



MEMORANDUM

To: Lisa Skumatz, Bob Wirtshafter, and Ralph Prah, Connecticut Energy Efficiency Board Evaluation Contractors, Evaluation Committee

From: NMR Group and Cadeo (Evaluation Team)

Date: September 6, 2022¹

Re: R1983 Air Sealing and Insulation Gross Realization Rate Recommendation for PSD - Final

This memo provides Eversource and Avangrid (the companies) with insights from the ongoing Home Energy Solutions (HES) and Home Energy Solutions Income Eligible (HES-IE) evaluation (R1983) to inform impending updates to the Connecticut Program Savings Document (PSD). The evaluation covers the single-family participants, i.e., those living in 1–4-unit buildings.

The results of the evaluation team's natural gas billing analysis of air sealing² and insulation³ measures delivered through HES and HES-IE are considerably lower than the previous impact evaluation (R1603) and the companies reported savings (provided in the program tracking data).⁴

The evaluation team recommends that the companies use the results in this memo to make proactive updates to the PSD for HES and HES-IE air sealing and insulation measures (across all heating fuel types)⁵ in advance of the final R1983 report. Making updates now will limit the level of disparity between the PSD and evaluation at the conclusion of R1983 later this fall.

¹ The evaluation team originally submitted a draft of this memo on July 1, 2022. This final memo / report incorporates comments received.

² Does not include duct sealing.

³ Does not include pipe insulation.

⁴ West Hill Energy and Computing, CT Home Energy Services-Income Eligible and Home Energy Solutions Impact Evaluation: Program Years 2015-2016, prepared for the CT EEB Evaluation Team, October 2019, <https://acrobat.adobe.com/link/review?uri=urn%3Aaid%3Aascds%3AUS%3A6ad1a31e-b53f-43aa-81bc-d5646e8c7d45#pageNum=1>.

⁵ Since consumption information is unavailable for HES & HES-IE, participants that heat with a delivered fuel (i.e., heating oil or propane), the evaluation team leveraged the results of the natural gas billing analysis to evaluate air sealing and insulation savings for home using delivered fuels. We undertook a similar approach for electrically heated participants as the sample size for insulated electric customers was insufficient to produce a statistically reliable result. This means the overall findings associated with the natural gas billing analysis—in terms of both evaluated savings and observed trends in consumption—are also applicable to delivered fuel and electrically heated participants. The evaluation team's process for leveraging the natural gas results included making a series of engineering adjustments to account for differences in the homes and heating system efficiencies.

The evaluation team recommends the companies apply a placeholder gross realization rate of at least 50% (relative to the reported savings for 2019 participants) for air sealing and insulation for both programs pending the completion of R1983.

This memo focuses on natural gas air sealing and insulation in recognition of the key role these measures play for residential retrofit programs. As explained in the footnote above, the natural gas results in this memo are also relevant for HES & HES-IE participants that heat with other fuels. The evaluation team will provide evaluated savings for the complete set of HES & HES-IE measures and fuels at the conclusion of R1983 in Q3 2022.

Section 1 Results

As with the previous HES and HES-IE evaluation, the evaluation team is using billing analysis to estimate the natural gas savings associated with air sealing and insulation. Described in the R1983 work plan, billing analysis is industry best practice when model results are sufficiently precise (i.e., at least 20% precision threshold at 90% confidence). This is because billing analysis implicitly accounts for myriad factors (e.g., preconditions, installation quality, and customer behavioral change) that impact savings and because the approach uses a control group (made up of future program participants) to account for nonprogrammatic factors. See 0 for a brief overview of the team’s billing analysis methodology.

The evaluation team’s estimated savings for HES and HES-IE participants⁶ who only received air sealing during their assessment (referred to as “Core” participants) separately from those who, following their assessment, installed one or more types of insulation (“Rebated” participants).⁷ The evaluation team was also able to estimate statistically significant savings for duct sealing through the natural gas billing analysis. In both HES and HES-IE, the average savings per participant that received duct sealing was 8 therms. These savings are separate from and additive to the air sealing and insulation savings presented in the following tables.

Table 1 presents the average per-participant savings we determined for both programs and participant types (i.e., Core and Rebated). As presented in the next section, these savings are much lower than the previous evaluation and reported savings in the tracking data, which is the basis for our team’s early recommendation that the Companies update the PSD now.

