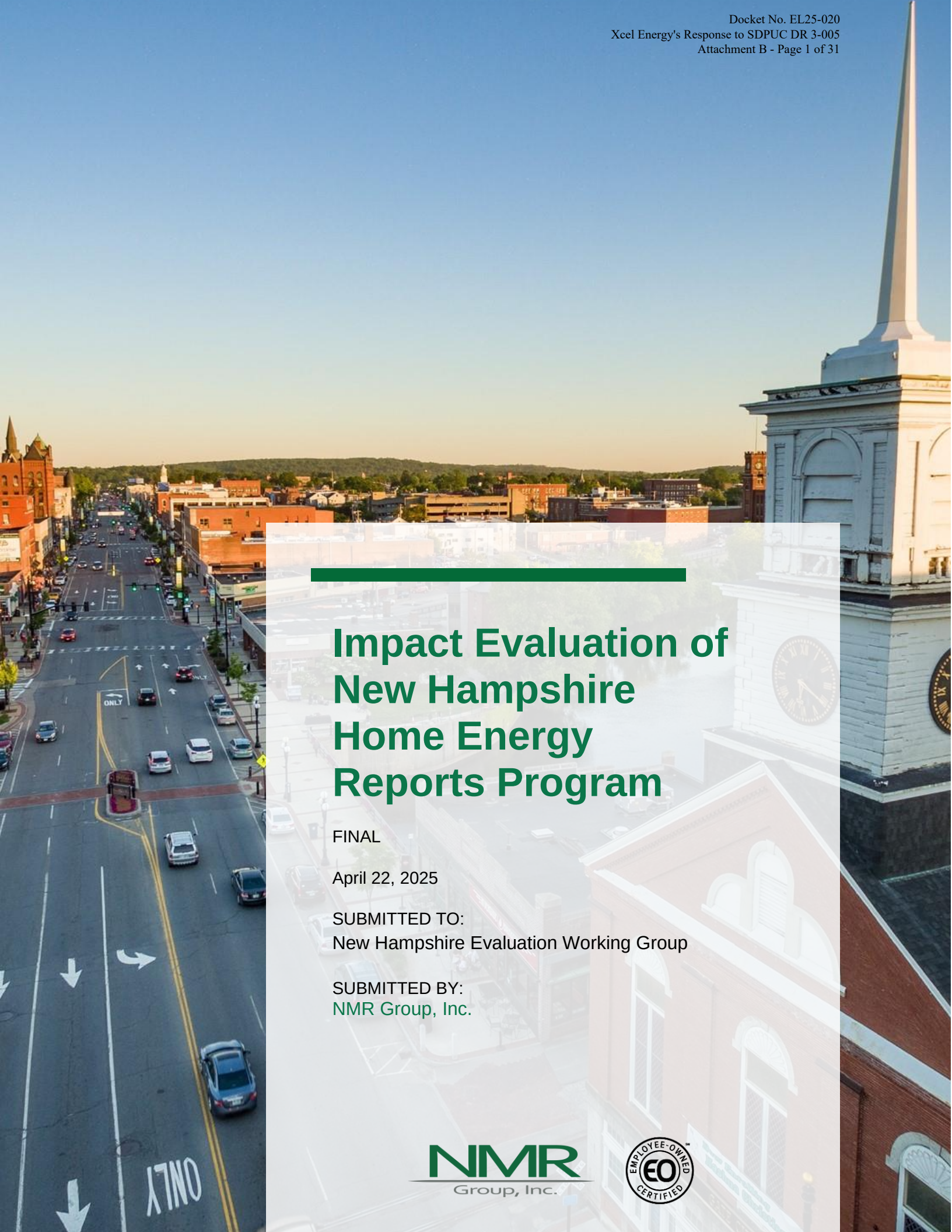

Impact Evaluation of New Hampshire Home Energy Reports Program

FINAL

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SUBMITTED TO:
New Hampshire Evaluation Working Group

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EMPLOYEE-OWNED CERTIFIED

New Hampshire Home Energy Reports Program 2023 Impact Evaluation Summary

NMR Group, Inc.

The **Home Energy Reports (HER) program** promotes residential energy conservation by providing households with personalized feedback on their energy usage through email and print reports.

Administered by **Liberty Utilities** and **Unitil** in New Hampshire, the program employs a **randomized controlled trial (RCT)** to assess energy savings. Participants are randomly assigned to either a **treatment group** (receiving reports) or a **control group** (not receiving reports). Energy savings are determined by comparing the consumption of these groups through **billing analysis**.

Key Findings

Evaluated savings in 2023 were consistent with reported savings. The realization rates are not statistically significantly different from 100%. Therefore, **the study recommends that 100% realization rates for the HER program remain in effect.**

Evaluated Savings per Household

	Electricity	Natural Gas
Liberty	203 kWh (2.5% of annual usage)	19.1 therms (2.5% of annual usage)
Unitil	133 kWh (1.5% of annual usage)	12.0 therms (2.1% of annual usage)

Realization Rates

	Electricity	Natural Gas
Liberty	94%	121%
Unitil	91%	96%

Program Validity & Uplift Savings

- **Any differences between treatment and control groups were not statistically significant**, increasing confidence that observed savings can be attributed to the HER programs rather than pre-existing geographic or usage differences.
- **There were no statistically significant uplift savings** from participation in other energy-efficiency programs in 2022 and 2023. The study could not measure uplift in prior years.
- Uplift savings from **upstream lighting programs**, which are difficult to measure, **are expected to be minimal.**

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Executive Summary

The Home Energy Reports (HER) program promotes residential energy conservation by providing households with personalized feedback on their energy usage through both email and print reports. By comparing a household's energy consumption to that of similar neighbors, the program encourages customers to adopt energy-saving behaviors and make more informed decisions about their energy use.

Administered by Liberty Utilities and Unitil in New Hampshire, the HER program uses a randomized control trial (RCT) design, in which customers are randomly assigned to either a *treatment group* that receives reports or a *control group* that does not. Energy savings are determined by measuring the difference in energy usage between these groups, ensuring an objective and unbiased evaluation of the program's impact.

Liberty has offered HER programs for natural gas since 2014 and for electricity since 2018, providing a combination of paper and email reports along with online access to energy usage data. Unitil introduced its electric and gas HER programs in 2018, following a similar structure of delivering reports through both digital and print formats.

NMR conducted this study to evaluate the energy savings impacts of the HER programs in 2023. After confirming that the treatment and control groups in Liberty and Unitil's program designs were not statistically different from each other based on geography and pre-program usage, the study estimated savings through a billing analysis, calculated realization rates, examined the impact of participation in other programs on HER savings, and explored savings degradation after repeated treatment.

Key Impact Findings

The evaluated savings for both utilities and fuel types are consistent with the reported savings. Although there is some variation in realization rates across utilities and fuel types, these differences are not statistically significant, nor do they deviate significantly from 100%.

