September 2020

Impact & Process Evaluation

EnergyWise Single Family Program

National Grid Rhode Island

Developed For

National Grid
40 Sylvan Road
Waltham, MA 02451

Developed By

Cadeo & ILLUME
107 SE Washington Street, Suite 450
Portland, OR 97214

cadeo ILLUME

Executive Summary

National Grid offers EWSF to help customers who live in one- to four-unit residential buildings in Rhode Island improve the efficiency of their homes. The program offers whole-home energy assessments during which trained assessors and technicians directly install a variety of no-cost efficiency measures and identify opportunities for larger energy saving improvements such as weatherization (i.e., air sealing and insulation). In 2019, EWSF completed more than 12,000 home energy assessments and helped more than 3,000 customers insulate their homes.

Why Evaluation?

National Grid uses evaluation to retrospectively assess the performance of its programs and estimate future program savings. In March 2020, National Grid contracted with Cadeo and ILLUME Advising, third-party energy efficiency program evaluators, to complete an impact and process evaluation of EWSF 2017-2019 program years. The evaluation produced verified energy savings for every EWSF measure, and yielded insights and recommendations National Grid can use to continue improving the program.

Key Impact Findings

The evaluation team used three complementary methods - billing analysis, engineering algorithms, and building simulation - to determine savings for every EWSF measure. The program's key measures are lighting (LED bulbs and fixtures) and weatherization, which collectively generated more than 80% of the program's annual 2019 savings.

- Estimated Savings
- Evaluated Savings
- Direction of Change

LED Lighting

33-38 kWh/year/bulb

15-34 kWh/year/bulb

Based on an electric billing analysis, net per-unit savings for LED lighting (18 kWh for the most installed bulb type) are lower than National Grid planned. The evaluation also found that installation rates are dropping; assessors are finding less inefficient lighting (incandescent and halogen bulbs) to replace with program LEDs. In fact, after representing 47% of total EWSF savings just three years ago, lighting made up just 25% in 2019.

Weatherization

108 therms/year/home

96 therms/year/home

The evaluation's billing analysis showed that participants who weatherized their homes saw lower-than-anticipated gross energy savings (96 therms/year vs. the 108 therms/year planning estimate). The evaluation found a net-to-gross ratio of 87%, indicating that most participants would not have weatherized their home if not for EWSF. Weatherization, particularly for oil heated homes, has become a larger contributor to overall program savings in recent years.

Key Process Findings

Process evaluation activities found that the program is performing at a high level. Participants expressed satisfaction with EWSF (91%), saying that they had a positive experience "from start to finish" and stakeholders appreciate how well the program is managed and delivered to customers. In-home assessments ran smoothly in 2019, as did virtual assessments, which the program rolled out in response to the COVID-19 outbreak. The effectiveness of virtual assessments compared to in-home assessments is still to be determined; however, stakeholders are optimistic that virtual assessments will have a long-term role in EWSF by providing National Grid an opportunity to customize the program to meet different customer needs.

Table of Contents

Executive Summary

This report details the findings of Cadeo and ILLUME's impact and process evaluation of National Grid's EnergyWise Single Family (EWSF) program in Rhode Island. The scope of our gross impact evaluation included EWSF participants who received their home energy assessment (HEA) in 2017 or 2018, while our process evaluation and net-to-gross analysis focused on the participants who had their HEA in 2019.

Key Impact Findings

The two key EWSF measures are lighting (LED bulbs and fixtures) and weatherization. Collectively, these generated more than 80% of the program's total 2019 savings.

LED Lighting kWh/year

33-38

15-34

Based on an electric billing analysis, per-unit savings for LED lighting (18 kWh for the most installed bulb type) are lower than National Grid planned. The evaluation also found that installation rates are dropping; assessors are finding less inefficient lighting (incandescent and halogen bulbs) to replace with program LEDs. In fact, after representing 47% of total EWSF savings just three years ago, lighting made up just 25% in 2019.

Weatherization therms/year

108

96

The evaluation's billing analysis showed that participants who weatherized their homes saw lower-than-anticipated energy savings (96 therms/year vs. the 108 therms/year planning estimate). This evaluation had a larger sample of EWSF participants (2,156 versus 1,252) available for inclusion in its billing analysis, which yielded a more precise evaluation result (±8% versus ±10%). Weatherization, particularly for oil heated homes, has become a larger contributor to overall program savings in recent years.

Planning Estimate Evaluated Savings Direction of Change

Key Process Findings

Participants had a positive program experience. 92% of participants reported they were satisfied with their experience in EWSF. In another indicator of satisfaction, 97% of participants said they would recommend the program to a family or friend. Also, 72% of EWSF participants shared that their experience in the program favorably changed their perception of National Grid (26% said it did not change their existing perception and only 2% said their experience had a negative impact.)

Stakeholders credit RISE for creating a high functioning program environment. Assessor and contractors consistently cited RISE's responsiveness to their feedback and effort to improve EWSF for participants and program stakeholders alike. Contractors appreciate RISE's management of the program and are satisfied with the steady way they get new weatherization jobs through RISE. Several assessors mentioned that they feel like RISE is supportive and listens to their feedback and is committed to making the program a positive experience for assessors as well as participants.

Participants increasingly know what they want. Assessors observed that an increasing number of EWSF participants sign up for the assessment knowing they want to get their home weatherized or

specifically to access the HEAT loan financing for a heating system upgrade. Assessors noted that, in the past, most participants were unsure of what their home needed prior to the assessment or what the program could do for them. The results of the participant survey supported this observation; 80% of participants cited access to weatherization incentives as very important in their decision to get an assessment. This finding is consistent with a maturing program and indicate that National Grid's ongoing marketing efforts are building familiarity with the program and its offerings.

Health and safety barriers remain problematic — for participants and contractors. According to program records, assessors identified a health and safety barrier in nearly two-thirds (64%) of EWSF homes in 2019. Of these participants, only 21% went on to weatherize their home, a lower weatherization rate than participants who did not face a health and safety barrier (43%) or for EWSF participants overall (25%). However, the program data showed that 57% of participants who weatherized their home in 2019 overcame at least one health and safety barrier, which is encouraging. Assessors expressed frustrations that they, per program guidelines, could not provide participants with more direct guidance to help them remediate identified barriers. Specifically, assessors frequently mentioned that they wished they could recommend specific remediation contractors or at least provide participants with a list of program-approved remediation contractors. Assessors felt that putting the onus on customers to identify and engage remediation contractors themselves caused a drop-off in participation.

Opportunities exist to serve delivered fuel customers more comprehensively. Assessors consistently noted the program's current inability to incentivize energy optimization measures, such as ductless mini-splits that enable participants with an inefficient oil and/or propane heating system, to switch to a high efficiency electric or gas option, prevents many participants from taking action. . According to assessors, bringing back the incentives previously offered for ductless mini-splits and/or allowing delivered fuel customers to finance heating system upgrades (to more efficient delivered fuel systems or to a high efficiency electric or gas option) would unlock much of the unrealized savings opportunities they identify in EWSF participating homes. However, the decision to incentivize energy optimization measure resides with the Public Utilities Commission, not National Grid.

The 100% landlord incentive has increased rental property participation. Program managers and assessors alike reported that the increase to a 100% renter/landlord incentive (in 2019) has enabled the program to reach previously hard-to-access rental properties. Program data support their statements: 12% of participants in 2019 lived in a rental property, a 50% increase over 2017 and 2018 (8%). Assessors also shared that the paperwork and coordination necessary to get renters and landlords on the same page can be tricky because the landlords often live elsewhere, or the renters are not overly engaged in the process.

Virtual assessments are promising but stakeholders share a healthy skepticism. Assessors shared that participants seem to enjoy and engage in virtual assessments. Assessors themselves also appreciate the streamlined and shortened assessment process, particularly the time they save for themselves (e.g., traveling to homes) and customers (e.g., scheduling 45-minute assessment during work day rather than taking time off work for a 2 ½ hour appointment). Assessors mentioned that the virtual process is much easier for straightforward home layouts (e.g., ranch style home) whereas it can be problematic for older

homes of certain styles (e.g., Victorians). Assessors, program managers, and contractors expressed a healthy skepticism regarding accuracy of virtual assessments relative to in-home assessments; they are all curious to see whether the virtual assessment yields sufficiently accurate weatherization scopes of work and adequately identifies pre-weatherization barriers. Assessors noted that while the verdict will be out until contractors go back on site in greater numbers, they are optimistic that there is a place for the virtual assessments in the program long-term.

Recommendations

In response to these, and other findings detailed later in the report, our team developed three recommendations for National Grid to consider as part of future EWSF delivery.

Table 1. Summary of Recommendations

#	Recommendation	Details
1	**Leverage word-of-mouth program awareness through realtors or home inspectors**	Many assessors noted that participants who recently purchased their home frequently heard about the program through their realtor or home inspector. National Grid should cultivate relationships and provide EWSF marketing materials to local realtors and inspectors to increase new home buyer participation and encourage customers to act early in their time in the home to maximize the return on their efficiency improvements.
2	**Increase facilitation of health and safety barrier remediation**	Assessors and participants described the difficulty of remediating health and safety issues and expressed a desire for more support from the program. Specifically, National Grid should work with RISE to (1) Create a list of approved electricians and/or increase RISE's ability to handle some barriers, (2) Providing informational materials explaining issues and step by step process to address issue, or (3) Raise $250 incentive for certifying knob and tube deactivation to encourage more contractors to undertake these critical inspections.
3	**Identify the optimal long-term role for virtual assessments**	Though there is some uncertainty, stakeholders assert that there is a place for virtual assessments long-term. Virtual assessments may be more successful depending on the type or layout of home and participant engagement. National Grid should identify the optimal role for virtual assessments long-term by experimenting with deploying virtual assessments participant segments including participants with straightforward home types or by participant interest or need (scheduling need, safety need etc.). Offering a mix of in-home and virtual assessments may yield similar savings with lower program delivery costs. Future evaluations could embed more research specifically related to virtual assessments and virtual program components overall. Evaluation research focused on virtual assessments could help inform program design and delivery issues, as well as how virtual processes implemented for assessments could be leveraged for other program components. This type of assessment has implications for both process and impact evaluation components, given issues related to direct versus self-install of energy efficient measures.

Introduction

This report details the findings from Cadeo and ILLUME's impact and process evaluation of National Grid's EnergyWise Single Family (EWSF) program in Rhode Island.

About EnergyWise Single Family

National Grid Rhode Island's EnergyWise Single Family (EWSF) program helps customers who live in one- to four-unit residential buildings in Rhode Island improve the efficiency of their homes by replacing inefficient appliances, products, as well as lighting, air sealing and insulating the building shell, and providing energy education. The program offers whole-home energy assessments during which trained assessors and technicians directly install a variety of no-cost efficiency measures and identify opportunities for larger energy saving improvements such as weatherization, which the program covers a large portion (typically 75%, up to $4,000) of the upfront cost. National Grid made several program enhancements in 2019 including the addition of a 100% landlord incentive to access hard to reach customers living in multiple-unit homes as well as, on a limited basis, home energy score asset ratings and an online assessment feature designed to provide additional information to energy auditors and convenience to residents prior to in-home assessment.

As noted above, all program participants receive a no-cost home energy assessment during which the program surveys their home and identifies energy saving opportunities. This program is facilitated by RISE Engineering who is responsible for conducting home energy assessments and coordinates weatherization and heating system upgrades. Assessments typically last 2-2 ½ hours, although larger and/or older homes can take longer. Assessments are conducted by two RISE staff: an Energy Specialist (assessor) responsible for completing a basement-to-attic evaluation and providing recommendations for improvement, and a technician responsible for installing instant savings measures and completing the blower door and combustion safety tests. During the assessment, the technician directly installs a variety of energy-saving measures such as efficient lighting (LEDs), domestic hot water upgrades (faucet aerators, showerheads, and pipe wrap), thermostats, and refrigerator brushes. The technician also identifies opportunities for the installation of smart power strips, which the program leaves behind for the participant to self-install after the assessment. Participants may also qualify for weatherization (air sealing and/or insulation) and replacement of inefficient refrigerators. At the conclusion of the assessment, the assessor provides each participant with an individualized action plan including educational materials and tailored recommendations for improving home energy efficiency. The assessor walks participants through their customized action plan, discusses participants options, answers questions, and encourages participants to take the recommended next steps such as weatherization and heating system upgrades.

Participants may apply to use the 0% interest HEAT loan to complete weatherization work, heating system upgrade, or health and safety remediation costs, if applicable.

Participants who decide to move forward with weatherization upgrades either choose their insulation contractor from a list provided by National Grid or elect to have a contractor assigned to them. Participants and contractors coordinate scheduling their insulation retrofit. RISE assigns an internal inspector to work with the contractors to assist with weatherization project management and be a liaison between contractor and EWSF participant. The

internal RISE inspector oversees the insulation project and checks for quality control on-site for every insulation project completed through the EWSF program. In addition to the internal RISE inspection, RISE also uses a third-party inspector, CMC, to complete a quality control inspection on about 5% of the weatherization jobs completed. CMC inspections may occur during an assessment (Tier 1), between assessment and weatherization work (Tier 2), and after insulation work is completed (Tier 3).

In 2019, RISE facilitated over 12,000 assessments and more than 3,000 weatherization projects.

Measures

The scope of the EWSF evaluation included the following 18 measures associated with six measure groups.

As noted below, our team also assessed the potential savings associated with four measures (smart plugs and all three early retirement measures) that National Grid is considering adding to EWSF. Since our team did not have any EWSF-specific data for these four measures, our savings assessment relied entirely on secondary data.

Of the remaining 14 measures, 12 (all but weatherization and refrigerator rebates) are instant savings measure directly installed during the home energy assessment or left behind following the assessment.[1] Participant receive these instant savings measures at no cost[2] as part of their assessment, whereas they pay a portion of the cost associated with installing weatherization and/or a new refrigerator following their assessment.[3]

Table 2. EWSF Measures and Measure Groups

Measure Group	Measure
Domestic Hot Water	• Aerators • Showerheads • Pipe Wrap/Insulation
Lighting	• LED Bulbs (i.e., General Service Lamps) • LED Specialty/EISA Exempt Bulbs • LED Reflectors • LED Fixtures
Controls	• Programmable Thermostats • Wi-Fi Thermostats
Appliance & Plug Load	• Refrigerator Rebate (for replacing existing refrigerator with an ENERGY STAR-qualified model) ** • Refrigerator Coil Brush • Smart Power Strips • Smart Plugs*

[1] Unlike the other instant savings measures, assessors – for liability reasons - leave smart strips behind for the participant to install themselves after the assessment. The assessor directly installs the other instant savings measure during the assessment.
[2] Except Wi-Fi thermostats, which include a participant co-pay.
[3] Typically, National Grid has covered 75% of the installed cost of weatherization improvements and/or efficient refrigerators; the participant pays the remainder. However, the exact portion of the cost covered by National Grid can vary depending on the specific participant (e.g., in 2019, National Grid started covering 100% of the costs for rental properties) and timing (e.g., National Grid temporarily increased its coverage to 100% during the COVID-19 crisis).

Weatherization	• Weatherization (i.e., air sealing and/or insulation) ** • Air Sealing Kit[#]
Early Retirement	• Room Air Conditioner* • Dehumidifier* • Clothes Washer & Dryer*

*Not currently offered as part of EWSF

**Major measures

[#]Air sealing kits are a combination of lighting and air infiltration improvement measure. The kits provide better air sealing for recessed lighting cans on thermal boundaries after replacing incandescent or halogen lamps with LEDs (since LED bulbs do not require the same airflow to safely distribute lighting waste heat). The savings associated with this measure are related to the air sealing benefits only; lighting savings associated with the bulb upgrade are captured separately.

Summary

According to National Grid's 2019 reporting, weatherization (56%) and lighting (25%) are responsible for most of EWSF's savings across all fuel types. Add in controls (programmable and Wi-Fi thermostats) and these three measure groups constitute 97% of the program's total electric, natural gas, and delivered fuel (i.e., oil and propane) savings.

Figure 1. Savings by Measure Group (MMBTU, 2019)

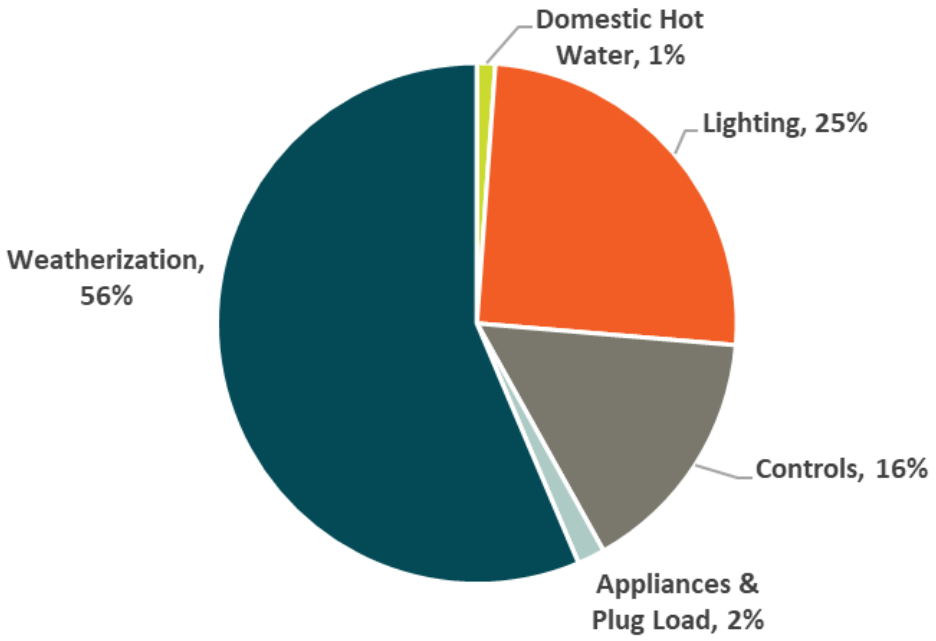
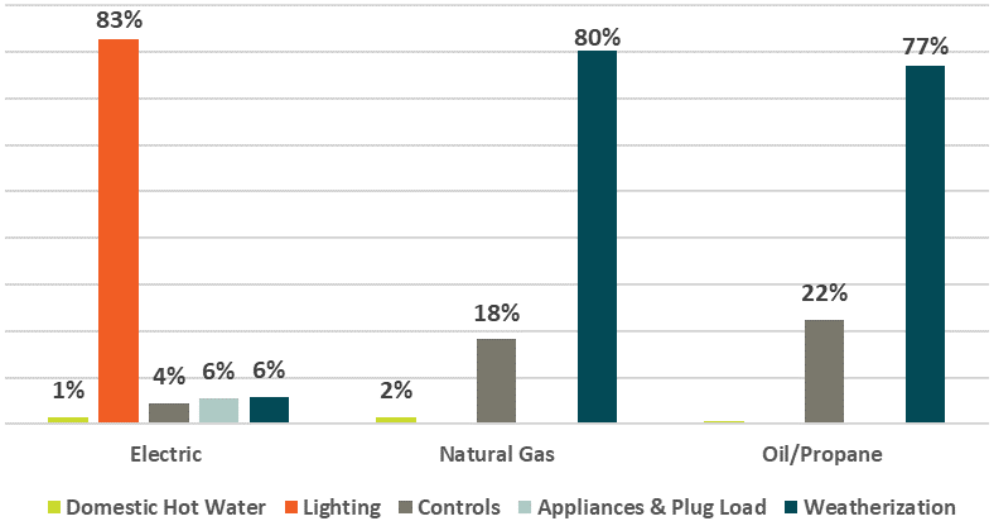


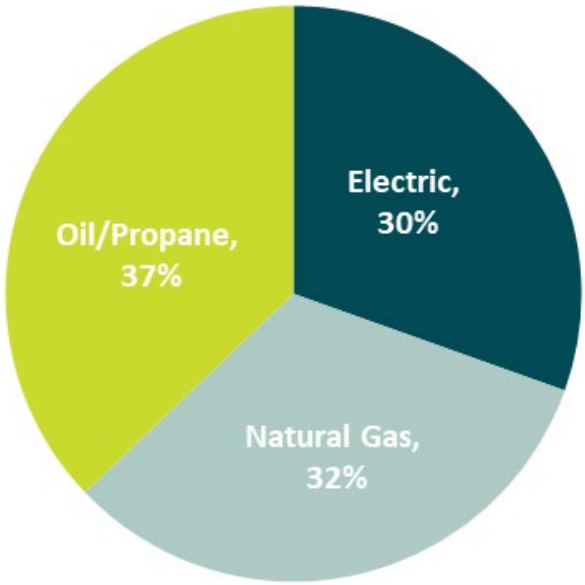
Figure 2 looks at the savings from these same measure group savings by fuel type. Not surprisingly, most of the electric savings come from lighting, whereas weatherization and controls are responsible for nearly all natural gas and delivered fuel savings.

Figure 2. Savings by Measure Group and Fuel Type (2019)



The team also investigated how each fuel type—electricity, natural gas, and oil/propane—contribute to the program's overall savings. As evident in Figure 3, oil/propane savings (37%) are the largest source of EWSF's savings in 2019, followed by natural gas (32%) and electricity (30%).

