 3.1 requirements in order to increase the average performance of participant homes heated with air source heat pumps relative to and IECC 2009 UDRH.

This section takes the findings of the various areas of research of the evaluation and synthesizes those individual observations and results into observations concerning the Program at large.

The Program should work with their HERS raters to identify the characteristics of participants' homes with HERS indices below 50 and to assess the Program revisions, in terms of outreach and education, required to consistently deliver homes that meet or exceed this performance level. The suggested target of 49 is based on observations within the data set; any revision to the HERS target for eligibility should

ultimately be based on the savings potential when compared to IECC 2009 and the ability of HERS raters and builders to consistently build to the higher levels of performance.

The HERS index cited by RESNET for a zero net energy (ZNE) home is 0. The evaluators have found through measurement and verification work in other states in the Northeast that a HERS index target of 10, including the impact of renewables, is a good predictor of ZNE performance. While it was not within the scope of the study to model and determine the HERS index values for the nonparticipant homes[28], the utility data analysis suggests that the P and NP populations perform in a similar fashion. Therefore, it is assumed that the average NP home would have a HERS index of approximately 49, the same value of the P population. The evaluators suggest revising the qualifying HERS index to a lower value to increase the overall performance of the participant homes compared to nonparticipant homes. The Program could consider revising the minimum qualifying HERS value to the current average and offer additional incentive tiers for homes that achieve HERS indices lower than this value. This represents a substantial increase in the required performance of participant homes, but it is achievable.

[28] The specific physical characteristics of nonparticipant homes that are required for modeling within REM/Rate are not available, and procuring this information goes beyond the scope of the evaluation activities.

SECTION 7: SYNTHESIS OF FINDINGS

7.1 SUMMARY OF FINDINGS

The findings of the evaluation can be grouped into three major categories, described below.

1. **The Program is well run.** The Utilities have been successful in establishing working relationships with builders and HVAC contractors. They have listened to the challenges experienced by builders and HVAC contractors, particularly as those challenges relate to the increasing requirements of ENERGY STAR v3.0. The builders and HVAC contractors appreciate the interaction and training opportunities offered by the Utilities and would like more interaction and more training with them. The knowledge that Program staff have of the Program, and of individual projects, was evident according to formal interviews conducted during the process evaluation and through regular conversations and interaction with the impact evaluation team.

2. **New methods of outreach and engagement are required to bring additional builders and HVAC contractors into the Program.** While the exiting channels of Program engagement have provided sufficient participants to satisfy Program needs, the increasing goals of the Program will require a greater number of participants.

3. **The UDRH should be updated to reflect the more efficient building practices observed in NH**. Several findings have converged to support the premise that the residential building market in NH produces more efficient homes than are represented in the current UDRH. One example is the comparison of Program-estimated savings for an electrically heated home compared to the average actual energy consumption of nonparticipant homes within the utility analysis. On average, the Program estimated that ENERGY STAR electrically heated homes would consume 14,559 kWh more than a nonparticipant home. Electrically heated NP homes were found to consume, on average, 13,491 kWh annually (see Table 3-7, above). The savings claim over the baseline home exceeds the actual consumption of the baseline home.

   The builders, HVAC contractors, and HERS raters also suggested that NP homes are being built to high standards, with many builders stating that they build highly efficient homes regardless of Program participation.

   As discussed, IECC 2009, which contains many requirements equal or near-equal to ENERGY STAR v3.0 requirements, has been the mandated code in NH for over 6 years. While code is notoriously difficult to enforce, and this paper did not investigate code compliance, it is reasonable to assume that the overall performance of NP homes has increased in the state since the adoption of

this code. While there are undoubtedly many instances of below-code construction occurring since the adoption of IECC 2009, there are also many instances of NP homes performing well beyond code requirements.

Finally, there are the results of the utility analysis. While the results of the utility analysis alone do not and cannot detail why the NP population performs as it does, the results clearly indicate that the P and NP populations perform in a very similar fashion in terms of energy use, intensity, and variability. Based on the above and as detailed throughout the report, the evaluation team concludes that the current UDRH underestimates the performance of the NP population.

4. **Improved performance will be needed from participant homes to generate savings that can be observed at the meter –** The evaluation team believes that the performance of the NP population will continue to improve as more efficient building practices continue to matriculate into the residential market and become common practice. With ever-increasing baseline performance, participant home performance will need to improve in order to generate measurable savings and to counteract the large variability in energy use for any given home and its impact on utility analysis.

7.2 SUMMARY OF RECOMMENDATIONS

The recommendations arising from the impact and process evaluation largely revolve around increasing Program participation and updating the UDRH and Program requirement to reflect the current building practices in NH and to produce participant homes that perform notably better than nonparticipant homes.

- Program design recommendations
  - Update the UDRH to align with IECC 2009, the current statewide building code[29]. Consider increasing the HSPF requirement for homes heated with air source heat pumps to a value above what is required by ENERGY STAR v3.0 and 3.1. An HSPF requirement of 11.0 represents a 34% improvement in performance over IECC 2009.
  - Revise the Program to require a lower HERS index score for eligibility. Consider a HERS index target of 49 as a starting point for investigating the savings compared to IECC 2009 and the ability of the market to consistently build to the higher performance levels. As noted in

[29] With the exception of the town of Durham, which has adopted IECC 2015 as code.

Section 4, single-family and multifamily participant homes have achieved modeled HERS indices of 49 or better within the 2014–2015 Program year, and their characteristics can be used as a starting point for identifying systems and methods to achieve the higher levels of performance.

- Consider a program design update that creates additional tiers for zero net energy (ZNE) ready homes.
- Perform cross-marketing to owners of, or tenants in, ENERGY STAR homes to alert them to other program offerings and energy efficient behaviors.
- Consider additional studies to provide a more complete picture of the market for new homes in New Hampshire.

- Barriers to participation (goal: increase participation)
  - Use outreach, education, and targeted incentives to overcome some of the major barriers to HVAC contractor participation.
- Awareness and outreach (goal: increase participation)
  - Consider other ways to use marketing collateral to supplement direct outreach, including online communication, press releases, and additional builder materials.
  - Survey builders and HVAC contractors on the effectiveness of utility-sponsored training and what topics they would find most valuable.
  - Develop materials to reach and educate first-time home builders and homeowner/home builders.
- Program efficiency (goal: reduce administration time/cost)
  - Devote part of a monthly meeting with all utilities and the HERS raters to discussing expectations for uniform project reporting and frequency of updates from HERS raters.
  - Harmonize participation information across electric and gas utilities to increase transparency while also ensuring that no double-counting is occurring.