Table 1 summarizes the electric savings results from the billing analysis, along with the realization rates, by comparing these findings to Liberty's and Unitil's 2023 reported savings for the HER program. In 2023, the results suggest that there were statistically significant savings of 203 kWh per participant, or 2.5% of annual usage, in Liberty's electric HER program. For Unitil, the results indicate statistically significant savings of 133 kWh per participating home, or 1.5% of annual electricity use. The realization rates were 94% for Liberty and 91% for Unitil. Note that both the estimated and reported savings presented exclude any uplift savings, enabling a direct, like-for-like comparison.

Table 1: Electric Savings and Realization Rates in 2023

	Liberty	Unitil
Number of Households	8,027	18,791
Estimated kWh savings per household (90% CI)	202.5 (105.2, 299.9)	132.6 (45.6, 219.5)
Estimated % savings per household (90% CI)	2.5% (1.3%, 3.7%)	1.5% (0.5%, 2.4%)
Reported kWh savings per household	214.6	145.4
Program RR (90% CI)	**94% (49%, 140%)**	**91% (31%, 151%)**

Similarly, Table 2 provides a summary of the gas savings results from the billing analysis, along with the associated realization rates. In 2023, the results suggest statistically significant savings per HER participant of 19.1 therms for Liberty, representing 2.5% of annual usage. For Unitil, the results suggest statistically significant savings per HER participant of 12.0 therms, or 2.1% of annual gas consumption. The realization rates were 121% for Liberty and 96% for Unitil.

Table 2: Gas Savings and Realization Rates in 2023

	Liberty	Unitil
Number of Households	21,137	13,686
Estimated therm savings per household (90% CI)	19.1 (10.0, 28.2)	12.0 (4.1, 19.9)
Estimated % savings per household (90% CI)	2.5% (1.3%, 3.7%)	2.1% (0.7%, 3.4%)
Reported therm savings per household	15.8	12.5
Program RR	**121%**	**96%**

The differences between the treatment and controls groups were not statistically significant. The study assessed comparability of the two groups based on pre-program usage and geographic distribution. Graphical representations indicated that the groups were similar, and statistical testing did not find any observed differences to be statistically significant. This suggests that the random assignment created well-balanced groups, increasing confidence that observed savings can be attributed to the Home Energy Report programs rather than pre-existing geographic or usage differences between the groups. Due to data limitations, NMR did not evaluate the comparability of the two groups in terms of other factors, such as income or educational attainment.

Uplift savings from participation in other programs in 2022 and 2023 were not statistically significantly greater than zero. The study examined whether treatment group households participated in Liberty's and Unitil's Home Energy Assistance (HEA), Home Energy Performance (HEP), or ENERGY STAR Products programs at a higher rate than control group households. The analysis found no statistically significant difference in participation rates, indicating that the uplift savings from participation in other programs in 2022 and 2023 were not statistically significantly greater than zero. However, due to data limitations, the study could not account for

uplift savings from earlier years. This means that any uplift that may have occurred between the start of the HER programs and December 2021 could not be estimated.

Uplift savings from upstream lighting programs, which are difficult to measure, are expected to be minimal. Few studies included in the literature review for this study have assessed this impact, mostly through surveys, with inconclusive results. Some found a slight uplift of 1% to 3% of total HER savings, while others found no significant differences in program-supported light bulb purchases between treatment and control groups. A recent Rhode Island study concluded that measuring uplift in upstream lighting would be costly and unlikely to produce meaningful results, in alignment with similar findings from Michigan.

BENCHMARKING

The evaluated 2023 electric and gas savings for both Liberty and Unitil exceed typical HER program results. A 2022 comprehensive meta-analysis[1] of research and evaluation reports for HER programs (2017–2022) found electric savings ranging from 0.6% to 1.7% (weighted mean: 1.16%) and gas savings from 0.3% to 1.7% (weighted mean: 0.87%). The meta-analysis also found a moderately strong positive correlation between the number of years a wave received HERs and its annual savings. This may help explain the higher savings observed for Liberty and Unitil, as each wave had been active in the program for at least five years prior to 2023.

[1] ILLUME. *Behavioral Programs Come of Age: Analyzing Savings from Recent Home Energy Report Program Studies*. June 2022. https://illumeadvising.com/files/Home-Energy-Report-Analysis_Final-Report_ILLUME-1.pdf

Section 1 Introduction

This section provides an overview of the Home Energy Reports (HER) programs, including their purpose, implementation, and participation details. It also outlines the objectives of this impact evaluation.

1.1 About the Home Energy Reports Program

For years, Home Energy Reports (HERs) have been a key strategy in encouraging energy conservation among residential customers. Delivered via email and/or print, these reports provide personalized energy consumption data and energy-saving tips, comparing a household's usage with that of neighbors. The goal is to promote energy-saving behaviors through clear, accessible information.

The HER program is grounded in social psychology theory, which suggests that people are likely to alter their behavior in response to normative information and feedback. Positive feedback comparing a customer's energy use to that of similar households motivates them to maintain or further reduce their energy consumption. Conversely, households informed that their energy use is higher than their neighbors are encouraged to lower their consumption. The HER program influences energy consumption by promoting a broad range of customer behaviors, rather than targeting specific end uses or appliances. Since this approach encourages overall energy-saving actions across various aspects of daily life, from adjusting thermostat settings to modifying usage patterns and purchase decisions for lighting and appliances, the savings are best measured using a whole-house energy consumption analysis.

The programs establish savings using a randomized control trial (RCT) experimental design: customers who meet the eligibility criteria are randomly assigned to either a *treatment group* that receives reports or a *control group* that does not. Random assignment, in theory, ensures that the treatment and control groups are comparable in terms of energy use and other characteristics, allowing the control group to serve as a baseline or counterfactual. This provides a basis for understanding what would have happened to the treatment group without the HER program, enabling a clear assessment of the program's impact.

Currently, Liberty Utilities and Unitil are administering these programs for both electric and natural gas customers in New Hampshire. They are contracted with Oracle to implement the program.

1.1.1 Program Measures

Liberty. The Liberty Gas HER program was initiated in 2014 and the Liberty Electric HER program was launched in 2018. The treatment group in the Gas HER program receives four paper reports annually and six email reports during the heating months (November-March). The electric HER treatment group receives reports year-round, alternating between print and email every other month, resulting in six reports of each type annually. Both programs offer online access to reports and energy data, helping customers compare their usage with peers. Liberty also uses HERs to promote other NHSaves programs.

The program aims to increase savings going forward by rotating the recipient pool, modifying the report distribution frequency, and customizing the content of reports and tips in both printed and web-based formats.

Unitil. Unitil's Electric and Gas HER programs were initiated in 2018. The treatment groups in both programs receive 12 email reports annually, with the Gas HER treatment group also receiving an additional four paper reports during the heating months (November – March), and the Electric HER treatment group receiving an additional six paper reports in the summer. Both of these programs aim to achieve significant energy savings in the residential sector and will continue through the current vendor contract.

1.2 Participation Summary

Table 3 provides the distribution of households assigned to the treatment and control groups for each wave across both utilities in the original study design. Waves refer to different implementations or iterations of a HER program. For example, a utility might launch a HER program in phases, with each phase being referred to as a "wave". Each wave may also target different customer segments and fuel types. Liberty's original RCT design included 85,015 households, with 55,894 assigned to the treatment group. Unitil's design comprised 76,000 households, of which 48,154 were in the treatment group. In 2023, 52% of Liberty's households and 67% of Unitil's households from the original design were active in the program.