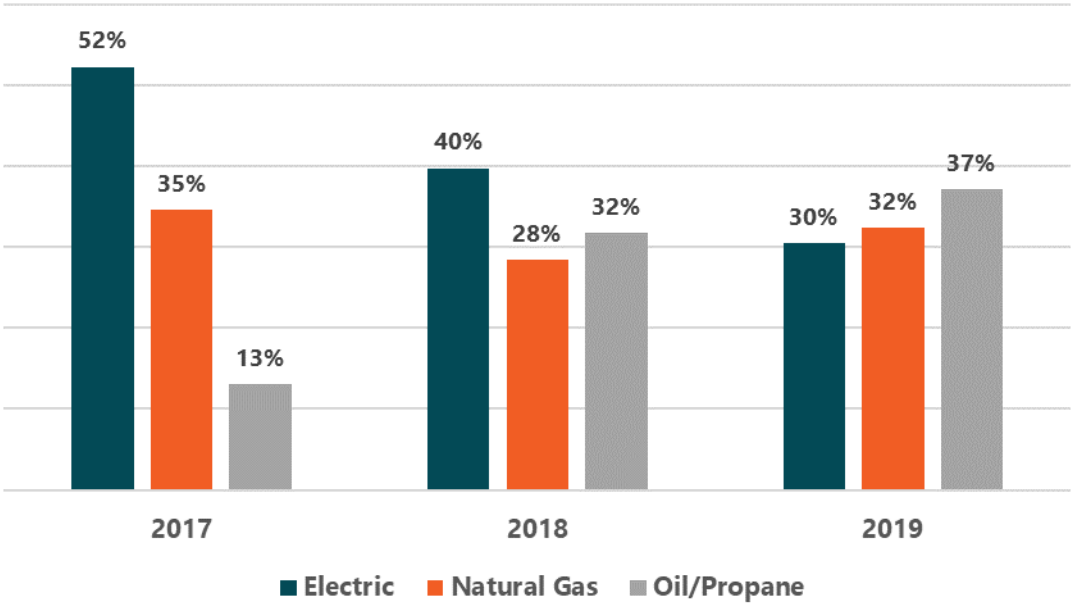
Figure 3. Savings by Fuel (MMBTU, 2019)



Delivered fuels representing the largest contribution to total EWSF savings is a recent development. As recently as 2017, oil and propane savings constituted only 13% of program savings. Indeed, the program landscape has changed dramatically in just over three years. In 2017, electric savings—driven by direct install lighting—

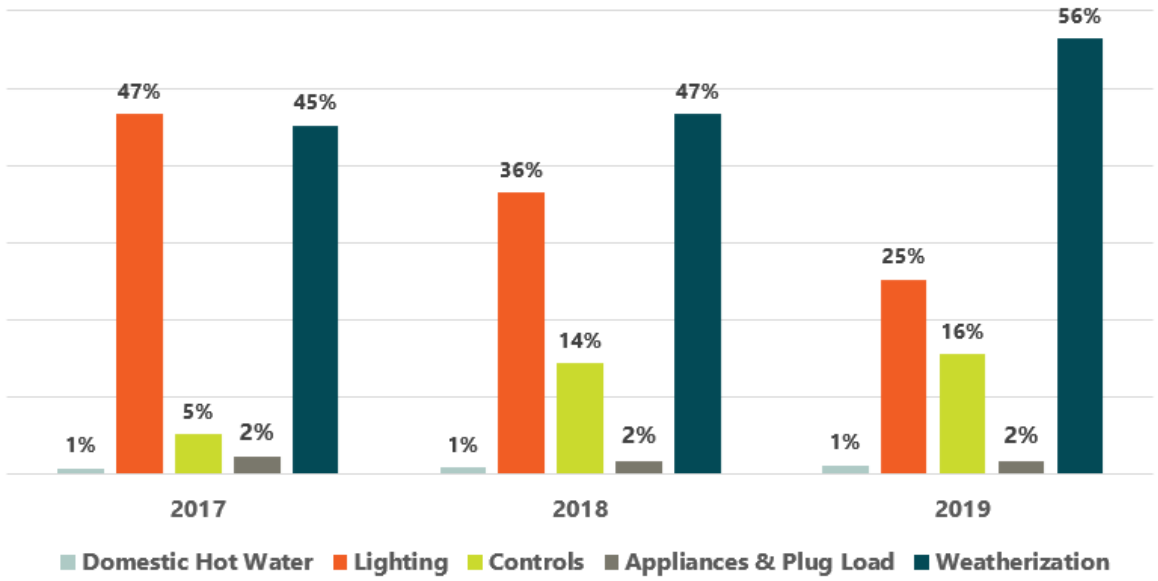
represented more than half (52%) of the EWSF savings; that value dropped to 30% by 2019. At the same time, National Grid increased incentives for delivered fuel measures, which, by 2019, reached the same level (75%) as electric and natural gas measures. Prior to that National Grid had offered lower incentives (25% before October 2017 and 50% between October 2017 and April 2018) for oil and propane measures.

Figure 4. EWSF Savings by Fuel by Year (2017-2019)



The shift from electric to non-electric savings is also clearly reflected in the change in measure group savings between 2017 and 2019. Figure 5 shows how lighting savings have decreased from 47% to 25% of savings while weatherization and controls (i.e., programmable and Wi-Fi thermostats) have both increased.

Figure 5. EWSF Savings by Measure Group and Year (2017-2019)



Our team also assessed trends in conversion rates over time. There are many ways to define and calculate conversions rates. For this evaluation, our team defined conversion rate as the percentage of assessed EWSF participants who installed at least one major measure (mostly commonly a type of insulation) following their assessment.[4]

It is important to note that many EWSF participants take weeks, if not months or even years to decide to act on a recommendation. The delay in decision making is often unrelated to the program offer and instead a function of the customer's financial status, other home improvement or life priorities, time constraints, and/or uncertainty about their long-term status in the home. Regardless of the reason, the extended nature of the decision-making process means that conversion rates for recent participants can be misleading (since some of these participants will likely decide, later, to act). While participants who had their assessment multiple years ago could still decide to act, conversion rates are generally representative of customer's response to the program's recommendations approximately 12-18 months after their assessment.

As shown in Table 3, EWSF had a steady conversion rate in 2017 and 2018 (38% and 37%, respectively). Direct comparisons are problematic given definitional ambiguities and data constraints, but, generally, these conversion rates are comparable with similar programs in neighboring states.[5] The lower rate for 2019, as noted above, is a function of the lesser amount of time these participants have had to act since their assessment.

[4] This definition underreports actual conversion rates as some (relatively small) portion of EWSF participants are not recommended a major measure following their assessment. However, the data provided to our team did not include information about recommended measures (only installed measures) so we were unable to limit the denominator of our conversion rate calculation to only those participants who were recommended at least one major measure.

[5] For example, an analysis of the Home Energy Services program participation in 2018 in Massachusetts (now the Residential Coordinated Delivery program) found, statewide, that 34% of assessment participants installed a major measure. http://ma-eeac.org/wordpress/wp-content/uploads/MA-RES-35-HES-Process-Evaluation-Comprehensive-Report_FINAL_31MAR2018.pdf

Table 3. Conversion Rates – By Year of Assessment

	2017		2018		2019	
Participant Type	**N**	**%**	**N**	**%**	**N**	**%**
Assessment Only	5,026	62%	6,701	63%	9,347	75%
Major Measure	3,087	38%	3,972	37%	3,125	25%
Total	**8,113**	**100%**	**10,673**	**100%**	**12,472**	**100%**

Key Terminology

The team uses the language defined in Table 4 throughout the report to explain key evaluation concepts.

Table 4. Key Evaluation Terminology

Term	Definition
Participant	An individual or household (also identified by a unique account number) who receive a home energy assessment through the EnergyWise Single Family program in 2017, 2018, or 2019.
Stakeholder	An individual responsible for some part of implementing and carrying out the EWSF program, including program managers, assessors, inspectors, and contractors.
Major Measure Participant	The subset of EWSF participants (as defined above) that, following their home energy assessment, installed at least one of the larger, energy efficiency improvements (weatherization and/or refrigerator rebate) recommended by their assessor. Most, but not all, major measure participants also receive instant savings measures directly installed (e.g., LEDs, showerheads) or left behind (e.g., advanced power strips) by the assessor during their home energy assessment.
Assessment-Only Participant	The subset of EWSF participants (as defined above) that did not install any of the recommended, larger energy efficiency improvements recommended by their home energy assessor. Most, but not all, assessment-only received instant savings measures (e.g., LEDs, showerheads) directly installed by their assessor during their home energy assessment.
Conversion Rate	There are many ways to define and calculate conversions rates. For this evaluation, our team defined conversion rate as the percentage of assessed EWSF participants who installed at least one major measure (mostly commonly a type of insulation) following their assessment.
Ex Ante Savings	Savings assumed by National Grid prior to an evaluation, usually based on the prior EWSF impact evaluation and/or the Rhode Island TRM.
Ex Post Savings	Savings determined through this evaluation.
Gross Savings	Savings generated by the program without consideration for whether the participant would have taken the same/similar actions absent EWSF
Net Savings	Savings generated by the program that account for the participant's likely action in the absence of the program. In the case of this EWSF evaluation, net savings are determined using either participant self-report or, for select measures, through billing analysis.
Impact Factors	Other factors, such as in-service rate (also known as removal rate, measure retention rate, or savings persistence rate) that impact the savings generated by program measures.
Treatment Group	The EWSF participants for whom the team estimated ex post savings: customers who received EWSF measures in program year 2017 or 2018. The treatment group for the billing analysis was limited to participants prior to October 2018, to ensure a full heating season in the post-installation period after accounting for a blackout period around the measure installation date.[6]
Control Group	The set of customers used in a billing analysis to serve as a counterfactual for estimating the program's impact. The control group accounts (or controls) for exogenous factors such as moves and rate changes that can otherwise obscure program-generated savings. In the context of this evaluation, the team used future EWSF participants (i.e., 2019 EWSF participants) as the control group.
Weatherization	A general term used to describe air sealing and/or insulation (one of more of attic, wall, or floor insulation). References to air sealing or insulation in the report are specific to that measure, whereas weatherization refers to one or both measures.
Pre-weatherization Barrier	Typically, a storage or clutter issue identified during in-home assessment that prevented participants from moving forward with upgrades until it could be remediated.
Health and Safety Barrier	A health and safety issue that was identified during an in-home assessment that prevented participants from moving forward with upgrades unless issue could be remediated.

How to Use the Results of this Evaluation

We present the results of this evaluation in three parts: An **Evaluation Summary,** a **Supporting Documentation workbook,** and an **Appendix**.

The **Evaluation Summary,** which this section is part of, summarizes the results of the evaluation and outlines the evaluation methodologies used. For key EWSF measures, such as natural gas weatherization and lighting, the Evaluation Summary includes a detailed explanation of how our team calculated ex post savings. The Evaluation Summary does not, however, include details such as the engineering algorithms and the specific primary and secondary data used to develop ex post savings for other measures.

For these types of details, users of this evaluation should reference the **Supporting Documentation workbook**. The Supporting Documentation workbook includes a tab for each EWSF measure that was evaluated using an engineering approach (i.e., either algorithms or building simulation). For measures assessed using an algorithmic approach, the workbook details the Rhode Island TRM engineering algorithm used to evaluate that measure and the values (and sources) for all inputs used in that algorithm. Each measure-specific worksheet also includes a direct comparison of ex ante and ex post savings. Each of these tabs link to common set of participants, housing stock, and engineering assumptions, which ensures consistency across measures. Readers interested in accessing the Supporting Documentation Workbook should request access from the National Grid's EWSF evaluation manager.

The third and final part of this evaluation is the **Appendix,** which contains all the interim deliverables our team created as part of this evaluation process. The appendix includes:

A. Evaluation Scope of Work
B. Impact Analysis Plan
C. Net-to-Gross Methodology Memo
D. Additional NTG Analysis Details
E. Program Manager Interview Guide
F. Stakeholder Interview Guide
G. Participant Survey
H. Additional Participant Survey Results
I. Cycle time analysis additional results

[6] For the billing analysis, the team began each participant's post-installation period with the second full billing cycle after the participant's final measure installation date, which allows for at least one full month of "transition time" between pre- and post- period.

Methodology

Activities

The evaluation team completed seven complementary impact and process tasks to evaluate EWSF. Four of the tasks (billing analysis, engineering algorithms, building simulation, and participant surveys) allowed our team to estimate the **gross** and **net savings** associated with electric, natural gas, oil, and propane efficiency measures delivered through EWSF.

For electric and natural gas measures, our team relied on billing analysis whether possible (i.e., when results are sufficiently precise) as billing analysis accounts for the myriad of factors (pre-conditions, uninstallation, and behavioral change) that impact savings. When billing analysis results were not possible for these fuels, our team turned to one of the two engineering approaches (building simulation or engineering algorithms). For some measures, our team combined billing analysis and one of these engineering approaches to estimate savings.

Due to lack of accessible billing data, our team could not undertake a similar billing analysis for oil or propane measures. For these delivered fuel measures, our team either relied on an engineering approach, or—if a billing analysis-based result existed for the same measure—applied that result (after accounting for differences in heating system efficiencies) for oil and propane. For example, as shown later in Table 6, our team used the billing analysis result for natural gas weatherization to estimate weatherization savings for delivered fuels. This approach enabled our team to leverage the benefits of billing analysis noted above for delivered fuels, while still accounting for important differences between the equipment used for these fuel types.

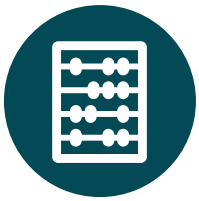
Two other tasks—our review of program materials and stakeholder interviews—primarily yielded process insights.

Table 5 briefly summarizes each task.

Table 5. Evaluation Tasks

Billing Analysis

- Used to report ex post savings when measure-specific billing analysis results met pre-determined threshold of better than ±25% precision at the 90% confidence level
- Combined customer billing records with weather and measure installation data to get a complete perspective of 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 (future EWSF participants) customer with a similar, monthly, preinstallation period energy consumption pattern
- Specified and refined a monthly post-program regression (PPR) model
- Generated results, which were weather-normalized (where applicable) using 30-year historical weather data from three different weather stations across Rhode Island; each participant was mapped the closest weather station
- Disaggregated billing data into specific end uses (heating, water heating, and baseload)



Engineering Algorithms

- Relied primarily on the algorithms documented in 2020 Rhode Island TRM7
- Relied on recent studies from other jurisdictions (notably Massachusetts) where the Rhode Island TRM did not specify a savings algorithm or specific input value
- Leveraged detailed EWSF program data to calculate baseline and efficient cases for each measure
- Relied on regionally appropriate secondary data sources and other relevant studies when program data was not collected or unavailable (sources included the Residential Energy Consumption Survey, ENERGY STAR® standards, Building America Benchmark Program Database, etc.)
- Included a literature review of recent studies, relevant US Department of Energy appliance standards, other state TRMs, and similar evaluations in other states
- Used to adjust billing analysis results for select measures to be applicable for delivered fuels

Building Simulation

- Modeled using BEopt (Building Energy Optimization) software developed by the National Renewable Energy Laboratory
- Constructed baseline home geometry and building characteristics using inputs like square footage, number of floors, and baseline infiltration rates from EWSF program data
- Leveraged a similar building model used during the 2018 MA Home Energy Services impact evaluation for inputs that could not be estimated through program data
- Simulated ten different scenarios reflecting various building types, heating fuels, heating system combinations, and cooling scenarios
- Calibrated each model using EWSF participant billing data. The team calibrated to multiple scenarios including different heating systems (boiler, furnace, heat pump, and electric radiant) and cooling configurations (Central AC, window AC, and no AC).
- Weighted the result of the ten models into a statewide average using the building type, heating fuels, heating type, and cooling type characteristics of 2017 and 2018 EWSF customers

[7] http://rieermc.ri.gov/wp-content/uploads/2019/11/ngrid-ri-2020-trm.pdf

Materials Review

- Requested and reviewed program materials from National Grid and RISE including the materials provided to participants before, during, or after their energy assessment, operations guides, and field manuals, and marketing materials
- Helped our team become more familiar with EWSF, which in turn allowed us to ask more nuanced questions during the stakeholder interviews and participant survey
- Enabled our team to better contextualize and interpret statements made during the interviews and survey
- Descriptions about health and safety barriers were particularly important references throughout the evaluation as we heard differing statements regarding program practices and protocols

Stakeholder Interviews

- Focused interview topics on EWSF design, delivery, and perceived participant experience
- Completed 30 interviews with:
  - National Grid Strategy and Implementation Managers (n=1)
  - Lead Vendor (RISE) Managers (n=1)
  - Lead Vendor In-Home Assessors (n=15)
  - Installation Contractors (n=9)
  - Lead Vendor Internal QA/QC Auditors (n=2)
  - Third-Party QA/QC Manager and Auditors (n=2)

Participant Surveys

- Surveyed 289 randomly sampled 2019 EWSF participants stratified by participation type (assessment-only and major measure participants).
- Sampled EWSF participants and sent web-based survey via email. We also offered an option to take the survey in Spanish over the phone.
- Provided all participants who completed the survey with a $10 incentive.
- Focused survey topics on customer experience and opportunities to improve program delivery
- Determined smart strip installation rates, the only EWSF instant savings measure not directly installed by assessors during the assessment; left behind for the participant to install in identified locations)
- Calculated measure-specific in-service rates (also known as measure retention or savings persistence rates)
- Estimated net-to-gross ratios for each of the five EWSF measure groups.[8]
- Weighted survey results to account for more responsive major measure participants. [9]

Cycle Time Analysis

- Reviewed EWSF program data across several program years to calculate the typical time required for a customer to move through key milestones in the EWSF program.
- Examined participant type over time to assess potential trends or shifts in program participations, including prevalence of health and safety barriers and home demographics.

[8] Our team did not ask participants about the sixth measure group (Early Replacement) since, as noted above, these measures are not currently available through EWSF.

[9] The survey sample participant type proportions (45% and 55% assessment-only and major measure participants, respectively) were different than the proportions for the 2019 participant population (75% and 25%), thus, our team added survey weights.

Data Sources

National Grid has provided the following datasets, which our team will use to inform our evaluation activities.

EWSF Program Data. These data include basic customer (account number, address, ZIP code) and measure (type, quantity, savings) information for 2017, 2018, and 2019 participants. These data also include some information about pre-existing conditions for each participant. As described in more detail later in the report, our team used data regarding 2017 and 2018 participants for all three impact evaluation tasks and data for 2019 participants as a control group for our billing analysis, as well as the sample frame for our participant survey.

Supplemental Participant Data. These data provide additional information regarding the physical structures of participating buildings, as well as mechanical systems. This information includes but is not limited to HVAC system types (heating and cooling), heating fuel, water heating fuel and type, building size, building vintage, and rent/own status. Our team used this information to inform our engineering analyses.

Cross-Program Participation Data. As an assessment program, EWSF can serve as a gateway to participating in other, complementary National Grid residential programs. Since it is critical to account for participation in other programs when estimating savings, we will flag cross-program participants so that we can control for the energy savings from other programs as part of our billing analysis. To enable this, National Grid provided participation data for four of its other residential programs: Natural Gas Heating and Water Heating, ENERGY STAR HVAC, ENERGY STAR products, and the Home Energy Reports behavioral program.[10]

Billing Data. National Grid provided monthly energy consumption data ranging from January 1, 2012 to December 31, 2019.[11] These data include billed, gas and electric energy consumption for all National Grid Rhode Island's residential customers – including both program participants and program future participants. The team did not attempt to gather any information regarding delivered fuels (i.e., heating oil and propane).

Program Materials. National Grid and RISE provided program materials including example program documents (e.g., action plan, contract, pre-weatherization opt out forms), email communication examples, marketing materials, material and installation standards and assessment manuals. These materials with the addition of program manager interviews helped the evaluation team get a better idea of how program activities are communicated to participants and informed the creation of the interview guides for assessors, contractors, inspectors as well as the participant survey.

In addition to the five data sources already listed, the evaluation team acquired weather data from National Oceanic and Atmospheric Administration (NOAA):

Weather Data. Our also team acquired contemporaneous, hourly weather data from NOAA for all weather stations in Rhode Island. We used these data to calculate weather normalized consumption for program participants, which we then used to calibrate building simulations and to determine weatherization energy savings for a typical meteorological year (TMY3).

[10] Excludes upstream lighting since that program does not collect customer information that would allow for mapping cross-participation. As noted later in the document, the exclusion of upstream lighting means, among other factors, that users of this evaluation should interpret the billing analysis results for lighting measures as net savings.

[11] The billing data provided by National Grid will also support our team's concurrent Home Energy Reports (HER) impact evaluation. The HER analysis spans a much longer participation period, which is why National Grid provided consumption data as far back as 2012.

Impact Evaluation Findings

In this section, our team summarizes the gross and net savings determined for EWSF measures and measure groups.