Table 1: Statewide⁸ Savings for 2019 Participants (therms/year)⁹

Program	Core (Air Sealing Only)	Rebated (Air Sealing & Insulation)
HES	13	63
HES-IE	13	133

⁶ The evaluation team analyzed of HES and HES-IE participants who installed air sealing and/or insulation in 2019 using a control group comprising “future” participants (that participated in 2020) with similar preprogram consumption.

⁷ For simplicity, the evaluation team uses “rebated” for both HES and HES-IE participants. The term is most appropriate for HES participants, who paid a copay toward their insulation, while HES-IE participants received insulation at no cost.

⁸ Combines Eversource and UI participants in both programs to increase sample sizes and statistical significance.

⁹ Does not include duct sealing, which our team assessed and will report separately.

Section 2 Savings Comparison

In this section, the evaluation team provides three comparisons for the values in Table 1:

1. The previous HES and HES-IE impact evaluation (R1603)
2. Reported savings in the provided program tracking data
3. Evaluation results of similar programs in neighboring states

The evaluation team has also provided additional information regarding the possible cause of the decline in average savings per participant (relative to these points of comparison) in Section 3.

2.1 COMPARISON TO PREVIOUS EVALUATION

R1603, completed in 2019, evaluated savings for the 2015 and 2016 HES and HES-IE program years. For HES, R1603 found an average statewide evaluated savings of 64 therms for air sealing and 154 therms for insulation.¹⁰ For HES-IE, the comparable evaluated values were 59 and 158 therms.¹¹

The evaluated R1603 savings for air sealing and insulation are mutually exclusive and additive. In other words, HES participants who had their home air sealed during the assessment and then installed insulation saved an estimated 218 therms on average. The combined savings from R1603 (Table 2) is comparable to the “rebated” savings ranges in Table 1. R1603 included duct sealing in its air sealing savings estimate, whereas the current evaluation does not. This difference in approach¹² leads to a slight incongruence in the table below. Adding duct sealing savings to the R1983 air sealing and insulation savings below would increase all R1983 estimates by approximate 3 therms.¹³

Table 2: Comparison #1: 1603 Evaluated Savings (therms/year)

	Core (Air Sealing Only)		Rebated (Air Sealing & Insulation)	
	R1983	R1603	R1983	R1603*
	2019 Participants	2014 & 2015 Participants	2019 Participants	2014 & 2015 Participants
HES	13	64	63	218
HES-IE	13	59	133	217

*Combination of evaluated air sealing and insulation savings, which were assessed separately as part of R1603.

¹⁰ Table ES-6.

¹¹ Table ES-7.

¹² The current evaluation team was able to isolate and separately estimate duct sealing (apart from air sealing) whereas the previous evaluation team could not.

¹³ Approximately 38% participants received duct sealing, which saved an average of 8 therms/participant when installed.

2.2 COMPARISON TO REPORTED SAVINGS

The HES and HES-IE program tracked data provided Eversource and UI included reported savings by measure and participant. Table 3 summarizes average reported savings for Core and Rebated participants.¹⁴

Table 3: Comparison #2: Program Tracking Data – Average Reported Savings (therms/year) for 2019 Participants

	Core (Air Sealing Only)		Rebated (Air Sealing & Insulation)	
	R1983 Savings	Program Tracking Data	R1983 Savings	Program Tracking Data *
HES	13	109	63	264
HES-IE	13	130	133	360

*Combination of reported air sealing and insulation savings, which the evaluation team calculated (using the PSD algorithm) and reported separately in HES and HES-IE program tracking data.

2.3 COMPARISON TO SIMILAR EVALUATIONS IN NEARBY STATES

The evaluation team has completed several evaluations of similar market-rate and income-eligible programs in Rhode Island and Massachusetts. Table 4 summarizes the findings of these studies, which all yield lower savings than R1603 values and 2019 reported savings, but closer to the savings ranges for R1983 in Table 1. It is important to consider the participation cohort (i.e., the year participants installed measures) when comparing across studies. As discussed in the next section, the evaluation team has seen a decline in preprogram consumption for participating HES customers, which reduces the opportunity for program savings.