In the original RCT design, Liberty had more households in the gas waves, particularly in the 2014 wave, where 30,000 households were assigned to the treatment group. In contrast, Unitil had more households in the electric wave, with 23,136 assigned to the treatment group in the 2018 Electric wave. Additionally, Unitil launched a small dual fuel wave in 2018, which was not present in Liberty's design, as Liberty does not serve any dual-fuel residential customers in New Hampshire. For both utilities, none of the waves targeted specific geographies or customer segments, such as high-usage households, according to communications from the program vendor, Oracle, and the utilities.

Table 3: Number of Households by Wave

Liberty				Unitil			
Wave	Treatment Group	Control Group	Total	Wave	Treatment Group	Control Group	Total
2014 Gas	30,000	10,000	40,000	2018 Electric	23,136	11,968	35,104
2017 Gas	13,915	11,990	25,905	2018 Gas	22,517	14,273	36,790
2018 Electric	11,979	7,131	19,110	2018 Dual Fuel	2,501	1,605	4,106
Total	**55,894**	**29,121**	**85,015**	**Total**	**48,154**	**27,846**	**76,000**

1.3 Overall Study Goals

NMR conducted this study to evaluate electricity and natural gas savings from HER programs in New Hampshire in 2023. The analysis focused on households in the HER program's treatment

and control groups during 2023, as it was the first full year of savings in which persistence from prior years had not already been claimed in previous program years.[2]

The study was designed to achieve the following objectives:

1. Assess the comparability of the HER treatment and control groups based on geographic location and pre-program energy usage.
2. Estimate 2023 electric and natural gas savings by utility through a billing analysis.
3. Assess realization rates by comparing estimated savings to utilities' reported savings.
4. Analyze uplift savings, i.e., additional savings from participation in other NHSaves programs such as Home Energy Assistance (HEA), Home Energy Performance (HEP), and ENERGY STAR Products programs.
5. Examine savings degradation over time and HER savings attributable to upstream lighting programs through a literature review.

[2] Liberty Gas and Electric switched from a three-year to a single-year measure life for calculating program energy savings at the end of 2022. Consequently, annual savings now reflect the measured savings for that year alone, without accounting for persisting savings.

Section 2 Methodology

To meet the study objectives, NMR employed a comprehensive set of research methodologies. This section outlines the methodologies used, including data sources, analytical techniques, and key evaluation strategies. Detailed information on the billing analysis, including model specification and data preparation steps, is provided in Appendix A for further reference.

2.1 ACTIVITIES

The study methodology included the following core activities.

2.1.1 Billing Analysis

NMR performed a billing analysis leveraging the experimental design of the program to independently verify HER program savings. The monthly utility bills for the HER program's treatment and control groups were the primary source of data for both electric and gas billing analysis. The HER program control group data provided a counterfactual to the treatment groups' savings, which allowed NMR to measure net changes in energy consumption among the treatment group and validate that these changes were caused by the program.

This analysis focused on estimating the program's effect on energy consumption in 2023 for the following reasons:

1. **Transition in Measure Life Calculation**: At the end of 2022, Liberty and Unitil shifted from a three-year to a single-year measure life for calculating program energy savings, so focusing on the period after this change avoided complicating the lifetime savings calculation.
2. **Efficiency Gains with Data Processing**: NMR had already processed the other program tracking data for 2022 and 2023 for the most recent HEA and HEP impact evaluations and was able to reuse these data for this HER evaluation.
3. **Database Updates**: NMR required information on participation in other residential programs to assess and adjust for HER savings counted by other programs. The Utilities updated their residential program tracking databases in 2022, and earlier program tracking data from their legacy databases would be stored in a different format. Obtaining and processing earlier program tracking data in the legacy database would have delayed the study and increased costs.

NMR utilized the same model specification as Oracle: a lagged dependent variable (LDV) model, which incorporates pre-program period data as a lag variable. Because past energy use is correlated with current energy use, including pre-program usage as a control variable helps account for systematic differences in energy consumption among participants. The model does not include weather variables, as factors influencing energy use—such as weather—are inherently captured and controlled for through the energy consumption behavior of the control group in a randomized control trial (RCT) design. Appendix A provides a detailed discussion of the model specification, along with the steps NMR took to prepare the data for the billing analysis.

2.1.2 Examining Treatment and Control Group Comparability

Accurate estimation of savings from report-based behavior programs rests on the assumption that the random assignment process resulted in treatment and control groups that are similar. NMR examined the comparability of the treatment and control groups in two ways.

Geographic Distribution. NMR compared the proportion of treatment and control group households, by utility and fuel type, across three climate regions in New Hampshire. Given the state's north-south orientation and diverse topography, ranging from sea level to nearly 6,300 feet, any unequal assignment of households to climate regions could introduce bias into the results. This comparison was conducted to verify that assignment was consistent across climate regions. NMR defined the three climate regions by combining the International Energy Conservation Code (IECC) climate zones with National Oceanic and Atmospheric Administration (NOAA) climate divisions, assigning each household in the treatment and control groups to one of these climate regions.

Pre-Program Usage. NMR compared pre-program energy use to assess whether the treatment and control groups were statistically similar before the program began. This was done through: 1) a visual inspection of overlaid plots comparing the pre-program monthly mean energy use of both groups, and 2) regression analysis on pre- program usage with the treatment/control group as a variable. Given the large population sizes, small differences in pre-program usage between the treatment and control groups could bias the results, overstating or understating savings.

2.1.3 Checking for Participation in Other Programs

Customers who receive HERs may participate in other energy efficiency programs (e.g., HEA, HEP, and ENERGY STAR® Products) at higher rates than control groups. Program theory suggests that the messaging in HERs and cross-program promotions may drive this increased participation. Since those other programs also claim savings, there is a risk of double-counting savings if they are captured in both HER net savings and other programs. To address this, NMR assessed the lift in participation due to the HER treatment (participant uplift).

NMR matched the 2022 and 2023 program tracking data for the Home Energy Assistance, Home Energy Performance, and ENERGY STAR® Products programs to the HER program treatment and control groups using account numbers. This analysis aimed to determine whether there were statistical differences in non-HER program participation rates between the two groups. In HER program evaluations, any uplift in savings from other programs attributable to the HER program are typically excluded from HER savings estimates to prevent double counting of savings already claimed by other programs.

This analysis excluded upstream programs, such as the ENERGY STAR Lighting program, as the utilities do not have a record of which customers purchased supported light bulbs and how many they purchased. However, the Literature Review searched for information that might allow the study to address upstream lighting savings.

2.1.4 Literature Review

NMR conducted a literature review to explore three key topics:

(1) savings degradation over time with repeated HER treatments,

(2) legacy uplift savings, referring to savings from participation in other programs in earlier program years, and

(3) the influence of upstream lighting programs on HER savings.

Due to constraints in budget, data availability, and timeline, conducting primary analyses to directly quantify these impacts was not feasible for this evaluation. Instead, NMR reviewed existing research on similar HER programs, drawing on insights from previous evaluations that have examined these issues. This approach provided valuable context for assessing potential impacts on HER savings and informed any necessary adjustments.