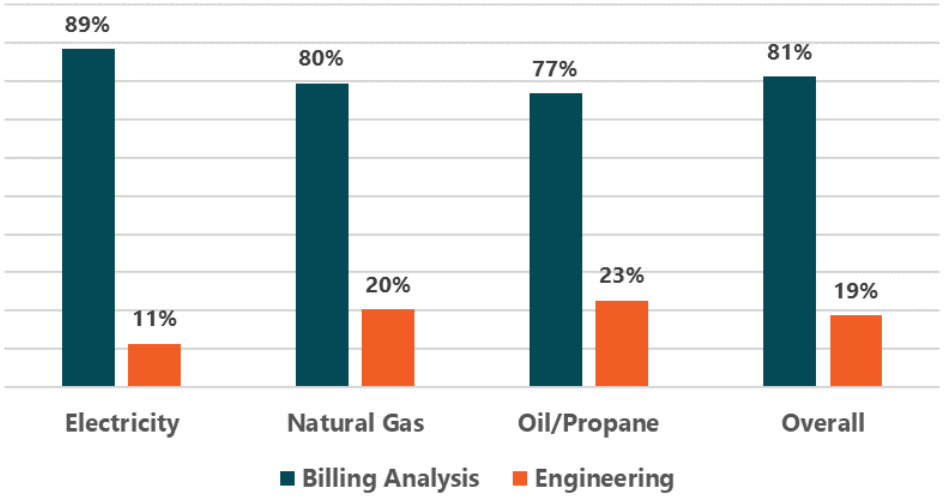
About Using Multiple Methodologies

As noted in the Methodology section, our team prefers billing analysis to report savings whenever possible. This is because we believe billing analysis results—at appropriate level of specification—offer the most accurate assessment of program savings. This is largely due to billing analysis' inherent ability to account for the myriad of factors (installation quality, uninstallation rates, behavior changes, interactive effects, etc.) that influence realized savings.

Though it is our preferred approach, billing analysis does have limitations—it does not reliably estimate energy savings for measures that have small energy savings (i.e., less than 5 percent of consumption) or for measures with limited installation counts (i.e., fewer than 500 participants). Our team aggregated these smaller savings and less frequently installed measures to increase our chances of estimating savings via billing analysis, but none of our billing analysis specifications yielded statistically significant energy savings for these measures in the presence of weatherization (natural gas) and lighting (electric). Ultimately, our team relied on engineering approaches to estimate per-unit savings for these measures. While our team used an engineering approach to estimate savings for many individual EWSF measures, these measures collectively constitute a relatively small percentage (19%) of EWSF total savings.

As shown in Figure 6, the majority (81%) of EWSF 2019 total savings (across all fuel types) were estimated through billing analysis. In most cases, our team used billing analysis to directly report savings for a given measure and fuel type—most notably for lighting for electricity and weatherization for natural gas heated homes. In other instances, our team leveraged the results of the billing analysis to estimate savings for delivered fuels (e.g., using the natural gas weatherization billing analysis-based savings to report savings for weatherized oil and propane heated homes). In these cross-fuel uses of billing analysis results, our team accounted for differences in space heating equipment efficiencies across fuel types. This cross-fuel, engineering adjusted approach allowed us to realize the benefits of billing analysis results for more measures and, notably, delivered fuels where we do not have access to participant's consumption history.

Figure 6. Total EWSF Savings by Evaluation Approach and Fuel (2019)



It is noteworthy that nearly all the 19% of EWSF cross-fuel savings that our team did not evaluate directly or indirectly through billing analysis come from programmable and/or Wi-Fi thermostats (16%). We attempted to estimate savings for thermostats (for programmable and Wi-Fi separately, as well as thermostats in general) via billing analysis, but we were unable to generate sufficiently precise results – largely due to the controls' high correlation with weatherization.

Before finalizing our ex post savings for natural gas and electric measures, our team, compared the sum of our initial per-unit, ex post savings for all measures—assessed using a combination of billing and engineering approaches —to the average total observed decrease in EWSF participant's annual natural gas and electric consumption between the pre- and post-period.[12] This comparison offers a "reality check" on how well our "top-down" (i.e., billing analysis) and "bottom-up' (i.e., engineering algorithms and building simulation) approaches, in concert, combine to reflect the overall impact of program on participants consumption (based on their whole-home billing data).

For natural gas, the total of our team's per-unit, ex post savings (after accounting for a variety of necessary adjustments)[13] summed to just slightly more (+2%, or 2 therms) than the total observed, difference in pre-to-post participation energy consumption for those same EWSF participants. The close alignment confirmed that our team's per-unit, ex post savings were appropriate and that we did not need to make any adjustments to ex post savings for natural gas measures.

However, a similar analysis for electric savings yielded a larger disparity (+23%, or 112 kWh). The larger disparity for electric measures than natural gas is not surprising given the number of electric measures offered through EWSF, as well as greater variability in customer's electric usage. To bring the sum of our team's per-unit ex post savings into closer alignment with the average total electric savings for EWSF participants, our team decided to

[12] Accounted for changes in the control group, focused on the subset of EWSF participants in our billing analyses, and reflected the mix of measure installed by these participants.
[13] Included applying the in-service and NTG rates reported in this evaluation, as well as accounting for the savings associated with customer's participation in other National Grid residential efficiency programs.

adjust our initial ex post savings for programmable and Wi-Fi thermostats in electrically heated homes. This is because, as noted above, thermostats represent the lion's share of the electric savings not already captured through billing analysis as part of the current evaluation.

Specifically, our team decided to maintain the existing ex ante savings for programmable thermostats (214.6 kWh). The existing savings, which were determined through a billing analysis as part of the previous EWSF impact evaluation, are lower than the savings our team initially estimated (287 kWh) via engineering algorithms informed by a literature review in neighboring Massachusetts.[14] We decided to recommend the same savings for Wi-Fi thermostats (again, 214.6 kWh) since our engineering approach also yielded a higher savings (440 kWh) for that control type.[15,16]

It is important to note that our team is aware of ongoing billing analysis-based programmable and Wi-Fi thermostat studies in Massachusetts for comparable programs in National Grid Rhode's neighboring territory. We suggest that National Grid review the results of those studies once available (likely mid-2021), as well as any other more recent thermostat-focused studies, and consider potential applicability of the results for EWSF.

Gross Savings

Table 6 presents the ex post gross results for each EWSF measure.[17] The table also indicates which methodology the evaluation team used to estimate savings.

The team used engineering algorithms to evaluate most measures, while the billing analysis focused on the two EWSF measures (lighting and natural gas weatherization) where the evaluation team could report savings at better than the required ±25% precision at the 90% confidence all level.[18]

[14] Our team initially estimated savings by applying fuel-specific heating load percent savings estimates from a recent Massachusetts literature review to the average annual heating and cooling consumption determined (through the billing analysis) for EWSF participants.
[15] Since the recommended savings for both programmable and Wi-Fi thermostats is based on a billing analysis, it is important to note that National Grid should not apply a separate in-service rate (ISR) when estimating the total impact for thermostats. It is, however, appropriate to apply a net-to-gross ratio for both thermostat types as the result of the previous billing analysis should be considered gross values.
[16] For the sake of consistency across fuels, we recommend National Grid use the same savings for programmable and Wi-Fi thermostats-across all fuel types-until primary, billing analysis-based information is available to differentiate between the two types of controls.
[17] Except for the four lighting measures, which reflect net savings. This is explained in more detail later in this section.
[18] The team attempted billing analysis for other EWSF measures, notably thermostats, but none of the results were statistically significant.

Table 6. EWSF - Ex Post Gross Savings by Measure and Fuel[19]

Measure Group	Measure	Electric (kWh/year)	Natural Gas (therms/year)	Oil (MMBtu/year)	Propane (MMBtu/year)
Domestic Hot Water	Aerators	28	1.4	.15	.14
	-Water Savings (gal)	269	269	269	269
	Showerhead	213	11	1.2	1.1
	-Water Savings (gal)	1,565	1,565	1,565	1,565
	Pipe Wrap/Insulation	46	3	0.3	0.3
Lighting	LED Bulbs	18**			
	LED Specialty/EISA Exempt	15**			
	LED Reflectors	19**			
	LED Fixtures	34**			
Controls	Programmable Thermostat (Heating Savings)	214.6	32	3.3	3.2
	-Fan/pump Savings (kWh)	6	19	19	19
	-Cooling Savings[#] (kWh)	2	8	8	8
	Wi-Fi Thermostat (Heating Savings)	214.6	32	3.3	3.2
	-Fan/pump Savings (kWh)	6	19	19	19
	-Cooling Savings[#] (kWh)	2	8	8	8
	Wi-Fi Thermostat (Cooling Only)	51			
Appliances & Plug Load	Refrigerator Rebate	914			
	Refrigerator Brush	10.9			
	Smart Strip	105			
	Smart Plugs°	-			
Weatherization	Air Sealing Kit	94	3.7	0.38	0.38
	Weatherization (Heating Savings)	803	96	9.8	9.6
	-Furnace Fan Savings (kWh)	10	32	32	32
	-Cooling Savings[^] (kWh)	27	16	16	16
Early Retirement	Room Air Conditioner°	161			
	Dehumidifier°	159			
	Clothes Washer°,*	Varies; see engineering workbook for details			

*Includes various combination of water heating and dryer fuel types

**Net savings, not gross

°Not offered in 2017/2018; estimating savings for prospective use only.

[#]Only relevant for central air conditioners (CAC); per-unit savings are weighted to reflect prevalence of CACs for EWSF participants (11%)

[^]Relevant for all cooling types; per-unit savings are weighted to reflect prevalence of CACs, room air conditioners, and no air conditioning

Key

- Billing Analysis
- Engineering Algorithm
- Building Simulation
- Engineering Adjusted Billing Analysis

Comparing Ex Ante and Ex Post Savings

Table 7 and Table 8 compare the ex post savings presented in the previous table with the program's ex ante savings. Table 7 focuses on electric measures, while Table 8 compares natural gas, oil, and propane measures. Both tables include a brief explanation of why ex ante and ex post savings may differ. Our team provided additional details regarding the specific inputs, assumptions, and algorithms that we used to generate these savings in the evaluation's Supporting Documentation workbook.

[19] Again, except for the four lighting measures, which are reflect net savings.

Table 7. Comparison of Ex Ante and Ex Post Savings – Electric Measures (kWh/year)

Measure	Ex Ante	Ex Post	RR	Details
Aerators	36.6	28	78%	The previous and current evaluations employed different methodologies to evaluate DHW measures (proportioning of whole home billing analysis results and engineering algorithms informed by EWSF data and secondary resources, respectively). These methodological differences result in an apples-to-oranges comparison for ex ante and ex post savings that prevents our team from explaining why the ex ante and ex post values depart (beyond the methodological drivers). It is worth noting that while the showerhead realization rate is very high, the ex post savings are comparable to recent evaluations of similar programs in New England.
Showerhead	34.3	213	621%	
Pipe Wrap/ Insulation (DHW)	33.3	46	139%	
LED Bulbs*	32.72	18	55%	Ex post savings (determined by disaggregating whole-home lighting billing analysis results into lamp-type specific estimates) were universally lower than the program's ex ante values, which were based on a 2020 planning document that leveraged National Grid's lighting Market Adoption Model[20] and 2018 lighting NTG study in MA.[21] The lower ex post savings are based on the team's whole-home lighting billing analysis. The average savings across all lighting measures (17 kWh) is consistent with the findings of the recent low-income single-family impact evaluation in Rhode Island[22] (also 18 kWh).
LED Specialty/EISA Exempt*	32.72	15	46%	
LED Reflectors*	37.44	19	51%	
LED Fixtures*	32.72	34	104%	
Programmable Thermostat	214.6	214.6	100%	As discussed above, our team initially applied a heating load percent savings value (determined through a recent literature review in MA) to the EWSF-specific heating consumptions (determined through billing data disaggregation) to estimate programmable and Wi-Fi thermostat savings. However, this approach yielded savings that were out of alignment with the average total savings observed for electrically heated customers. As a result, the team suggests that National Grid continue to use the ex ante savings for programmable thermostats, and associated fan and cooling savings, until future research is completed. Also, given the uncertainty around the difference in savings between programmable and Wi-Fi thermostats, our team suggests that National Grid use the same savings, again until better information is available, for both types of electric thermostats.
Wi-Fi Thermostat	97	214.6	221%	
Wi-Fi Thermostat (AC only)	64	51	80%	
Refrigerator Rebate	460.8	914	198%	Due to small number (81) of replaced refrigerators in 2017-2018, billing analysis (the previous evaluation methodology) was not viable. Instead, our team leveraged metered data on replaced refrigerators collected during home energy assessments, as well as the average consumption of the new ENERGY STAR unit (460 kWh). Ex post savings are higher than ex ante, but reasonable since EWSF a) only replaces sufficiently inefficient refrigerators and b) the estimated average annual consumption of replaced units (1,392 kWh) is within reason for the older, inefficient units that qualify for replacement.
Refrigerator Brush	10.9	10.9	100%	No additional information exists to update savings.

[20] MA PAs (2019). Lighting Worksheet PY2019-2021 - Updated for RI.xlsx
[21] 0.80 for all direct install lighting measures (http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_185_HEALEDNTG_REPORT_23July2018_Final.pdf)
[22] http://rieermc.ri.gov/wp-content/uploads/2019/04/ng-ri-ies-impact-evaluation-report_final_30aug2018.pdf

Smart Strip	21.6	105**	486%	As with other measures, a direct comparison of the ex ante (from billing analysis) and ex post (secondary metering study) is not possible. Our team relied on a recent advanced smart strip metering study (MA, 2018). While the ex post savings are a nearly five-fold the ex ante savings, 105 kWh per Tier 1 smart strip is similar to the program's estimated savings prior to the previous evaluation (75 kWh), consistent with the current estimate for EWMF (105 kWh), and in line with savings in neighboring state TRMs.
Air Sealing Kit	93.8	93.8	100%	The team employed the same algorithm used for the ex ante savings and, following a review of the current input values, did not identify any new/EWSF-specific information for updating savings.
Insulation/ Weatherization	782	803	103%	Due to limited sample sizes, the team could not achieve adequate precision in our attempt to estimate weatherization savings in electric-heated homes using billing analysis. Therefore, our team applied the percent of heating consumption saved from gas weatherization billing analysis (11%) to the average heating load for weatherized electric participants to estimate electric weatherization savings).

*Ex ante and ex post savings are net; all other measures are gross.

**105 kWh are the gross savings associated with a properly installed smart strip. A recent study in Massachusetts determined that 8% of strips are improperly installed. As a result, National Grid should apply a 92% realization rate to this savings value, in addition to the ISR and NTG rates reported later in this report, when calculating the net savings for smart strips. (http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_173_APSMeteringReport_Revised_18March2019.pdf)

Table 8. Comparison of Ex Ante and Ex Post Savings – Natural Gas (therms/year), Oil (MMBTU/year), and Propane Measures (MMBTU/year)

	Natural Gas			Oil			Propane			
Measure	**Ex Ante**	**Ex Post**	**RR**	**Ex Ante**	**Ex Post**	**RR**	**Ex Ante**	**Ex Post**	**RR**	**Details**
Aerators	0.8	1.4	174%	0.22	0.15	68%	.22	.14	63%	Similar to the electric domestic hot water measures above, it is not possible to directly compare natural gas ex ante savings and ex post savings due to methodological differences between evaluations. However, it is possible to compare oil and propane savings since the ex ante savings are based on a recent study in MA that used a similar evaluation approach.[23] Relative to that evaluation, the number of installed aerators was much lower (1.0 vs 1.8), post-retrofit showerhead flow decreased (1.5 gpm, down from 1.6), and the average length of pipe wrap insulation was greater.
Showerhead	1.9	11.1	584%	0.98	1.23	120%	0.92	1.1	120%	
Pipe Wrap/ Insulation (DHW)	0.6	2.9	487%	0.2	0.3	152%	0.29	0.29	101%	
Programmable Thermostat	10.1	32.0	317%	3.5	3.3	93%	3.5	3.2	91%	Our team attempted to estimate savings via billing analysis; however, the results did not have sufficient precision. Consequently, our team applied percent savings determined through a recent literature review in MA for programmable thermostats (3.6%) to the average heating load determined for EWSF participants heating with electricity. Like electric controls, we recommend that National Grid use the same heating, fan, and cooling savings for programmable and Wi-Fi thermostats until better information is available. It is important to note that there are two ongoing billing analysis-based, thermostat-focused studies in MA (one for programmable and one for Wi-Fi). Once available, National Grid should review the results of the MA studies, and any other recent controls studies, and consider leveraging the results for EWSF.
Wi-Fi Thermostat	31.1	32	103%	3.1	3.3	105%	3.1	3.2	103%	
Air Sealing Kit	3.9	3.7	96%	0.38	0.38	100%	0.37	0.37	101%	The team employed the same algorithm used for the ex ante savings and, following a review of the current input values, did not identify any new/EWSF-specific information for updating savings.
Insulation/ Weatherization	110.9	96	87%	14	9.8	70%	14	9.6	69%	Both the ex ante and our team's ex post natural gas savings use billing analysis. Our team's ex post savings, which is somewhat lower than the previous evaluation, is better suited for prospective use since it reflects more recent participation in EWSF (2017/18 participants vs 2014 participants) and had greater precision (±6% vs ±10%).

Net Savings

Table 9 presents the NTG ratios for each measure group as determined through surveys with recent EWSF participants. As detailed in the separate NTG methodology finalized in May (provided in Appendix B), our NTG estimates considered both freeridership and spillover, and account for key factors such timing, quantity, and efficiency when considering the participant's self-reported action in the absence of EWSF. Appendix C provides additional detail on the spillover analysis.

As evident below, the team found the lowest rate of freeridership and, relatedly, the highest NTG ratio, for weatherization. This result is intuitive for two reasons. First, educating participants about the importance and value of weatherizing their home is central to EWSF's message and program design. Second, weatherization is a significantly more expensive efficiency upgrade (relative to the program's direct install measures) and these results suggest the program's financial support is critical to encouraging participants to move ahead with weatherization.

Conversely, we found the highest freeridership (and lowest NTG) for programmable and wi-fi thermostats. Respondent likelihood to purchase a thermostat on their own within six month drove the higher freeridership, with just under half rating their likelihood a five or higher on a 0 to 10 point scale (where 0 was not at all likely and 10 was extremely likely.)

Table 9. EWSF – Net-to-Gross Ratios (Measure Group)

Measure Group	Relevant Measures	Sample Size	Freeridership	Spillover	NTG
Domestic Hot Water	Showerheads, Aerators, & Pipe wrap	52	0.27	0.01	0.74
Appliances & Plug Load*	Smart Power Strips	163	0.31		0.70
Controls	Programmable & Wi-Fi Thermostats	40	0.47		0.54
Weatherization**	Air Sealing & Insulation Types	151	0.14		0.87

*Too fewer refrigerator rebates in 2017/18 to assess NTG

**No statistically significantly different results by fuel type

Table 9 does not include lighting because the team's ex post, per-unit lighting savings (reported in Table 6) were estimated using a billing analysis that produces net savings for lighting measures.[24] Therefore, we

[24] In general, billing analyses produce results on a spectrum between gross and net savings. The exact location on that spectrum for any given result depends on the type of customers in the control group and the efficiency measure being analyzed. Our team relied on future EWSF for our control group and used billing analysis to estimate savings for two key EWSF measures: weatherization (in natural gas-heated homes) and lighting. The billing analysis results for weatherization—per the guidance of the Uniform Methods Project—should be considered gross as the future participants in the control group later weatherized through EWSF (implying they were not doing so outside of the program). However, the team's billing analysis results for lighting measures should be interpreted as net savings since it is likely that future participants, like residential customers in general, were increasingly installing LEDs prior to their home energy assessment.

did not apply a separate, standalone lighting NTG ratio, as doing so would double count the freeridership effect in net lighting savings.

However, to provide National Grid with insight into the potential freeridership inherent in the lighting billing analysis results, our team asked surveyed EWSF participants questions related to the lamps and fixtures directly installed in their home. Accordinging to the survey, participants self-reported that they would have likely installed slightly more than a third (36%) of the program's direct install LEDs themselves within six months of their assessment had EWSF not installed them.[25] Since the EWSF program installed an average of 27 LEDs per home (across all lamp types and fixtures) in 2017 and 2018, this equates to approximately 9 LEDs per participant.

Again, our team does not recommend that National Grid utilizes this value when determining net lighting savings and/or assessing cost-effectiveness; this information is for context and program planning purposes only.

Benchmarking

Prior to this evaluation, National Grid assumed an NTG ratio of 0.8 for all EWSF lighting measures (based on a 2018 NTG study in Massachusetts[26]) and 1.0 for all EWSF non-lighting measures.

Our study found lower NTG values for all non-lighting measures than National Grid's 1.0 ex ante assumption. The difference is relatively small for weatherization (0.13 less than assumed 1.0 ex ante), but larger for the other three measure groups – as much as 0.46 less (for thermostats).