Table 4: Comparison #3: Evaluations of Similar Programs – Average Reported Savings (therms/year)

Program (Completion Year)	State	Participant Cohort	Air Sealing & Insulation**
EnergyWise Single Family	Rhode Island	2017–2018	96
Income-Eligible Single Family	Rhode Island	2015–2016	124
Home Energy Services*	Massachusetts	2015–2016	130

*Now the Residential Coordinated Delivery program.

**The billing analysis results from all three studies produced a combined air sealing and insulation savings estimate, referred to as “weatherization savings.”

Section 3 Preprogram Consumption Trends

To create a control group for the billing analysis, the evaluation team assessed preprogram consumption for five years of HES and HES-IE cohorts (2017–2020). Figure 1 provides the average consumption in a given calendar year (indicated at the bottom of the figure) for a given HES participant cohort (indicated at the top of the figure). The arrows compare the preprogram consumption of subsequent cohorts as they entered HES.

¹⁴ The evaluation team will confirm the participant-specific reported savings for the relevant customers and measures with each company’s program staff prior to finalizing the R1983 gross realization rates.

What is most notable about Figure 1 is the decline in preprogram consumption for each subsequent cohort. For example, the 2018 participant cohort consumed, on average, approximately 1,000 therms in 2017. As a point of comparison, the set of HES participants in 2019 that air sealed and/or insulated their homes used closer to 800 therms in 2017—a 20% decrease. The trend continues for the 2020 cohort, which averaged even less consumption in 2017 (less than 700 therms). While the figure below reflects HES participants, we saw a similar trend for HES-IE participants.

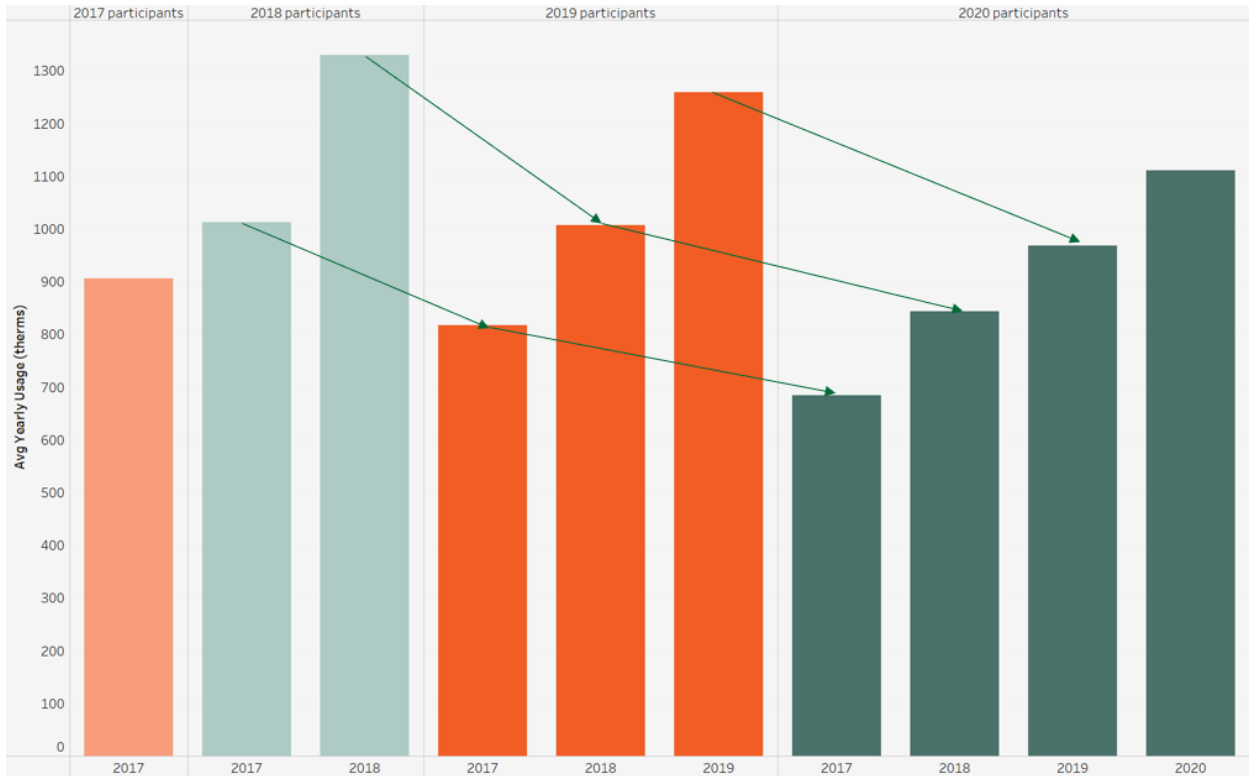
The clear year-over-year decline in average preprogram natural gas energy consumption has a direct impact on program savings: lower preprogram consumption means less opportunity for post-program energy savings. The average decline in consumption could be the result of numerous, concurrent factors:

- Customers with least efficient homes and highest bills have already participated (i.e., there remains less “low hanging fruit”)
- Increasing saturation of condensing natural gas furnaces and boilers
- Trend of smaller home (square footage of conditioned space) participating over time
- Trend of older homes participating over time¹⁵
- Increasing saturation of smart thermostats
- Repeat program participation

Momentarily setting aside the issue of causation, as well as the complicated nuances of billing analysis regression models, the simple pattern of declining total consumption in Figure 1 intuitively suggests much lower average savings over time. Specifically, the average savings for the 2020 HES cohorts would be 30 to 40% lower than the 2018 cohort based on total preprogram usage alone. If the trend extends backward (to the 2015 and 2016 cohorts participants included in R1603), the large disparity between the R1603 and R1983 results is expected. Further, if the trend continues forward to future HES participants, for which the updated PSD would be relevant, the companies should expect steadily lower savings over time—although perhaps at a decelerated rate.

¹⁵ Although older homes represent an opportunity, they also more frequently present challenges (i.e., pre-weatherization barriers such as knob and tube wiring, mold, or asbestos) to fully weatherizing a home.

Figure 1. Pre-Participation Annual Natural Gas Consumption by HES Participant Cohort (therms/year)



Section 4 Guidance for PSD Updates

The savings determined by evaluation team are lower than the previous evaluation and reported savings) for HES and HES-IE participants who heat with natural gas and who have air sealed and/or insulated their homes. The savings estimated as part of our recent evaluations of similar programs in other states, as well as the year-over-year decline in preprogram consumption, suggest the relatively lower savings have both a theoretical basis and empirical support.

The evaluation team recommends that the companies use the findings in this memo to make interim and proactive updates to the PSD in advance of the evaluation team finalizing the R1983 report later in 2022. Making updates now will limit the ultimate disparity between the PSD and evaluation at the conclusion of R1983 and better reflect the overall energy consumption of more recent and future HES and HES-IE participant cohorts.

The evaluation team recommends the companies apply a placeholder gross realization rate of at least 50% (relative to the reported savings for 2019 participants) for air sealing and insulation for associated with all heating fuel types both programs pending the completion of R1983.

Again, these results are part of the full set of gross (and net) savings all HES and HES-IE measures that the evaluation team will provide in the full R1983 report later in 2022. As part of that process, we will work closely with the Energy Efficiency Board and companies to

communicate findings and offer formal, actionable, and accurate recommendations for PSD updates.¹⁶

¹⁶ We will ensure the recommendations account for temporal differences (e.g., the method used to report savings for the 2019 cohort of participants has changed as part of subsequent PSD updates).

Appendix A: Billing Analysis Methodology Overview

The bullets below provide brief overview of the billing analysis methodology¹⁷ the evaluation team used to generate the initial, high-level results presented in this memo approach for the R1983 billing analysis:

- Combined customer-specific billing records with weather data and measure installation data to understand each customer's energy consumption drivers.
- Conducted a structured screening process to ensure that the model uses only those customers with sufficient billing data and without spurious billing records.
- Matched each treatment group customer to a control group (consisting of future HES and HES-IE participants) customer with a similar monthly preprogram energy consumption pattern.
- Disaggregated billing data into specific end uses (heating, water heating, and baseload) to inform concurrent engineering algorithms and building simulation activities.
- Specified and refined a monthly post-program regression (PPR) model.
- Estimated separate participant-specific "difference of differences" savings (using matched control) to corroborate pooled PPR model results and provide greater insight into differences in savings by contractor.
- Generated results, which were weather-normalized (where applicable) using 30-year historical weather data from National Oceanic and Atmospheric Administration weather stations across Connecticut; each participant was mapped to the closest weather station.
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¹⁷ The evaluation team is also using two complementary methodologies (engineering algorithms and building simulation) to evaluate other HES and HES-IE measures.