2.2 Data Sources

Energy Consumption Data. Evaluations of report-based behavior programs rely heavily on access to customer billing (consumption) data. NMR requested and received monthly electricity and natural gas consumption data from Oracle for all HER treatment and control group customers active in the program in 2023. The dataset covered a period extending from 15 months before each program's initial start date (by utility and fuel type) through March 31, 2024. Each billing record included a unique customer ID, billed consumption (in kWh for electricity and therms for natural gas), meter read dates, the number of days in the billing period, and a designation indicating whether the read was actual or estimated.

In addition to billing data, Oracle provided supplementary customer-level information, including wave assignment, treatment status, treatment start and end dates, and customer addresses. The addresses enabled NMR to match households to climate zones for geographic equivalency testing.

Other Program Participation Data. This study assessed whether the treatment group participated in other direct install energy efficiency programs in 2022 and 2023 at a greater rate than the control group to adjust for any savings attributable to those other programs. As part of a larger impact and process evaluation of residential programs, NMR had requested and received program participation data from the Utilities for residential program participants from 2023. Utilizing this data that has been cleaned and processed for the larger study allowed NMR to leverage evaluation resources for this HER impact evaluation.

Section 3 Impact Evaluation Findings

This section presents the findings from the impact evaluation, structured as follows:

1. **Comparability Checks** – Findings on the comparability of treatment and control groups.
2. **Billing Analysis** – Results from the billing analysis of monthly electricity and gas consumption data for HER treatment and control group homes.
3. **Uplift Analysis** – Estimates of participation rates in other programs and the HER savings attributed to participation in these other programs.
4. **Literature Review** – Findings from the literature review on savings degradation, legacy uplift, and upstream lighting program savings.

3.1 Comparability of Treatment and Control Groups

The HER programs are implemented using an RCT design, which enables the estimation of savings by comparing energy consumption between treatment and control groups. In theory, random assignment increases the likelihood that these groups are not statistically different, thereby reducing systematic bias and enabling an unbiased measurement of the program's causal impact. However, it is crucial to perform comparability checks to help validate the integrity of the experimental design and strengthen confidence in the program's measured savings impact. NMR conducted such comparability checks for geographic distribution and pre-program energy usage. Due to data limitations, NMR did not evaluate the comparability of the two groups in terms of other factors, such as income or educational attainment.

3.1.1 Geographic Distribution

To assess the geographic comparability of the treatment and control groups, NMR first assigned each HER household to one of three climate regions—Northern, Southern, or Central— in New Hampshire based on their home address, as illustrated in Figure 1.

Figure 1: Climate Regions in New Hampshire

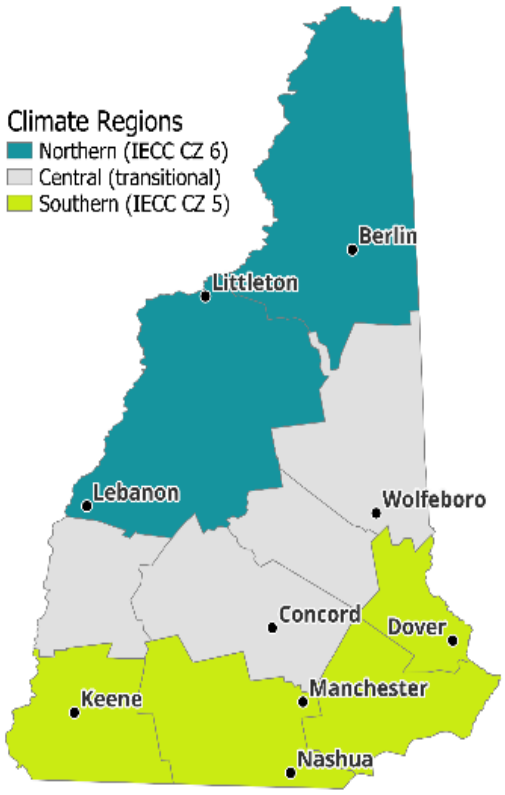


Table 4 presents the distribution of households across climate regions within each HER wave for Liberty, including both counts and percentages. To determine whether any geographic differences existed between the treatment and control groups, NMR conducted a chi-square test. The results indicated that *none* of the observed differences were statistically significant at the 90% confidence level for any wave.

Table 4: HER Households by Climate Region – Liberty

Wave/Climate Region	Treatment Group		Control Group		Total	
	n	%	n	%	n	%
2014 Gas Wave	**30,000**	**100.0%**	**10,000**	**100.0%**	**40,000**	**100.0%**
Central	6,332	21.1%	2,146	21.5%	8,478	21.2%
Southern	23,668	78.9%	7,854	78.5%	31,522	78.8%
2017 Gas Wave	**13,915**	**100.0%**	**11,990**	**100.0%**	**25,905**	**100.0%**
Central	2,722	19.6%	2,378	19.8%	5,100	19.7%
Southern	11,193	80.4%	9,612	80.2%	20,805	80.3%
2018 Electric Wave	**11,979**	**100.0%**	**7,131**	**100.0%**	**19,110**	**100.0%**
Northern	4,507	37.6%	2,707	38.0%	7,214	37.7%
Central	984	8.2%	582	8.2%	1,566	8.2%
Southern	6,488	54.2%	3,842	53.9%	10,330	54.1%

Similarly, Table 5 shows the distribution of households across climate regions for each HER wave for Unitil. Compared to Liberty, Unitil HER households exhibited less geographic variation, with only the 2018 Electric wave spanning multiple climate regions. A chi-square test confirmed that the geographic differences between the treatment and control group in this wave were also *not* statistically significant at the 90% confidence level.

Table 5: HER Households by Climate Region – Unitil

Wave/Climate Region	Treatment Group		Control Group		Total	
	n	%	n	%	n	%
2018 Dual Fuel Electric Wave	**2,501**		**1,605**		**4,106**	
Southern	2,501		1,605		4,106	
2018 Dual Fuel Gas Wave	**2,475**		**1,589**		**4,064**	
Southern	2,475		1,589		4,064	
2018 Electric Wave	**23,136**	**100.0%**	**11,968**	**100.0%**	**35,104**	**100.0%**
Central	9,909	42.8%	5,048	42.2%	14,957	42.6%
Southern	13,227	57.2%	6,920	57.8%	20,147	57.4%
2018 Gas Wave	**22,517**		**14,273**		**36,790**	
Southern	22,517		14,273		36,790	