Since there are not NTG results from previous EWSF studies to benchmark against, our team looked to studies of similar programs in other New England states. The Residential Coordinated Delivery program (formerly known as Home Energy Services) in National Grid's Massachusetts service territory utilizes NTG values from a 2012 evaluation.[27] While dated, the results from that study offer regional context and a point of comparison for our team's weatherization NTG value; none of the other measures included in the 2012 Massachusetts study are offered through EWSF.

As part of that study, Cadmus found a freeridership rate of 0.25 for weatherization, which is almost twice our 0.14 estimate for EWSF. However, the Cadmus study found much higher levels of participant spillover than our team found for EWSF (0.20 versus 0.01) and included a separate contractor-based, discrete choice analysis that resulted in an additional 0.28 for nonparticipant spillover. Collectively the spillover savings in Massachusetts more than compensated for the higher rate of freeridership relative to EWSF and produced a much higher weatherization NTG ratio (1.23).

[25] Participant's estimated self-install rates in absence of the EWSF does not differentiate between early replacement and replace-on-failure for existing lights.

[26] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_185_HEALEDNTG_REPORT_23July2018_Final.pdf

[27] http://ma-eeac.org/wordpress/wp-content/uploads/Home-Energy-Services-Net-to-Gross-Impact-Evaluation_Part-of-the-Massachusetts-Residential-Retrofit-Low-Income-Program-Area-Evaluation.pdf

As evident in Table 10, the primary driver of the difference in the two NTG estimates is the scope of the spillover analysis and the magnitude of the resulting savings.

Table 10. EWSF – Net-to-Gross Benchmarking

NTG Element	RI (EWSF - Weatherization)	MA (HES - Insulation)
Freeridership	0.14	0.25
Participant Spillover	0.01	0.20
Nonparticipant Spillover	Not included	0.28
NTG	**0.87**	**1.23**

In-Service Rates

In addition to NTG, our team determined the in-service rate for each EWSF direct install measure group.[28] The in-service rates below reflect the percentage of measures installed by EWSF during home assessments that participant's self-reported were still installed at the time of the web survey (June 2020).

We found high in-service rates for both domestic water measures (98%). Not surprisingly, we found lower in-service rate (84%) was associated with smart power strips, which EWSF assessors leave behind for the participant to self-install (for liability reasons) after the HEA.

Table 11. EWSF – In-Service Rates (Measure Group)

Measure Group	Relevant Measures	Sample Size	Installed	Removed	In-Service Rate
Domestic Hot Water	Faucet Aerators, Showerheads, Pipe Wrap	45	242	5	98%
Appliances & Plug Load	Smart power strip*	246	415	66	84%

*Based on the total number of smart power strips left for participants to install (not the subset of units that participants went on to install). Also, as noted above, a recent study in Massachusetts determined that 8% of strips are improperly installed. As a result, National Grid should apply a 92% realization rate (in addition to this ISR - and NTG rate) when calculating the net savings for smart strips.

Like the NTG discussion above, our team's billing analysis-based savings for lighting measures accounts for EWSF LEDs uninstalled by program participants. So, as with NTG, it is incorrect to apply a separate in-service rate impact factor for lighting. Given that our team is also recommending that National Grid continue to use a billing analysis-based savings estimate for controls (from the previous EWSF impact evaluation), it is also incorrect to apply an in-service rate for that measure group.

While unnecessary to apply a lighting or controls in-service rate, our team used the participant survey as an opportunity to determine the extent to which EWSF participant are removing program LEDs and

[28] The team did not assess in-service rates for either major measure because removing insulation is uncommon and too few refrigerator rebates occurred in 2019 to develop a reliable estimate.

thermostats. (Note: Although the billing analysis result accounts for removed LEDs and thermostats, it does not provide direct insight into removal rates.)

We found that 9% of all participants had removed at least one LED and, in aggregate, that 2% of all program-installed LEDs had been removed at the time of the survey (i.e., 98% in-service rate). When asked why they removed the LEDs, the most common responses were "The bulbs were of inferior quality to what was wanted", "The lights blew out or flickered", and "Did not work properly with the fixture". National Grid should only use this information to understand LED performance and participant measure acceptance/satisfaction – not for determining net and/or lifetime savings.

Regarding thermostats, we found very few were uninstalled; in fact, only 5 of 141, which suggests a 96% retention or in-service rate.

Additional Details: Natural Gas Weatherization

Our team used billing analysis to evaluate energy savings for EWSF weatherization in natural gas-heated homes. As noted previously, weatherization refers to one or more of the following measures: air sealing, attic insulation, wall insulation, and floor/basement insulation.

To begin, the team identified a treatment (2017 and 2018) and control (2019) EWSF participants who meet the necessary criteria for inclusion in the billing analysis.[29] The team's screening process removed natural gas participants without sufficient billing records or whose usage exhibited extreme or counter-intuitive energy consumption. In total, our billing analysis used a total of 2,156 National Grid natural gas-heated households weatherized through EWSF.

Table 12. Billing Analysis Sample Attrition – Natural Gas

Reason for Exclusion	Removed	%	Remaining
All Homes			4,606
Could not be mapped to billing data	645	14%	3,961
Insufficient (less than 12 months) Pre- and/or Post-Participation Billing Data	1,542	39%	2,419
Did not match control with sufficiently similar consumption for all 12 months of pre-period*	189	8%	2,230
Energy Consumption Outliers (<1st and >99th Percentile)	45	2%	2,185
Extreme consumption behavior (< 3.41 avg monthly therms or > 341 monthly therms)	29	1%	2,156
Extreme Changes in Consumption (±>50% Change between Pre and Post)	0	0%	2,156
Overall	**2,450**	**53%**	**2,156**

*Control customers are matched to treatment customers based on similarity of their energy consumption during the same time span before each customer participant in EWSF. Variability in gas consumption patterns leads to an evaluation tradeoff between treatment/control match rate and the accuracy of the match. For this model, our team prioritized limiting the amount of attrition to retain overall population size, which was small relative to the lighting billing analysis described later in the report.

[29] See the Impact Evaluation Analysis Plan in Appendix A for more information about how our team identified treatment and control group participants.

Our team used the PRR model specification, below, to estimate weatherization savings for participants who heat their homes with natural gas:

$$ADC_{ct} = b_1 Treatment_c + b_2 Therm_c + b_3 LagADC_{ct} + \sum_{month\ i} b_{4i} Month_{it} + b_5 CrossProg_c + e_{ct}$$

Where:

ADC_{ct} = average, daily energy consumption for customer c at calendar month t

- $Treatment_c$ = 1 if customer *c* is in treatment group, 0 if customer *c* is in control group.
- $Therm_c$ = 1 if customer *c* is received a programmable or Wi-Fi thermostat, 0 if customer *c* did not receive a thermostat.
- $LagADC_{ct}$ = average daily consumption from customer *c* during calendar month t of the pre-program period
- $Month_{it}$ = 1 when index i = calendar month t, 0 otherwise. We include this series of 12 terms to capture month-specific effects in our analysis.
- $CrossProg_c$ = 1 if customer c received an energy-efficiency measure from any non-EWSF program.[30]
- e_{ct} is a cluster-robust error term for customer k during billing cycle t. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

Results

As shown in Table 13, we determined that natural gas-heated EWSF participants who weatherized their homes saved 96 therms/year[31] on average, or 8% of pre-participation household natural gas consumption. Our team also attempted to estimate savings for thermostats (programmable or Wi-Fi) installed as part of EWSF. However, precision associated with the savings estimate for thermostats (±51% at the 90% confidence level) was well outside our team's requirement (±25%) for reporting billing analysis-based results.[32]

Table 13. 2017–18 Natural Gas Billing Analysis Results

Measure	Billing Analysis Sample N	Energy Savings (Therms)	Precision (% +/-)	Normalized Annual Consumption (Therms)	% of NAC
Weatherization	2,156	96	6%	1,137	8%

[30] The total savings from Cross Program analysis was consistent across multiple specification of the model. There were significant savings contribution from the High-Efficiency Heating Equipment program only.

[31] We applied an adjustment to the weather normalize the billing analysis model result. The average annual, post-period weather for participants, 4,333 HDD with 60 degree base, was warmer than the average TMY3 weather of 4,796 HDD with 60 degree base.

[32] In controlling for cross-participation, our team did find statistically significant savings (36 therms/year at ±19% relative precision) for EWSF participants who also participated in another National Grid residential program. While our team did not find statistically significant results for model specifications that assessed the individual impacts of National Grid's other residential programs, most of the cross-participation savings identified in those model iterations were consistently associated, not surprisingly, with the Natural Gas Heating and Water Heating program.

Benchmarking

The team's ex post billing analysis savings for weatherization are lower than the billing analysis results (108 therms, ±10%) estimated as part of the previous EWSF impact evaluation, which informed the program's ex ante assumption.

Table 14 compares these estimates more closely, providing additional information about the analysis sample sizes and confidence intervals associated with each estimate. While the results of the two billing analyses are not statistically different, the sample sizes associated with the current evaluation was larger and, relatedly, the precision associated with the point estimate is greater. Additionally, the current evaluation reflects more recent participation in EWSF, which is a better predictor of savings in future program. For these reasons, our team recommends National Grid uses the weatherization results from this evaluation for prospective program planning.

For broader context, Table 14 also includes the natural gas weatherization savings from National Grid's Income Eligible Service (IES) and Massachusetts Home Energy Services (HES) impact evaluations completed in 2018.

Table 14. Benchmarking: Weatherization (Natural Gas)

State	Program	Evaluated Program Year(s)	Energy Savings (Therms)	Precision (% +/-)	% of NAC	Billing Analysis Sample N
RI	**EWSF**	**2017-2018**	**96**	**6%**	**8%**	**2,156**
RI	EWSF	2014	107.8	10%	10%	1,252
RI	IES (SF)	2015-2016	124	5%	13%	785
MA	HES	2015-2016	127	2%	n/a	3,357

Weatherization Type-Specific Savings

Our team also explored using billing analysis to estimate the savings associated with specific elements of weatherization, such as air sealing and attic, wall, floor/basement, and duct insulation. However, none of our more granular model specifications yielded statistically significant, measure-level results. This is due to several factors:

1. **Multicollinearity.** Nearly all air sealing participants also install at least one kind of insulation, which makes it difficult for the billing analysis regression model to attribute savings accurately
2. **Smaller savings.** The savings associated with a specific type of weatherization (e.g., attic insulation) is less than the total savings from weatherization overall (e.g., attic insulation and air sealing). This decreased "signal" (weatherization type savings) to "noise" (total household consumption) ratio contributes to modeling difficulty.
3. **Smaller sample sizes.** While 2,156 natural gas participants installed weatherization measures, the number that received a specific type of weatherization measure, for example wall insulation, is smaller (789), which impacts precision.

Though the billing analysis was unable to reliably estimate specific savings for air sealing or for each type of insulation installed through EWSF (attic, wall, floor/basement, and duct insulation), our team used the

calibrated building simulation models to disaggregate the overall billing analysis weatherization results into these weatherization sub-elements. In other words, our team utilized the relative savings for each type of weatherization (determined through the building simulation process) and the profile of the average weatherization participant (from program records) to divide the overall weatherization savings determined through the billing analysis its constituent parts. The results of this process, detailed in Table 15, could also be described as billing analysis-calibrated building simulation estimates.

As shown below, the average natural gas-heated EWSF participant (that weatherized their home) received 2.9 types of weatherization. Virtually every participant (97%) had their home air sealed, while the most common insulation type was attic insulation (87%). As evident in Table 15, basement/floor (58%) and wall insulation (43%) were less common, while duct insulation was rarely installed (6%). According to our analysis, attic insulation was the largest weatherization saver (46 therms/year), followed by air sealing (34 therms/year). They are also the two most installed weatherization elements.

Table 15. Natural Gas Weatherization Savings by Weatherization Type (therms/year)

	Air Sealing	Attic Insulation	Wall Insulation	Basement/Floor Insulation	Duct Insulation	Overall
Building Simulation Savings*	69	94	45	46	20	
Pct. of weatherized participants who received each weatherization type**	0.97	0.87	0.43	0.58	0.06	2.91
Billing Analysis-Calibrated Savings	**34#**	**46#**	**22#**	**22#**	**10#**	**96^**

*Reflects the savings, based on building simulation modeling, associated with installing each weatherization element independently (i.e., our team modeled each weatherization element separately).

**Based on the same set of EWSF natural gas-heated weatherization participants included in the billing analysis

#Reflects the savings associated with installing each weatherization element independently. This row calibrates building simulation results to billing analysis results (and accounts for the mix of installed weatherization types present in the billing analysis).

^Overall savings from billing analysis, which reflects the average of the billing analysis-calibrated weatherization type savings weighted by the percent of natural gas participants who received each type of weatherization.

It is critical to note that the overall weatherization result – determined through the billing analysis – is more reliable than the disaggregated air sealing and insulation type-specific savings below. This because, due to interactions between elements, installing multiple weatherization elements will result in a total savings that is less than the sum of the savings associated with each weatherization element. Users of this evaluation should therefore leverage the overall weatherization results, rather than the disaggregated weatherization elements, when possible.

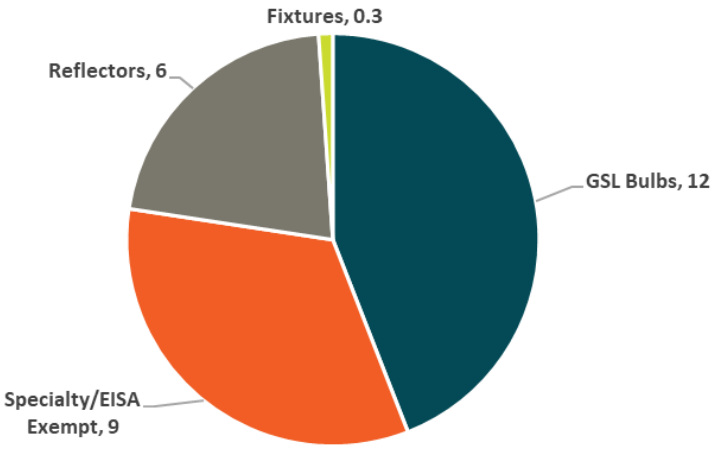
It is also important to note that National Grid does not assess the cost-effectiveness for individual weatherization elements. However, additional perspective regarding the relative savings generated by each type of weatherization types can indicate where the program is more (or less) successful when weatherizing participant's homes, which can inform future EWSF planning efforts

Additional Details: Lighting

National Grid installed four different types of lighting measures in 2017 and 2018 during EWSF assessments: general service LED lamps, specialty/EISA exempt LED lamps, LED reflector lamps, and LED fixtures. On average, participants who received lighting measures during their assessment received an average of 27 total bulbs (across all four lighting measures).

As shown in Figure 7, just under half of the bulbs installed in the average EWSF participant's home were general service LEDs. Specialty/EISA exempt bulbs and reflectors were also common, but the program rarely installed fixtures.

Figure 7. Lighting Measures installed in Average EWSF Participating Home (2017 & 2018)



While the team could not attribute savings to specific types of lighting measure though billing analysis, the aggregated impact of the lighting measures installed through EWSF – given the high number of lighting measures installed – made it possible for our team to accurately estimate the impact of lighting at the household level through a billing analysis.

Like the process described above for the natural gas weatherization billing analysis, our team screened out participants with insufficient electric billing records and/or whose bills exhibited extreme or counter-intuitive energy consumption. In addition, to better to detect lighting savings, we also excluded the small number of electrically heated households that were weatherized through EWSF. Excluding these customers from this lighting-focused billing analysis sample minimized variance and allowed our team to better isolate lighting-related savings. In total, our team included 5,537 2017 and 2018 EWSF participants in our lighting billing analysis sample.

Table 16. Electric Billing Analysis Sample Attrition

Reason for Exclusion	Removed	%	Remaining
All Homes			**10,111**
Could not be mapped to Billing Data	724	7%	9,388
Insufficient (less than 12 months) Pre- and/or Post-Participation Billing Data	896	10%	8,492
Energy Consumption Outliers (<1st and >99th Percentile)	169	2%	8,323
Extreme consumption behavior (< 100 avg monthly kWh or > 10,000 monthly kWh)	0	0%	8,323
Extreme Changes in Consumption (±>50% Change between Pre and Post)	0	0%	8,323
Did not match control with sufficiently similar consumption for all 12 months of pre-period**	2,716	33%	5,607
Remove Participants with electric heating	70	1%	5,537
Overall	**4,575**	**45%**	**5,537**

*To allow the team to detect lighting savings, the team excluded the small number of electrically heated households that were weatherized through IES, as well as those that received freezer replacement, or appliance removal. Excluding these customers from the billing analysis sample minimized variance and allowed the team to isolate lighting-related savings.

** Our team controls the exactness of the matching process (i.e., the similarity of a treatment and control group customer to be considered a match). In one extreme, our team could theoretically set matching requirements such that treatment and control customers must exhibit nearly the exact same pre-program consumption and usage profile to be matched. Such a matching requirement would lead to nearly all participants failing to find a match and falling out of the analysis. At the other extreme, setting lax matching requirements (e.g., matches must be within 5,000 kWh of each other) would lead to every participant, technically, having a "match". However, the appropriateness of the many of those "matches" would be questionable, leading to poor model diagnostics and less robust results. For every analysis, our team customizes the matching requirements in a way that balances the exactness of the match with the sample size available for analysis. A closely matched sample is robust to small changes in procedures and produces a data set that is by design less sensitive to modeling assumptions. Our goal is always to optimize the matching requirements such that the analysis yields the most accurate results possible. Since far more EWSF participants received lighting than to weatherization (~10,100 vs. ~4,600, respectively), our team was able to use more stringent matching requirements for lighting while still retaining adequate sample size for our analysis. It is important to highlight that stricter matching requirements, as implemented here, require the treatment participants in the analysis to look more like the control group. Since the control group is made up of "future" (i.e., more recent) EWSF participants, this requirement ensures the results of the billing analysis better reflect more recent participation in the program, which, in turn, is best for prospective use.

Below is the model specification that our team used to assess total lighting savings for these EWSF participants:[33]

$$ADC_{ct} = b_1 Treatment_c + b_2 Elect_c + b_3 LagADC_{ct} + \sum_{month\ i} b_{4i} Month_{it} + b_5 CrossProg_c + e_{ct}$$

Where:

ADC_{ct} = average, daily energy consumption for customer c at calendar month t
$Treatment_c$ = 1 if customer *c* is in treatment group, 0 if customer *c* is in control group.

[33] Before arriving at this specification, our team specified several models to try and estimate lighting measure type-specific (e.g., GSL LED versus LED reflector) savings. Consistent with past efforts, our team was unable to develop models that produced sufficiently precise results at this finer level of measure granularity

$Elect_c$ = 1 if customer *c* is in received other electric measures during the evaluation period, 0 if customer *c* did not receive other electric measures.
$LagADC_{ct}$ = average daily consumption from customer *c* during calendar month t of the pre-program period
$Month_{it}$ = 1 when index i = calendar month t, 0 otherwise. We include this series of 12 terms to capture month-specific effects in our analysis.
$CrossProg_c$ = 1 if customer c received an energy-efficiency measure from any non-EWSF program.[34]
e_{ct} is a cluster-robust error term for customer k during billing cycle t. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

Results

As shown below, the team estimated that participants who received lighting measures through EWSF saved, 467 kWh on average. This billing analysis results reflects participant's total lighting-related savings; the team then estimated per-bulb savings (17 kWh/year) by dividing the total savings by 27—the average number of bulbs installed in participant's homes.

Table 17. 2017–18 Lighting Billing Analysis Results

Measure	Billing Analysis Sample N	Total Lighting Savings (kWh)	Precision (% +/-)	Average Lighting Measure/Participant	Per-Unit Lighting Savings (kWh)
Lighting	5,537	467	7%	27.0	17

About Net-to-Gross and Interactive Effects

As noted above, the results of this billing analysis reflect net savings as LEDs, which are readily available and relatively affordable, are likely installed by the future-EWSF participant control group prior to their HEA.

It is also important to note that the electric billing analysis results above account for any cooling-related impacts (due to post-participation reduction in waste heat) associated with installed EWSF lighting, as well as heating impacts for participants who heat with electricity. In addition, the natural gas billing analysis, detailed in the previous section, accounts for the interactions between lighting and heating systems/weatherization for the subset of participants who weatherized their home in addition to receiving lighting during their HEA.[35]

Benchmarking

As shown below, our team's per-unit ex post lighting savings are statistically significantly lower than the results from the previous EWSF evaluation. However, as noted in the previous evaluation, the billing analysis savings from that evaluation were not directly appropriate for prospective use given the small

[35] The billing analysis results do not reflect the impact of EWSF lighting retrofits on space heating for participants who heat with natural gas or delivered fuels and that did not weatherize their home. Our team has identified appropriate interactive effects to account for this impact and will work with National Grid to apply the interactive effect factors to the appropriate percentage of applicable ESWF lighting measures in a way that aligns with National Grid's current program tracking and reporting.

number of average bulbs installed (8.2) in 2014 and the program's transition from CFLs and LEDs to exclusively LEDs.

That said, the results of our lighting billing analysis are also considerably less than National Grid's ex ante lighting savings, which are gross savings values from a three-year planning workbook created in Massachusetts and customized for Rhode Island.[36] Those values vary slightly by lamp type (ranging from 40.9 to 46.8 kWh/year). Applying the National Grid's 0.8 NTG assumption[37] to convert the gross savings to net (33.2 to 37.9 kWh) provides a more direct comparison with the results of our team's billing analysis. While doing so lessens the disparity between ex ante and ex post savings, the difference remains significant. The difference implies that one or more of National Grid's bottom-up ex ante lighting savings assumptions – the assumed NTG, delta watts[38], hours of use (HOU) [39], and in-service rate – do not accurately reflect EWSF. While billing analysis yields reliable information regarding the actual savings generated by EWSF lighting, it does not provide insight into these specific inputs for identifying the source(s) of the disparity.

It is worth noting that the billing analysis results for EWSF are nearly identical to the savings – both at the household and per-unit level – found as part of the 2018 IES impact evaluation.

Table 18. Benchmarking: Lighting

State	Program	Evaluated Program Year(s)	Energy Savings (kWh)	Precision (% +/-)	Average Lighting Measures/ Participant	Per-Unit Lighting Savings (kWh)	Billing Analysis Sample N
RI	**EWSF**	**2017-2018**	**467**	**7%**	**27.0**	**17**	**5,537**
RI	EWSF	2014	248	44%	8.2	30	4,640
RI	IES (SF)	2015-2016	458	13%	28	18	985

Installation Trends

Given the need to apply the results of this evaluation prospectively, our team assessed trends in both the quantity of lighting measures installed and the mix of lamp types installed between 2017 and 2019. Two clear trends emerged.

1. **Declining Installation Rates.** There is a consistent year-over-year decline in the number of lighting measures installed from nearly 30 (29.9) in 2017 to 21.3 in 2019. Given the program's objective to replace all inefficient lamps in participating home, this finding suggests that assessors are encountering fewer halogen and incandescent lamps and more LEDs and CFLs during their assessments. This finding also supports the notion that participants are installing LEDs prior to their assessment and that the results of the billing analysis should be considered net of freeridership.
2. **Shift Away from Specialty/EISA-Exempt Lamps.** There is also a clear shift away from installing specialty/EISA-exempt lamps (44% of installed lamps in 2017, but only 20% in 2019). At the same

[36] MA PAs (2019). Lighting Worksheet PY2019-2021 - Updated for RI

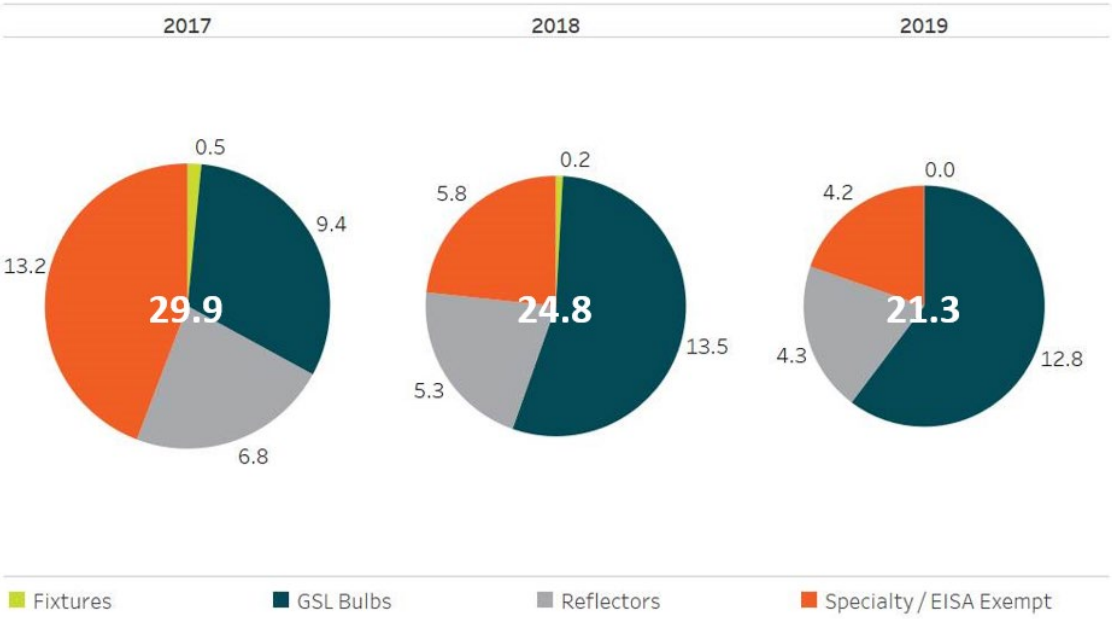
[37] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_185_HEALEDNTG_REPORT_23July2018_Final.pdf

[38] http://ma-eeac.org/wordpress/wp-content/uploads/MA19R09-E-DeltaWattReport-Memo_FINAL_2020.03.26.pdf

[39] http://ma-eeac.org/wordpress/wp-content/uploads/MA20R21-E-LTGHOU-Report-Final-2020.03.31.pdf

time, the share of general service lamps has nearly doubled going from 31% to 60% of all EWSF installs. It is also worth noting that LED fixtures, while never a significant factor in the program, declined as well and were rarely installed in 2019.

Figure 8. Lighting Measures installed in Average EWSF Participating Home (2017-2019)



Savings by Installation Quantity

Impact evaluations, including the previous EWSF evaluation, have consistently found that per-unit lighting savings are inversely related to the number of lighting measures installed. In other words, once programs install efficient lighting in the subset of most used sockets, there are diminishing returns to installing increasing number of bulbs.

Our team found this trend continued for EWSF in 2017 and 2018. Table 19 shows that homes that received 15 or fewer bulbs through EWSF saved an average of 23 kWh per bulb, while homes that received more than 45 saved an average of 16 kWh per bulb and beyond that 8 kWh per bulb. While this analysis cannot make any statements about causation (i.e., most likely EWSF bulbs were installed in low-use sockets in the home), this finding supports the previous hypothesis of diminishing returns for each incremental bulb.

Table 19. 2017–18 Per-Bulb Savings by Quantity of Bulbs Received

Number of Bulbs	Relevant Participants in Billing Analysis Sample N	Per Bulb Energy Savings (kWh)	Precision (% +/-)
1–15	2,008	23	28%
16–30	1,556	22	12%
31–45	906	15	15%
46–60	587	16	14%
60 or More	503	8	22%
All	**5,537**	**17**	**7%**

Lighting Type-Specific Savings

As noted above, our team attempted, but was unsuccessful, in modeling lighting type-specific savings via billing analysis. As with the weatherization analysis, our team utilized a hybrid billing analysis-engineering algorithm approach to estimate savings for each of the four lighting types delivered through ESWF.

To do so, we calibrated the lighting type-specific savings determined through engineering algorithms (informed by the same HOUs and delta watts assumptions used to develop EWSF's ex ante savings) using both the billing analysis' household-level lighting savings and the observed mix of lighting types installed by the average EWSF participant.

As evident below, the household (1,073 kWh/year) and per-unit (40 kWh/year) lighting savings estimated using engineering algorithms were far greater than the results of our team's billing analysis (467 and 17 kWh, respectively). The disparity is likely due to several factors, including the fact that the billing analysis results are net (while the engineering estimates are gross) and reflect decreased savings due to participants removing lamps (the engineering approach, without the application of a separate in-service rate, does not). It is also possible the that delta watt and/or hour-of-use assumptions used as part of the engineering approach do not represent EWSF.

In general, we found that lamp-type specific savings – except for fixtures – all hovered around the program's overall average of 17 kWh/lamp. This is largely because the per-unit savings determined through the engineering approach were relatively similar for all screw-in lighting types.

Table 20. Lighting Type-Specific Savings(kWh/year)

	LED Bulbs	LED Fixtures	LED Reflectors	LED Specialty/ EISA Exempt	Overall
Avg Bulbs Installed/Home	12	0.3	6	9	27
Algorithmic Savings/Unit (kWh)	41	79*	43	35	40
Algorithmic Savings/Home (kWh)	486	24	248	316	1,073
Algorithmic Savings/Home (%)	45%	2%	23%	29%	100%
Billing Analysis Adjusted Savings/Home (kWh)[#]	211	10	108	138	467
Billing Analysis Adjusted Savings/Unit (kWh)[^]	**18**	**34**	**19**	**15**	**17**

*Savings are per-lamp and EWSF data indicated the average fixture included 1.9 lamps

[#]Calculated by multiplying "Algorithmic Savings/Home (%)" by the billing analysis savings estimate of 467 kWh/home

[^]Calc

Process Evaluation Findings

Our process findings draw upon all evaluation activities and cover the following nine topics:

- About COVID-19
- Overall experience and satisfaction
- Assessment experience
- Reasons for in-home assessment
- Direct install measures
- HEAT loan
- Barriers
- Weatherization experience
- Program Enhancements
- Demographics

Please note that our program improvement recommendations appear in two places within the report. They are embedded in this section, alongside the relevant finding, and are also summarized in the Executive Summary section in the beginning of this report. Also, while Cadeo offers five official recommendations in this report, our team welcomes National Grid to act on or explore further any of the findings presented in this section that could result in EWSF delivery improvements—regardless of whether our team offered an explicit recommendation.

About COVID-19

Our evaluation of EWSF occurred concurrently with the COVID-19 pandemic outbreak in early 2020. As a result of COVID-19, the landscape of National Grid's retrofit programs changed dramatically. At the time of the evaluation, EWSF was not completing in-person home energy assessments and a RISE furloughed a significant portion of the programs' implementation team.

The findings discussed below pertain to program activities occurring before the outbreak of COVID-19. However, with the support of National Grid, the team adapted our evaluation strategy to inform future delivery of the programs after COVID-19 restrictions lessen– particularly assessing the implementation of virtual home assessments that National Grid offered during the pandemic to continue to provide no-cost energy services to customers. Through this process, our team adhered to National COVID-19 communication and policies when conducting the survey and interview outreach. We included National Grid-approved language in all customer and stakeholder outreach and aimed to demonstrate sensitivity to the situation in all our communications.

Overall experience and satisfaction

Participants, assessors, insulation contractors, inspectors, and program managers all agree that EWSF is an excellent program to be a part of. Participants reported having a positive experience in the program with 91% expressing satisfaction with the program overall. When asked if there was anything that the program could have done better or If they had any recommendations for National Grid about the program, many responded that they would not change a thing. This is supported by 97% of survey respondents indicating that they would recommend the program to their family and friends. In addition to these high satisfaction and recommendation rates, nearly two-third of participants (74%) reported that their perception of National Grid was changed by their experience in the program. Of those, virtually all of them (97%) responded that the program changed their perception favorably.

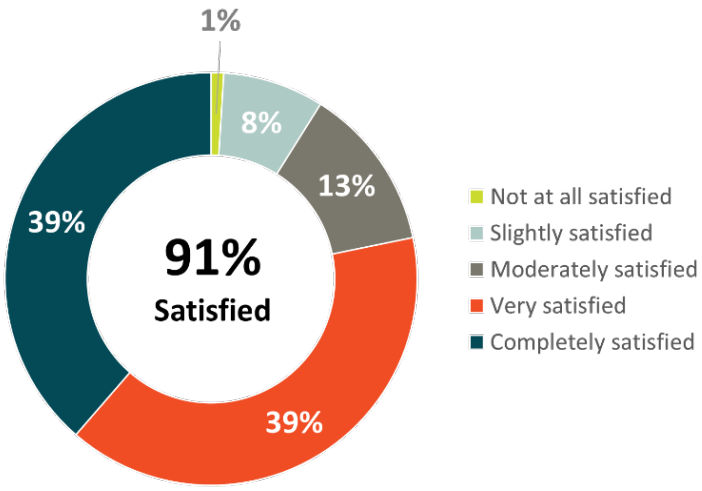
> *"It was a good experience from start to finish."* - EWSF participant

Assessors and contractors credit RISE as one reason for their positive experience helping deliver EWSF. Assessors noted that RISE is responsive to assessor feedback and strives to improve the program for customers and assessors alike. For example, assessors remarked that RISE listens to their feedback and implements changes. Indeed, RISE program managers describe constantly searching for ways to improve the services they offer. RISE program managers shared that they are dedicated to improving energy efficiency and serving customers and clients, and they "feel good doing it." These sentiments extend to non-RISE employees as well. Contractors, several of whom have worked with RISE for a long time, appreciate their working relationship with RISE, particularly the ease of communication, steady work, and pay. From a program delivery standpoint, it was clear to our team that assessors, program managers, and contractors are all invested in the success of the EWSF program.

> *"I feel like we're being heard and we're doing everything we can."* – EWSF Assessor

CMC inspectors also reported that they are satisfied with how the program is working. They noted that there are no glaring issues or specific common occurrences that are found while they conduct their inspections. Their inspections are fairly straightforward, taking between 30 minutes to 2 hours, depending on the size of the home; they ask customers about contractor punctuality, professionalism, cleanliness, and other key characteristics; and they have little interaction with the installation contractors.

Figure 9. Participant overall satisfaction



Assessment

Assessment experience and satisfaction

When asked about their in-home energy assessment, 94% of EWSF participants reported that they were satisfied with the assessment process. From assessors' perspective, assessors attribute positive assessment experiences to building a rapport with participants. Assessors frequently cited helping participants learn about the building science of their home as personally rewarding. They also viewed their relationship with the participant and helping them save money and improve their home as fundamental to the success of EWSF. According to participants, the feeling is mutual: 97% said that their assessor was pleasant to work with.

> *"You can really build good relationships with these people where they trust you, and they respect your opinion. And it's, I think a really positive experience."* – EWSF Assessor

One of the ways the assessors build rapport is by being a resource for customers during the assessment, often pointing them to the National Grid website when customers' questions are not related to program offerings. The assessors interviewed were clear that they did not offer advice on issues not related to the program, but instead tried to guide customers to information that was available online via National Grid, the Department of Energy, or other sources.

EWSF assessors almost unanimously said they have enough time in participants' homes. Most home assessments are completed in the 2 ½ hours allotted. Assessors and RISE program managers credit the speed and efficiency of the assessments to the 2-person (assessor and technician) assessment model in RI. Having the technician present during assessment visits allowed assessors to spend more time with customers, answering questions and walking through their action report. Several assessors described assessments as a team effort. Especially for houses with a complex layout (e.g., Victorian), assessors mentioned "tag-teaming" with their technician to complete tests and direct installations to ensure that

assessments are completed on time. Though not unanimous, a handful of assessors mentioned they would benefit from more time after the assessment when completing paperwork and following-up with customers. Assessors mentioned that this feedback has been raised to RISE managers and they are seeing changes in available office time to follow-up.

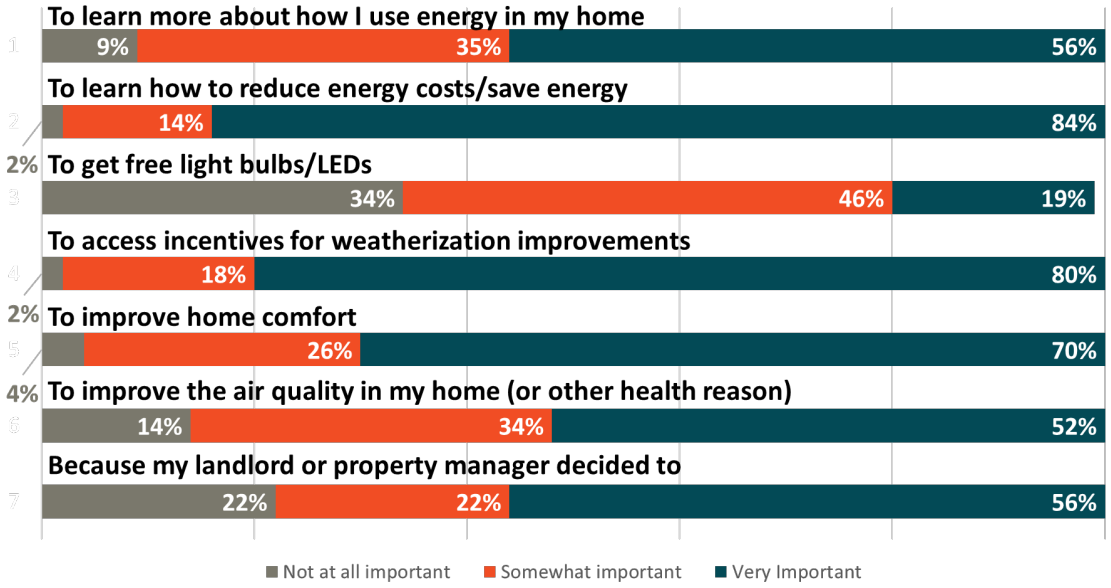
Assessors leverage their relationship with customers and building science education when encouraging participants to move forward with major measures. Assessors encouraged customers to move forward with major measures by: (1) taking extra care to educate customers about their house and use simple analogies, (2) drawing diagrams to communicate issues, (3) talking through bill and savings estimates, and (4) leaving detailed notes in the action plan. Several assessors reported that the action plan report is a useful tool for convincing customers to move forward. Indeed, educating customers about their home was most frequently described as the main sales angle for major measures.

> *"Just showing people what it is, why it matters and how to treat it and just making sure it's in plain English. If you can do analogies, that's usually the best way, you know, 'this is kinda like your house is wearing a tee shirt. It should be wearing a jacket.'"*
> – EWSF Assessor

Reasons for in-home assessment

Learning how to reduce their home energy consumption and ability to access weatherization incentives were reported as being the most important reasons to get an assessment. Specifically, 84% cited learning how to reduce their energy consumption and 80% of survey participants viewed accessing weatherization incentives as very important to them. While "free lightbulbs" have motivated a relatively smaller subset of customers to sign up for an assessment (19%), some assessors expressed concern about the program's likely transition away from lighting in future program cycles. One assessor's comment summarized this sentiment well, saying, "when the lighting goes away, I feel like we've lost our foot in the door."

Figure 10. Reasons for getting home energy assessment

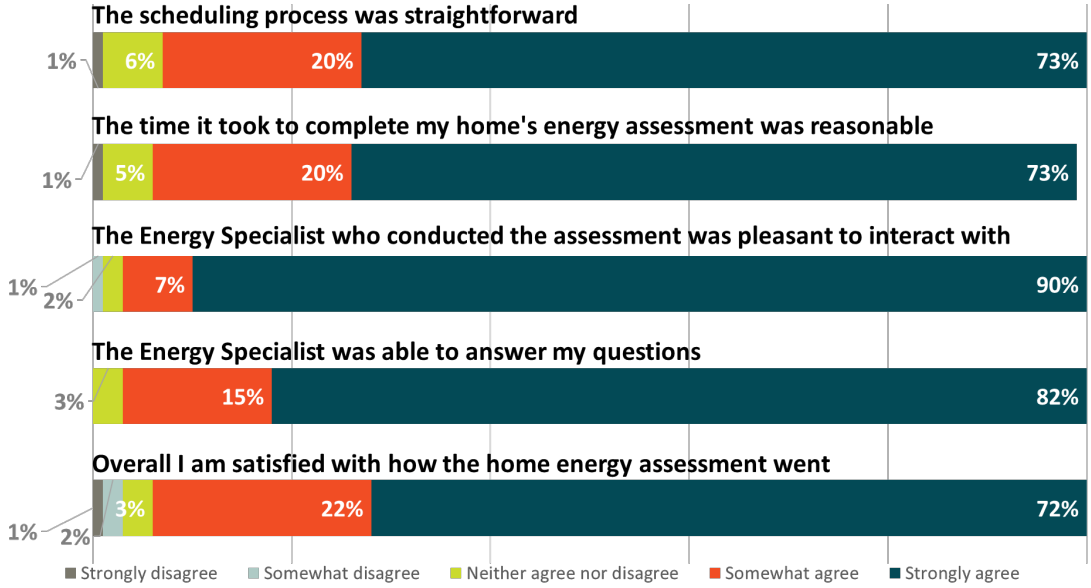


Note: Items may not sum to 100, "Not Applicable" was removed from analysis.

Home assessors noted they see more customers signing up expressly for weatherization or to access the HEAT loan for heating system upgrades. Assessors estimate that roughly 50% of customers come into the assessment knowing that they want insulation or heating system upgrades. This observation is consistent with the survey results shown above, as well as the program's long-term marketing efforts, which prioritize on the value of weatherization and opportunity to use the HEAT loan.

One interesting finding emerged from assessors was related to how participants learned about the EWSF program. Assessors mentioned that customers heard about the program through their realtor or home inspector when recently buying their home. Cultivating a relationship with local realty groups to reach customers who have recently purchased their home could be an avenue for program marketing, especially when employing messaging encouraging new homeowners act quickly to schedule their assessment.