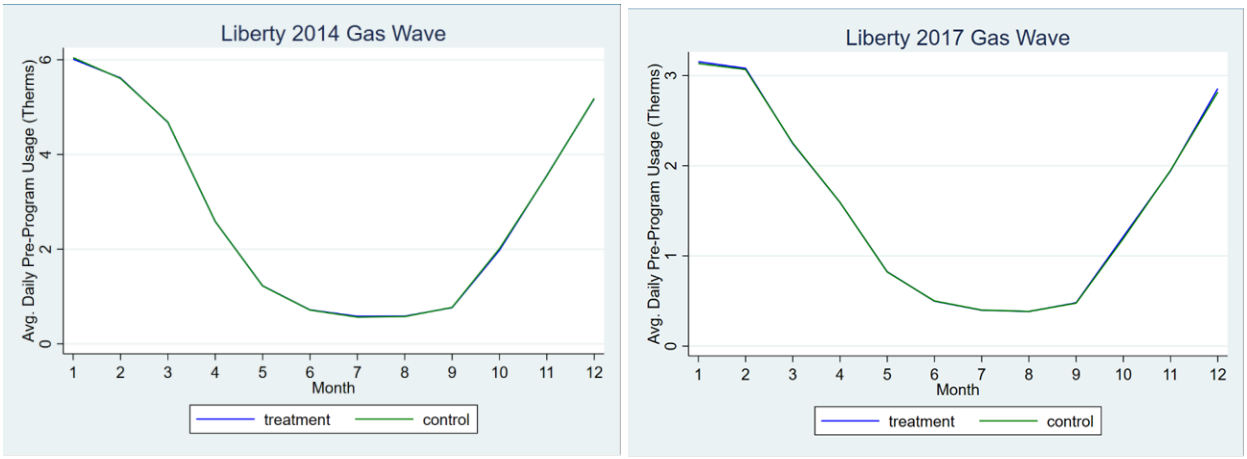
These findings indicate that the randomization process created well-balanced treatment and control groups in terms of geographic location for both Liberty and Unitil.

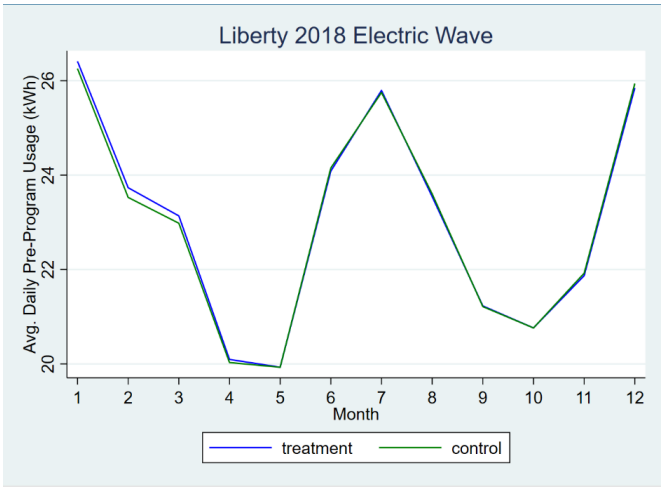
3.1.2 Pre-Program Usage

To assess the comparability of the treatment and control groups in terms of pre-program energy usage, NMR examined the pre-program average daily electricity and gas usage by month for the treatment and control groups in each wave.

Figure 2 presents plots of pre-program average daily electricity and gas usage by month for the treatment and control groups in each wave for Liberty. The graphs suggest that pre-program usage was nearly identical between the two groups in all waves across all months.

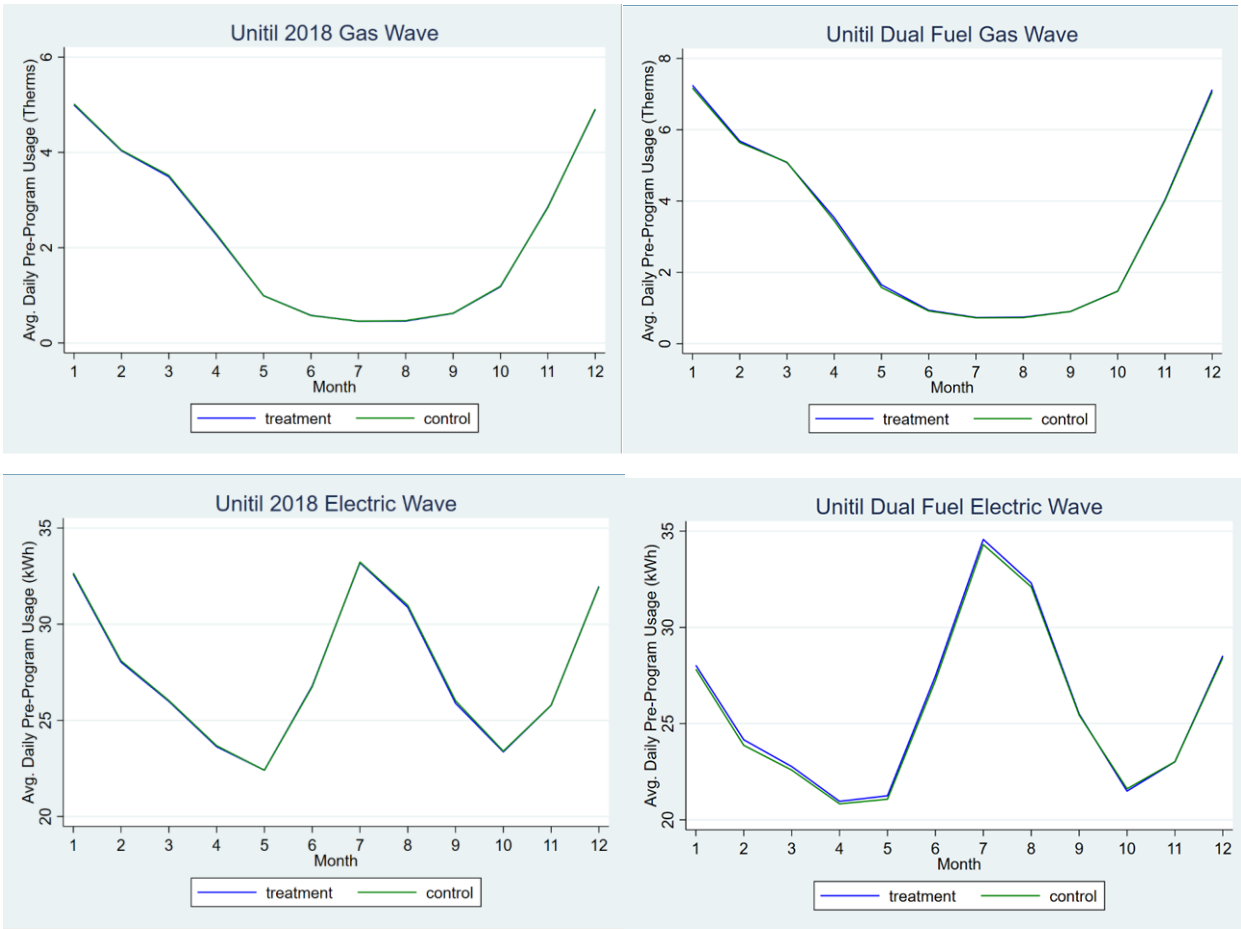
Figure 2: Average Daily Pre-Program Usage by Month, Treatment vs. Control Group – Liberty





Similarly, Figure 3 presents plots of pre-program average daily electricity and gas usage by month for the treatment and control groups in each wave for Unitil. The graphs suggest that pre-program usage was nearly identical between the two groups in all waves across all months.