Figure 11. Participant home energy assessment experience



Note: Items may not sum to 100, "Not Applicable" was removed from analysis

Direct install measures

Participants rated direct install measures highly, though thermostats and power strips may have some downsides. Participants were generally satisfied (91-95%) with the instant savings measures installed during the assessment; however, they seem to be less content with the thermostats and smart power strips. Assessors claim that thermostats are generally favored by customers, but the installation of the Wi-Fi thermostats can be tricky to install and difficult to use. Similarly, assessors note that while customers show an interest in power strips, they often have difficulty understanding how to use them. One assessor mentioned that when following up with customers, he has seen them "tossed in a box in the basement". In-service rates determined through the participant survey support assessor's statements. We found that 84% of smart power strips were installed at the time of the survey, a much lower rate than any of the other direct install measures, which ranged between 96% and 98%. When asked why they removed their smart power strips, surveyed participants offered: "I couldn't figure out how to work it properly," and that the strips were, "bulky, [with] not enough 'active' ports."

Recommendation 1:
Leverage word-of-mouth program awareness through realtors or home inspectors.

Many assessors noted that participants who recently purchased their home frequently heard about the program through their realtor or home inspector. National Grid should cultivate relationships and provide EWSF marketing materials to local realtors and inspectors to increase new home buyer participation and encourage customers to act early in their time in the home to maximize the return on their efficiency improvements.

HEAT loan

According to surveyed participants who received the HEAT loan (n=27), the majority (n=20) were satisfied with the loan process. Participants responded that the loan was mostly used for weatherization work (31%) or upgrading heating systems (26%).

Assessors reported that customers in many cases do not want to use financing or the project is not worth the return on investment. A few assessors mentioned that in most cases, the loan does not need to be used to complete weatherization work because the incentives are so good. One assessor described that the HEAT loan is a great option for low- or moderate-income participants, saying it provides the extra bandwidth to cover weatherization cost after the incentive. In other words, participants often do not need financing, or the job is so expensive that they do not want to take on the debt. Indeed, for survey respondents who received info on financing but did not use the loan (n=80), nearly 60% said they did not need financing. When examined by participant type, assessment-only participants seemed to respond that they did not get financing because they did not think they would qualify (n=15), whereas almost no one with at least one major measure participants shared this concern (n=2).

Whether or not participants use financing, several assessors suggest that it is a good foot-in-the-door tactic for the program, since an in-home assessment is required to apply for the loan. In addition, one assessor explained that in most cases the HEAT loan meets customers' needs unless the participant wants to use the loan to complete several upgrades at the same time (e.g., weatherization, health and safety barrier remediation, and a heating system upgrade). Several assessors reported that the one aspect of the HEAT loan offer that consistently prevents customers from taking action is the fact it does not cover upgrades for delivered fuel customers. Assessors observed that customers who heat with oil or propane do not have a lot of options if they want to upgrade their heating system. They recalled that customers appreciated the incentives for mini-splits that were offered in the past and would like to see something similar for delivered fuel customers in the future.

Barriers

Energy Specialists often identify issues during in-home assessments that prevent participants from moving forward with weatherization or heating system upgrades. Participants must address all barriers identified before any work can be started on their home. The evaluation team analyzed program data related to barriers identified during in-home assessments. There are essentially two types of barriers: (1) pre-weatherization barriers, and (2) health and safety barriers. Table 21 illustrates the categorization of barriers into the pre-weatherization and health and safety barrier types. Pre-weatherization barriers tend to be issues such as clutter or storage in attic or basement spaces that participants can easily overcome to move forward with upgrades. Health and safety barriers include issues such as asbestos, mold issues, or knob and tube wiring that are more difficult to overcome to make additional upgrades.

Table 21. Barrier Categories

Barrier Type	Barrier Category	Brief Description
Health & Safety	Access	Health and safety barrier preventing work
	Air Quality / Carbon Monoxide	Carbon monoxide associated with oven, water heater, heating system; issue with indoor air quality
	Asbestos	Asbestos and vermiculite issues
	Knob & tube/Electrical	Knob and tube or other electrical issue
	Moisture	Moisture, mold or mildew issue
	Other	Issues related to combustion gas spillage, duct leakage, gas leak, lead pain, open framing, pest infestation
Pre-Weatherization Barriers	Ceiling type	Dropped Ceiling tiles, homasote ceilings (sound insulation material that can produce harmful cellulose dust)
	Contractor Contingency	Contractor contingency issues
	Inaccessible	Issues with crawlspace height; inaccessible attic, kneewall, crawlspace
	Other	Pre-weatherization barrier preventing work, balloon framing, plaster ceilings, weak attic framing
	Parking Limitations	Issues related to parking
	Storage	Storage issues in attic, basement, closet, crawlspace, garage or kneewalls

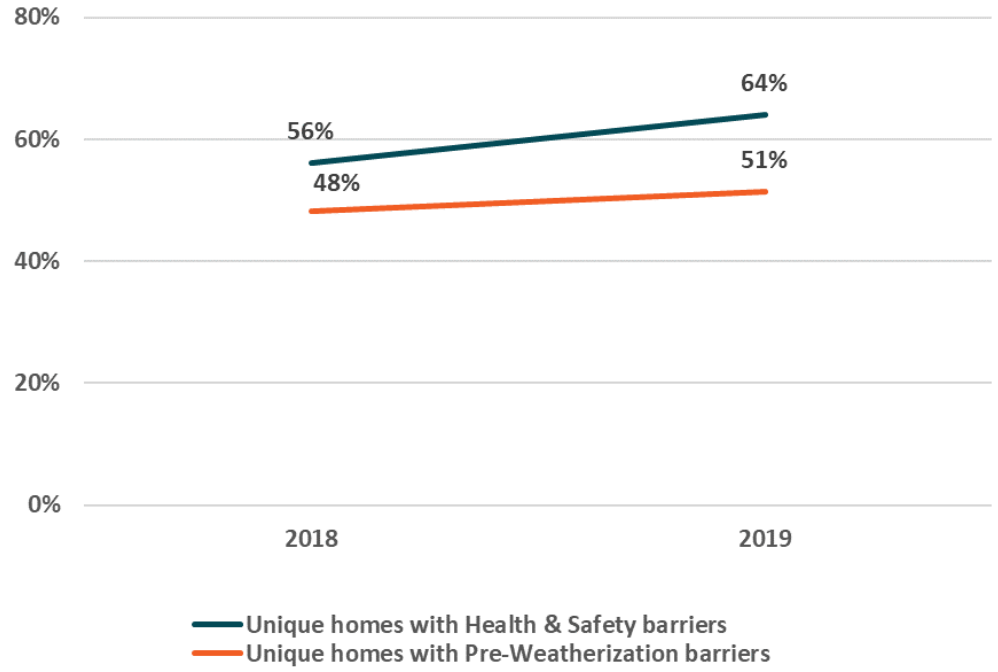
Health and safety barriers remain common and problematic. According to program data, health and safety barriers were identified in 64% of participant homes in 2019. Of those, only 21% went on to weatherize their homes, a lower rate than the overall weatherization rate for 2019 (25%).[40] However, the program data shows that 57% of participants who installed weatherization in their homes in 2019 overcame at least one health and safety barrier clearly indicating that mitigation is possible.

Further, the number of barriers identified seem to increase from 2018 to 2019[41] shows the number of homes with health and safety and pre-weatherization barriers identified between 2018 and 2019. The prevalence of Health and safety barriers seemingly raised from 56% of homes assessed in 2018 to 64% in 2019. Among the barriers identified– including pre-weatherization barriers– health and safety barriers represented 48%, and 51% of all barriers in the years 2018 and 2019, respectively. With only two years of robust data tracking of barriers, the evaluation team advises interpreting this tentative trend with caution. However, as the program continues to mature, National Grid should monitor potential trends to assess opportunities to serve the remaining stock of homes that may be more likely to have challenges such as health and safety issues.

[40] As noted earlier in the report, recent program years tend to understate conversion rates. As shown in Table 3, the overall EWSF conversion rate is 37-38% several years after customers have their assessment.

[41] RISE began robustly tracking barriers in program data after 2017.

Figure 12. Percent of Barriers Identified in Homes Between 2018 and 2019



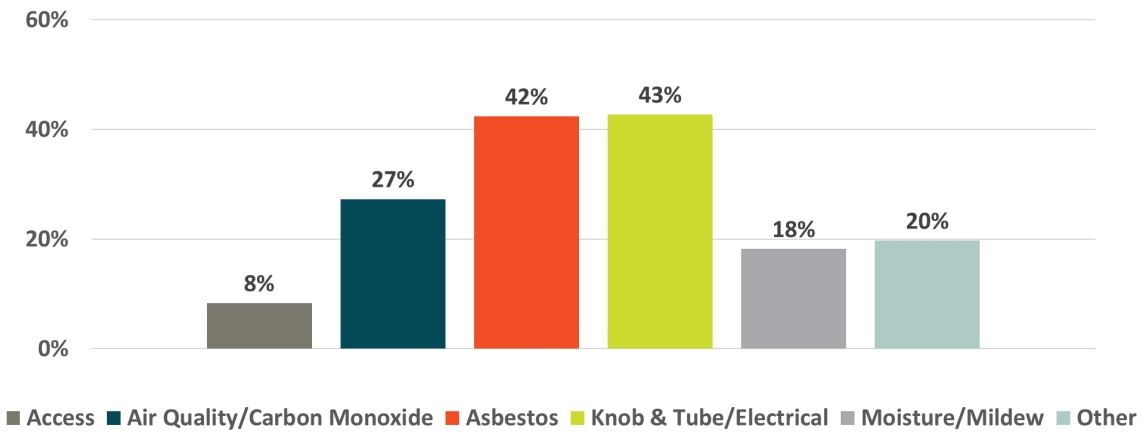
Note: Items may not sum to 100. Homes may have both Pre-weatherization and Health and Safety barriers present.

Participants and assessors report that knob and tube is one of the hardest barriers to overcome due to cost and lack of support for customers to address the issue. Figure 13 show the percentage of homes with each type of health and safety barrier. According to program data, homes commonly had knob and tube and other electrical barriers (43% of homes) followed by asbestos (42% of homes).[42]

Assessors described live knob and tube as "a job killer". Even when it's likely the identified knob and tube wiring is inactive, assessors find that customers have a hard time remediating knob and tube barriers. Assessors lamented not being allowed to recommend specific electricians. They cited leaving participants to find their own as point of attrition. Many assessors understand that National Grid may need to remain unbiased and providing a list can be a liability concern. However, some sort of additional resources including informational materials, pointing customers towards websites with contractors lists (e.g., Angie's List) or increasing the $250 incentive for certifying inactive knob and tube would go a long way for helping customers take advantage of the program and fill a gap in the whole-home approach to providing home assessments.

[42] Program data did not differentiate between active or inactive knob and tube issues.

Figure 13. Percentage of homes with each type of health and safety barrier overall (2018-19)



Note: Items may not sum to 100. Homes may have multiple barriers present

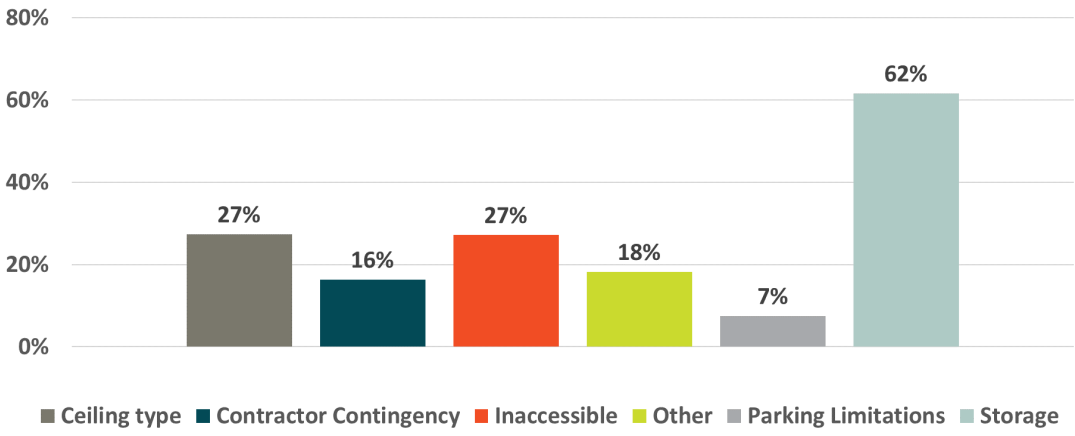
About half of homes have pre-weatherization barriers. Figure 14 shows the percentage of homes with different pre-weatherization barriers identified in 2018 to 2019. About 62% of homes have storage issues identified in which attic, basement, or kneewall spaces are cluttered with storage items and assessors cannot adequately conduct the assessment or complete testing. Of the homes with pre-weatherization barriers identified, 26% completed weatherization which is similar to the overall weatherization rate for 2019. Though pre-weatherization barriers are less difficult to address than health and safety issues in most cases, they do not necessarily mean an increase in weatherization rate.

Missed health and safety issues are also problematic. Several contractors noted that assessors tend to miss health and safety barriers during assessments. Contractors estimated that between 15% to 30% of jobs have a health and safety issue that was missed during the assessment and the job must stop until those issues are taken care of. This often means that the contractor loses the job. Several contractors also noted that many of the issues cannot be identified until walls are cut into, which is not something assessors do during the assessment. While contractors see the challenge of assessing health and safety issues during the assessment, it is often a frustrating experience for contractors once they get on-site to start a weatherization project.

Recommendation 2:
Increase facilitation of health and safety barrier remediation.

Assessors and participants described the difficulty of remediating health and safety issues and expressed a desire for more support from the program. Specifically, National Grid should work with RISE to (1) Create a list of approved electricians and/or increase RISE's ability to handle some barriers, (2) Providing informational materials explaining issues and step by step process to address issue, or (3) Raise $250 incentive for certifying knob and tube deactivation to encourage more contractors to undertake these critical inspections.

Figure 14. Percentage of homes with each type of pre-weatherization barrier overall (2018-19)



Note: Items may not sum to 100. Homes may have multiple barriers present

CMC inspectors also discussed the issue of health and safety issues. Specifically, CMC inspectors noted that they try to pay particular attention to any possible health and safety issues that may have been overlooked during the course of the assessment and installation work, and that have the potential to cause injury or illness to home occupants (i.e., poor ventilation). CMC inspectors submit their inspection report with any identified issues. However, they are not involved in the process after their report is submitted. As such, they report that they do not have insight into how problems are resolved.

Weatherization

The majority of contractors said that all their work comes from RISE. Contractors were very happy with how quickly and efficiently they are paid for completed work and mention that they are paid well for the work. Contractors are typically paid in full by RISE within 30 days of completing their projects, some contractors reported as little as 10 days. RISE program managers also felt that this is an efficient system – RISE receives invoice from contractors and then pays them in full. In fact, program managers commented that one of their goals is to make the payment process even quicker and reduce the billing time in the future. This evidence suggests that the contractors and lead vendor employees are invested in the program and value doing a good job.

One area that that has room for improvement according to contractors is the pricing of weatherization materials. A few contractors noted that it would be helpful for National Grid to evaluate the pricing of weatherization materials more than once a year since manufacturers tend to increase their material pricing several times a year.

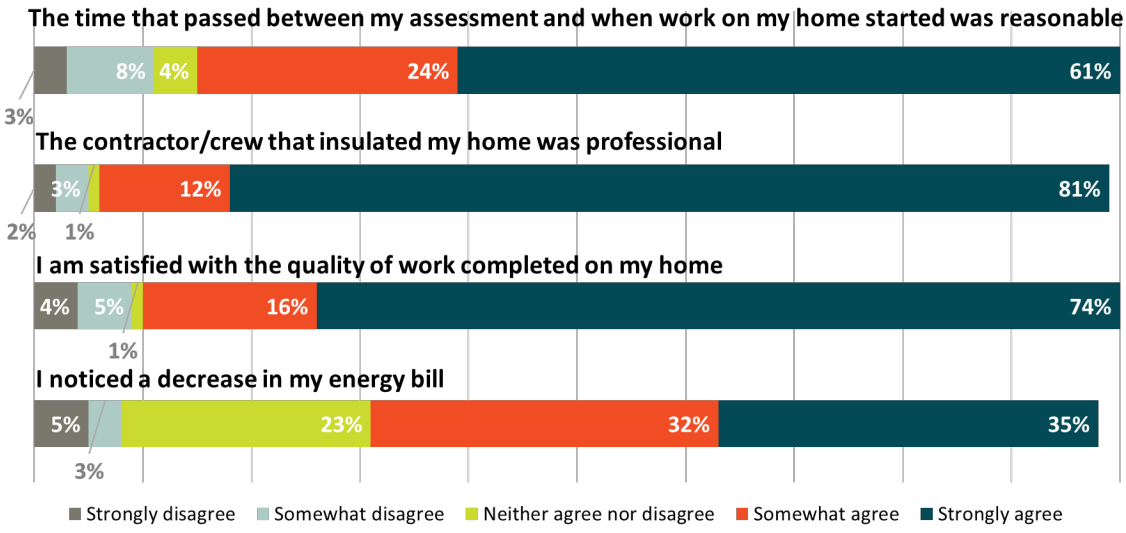
During weatherization jobs, RISE inspector and contractor relations seem to be going well. Internal RISE inspectors and contractors alike support making sure the job gets done well and that customers are

happy. Some contractors reported that they take pride in their work and they enjoy the second check that the inspectors provide on the homes Program managers claim that having a RISE inspector checking in on the weatherization work helps to keep the insulation process moving smoothly and gives the contractors a point of contact during the job. The process is more efficient with the introduction of electronic paperwork in recent years. RISE inspectors appreciate that paperwork can be completed electronically. RISE as well as CMC inspectors noted that digitizing the data collection for inspection reports has made it easier and more efficient, as well as transparent with participants.

Participants are generally satisfied with weatherization work and indicated that the contractor that worked on their home was professional. Many contractors reported in interviews that they make sure the customer understands what they are doing and why, and that they also follow up with customers before they leave their home. About 5%-11% of participants did not feel that their weatherization experience was satisfactory (see Figure 15). The areas where participants disagree include (1) energy savings after insulation ("my energy costs have not gone down"), (2) work quality ("insulation is a mess" or "some of my property was damaged"), and (3) timing for insulation work. One participant said that, "it was [a] 4-month wait for the insulation to installed in my home. I didn't think it would take that long."

From third-party inspectors' perspective, the program is working well. CMC inspectors are still finding errors or missed opportunities during inspections; however, inspectors reported that the prevalence of finding errors is low. When issues are identified during an inspection, they are typically minor errors and rarely significant or "glaring" errors according to CMC inspectors.

Figure 15. Participant weatherization experience



Note: Items may not sum to 100, "Not Applicable" was removed from analysis

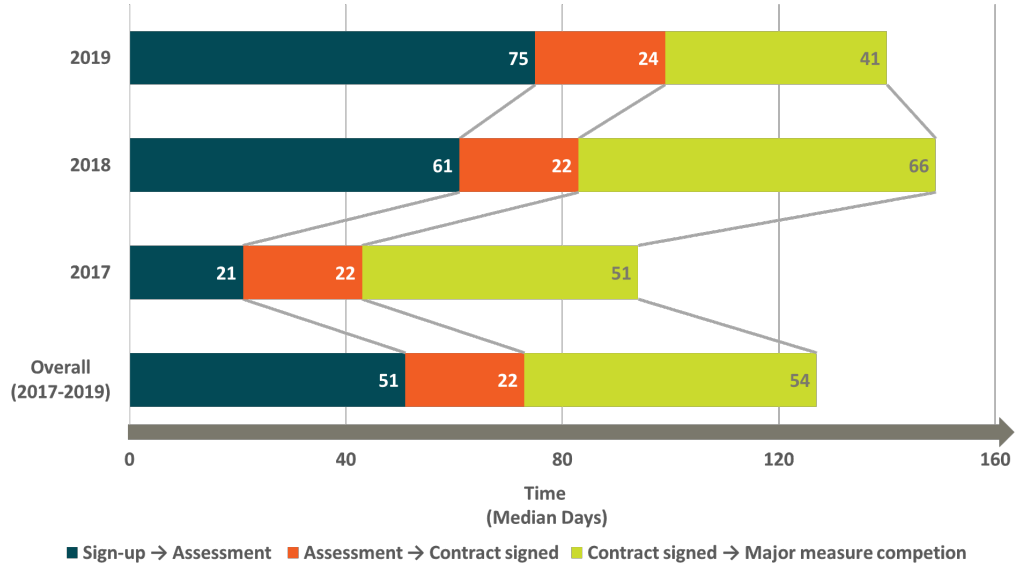
Cycle Time Analysis

The evaluation team used program data to examine the time it took for participants to make it through the EWSF program as well as to assess trends in program timing over the past three program years (2017-2019). Specifically, we looked at the median time between each major program milestone, the median

time to get through all the milestones, and how this timing varied from year to year. We used the following milestones in this analysis: program sign-up date, assessment date, contract sign date, major measure completion date.[43]

Our team's cycle time analysis revealed that in 2019, it took about 5 ½ months for a participant to get through the program (i.e., from sign-up to major measure installation completion). While signing weatherization contracts and coordinating scheduling insulation contractors is somewhat out of National Grid's hands, time between sign-up and assessment has historically been an area in which there is room for improvement. This past program year had the longest wait time between sign up and assessment date; participants waited 2 ½ months (Median = 75 days) to get their assessment in 2019. After the assessment, participants typically waited almost 3 months for their major measure installation. When considering other program years, the overall timing in 2019 is about the same or slightly shorter than 2018 in which close to 6 months passed from scheduling assessment to completion of major measure installation with the longest wait times occurring between assessment and major measure completion. In other words, while the wait time for assessments was the longest in 2019 than is has been in recent years, completing the weatherization project was more time efficient.

Figure 16. Median Days Between Program Milestones



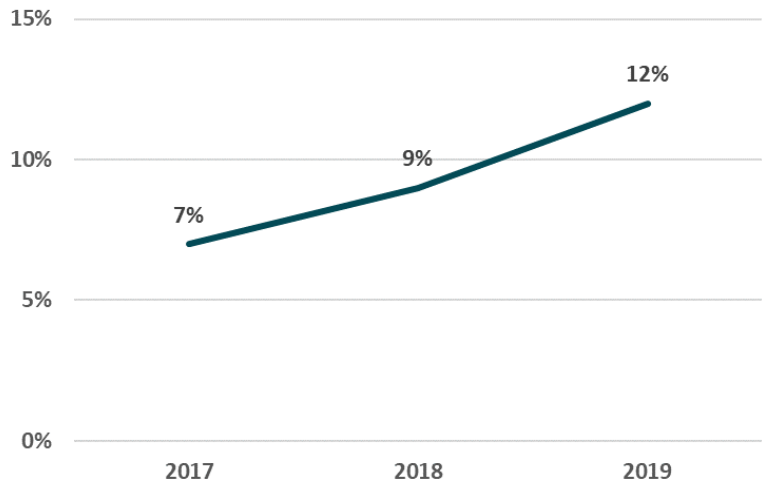
Program Enhancements

The program made several key enhancements in 2019, including a 100% landlord incentive for weatherization work, online assessments designed to provide additional information to energy auditors prior to in-home assessments, and home energy score asset ratings (officially beginning in 2018). Further, at the time of the evaluation, the program was also conducting virtual home assessments to customers in

[43] Our team used the date in which customer invoices were processed for the completion of a weatherization project to indicate major measure installation completion. Therefore, this date is not the exact date in which weatherization work started or completed at the home, rather it is the date in which the project was marked complete in the vendor tracking system.

order to continue offering EWSF services in early 2020 during the COVID-19 outbreak. The evaluation team asked about the virtual assessment process as the adapted service was rolled out in 2020.

Figure 17. Percentage of Rental Properties from 2017 to 2019



Landlord incentive

Assessors and program managers alike reported that the increased landlord incentive (100% of costs up to $4,000) has unlocked previously hard-to-reach savings in rentals, many of which are part of also hard-to-reach multi-unit buildings. Indeed, Figure 17 shows signs of an upward trend in renters participating in the EWSF program from 2017 to 2019, based on program data. Several assessors mentioned that the paperwork process that requires the assessor to coordinate between tenants and landlord can be difficult at times, especially if the tenants are not engaged or the landlord is not available or lives out-of-state. While the paperwork and coordination can be problematic, it is typically manageable. One assessor mentioned that sometimes the 100% incentive is misleading and causes confusion with landlords, (e.g., there is a knob and tube issue and need to get the extra work done before the free upgrades), so they have to be careful not to promise anything before seeing the building.

Online assessments

A relatively small number of surveyed participants (8%, n=23) took an online assessment before their in-home assessment. While the small sample prevents our team from drawing any definitive conclusions about the effectiveness of online assessments, these participants generally agreed that the online assessment process was easy, helped them identify energy saving opportunities, and encouraged them to move forward with onsite assessment. Again, while sample sizes are small, it is worth noting that surveyed online assessment participants had a generally similar major measure installation rate (26%, 6 out of 23) as the overall program (25%).

Home Energy Scores

In 2018, National Grid launched a home energy score (HES) pilot. As part of the pilot, two assessors gathered additional information during a subset of their assessments and provided those participants,

along with the standard assessment report, an energy score for their home based on a Department of Energy's energy efficiency rubric. According to interviewed program stakeholders, the purpose of the HES pilot was to (1) identify if HES improved conversion rates, and (2) assess the how HES could be integrated within home energy assessment processes. The pilot also aimed to give participants a meaningful way to compare their energy usage before and after completing weatherization projects.

In 2018 and 2019, the program provided 152 EWSF participants with home energy scores in 2018 and 2019 combined. All but six of the scores were calculated by two EnergyWise assessors provided special training for the pilot[44]. Our team interviewed a pilot administrator and one of the two assessors as part of our process evaluation; the other assessor was furloughed and unavailable.

The assessor that our team was able to interview described how they need to collect additional information—beyond that normally collected as part of an EWSF in-home assessment—to calculate a home energy score. Following the home assessment, the assessor shared that they would enter the additional information to a separate home energy score calculator and then send score to the participant via email, separate from the standard EnergyWise home assessment action report. According to the interviewed HES assessor, gathering additional information onsite and calculating the scores offsite added, on average, between 30-60 minutes to the standard EnergyWise in-home assessment.

Table 22 compares the "conversion rate" (i.e., the percentage of assessed participants who act on an identified major measure following their assessment) for participants who did and did not receive a home energy score. Specifically, the table compares the conversion rate for subset of 146 EWSF participants who received a score to the conversion rate for all other participants who received their assessment from the same two assessors but were not part of the pilot (i.e., did not receive a score).

As evident in the table, participants who received the score from the two assessors had a higher conversion rate (41%) than participants who did not (28%). While the difference is notable and appears to indicate the score was indeed effective at motivating participants to act, the relatively small sample of pilot participants prevent us from drawing definitive conclusions regarding the impact of the home energy score on participants' decisions to install a major measure. Regardless, the early returns on the pilot are promising.

Table 22. HES Conversion Rate Comparison (2018-2019)

	Received an HES		Did Not Receive an HES	
Participant Type	**N**	**%**	**N**	**%**
Assessment Only	86	59%	1,666	72%
Major Measure	60	41%	634	28%
Total	**146**	**100%**	**2,300**	**100%**

Our team also compared the incidence of health and safety and pre-weatherization barriers for these same homes since a significant difference in the presence of barriers could impact the validity of the comparison in Table 22. We found the incidence of health & safety barriers (59%) were exactly the same

[44] The program added another two assessors late in the pilot.

for 146 participants that received a score and the 2,300 participants that received their assessment from the same two assessors. We did find that the rate of pre-weatherization barriers was somewhat higher (66% versus 52%) for participant that got an HES. As noted above, the small sample of HES homes makes it difficult to draw definitive comparisons between these groups. However, our analysis of barriers does suggest that the higher conversion rate observed for HES participants is not a function of that subset of participant have fewer barriers to action.

According to the assessor interviewed, about two thirds of customers who received scores in the pilot seemed to appreciate getting the scores. Specifically, they appreciated learning how the efficiency of their house rated using a simple scoring rubric, as well as how their rating may change with the upgrades available through EWSF. The assessor noted that about one third of participants were dissatisfied with the scoring process, particularly, due to the conflicting results of the EWSF home assessment and their home energy score. For example, the assessor sometimes found that a home is using energy efficiently and requiring no major upgrades sometimes still scored low on the HES scale. The assessor attributed the low score to the HES scoring methodology's emphasis on heating system upgrades and home square footage rather than insulation or windows. The assessors reported that the assessment aligned best with the HES when homes were about 1,500 square feet or smaller. This incongruence led to some customers being confused by their HES, according to the interviewed assessor.

To complement the quantitative findings in the table above, our team asked the assessors whether they felt the score motivated participants to act on identified EWSF upgrades. The assessor indicated they were unsure whether the scores led customers to install weatherization or heating system upgrades through EWSF but said they did notice that several customers elected to report the HES when listing their home for sale.

This observation is consistent with the Department of Energy's intention for developing the score, which was to enable home buyers, owners, or renters to directly compare home energy use between properties on the housing market[45]. Indeed, a recent study showed that home energy scores influence home buyer decisions to purchase a home and may encourage buyers to pay more for energy efficient homes (particularly for wealthy and educated buyers)[46]. In this sense, providing home energy scores at no additional cost to participants may be of particular interest to customers who are planning on selling their home in the next few years and encourage participation in EWSF. Further, if National Grid develops marketing relationships with local realty groups to encourage participation in the EWSF (as recommended earlier in this report), expanding the HES pilot throughout the program may be one significant way to strengthen such relationships and provide a steady stream of new participants.

According to HES pilot stakeholders, the pilot helped National Grid and RISE learn how HES could be incorporated into the typical home assessment process. If the HES enhancement is expanded, the enhancement will require, "a sustained marketing effort to educate the consumer," according to the administrator interviewed. Another area for improvement could be to fold HES tracking and calculation into RISE's data system. The assessor and administrator we interviewed reported that it was a challenge to collect information in separate systems: one for the home energy score and one of the home assessment

[45] https://betterbuildingssolutioncenter.energy.gov/home-energy-score
[46] https://www.aceee.org/research-report/b2002

and related action report. By integrating HES score specification into the current assessment tracking system, the assessor estimated that the additional time added to the assessments to calculate scores would be greatly reduced and closer to the average assessment timing of about 2.5 hours in total. Program managers described that integrating HES inputs into RISE's current assessment data system is a priority for 2020.

Virtual Assessments

Assessors were surprised how well virtual assessments have worked and see a long-term role for them. Assessors report that customers really like the virtual audits. They are more convenient for customers time (45 minutes instead of 2.5 hours) and schedule and are less intensive. With the current incentives (100% or up to $15,000), almost all customers sign a proposal for insulation work during virtual assessments. However, assessors mentioned that they cannot be confident until in-home testing resumes and contractors successfully execute on virtual SOWs. CMC and RISE inspectors echo this feedback, describing that they are skeptical of virtual inspections and whether errors may be assessed accurately.

In addition, assessors reported that the virtual assessments did not work well when customers were distracted or not engaged. One assessor mentioned that it can be difficult when participants do not provide the materials necessary for the assessment to take place, including taking pictures of their home and submitting their LED bulb order. Assessors reported that virtual assessments work better with certain types of houses (e.g., ranch) where construction is simpler and more consistent and the assessors have a fair idea of what the house likely needs. Conversely, they shared that the virtual audits are less successful with houses with a "lot of nooks and crannies" (e.g., Victorian). Therefore, straightforward home types seem apt for virtual home energy assessments.

While we did not survey participants that received a virtual assessment, participants who received in-person assessments in 2019 had mixed opinions about virtual assessments. About 66% of surveyed participants agreed that virtual assessments would be safer if National Grid implemented them in the future; however, only 31% agreed that a virtual assessment was an attractive option to them in general. It is worth emphasizing that readers should interpret this finding with caution given that surveyed participants who already participated in the in-person assessment were asked to speculate about virtual assessments and is not based on personal experience.

Recommendation 3:
Identify the optimal long-term role for virtual assessments.

Though there is some uncertainty, stakeholders assert that there is a place for virtual assessments long-term. Virtual assessments may be more successful depending on the type or layout of home and participant engagement. National Grid should identify the optimal role for virtual assessments long-term by experimenting with deploying virtual assessments participant segments including participants with straightforward home types or by participant interest or need (scheduling need, safety need etc.). Offering a mix of in-home and virtual assessments may yield similar savings with lower program delivery costs. Future evaluations could embed more research specifically related to virtual assessments and virtual program components overall. Evaluation research focused on virtual assessments could help inform program design and delivery issues, as well as how virtual processes implemented for assessments could be leveraged for other program components. This type of assessment has implications for both process and impact evaluation components, given issues related to direct versus self-install of energy efficient measures.

National Grid would benefit from directly examining customer perspectives about virtual assessments in future evaluation work.

Demographics

Our team gathered demographic information from participants who responded to the survey, including information about their income level (to understand moderate income participation) and educational attainment.

Income

The number of people living in a home (i.e., household size) affects the definition of moderate income.[47] For example, as show in Table 23, a two-person household is considered to be moderate income if the household's combined annual income is between $39,750 and $53,000, whereas a four-person household is considered moderate income between $49,700 and $66,250.

The table also shows the income thresholds associated with "low Income" (less than 60% of State Median Income or SMI), "market rate" (81-120% of SMI), and "affluent" (more than 120% of SMI) Rhode Island residential customers, which also varies by household size.

Table 23. Income Definition by Household Size (2019)

Income Definition	SMI Range	One	Two	Three	Four	Five	Six or More
Low Income	<60%	$34,800	$39,750	$44,750	$49,700	$53,700	$57,650
Moderate Income	60-80%	$34,800-$46,350	$39,750-$53,000	$44,750-$59,600	$49,700-$66,250	$53,700-$71,550	$57,650-$76,850
Market Rate Income	80-120%	$46,350-$69,550	$53,000-$79,500	$59,600-$89,400	$66,250-$99,350	$71,550-$107,300	$76,850-$115,250
Affluent Income	>120%	$69,550	$79,500	$89,400	$99,350	$107,300	$115,250

To determine the relevant moderate income thresholds for each respondent, Cadeo first asked respondents how many people lived in their home. This enabled survey programming that customized the income ranges presented to each respondent. For example, we asked a participant indicating that four people lived in their home which of the following four tailored income ranges best reflected their annual household income in 2019:[48]

[47] https://www.rihousing.com/wp-content/uploads/2019-Rhode-Island-Income-Limits-for-Low-to-Moderate-income-Households-.pdf

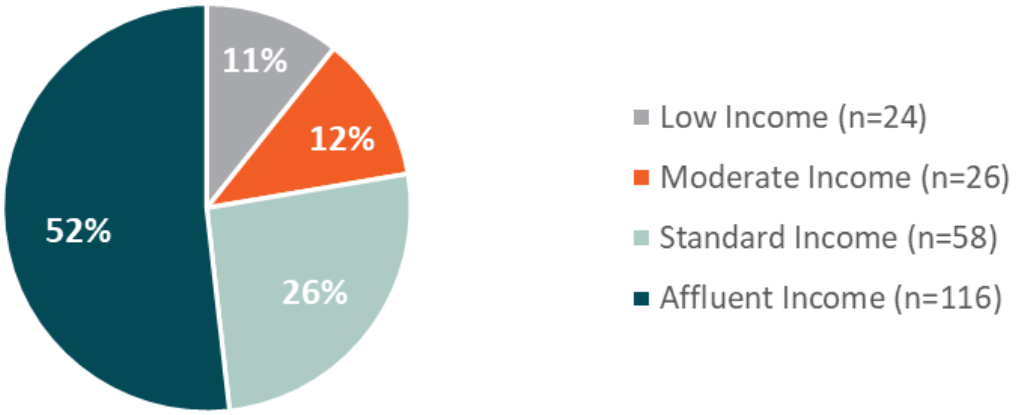
[48] Cadeo chose 2019 because it was the most recently completed tax year and thus the year for which respondents were most likely to have accurate estimates.

1. **Less than $49,700**
2. **Between $49,700 and $66,250**
3. **Between $66,250 and $99,350**
4. **More than $99,350**

This approach allowed Cadeo to assign each respondent to low income, moderate income, market rate, or affluent income categories.

As seen in Figure 18, 23% of responding EWSF participants self-reported an income associated with low- or moderate-income status (11% and 12%, respectively) given their household size. An additional 26 percent reported a market rate income (81-120% SMI) while 52% reported an affluent income (>120%).[49]

Figure 18. EWSF Income Distribution (2019)



Eleven percent of EWSF participants self-reported an income that would classify their household as low income based on the programmatic definitions above. Based on this information, these customers (had they passed the official income screening process) would have been eligible for National Grid's separate low income single family program, which offers many of the same energy efficiency upgrades as EWSF at no cost to the customer. There are several possible explanations for the fact these customers participated in EWSF and not the low-income program:

1. **Their income changed.** It is possible a participant's income changed between the time they participated (sometime in 2019) and the time of the survey (July 2020, likely after officially filing their taxes for 2019). This is particularly true for this survey given the economic impacts of COVID-19 on employment. While we specifically asked participating respondents about their 2019 household income, which predates the COVID-19 pandemic, participant may have taken more recent employment changes into account when providing their response.
2. **Their self-reported income is inaccurate.** Also, more generally, not all customers know their household income. It is likely that some respondents underestimated their income level, whereas

[49] About 60 respondents indicated that they prefer not to answer income questions

others overestimated theirs. Without a formal income verification process, it is not possible to definitively know how accurately EWSF participants self-reported their income.

3. **They were unaware of National Grid's low income program.** It is also possible that these customers would have qualified for National Grid's low income program but were unaware of National Grid's low income offer and, therefore, did not apply and complete the income screening process, or might have been unwilling to complete the process.

Given the fluidity between income classifications, particularly between low and moderate income, Cadeo recommends viewing the low- and moderate-income classifications in aggregate and thinking of the aggregated classification as **limited income participants**. Regardless of the uncertainty inherent in relying on self-reported income, the survey results indicate that approximately a quarter of National Grid customers participating in EWSF have limited incomes.

The team also analyzed the income distribution by participant type (i.e., major measure and assessment-only participants). As shown below, the income distributions are relatively similar for each participant type.

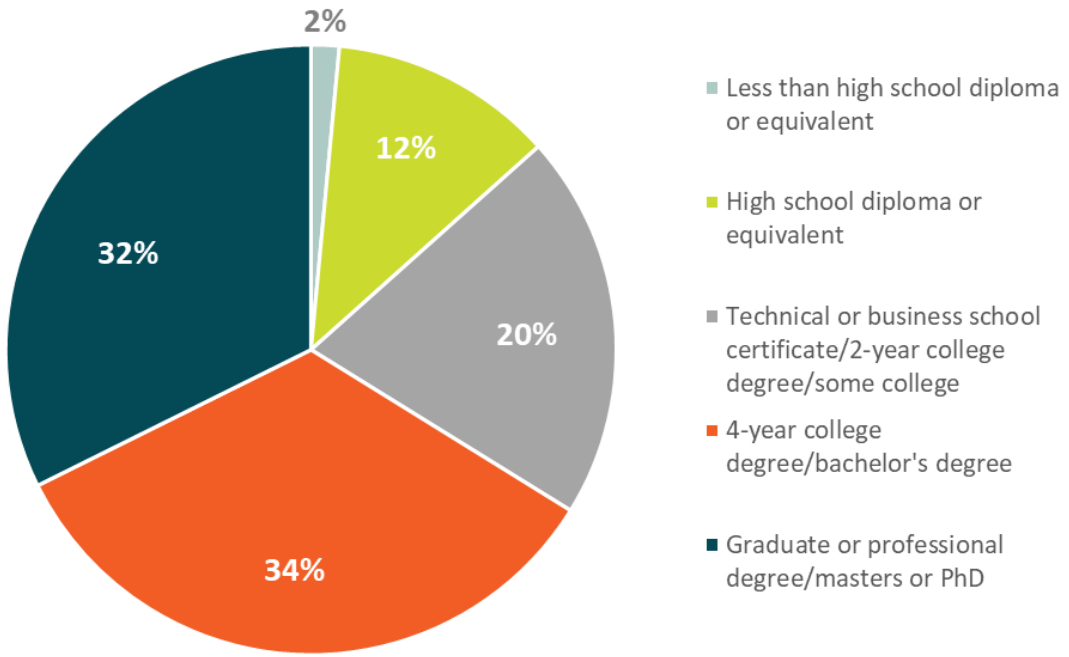
Table 24. Income Distribution by Participant Type (2019)

Income Designation	Major Measure (n=53)	Assessment Only (n=170)	Total (n=223)
Low Income (n=23)	6%	12%	11%
Moderate Income (n=26)	15%	11%	12%
Market Rate Income (n=58)	25%	27%	26%
Affluent Income (n=116)	55%	51%	52%
Overall	**100%**	**100%**	**100%**

Education

As shown in Figure 19, more than half of respondents have either a 4-year college degree (34%) or a graduate or professional degree (32%). Another 20% of respondents reported having obtained a certificate or completed some college, while 12% indicated having a high school diploma or equivalent. These values indicate that EWSF participants, as represented by survey respondents, are generally highly educated. Our team found very little difference in education levels by participation type.

Figure 19. EWSF Education Attainment (2019)



Appendix A. Evaluation Scope of Work

Memorandum

To: Romilee Emerick and Adam Wirtshafter, National Grid
From: Cadeo and ILLUME
Date: May 1, 2020
Re: EnergyWise Single Family, EnergyWise Multifamily, and Income-Eligible Multifamily Evaluation Workplan

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This document details Cadeo and ILLUME's plan for completing impact and process evaluations of three National Grid residential retrofit programs in Rhode Island: **EnergyWise Single Family (EWSF), EnergyWise Multifamily (EWMF), and Income-Eligible Multifamily (IEMF)**. Our team was specifically tasked with evaluating program years 2017 to 2019, although National Grid will use the results of our impact and process efforts to prospectively inform program planning and delivery improvements.

This document, which will serve as the scope of work for evaluating all three retrofit programs, consists of the following sections.