Figure 3: Average Daily Pre-Program Usage by Month, Treatment vs. Control Group – Unitil



NMR also conducted a regression analysis to evaluate the statistical comparability of pre-program energy usage between the treatment and control groups for each month. The regression model estimated the difference in average daily consumption between the two groups during month *m* of the pre-program period. Since households were randomly assigned to the treatment and control groups, these differences were expected to be minimal and statistically insignificant. The regression results confirmed this expectation, showing that, the differences in pre-program usage between the treatment and control group in a given month were not statistically significant for any Liberty or Unitil wave.

These statistical comparability tests confirmed the effectiveness of the randomization process, suggesting that the treatment and control groups were well-balanced in terms of both pre-program energy usage and geographic distribution. This increases confidence that any differences observed in 2023 energy consumption can be attributed to the impact of the HER program rather than underlying variations in household energy usage patterns or location-based factors.

3.2 Billing Analysis Findings

This section presents the findings from the billing analysis and compares the estimated savings to reported savings for the HER program.

3.2.1 Overall Findings and Realization Rates

Table 6 summarizes the 2023 annual electricity and gas savings estimates, along with realization rates, from the billing analysis for Liberty. The savings are expressed both in physical units and as a percentage of annual usage. Additionally, a confidence interval (CI) is provided for the savings and realization rate estimates. For Liberty, the results suggest statistically significant savings per HER participant in 2023 of 203 kWh, or 2.5% of annual usage. The results also suggest statistically significant gas savings in 2023 of 19 therms, also 2.5% of annual usage. The realization rate, which is the ratio of estimated savings to reported savings, was 94% for electric savings and 121% for gas savings.

Table 6: Overall 2023 Savings and Realization Rates – Liberty

Liberty	Electric (kWh)	Gas (Therms)
Number of Households	8,027	21,137
Estimated savings per household (90% CI)	202.5 (105.2, 299.9)	19.1 (10.0, 28.2)
Estimated % savings per household (90% CI)	2.5% (1.3%, 3.7%)	2.5% (1.3%, 3.7%)
Reported savings per household	214.6	15.8
Program RR (90% CI)	**94% (49%, 140%)**	**121% (63%, 179%)**

Similarly, Table 7 summarizes the 2023 annual electricity and gas savings estimates, along with realization rates, from the billing analysis for Unitil. For Unitil, the results suggest statistically significant savings per HER participant in 2023 of 133 kWh, or 1.5% of annual electricity usage. The results also suggest statistically significant gas savings of 12 therms, or 2.1% of annual gas usage, in 2023. The realization rate was 91% for electric savings and 96% for gas savings.

Table 7: Overall 2023 Savings and Realization Rates – Unitil

Unitil	Electric (kWh)	Gas (Therms)
Number of Households	18,791	13,686
Estimated savings per household (90% CI)	132.6 (45.6, 219.5)	12.0 (4.1, 19.9)
Estimated % savings per household (90% CI)	1.5% (0.5%, 2.4%)	2.1% (0.7%, 3.4%)
Reported savings per household	145.4	12.5
Program RR (90% CI)	**91% (31%, 151%)**	**96% (33%, 160%)**

For both utilities, the estimated electric and gas savings aligned with the reported savings, with the reported values falling well within the confidence interval of the estimated savings. Although

there is some variation in realization rates across utilities and fuel types, these differences were not statistically significant, nor did the realization rates differ statistically significantly from 100%.

The relatively wide confidence intervals around savings and realization rate estimates are a common finding in HER program evaluations. All impact evaluation reports listed Appendix B, which were included in the literature review for this study, contained similarly wide confidence intervals around the HER program savings estimates. This is primarily due to natural year-to-year fluctuations in household electricity and gas usage, which introduce noise into the data. Since the HER program's impact on energy consumption is relatively small compared to this variability, the billing analysis faces challenges in isolating the program's effect from background fluctuations, resulting in larger standard errors relative to the mean.

3.2.2 Findings by Wave

Liberty's HER program launched one electric wave in January 2018 and two gas waves in September 2014 and January 2017. Unitil's HER program introduced two electric waves—one single-fuel and one dual-fuel—as well as two gas waves, also split between single-fuel and dual-fuel, all beginning in October 2018. The dual-fuel wave included customers receiving home energy reports for both electric and gas.

Table 8 presents Liberty's gas results by wave. Although the 2014 gas wave achieved higher average savings per household than the 2017 wave, the percentage savings was similar across both waves. That is, the higher average savings for the 2014 gas wave reflects its higher average usage rather than a greater savings rate. The similarity of 2023 savings rates across the waves also suggests that repeated treatment may not necessarily lead to a decline in savings over time. If this were the case, one would expect the 2014 wave to exhibit a lower savings rate than the 2017 wave.

Table 8: 2023 Gas Results by Wave – Liberty

Liberty Gas Waves	2014 Gas	2017 Gas	Combined
Number of Households	15,656	5,481	21,137
Annual 2023 Usage (therms) per Household	803	581	745
Estimated therm savings per household (90% CI)	20.8 (11.9, 29.8)	14.2 (4.7, 23.7)	19.1 (10.0, 28.2)
Estimated % savings per household (90% CI)	2.5% (1.5%, 3.6%)	2.4% (0.8%, 3.9%)	2.5% (1.3%, 3.7%)

Table 9 presents Liberty's electric results by wave. As Liberty had only one electric wave, these results are identical to the overall electric results shown in Table 6.

Table 9: 2023 Electric Results by Wave – Liberty

Liberty Electric Wave	2018 Electric
Number of Households	8,027
Annual 2023 Usage (kWh) per Household	7,925
Estimated kWh savings per household (90% CI)	202.5 (105.2, 299.9)
Estimated % savings per household (90% CI)	2.5% (1.3%, 3.7%)

Table **10** presents Unitil's gas results by wave. Despite higher annual usage, the dual-fuel wave achieved lower and statistically insignificant gas savings compared to the single-fuel wave. However, its smaller participant count limited its impact on the combined gas results. Since the waves did not target specific geographies or customer segments, such as high-usage households, the higher average annual gas usage observed in the dual-fuel gas wave is likely due to the geographic distribution of Unitil's dual-fuel customers within its New Hampshire gas service territory.

Table 10: Gas Results by Wave – Unitil

Unitil Gas Waves	2018 Gas	2018 Dual Fuel	Combined
Number of Households	11,728	1,958	13,686
Annual 2023 Usage (therms) per Household	519	881	571
Estimated therm savings per household (90% CI)	12.6 (5.5, 19.6)	8.2 (-4.1, 20.4)	12.0 (4.1, 19.9)
Estimated % savings per household (90% CI)	2.4% (1.1%, 3.6%)	0.9% (-0.5%, 2.3%)	2.1% (0.7%, 3.4%)

Table 11 presents Unitil's electric results by wave. Unlike the gas results, the dual-fuel wave achieved higher electricity savings than the single-fuel wave, despite having slightly lower average annual electricity consumption. However, its smaller participant count again limited its impact on the combined electric results.

Table 11: Electric Results by Wave – Unitil

Unitil Electric Waves	2018 Electric	2018 Dual Fuel	Combined
Number of Households	16,824	1,967	18,791
Annual 2023 Usage (kWh) per Household	8,936	8,179	8,857
Estimated kWh savings per household (90% CI)	124.5 (54.4, 194.5)	202.5 (28.0, 377.1)	132.6 (45.6, 219.5)
Estimated % savings per household (90% CI)	1.4% (0.6%, 2.1%)	2.4% (0.3%, 4.4%)	1.5% (0.5%, 2.4%)

3.2.3 Benchmarking

This study is the first impact evaluation of Liberty and Unitil's HER programs and thus there are no prior New Hampshire results to benchmark against. Therefore, to contextualize the billing analysis results, NMR drew on findings from meta-analyses and literature reviews of HER evaluations in other jurisdictions. The results indicate that the evaluated 2023 electric and gas savings for both Liberty and Unitil's HER programs exceeded the typical savings estimates from HER program evaluations—particularly for gas.

A 2016 ACEEE report[3] reviewing 31 HER program evaluations found electric savings ranging from 0.5% to 5.2% and gas savings from 0.3% to 1.6%. The median estimates suggested that electric savings were roughly double those of gas—approximately 1.6% compared to 0.8%. A 2024 literature review conducted for a HER program evaluation in Connecticut[4] found electric savings ranging from 0.6% to 2% and gas savings from 0.5% to 1% in cold climates.

A 2022 comprehensive meta-analysis[5] of research and evaluation reports for HER programs (2017–2022) found electric savings ranging from 0.6% to 1.7% (weighted mean: 1.16%) and gas savings from 0.3% to 1.7% (weighted mean: 0.87%). The meta-analysis also found a moderately strong positive correlation between the number of years a wave received HERs and its annual savings. This may help explain the higher savings observed for Liberty and Unitil, as each wave had been active in the program for at least five years prior to 2023.

[3] ACEEE. *Behavior Change Programs: Status and Impact.* October 2016 https://www.aceee.org/sites/default/files/publications/researchreports/b1601.pdf
[4] Guidehouse. *CT R2255 Avangrid Behavioral Programs Impact Evaluation*. May 2024. https://app.box.com/s/llseur73bygr9g731769q910wukfwodr
[5] ILLUME. *Behavioral Programs Come of Age: Analyzing Savings from Recent Home Energy Report Program Studies*. June 2022. https://illumeadvising.com/files/Home-Energy-Report-Analysis_Final-Report_ILLUME-1.pdf

3.3 Uplift Savings Analysis Findings

HER programs encourage treatment group households to participate in other energy efficiency programs offered by the utilities. Since the savings from these additional programs are already accounted for within their respective programs, it is crucial to exclude any savings attributable to participation in other efficiency programs from HER savings to avoid double counting. These HER-induced other-program savings are referred to as "uplift" savings.

For both Liberty and Unitil, NMR checked whether the treatment group households participated in the HEA, HEP, or ENERGY STAR Products programs at a statistically significantly greater rate than the control group households in 2022 and 2023. To perform this analysis, NMR matched the HER program data with tracking data for these years using utility account numbers.

The uplift savings analysis could not be conducted for years prior to 2022 due to the unavailability of data from these other programs for earlier years. Additionally, we could not assess HER savings related to upstream lighting programs using the same methodology, as the utilities do not track ENERGY STAR Lighting program participation at the customer level. Specifically, they lack records for which customers purchased program-supported light bulbs and how many bulbs were purchased. NMR conducted a literature review to explore the implications of these limitations and identify ways to address them (Section 3.4.3).

Table 12 presents the rates at which HER treatment and control group households participated in Liberty's other programs during 2022 and 2023. *In a two-tailed test, a p-value below 0.05 indicates statistical significance at the 90% confidence level*. Since all p-values are above this threshold, the differences in participation rates between treatment and control group households in the HEA, HEP, or ENERGY STAR Products programs during these years are *not* statistically significant. This finding is consistent across all HER waves. This indicates that the uplift savings from participation in other programs in 2022 and 2023, were not statistically significantly higher than zero.

Table 12: Participation in Other Programs in 2022 and 2023 – Liberty

Program	HER Wave	Participation Rate for Treatment Group	Participation Rate for Control Group	Difference	P-Value
HEA	2014 Gas	0.3%	0.4%	-0.1%	0.133
HEA	2017 Gas	0.8%	0.8%	0.0%	0.986
HEA	2018 Electric	3.4%	3.3%	0.1%	0.821
HEP	2014 Gas	0.9%	0.8%	0.1%	0.675
HEP	2017 Gas	0.8%	0.6%	0.2%	0.292
HEP	2018 Electric	0.4%	0.4%	0.0%	0.691
ESP	2014 Gas	5.3%	5.2%	0.1%	0.807
ESP	2017 Gas	3.7%	4.1%	-0.4%	0.307
ESP	2018 Electric	5.0%	5.3%	-0.3%	0.432

Similarly, Table 13 presents the participation rates of HER treatment and control group households in Unitil's other programs during 2022 and 2023. Since all p-values exceeded 0.05, the results suggest that treatment group households did not participate in the HEA, HEP, or ENERGY STAR Products programs at a statistically different rate than control group households during these years. This finding is consistent across all HER waves, meaning uplift savings in these years were also not statistically significantly greater than zero for Unitil participants.

Table 13: Participation in Other Programs in 2022 and 2023 – Unitil

Program	HER Wave	Participation Rate for Treatment Group	Participation Rate for Control Group	Difference	P-Value
HEA	Gas	0.0%	0.0%	0.0%	0.261
HEA	Electric	0.2%	0.2%	0.0%	0.668
HEP	Gas	0.5%	0.5%	0.0%	0.741
HEP	Electric	0.7%	0.6%	0.1%	0.189
HEP	Dual Fuel Electric	0.2%	0.4%	-0.2%	0.292
ESP	Gas	0.8%	0.9%	-0.1%	0.567
ESP	Electric	6.2%	6.1%	0.1%	0.799
ESP	Dual Fuel Electric	5.6%	6.6%	-0.9%	0.294

Note that certain dual-fuel HER waves are excluded from this table because none of the customers in either the treatment or control group had matching records in the corresponding HEA, HEP, or ESP program data.

3.4 Literature Review Findings

This study estimated the 2023 savings from the Home Energy Report (HER) program using a billing analysis. Liberty's program waves were launched between 2014 and 2017, and Unitil's waves began in 2018—indicating that both had been active for several years prior to 2023. To contextualize the findings and examine issues that could not be directly assessed in this study, NMR reviewed 15 relevant evaluation studies, focusing on the following key areas:

1. Savings degradation over time with repeated HER treatments,
2. Legacy uplift effects, and
3. The extent to which HER savings are attributable to upstream lighting programs.

The list of reviewed study reports is provided in Appendix B. Each study is numbered, and references in the discussion are cited using their corresponding study number as [#].

3.4.1 Savings Degradation Following Repeated Treatment

While much research has focused on the persistence of savings after treatment ends, fewer studies have specifically addressed the issue of savings degradation due to repeated treatment.

Some studies indicated no significant degradation in savings between earlier and later treatment waves, suggesting that repeated treatments did not diminish the overall savings impact. [3, 4]

When degradation was observed, it was typically linked to factors such as gaps in treatment periods rather than a direct cause of time-related fatigue from repeated treatment. [3] Other studies reported slight degradation, particularly after the third year of ongoing treatment. [4] The overall evidence is mixed, suggesting that more research is needed to better understand the long-term effects and to draw more definitive conclusions about savings degradation with repeated treatment.

These findings align with this study's results, which showed similar savings rates in 2023 from Liberty's 2014 gas wave compared to the later gas waves launched by Liberty and Unitil in 2017 and 2018, respectively.

3.4.2 Legacy Uplift Savings

A significant portion of uplift research focuses on analyzing uplift at a single point in time, with fewer studies investigating trends over multiple years following the program's initiation.

Most findings suggest that there is no clear evidence indicating a greater uplift in the early years of the program compared to later years. Instead, the results point to the possibility that uplift effects may remain relatively stable over time. [9] However, to confirm any long-term trends or shifts in uplift over the duration of the HER programs, more longitudinal studies are needed.

3.4.3 Upstream Lighting Programs

Upstream lighting programs enable customers to purchase energy-efficient lighting at a reduced cost directly at the point of sale. The program sponsor negotiates pricing agreements with retailers, distributors, or manufacturers, eliminating the need for customers to complete paperwork or rebate forms to access the discount. As a result, individual purchases are not tracked, making it difficult to directly compare purchases between treatment and control groups. To address this, evaluators employ alternative methods to assess differences in upstream purchases, such as primary data collection through surveys, interviews, home assessments, and store-intercept interviews.

Limited research has examined the uplift in upstream lighting programs, and the findings are inconclusive. A few studies attempted to estimate uplift by surveying HER treatment and control group households. Some of these studies suggested that treatment group households had slightly higher participation in upstream lighting programs, estimating that uplift savings accounted for 1% to 3% of total HER program savings. [3, 4] However, other studies found no statistically significant differences in LED lightbulb purchases between the treatment and control groups. [2, 4, 6]

A recent study in Rhode Island concluded that conducting primary research on uplift in upstream lighting programs would be costly and unlikely to yield statistically significant results. [12] This conclusion was supported by findings from a Michigan study, which also recommended no adjustments for upstream lighting programs, further suggesting that the impact of these programs on HER savings is minimal. [2]

3.4.4 Discussion and Recommendations

Based on the literature review findings, NMR recommends no adjustments for uplift savings in HEP, HEA, and ESP programs, as no uplift savings were identified for 2022 and 2023.

Additionally, there is no reliable method to determine any differences in uplift between the years of prior treatments and 2022.

Similarly, NMR does not recommend adjustments for uplift savings in upstream lighting programs. The literature review presents inconclusive findings, with only minimal evidence of an impact on HER savings. Therefore, any potential uplift effect is not substantial enough to justify adjustments.

Appendix A Billing Analysis Methodology

This section details the data cleaning and billing analysis methodology.

A.1 Detailed Data Cleaning

For the data preparation procedure, NMR closely followed Oracle's methods. This approach was chosen because: (1) Oracle's methodology was reasonable and aligned with The Uniform Methods Project's Residential Behavior Evaluation Protocol,[6] and (2) NMR sought to ensure that any differences were not due to methodological changes. Initial steps involved trueing up estimated reads and billing calendarization.

True-Up Process for Estimated Reads

According to the true-up process NMR conducted, if a billing cycle contained an estimated read that was followed by a billing cycle with an actual read, we added these two periods together and the duration of these two periods combined was used to calculate average usage. For example, if a billing cycle spanning from June 10 to July 10 used an estimated read, and the billing cycle that followed from July 10 to August 10 was based on an actual read, we would combine these two periods for actual usage of the period June 10 to August 10.

Billing Calendarization

The calendarization of data involved reorganizing average daily usage by calendar month instead of by billing cycles which tend to span over two months. The average daily usage for each calendar month was summed and then average daily usage for each calendar month was recalculated. An example of how calendarization was conducted is described below.

For example, a customer's average daily use equals 35 kWh for February 13 to March 10, and 24 kWh for March 11 to April 12. The equation for March average daily use is listed below and yields an average daily use for March of 27.55 kWh.

$$March\ Average\ Daily\ Use = \frac{(35\ kWh\ \times 10\ days) + (24\ kWh\ x\ 21\ days)}{31}$$

Trimming

NMR excluded data points and customers from the analysis based on the following criteria:

- Any usage occurring after a customer had moved out

[6] Stewart, James and Annika Todd. 2020. Chapter 17: Residential Behavior Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures: September 2011 – August 2020. Golden, CO: National Renewable Energy Laboratory. NREL/SR-7A40-77435. https://www.nrel.gov/docs/fy21osti/77435.pdf.

- Usage that was less than -300 kWh or greater than 300 kWh per day for electric customers, usage less than -50 therms or greater than 50 therms per day for gas customers
- Usage that had occurred more than 12 months before the program start date

The average pre-program usage data was calculated after the true-up, calendarization, and trimming processes. Customers that had less than a full year of pre-program data were not removed, and instead missing values were imputed with the average pre-usage data across all customers in the population. The pre-program data was also sorted based on the season and pre-program winter and summer variables were created. The summer months were defined as June through September and the winter months were defined as December through March. Missing data for the winter and summer variables were imputed with each household's value for average pre-usage data.

A.2 MODEL SPECIFICATION

The billing analysis model can be specified in a number of different ways. NMR chose to implement Oracle's lagged dependent variable (LDV) model because (1) Oracle's model specification was consistent with The Uniform Methods Project's Residential Behavior Evaluation Protocol, and (2) NMR aimed to ensure that any differences in savings estimates would not be due to differences in model specification. This panel regression model incorporates pre-program data as a lag variable instead of individual data points. NMR estimated an LDV model independently for the electric and gas waves of Liberty and Until. The model excludes weather variables since these factors are accounted for and controlled through the energy consumption behavior of the control group in the randomized controlled trial (RCT) design. Household post-treatment usage data serves as the dependent variable, while pre-program usage data and group assignment (control or treatment) were the independent variables. The model is detailed below.

$$daily\_usage_{it} = \propto + \beta treatment_i + \gamma t Y_{oi} + mm_t + \varepsilon_{it}$$

where:

$daily\_usage_{it}$ = The average daily usage in kWh or therms for month t for household i in the post-treatment period.

$\propto$ = Intercept of the regression equation, which provides an estimate of the daily usage for the control group.

$\beta treatment_i$ = Coefficient and a binary variable which indicates whether household i is in the treatment group. The β coefficient provides the savings estimate per day.

Y_{oi} = Vector comprised of three pre-program usage control variables:

- Average daily usage
- Average daily usage for winter months (December to March)
- Average daily usage for summer months (June to September)

mm_t = Indicators for each month-year in the post-treatment period

γt = Coefficients for the relationship between average pre-program usage variables to post-treatment usage. Varies by month-year.

ε_{it} = error term, representing random influences on the energy consumption of household i in month t.

In the model, standard errors are clustered at the household level to account for the correlation in individual household consumption across time periods.

To calculate monthly savings, savings per day (β) were multiplied by the number of days a customer's account was active in each month. For cumulative savings, savings per day (β) were multiplied across all of the days a customer's account was active in the post-treatment period. The post-treatment period of focus for this analysis was the year 2023.

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