- Introduction
- Tasks
- COVID-19 Impact and Contingencies
- Data Request
- Timeline

Introduction

The key objectives for each program's process and impact evaluation are similar and include:

- Verifying gross and net energy savings
- Assessing overall program effectiveness
- Providing actionable recommendations to prospectively increase cost-effectiveness, participation rates and, customer satisfaction

In addition to these overarching objectives, our team will pay particularly close attention to assessing program enhancements planned for the 2020 program year. These enhancements are designed to increase participation, weatherization project uptake and, ultimately, energy savings from completed projects.

For EWSF, the enhancements, include, but are not limited to:

- A 100% landlord incentive to encourage weatherization in rental properties
- An asset rating or energy performance score for homes
- An online assessment designed to provide additional information to energy auditors and convenience to residents

Our team will also explore the following enhancements planned for EWMF and IEMF:

- Any program design changes made in response to findings from potential study
- Shifting energy savings away from lighting and toward custom projects and air source heat pumps
- A tiered approach to incentives
- Providing greater customer choice to the condominium market, including working with their preferred HVAC contractor
- Increased marketing and community focus with an emphasis on smaller-scale properties
- Optimizing best practices stemming from studies in neighboring Massachusetts, including the recently completed multifamily census study

We have also included several measures in our impact evaluation scope that were not offered in 2017 or 2018 so that National Grid assess the potential role of these nascent measure in future programs.

In fewer words, our evaluation efforts will seek insights from the programs' past and current performance that National Grid can use to inform future program improvement.

Tasks

Since all three retrofit programs share a similar delivery approach (i.e., each provides an assessment, free direct installation measures, and incentives for completed projects), our team proposes to use a similar set of core impact and process evaluation tasks across programs. At the same time, we recognize these programs are different from each other: they serve separate target markets, have unique program design elements aimed at mitigating market-specific barriers, and are individually preparing for future challenges to delivery as recognized in National Grid's Annual Energy Efficiency Plan for 2020. As such, we note program-specific nuances, where appropriate, throughout this multi-program work plan.

The team will use the following five tasks, and related subtasks, to evaluate each retrofit program:

- Task 1. Data Review and Preparation
- Task 2. Impact Evaluation
    - Engineering Algorithm Analysis
    - Building Simulation
    - Billing Analysis
- Task 3. Net-to-Gross Estimation
- Task 4. Process Evaluation
    - Stakeholder Interviews
    - Materials Review

    - Participant Surveys & Building Representative Interviews
    - Cycle Time Analysis
- Task 5. Reporting

Task 1: Data Review and Preparation

Timing: April

Deliverables: Findings Memo (if necessary)

Data reviews are an integral part of the evaluation process as the outcome of the review determines what is—and what is not—possible as part of an evaluation. For this reason, we began the data request and review process at the very outset of this evaluation. Our team sent National Grid a data request covering all three retrofit programs on March 4th and, to date, we have already received most of the requested data.[1]

Completing the data review right away will enable our team to confirm that the available program data and materials will support the activities and analytical methods described in this work plan. If the data review determines that any element of this work plan is not possible—or requires significant modification—we will communicate that outcome, as well as the relevant evaluation implications, to National Grid and evaluation stakeholders via memo before the end of April.

Task 2. Impact Evaluation

Timing: April-July

Deliverables: Analysis Plan (May) Preliminary findings presentation, supporting workbooks, and model (July)

After our team has reviewed and prepared the required data for analysis, we will use one of the following three complementary approaches to estimate gross, per-unit energy savings for each measure in the EnergyWise Single Family, EnergyWise Multifamily, and Income-Eligible Multifamily programs:

1. Engineering Algorithms
2. Building Simulation
3. Billing Analysis

Based on our experience using these impact approaches for similar National Grid programs in Rhode Island and Massachusetts, as well as initial measure counts provided by National Grid, we anticipate using the identified approach shown in Table 1 (on the following page) for each measure. As evident in the table, our proposed approach can for the same measure depending on the fuel and/or program.

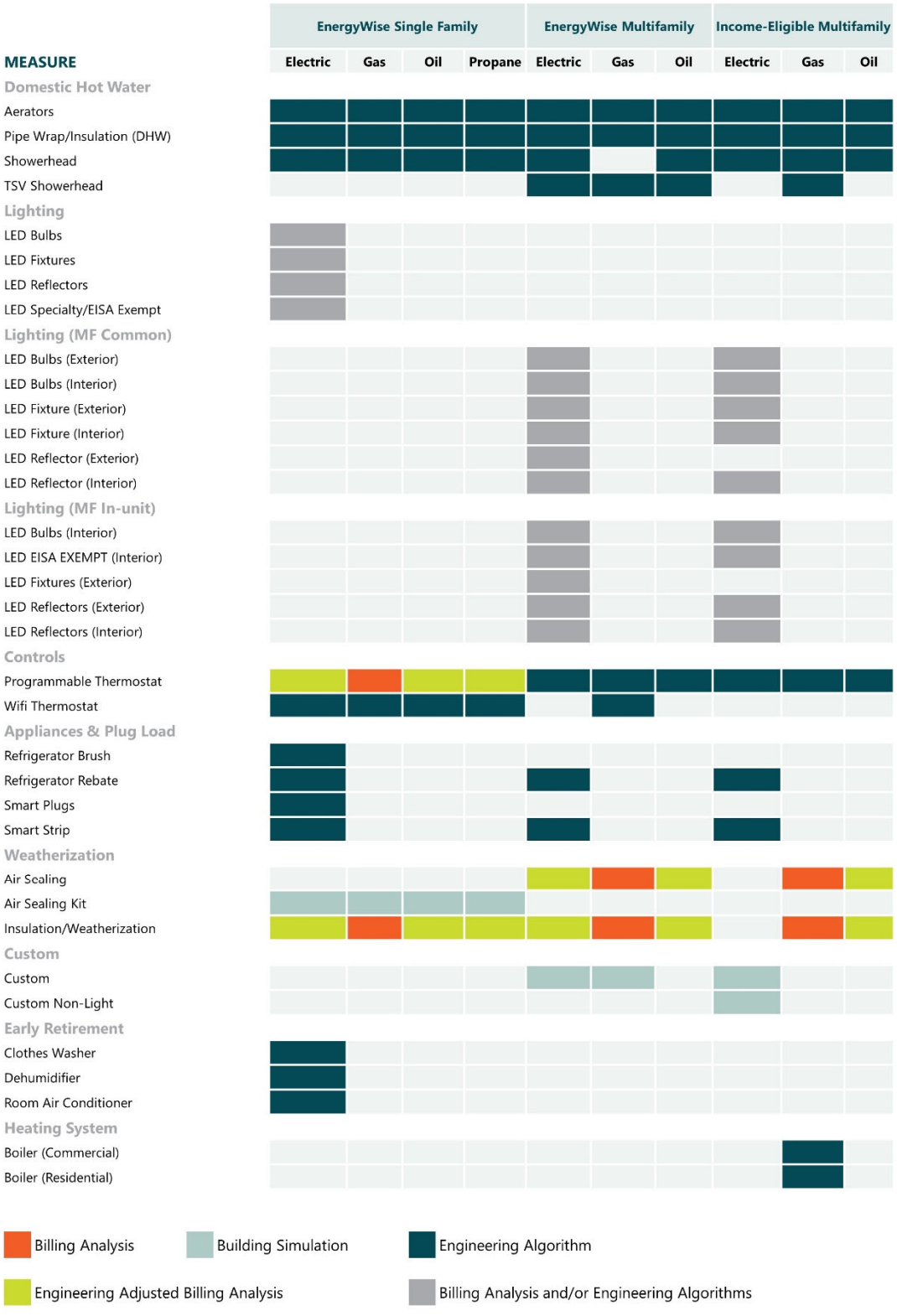
During initial evaluation discussions, National Grid requested that our team report gross savings at a measure level that is consistent with their internal program planning and benefit-cost screening procedures. As such, the measure names in Table 1 reflect this level of granularity and, collectively, represent a comprehensive list of the measures included in the impact evaluation scope.

[1] We have included a copy of the data request at the end of this work plan.

While the measures listed in Table 1 reflect the official scope of the impact evaluation, our team will also explore opportunities to estimate savings at other levels of measure specificity. For example, our team will attempt, through the billing analysis, to differentiate between the weatherization savings generated by air sealing and each type of insulation (attic, wall, and floor) installed through the retrofit programs. Although National Grid does not test the cost-effectiveness of these weatherization types individually, additional perspective regarding the savings associated with each element of weatherization may illuminate where the program is more (or less) successful when weatherizing participant's homes. However, it is important to note that reliable results for more granular measure types (i.e., air sealing and attic, wall, floor versus weatherization overall) are not always possible via billing analysis-largely due to overlap between measures (i.e. most air sealing participants also install some sort of insulation), smaller sample sizes, and a decreased signal (measure savings) to noise (total household consumption) ratio. Our team will buttress against this possibility by relying on building simulation to offer similar insights.

Conversely, our team will also aggregate the measures in Table 1 to gain additional perspectives on the program's impact on participant's energy usage. Specifically, our team will assess household-level lighting savings (via billing analysis) to complement—and potentially augment—the granular, lamp-specific savings that we will also estimate using engineering algorithms. Together, the top-down assessment of total household lighting savings provided by the billing analysis and the bottom-up, lamp-type-specific algorithmic approach will offer our team a well-rounded perspective on the program's lighting measures and a greater chance to observe the impetus behind the evaluated savings.

Table 1. Anticipated Impact Approach by Measure Type, Fuel and Program



Below, we describe each impact evaluation approach in greater detail.

Engineering Algorithms

We will primarily use the engineering algorithms to estimate energy savings for measures not impacted by interactive effects (i.e., the savings/usage of one program measure impacting another). As noted above, we will also use this approach for lighting measures (along with billing analysis), which do impact participant's post-participation heating and cooling usage. When appropriate, we will account for changes in heating and cooling loads (due to the decrease in lighting waste heat levels when participants shift to more efficient lighting) as part of our algorithmic approach.[2]

Using the program data reviewed and prepared as part of Task 1, as well as information from the Rhode Island TRM, our engineering algorithm analysis will produce a workbook with measure-specific worksheets that includes:

- The savings algorithm from the RI TRM
- High level summary explanation of the measure (i.e. what drives savings?)
- List of all inputs and input values, including sources
- A clear comparison of the TRM and evaluation inputs and savings
- Calculation of savings according to the algorithm specified in the TRM
- A succinct explanation for why any assumptions or inputs differ from the TRM and impact the reported gross savings

In addition to these measure-specific worksheets, the workbook also includes a cross-cutting tab for inputs and assumptions that are common across measures. Maintaining these common values (and the relevant sources) in a centralized location ensures that an update to a common input impacts all affected measures. Such clear, transparent, documentation will enable National Grid Rhode Island to later leverage these evaluation deliverables as planning resources.

Building Simulation

For measures known to generate (or be subject to) interactive effects but for which billing analysis is not a good fit or feasible (e.g., air sealing kits and/or delivered fuel weatherization), we plan to estimate average, measure-specific energy savings through building simulation modeling. Specifically, our team will use BEopt, modeling software created by the National Renewable Energy Laboratory that utilizes the Department of Energy's EnergyPlus as its simulation engine.

While we will determine the exact number of models necessary after completing the data review task, we anticipate developing (at least) four building type-specific models:

- Single-family detached structures (served through EWSF)
- 2-to-4 unit attached structures (served through EWSF)
- Small, low-rise multifamily structures (served through EWMF or IEMF)
- Large, high-rise multifamily structures (served through EWMF or IEMF)

[2] This adjustment is not necessary for the subset of participants that installed weatherization as the billing analysis for that measure will have already captured the waste heat related interactive effects of transitioning to LEDs.

Once we have created the relevant building type models, our team will populate them using each program's detailed participation data, run them reflecting the pre- and post-program conditions, and weight the various model's savings together (based on the prevalence of each building type in each program) to estimate overall savings. We will also leverage the billing analysis—discussed next—to calibrate our model's total consumption using actual participant consumption data (for the subset of customers living in each modeled home type).

Billing Analysis

In addition to engineering algorithms and building simulations, our team will undertake a billing analysis. As evident in Table 1, we anticipate primarily using billing analysis primary for insulation, air sealing, and, potentially, thermostats, but we will also explore lighting-related options.

Specifically, our team will use a monthly Post Program Regression (PPR) billing analysis model to estimate energy savings for a subset of measures for each of the three Retrofit program. The PPR model, which is the same model type our team will use as part of the concurrent Home Energy Reports program evaluation, uses the "post-program" period – that is, the period after the start of the program – energy usage only as the dependent variable in the model, as shown below:

$$ADC_{ct} = b_1 Treatment_c + b_2 LagADC_{ct} + \sum_{month\ i} b_{3i} Month_{it} + \sum_{month\ i} b_{4i} Month_{it} * LagADC_{ci} + b_5 NonProg_c + e_{ct}$$

Where

- ADC_{ct} = average, daily energy consumption for customer *c* at calendar month *t*
- $Treatment_c$ = 1 if customer *c* is in treatment group, 0 if customer *c* is in control group
- $LagADC_{ct}$ = average daily consumption from customer *c* during calendar month t of the pre-program period
- $Month_{it}$ = 1 when index i = calendar month t, 0 otherwise. We include this series of 12 terms to capture month-specific effects in our analysis
- $NonProg_c$ = 1 if customer c received a non-program energy-efficiency or health and safety-related improvement
- e_{ct} is the error term from the regression model

In this model, we use billed, pre-program period energy consumption as an explanatory variable which helps to condition expected, billed energy consumption in the post-program period. We also include monthly fixed effects and use the model to interact these monthly fixed effects with the pre-program energy use variable, which allows pre-program usage to have a different effect on post-program usage in each calendar month.

Our approach uses a control group made up of "future" participants from the same program (i.e., those that received measures in 2019 after the 2017-2018 analysis period) to account for the impact of various macroeconomic factors and other influences on pre- and post-program energy consumption that are unrelated to the installation of program measures. These include economic effects, the movement of people in and out of dwelling units, and fluctuations in per-unit energy costs. To identify the most relevant customers for the control group, we will use the quasi-experimental matched control group (MCG) method. The MCG method goes beyond random sampling of treatment and comparison groups and instead uses a nearest-neighbor algorithm to match each participant (treatment group) customer with a specific best-match from a pool of future participants (control group) based on pre-program energy usage. This approach identifies the future participant whose energy consumption pattern over the most recent 12 pre-participation months was most like that of the participant.

ARE BILLING ANALYSIS RESULTS GROSS OR NET?

Billing analysis produces a result that lies on a spectrum between net and gross savings. The exact location on that spectrum depends on the customers in the control group and the measure in question. Since we are focusing the billing analysis on weatherization, as well as using future participants as our control group, the results of our billing analysis—per the guidance of the Uniform Methods Project—should be considered **gross**. However, if the team uses billing analysis for lighting measures, the lighting results should be interpreted as **net**.

About Multifamily Buildings

We recognize that multifamily programs pose a challenge for billing analyses because of the variability in which utilities record their billing data and the level at which program services are tracked. Our team's early discussions with National Grid indicate program data is tracked at three, interrelated levels (units, buildings, and facilities) and that it will be possible for our team to tie each level to the relevant participant billing data. We anticipate that we will need to aggregate in-unit and common area billing records to the building or facility level for most participants, but we are optimistic about the viability of billing analysis for the identified subset of multifamily measures. (This aggregation process would also include accounting for any measures installed using C&I incentives.) However, if these challenges prove too great and reliable billing analysis results are not possible, our team will evaluate these measures using the existing multifamily BeOpt building simulation models.

Controlling for Cross-Participation

We also recognize the necessity of identifying, and controlling for, measures installed outside of EWSF, EWMF, or IEMF; not doing so would conflate the programs and overstate the billing analysis results. For

example, some EWSF participants also installed a high-efficiency heating system through a different National Grid program.[3] To avoid conflating savings across programs in instances such as this, our team requested (and National Grid provided) data for other residential programs. We will use these data to control for cross-program participation, specifically by including a program- or measure-specific dummy variable reflecting cross-participation in our model specification.

Task 3. Net-to-Gross Evaluation

Determining net savings requires estimating both **freeridership** (i.e., action likely without program support) and **spillover** (i.e., subsequent reductions in energy consumption due to program influences that accrue outside of direct participation).

Timing: April-June

Deliverables: Methodology memo with batteries and supporting algorithms

Specifically, our team will estimate net savings for the EWSF and EWMF programs at the measure group-level (i.e., the gray end-uses listed in Table 1). We will not collect NTG-related data for IEMF, which we will deem as 100% (standard practice for income eligible programs).

For efficiency reasons, we will include our NTG battery (i.e., the set of freeridership and spillover questions) in the participant process evaluation surveys described in more detail later in the work plan). The exact questions we will pose in NTG battery will vary by program and measure.

Best practices have generally shifted towards approaches that are simpler for respondents and avoid consuming an excessive amount of survey real estate. In particular, our team appreciates the relatively straightforward, yet rigorous approach used in Illinois and, in the absence of a standard algorithm for RI or MA, proposes to use it for this evaluation.[4]

We will share the details of how we will apply the Illinois approach to EWSF and EWMF in an NTG analysis plan memo in mid-April. However, it is important to note here that the approach accounts for the key elements of free-ridership (program influence on timing, efficiency level, and quantity), as well as participant "like" (i.e., more of the same measures installed through the program) and "unlike" (i.e., different measures than installed by the program) spillover.

WHAT ABOUT NONPARTICIPANT SPILLOVER?

Nonparticipant spillover captures the savings incurred at the nonparticipating market-level in response to program efforts. A rigorous and defensible nonparticipant spillover study can be expensive, time consuming, and, depending on methodology, face defensibility concerns. While we recognize nonparticipant spillover exists, we do not include it as part of this NTG research for these reasons.

[3] It is worth noting that National Grid confirmed that no non-National Grid funded measures were installed at participating IEMF facilities so that is not a potential source for billing analysis bias.
[4] 2020 IL TRMv8.0 Vol4_October 17, 209_FINAL

Task 4. Process Evaluation

Process evaluation activities provide insight into the customer journey, identify barriers to project completion, and inform opportunities to increase the energy savings obtained from each home. We are committed to ensuring that process evaluation activities result in recommendations that are actionable and forward-looking—focused on building upon program strengths while providing practical insight for program evolution where relevant for future success.

As noted at the beginning of this work plan, all three Residential Retrofit programs contain the same basic elements: a no-cost in-home energy assessment with direct installed measures, generating a set of participant-specific efficiency recommendations, and (ideally) customer adoption of those recommendations. These basic similarities will allow our team to create an initial set of process evaluation materials (stakeholder interview guide, participant survey, etc.) that is generally applicable to all three programs. We will then add tailored modules to each research instruments to address program-specific research needs.

This approach yields multiple benefits. First, it is economical. Creating a single standardized research instruments and then adjusting it for each program is less expensive than independently creating three individual documents. Second, it is faster for our team to create and for National Grid, and its evaluation stakeholders, to review. Third, the approach fosters consistency. By virtue of starting each program-specific document from the same place, it is easier to keep questions relevant for multiple programs (e.g., basic awareness and satisfaction questions) consistent across evaluation.

The following sections detail our four proposed process evaluation activities, which as mentioned, we will coordinate across programs.

- Stakeholder Interviews
- Materials Review
- Participant Surveys & Building Representative Interviews
- Cycle Time Analysis

Stakeholder Interviews

> *Timing:* April-May
>
> *Deliverables:* Interview guide

A first and foundational process evaluation task is to have in-depth discussions with the people involved in the daily execution of a program, specifically the program staff at National Grid and the primary implementation company. These initial discussions will provide our team with critical context, as well as the program-specific language we need to effectively converse with each program's participants.

Collectively, the stakeholders identified in Table 2 will offer broad insight into National Grid's design, marketing, and delivery of all three programs. Beginning with the utility implementation manager and lead vendor provides our team the most comprehensive introduction to a program. Informed by the information obtained in these interviews we, will shift our focus to those that are working directly with customers and are integral to program operations.

Table 2. Stakeholder Interviews*

Stakeholder	Stakeholder Group	EnergyWise Single Family	EnergyWise Multifamily	Income-Eligible Multifamily
National Grid Implementation Managers & Customer Energy Management Strategic Planners	Implementation/ Program Staff	1	1	1
Lead Vendor/Implementation Manager		1	1	1
Lead Vendor In-Home Assessors	Assessors	6	3	3
Installation Contractors	Contractors	6	4	4
Lead Vendor Internal QA/QC Auditors	QA/QC	2	2	2
Third-Party QA/QC Manager and Auditors		4	4	4
Total		**20**	**15**	**15**

*The totals in the table represent the number of interviews with each type of stakeholder. We anticipate that, in some cases, several stakeholders will participate in an interview. At the end of any group interviews, we will notify all interviewees that they are welcome to follow-up with our team individually (via phone or e-mail) if they have additional thoughts that they would like to share but either did not have time during the interview or felt uncomfortable doing so in a group setting.

We organized the six stakeholders into four stakeholder groups (assuming stakeholders within these groups will require similar types of questions). As described above, the interview guide will include program-specific modules as appropriate. As with all our deliverables, we will share draft interview guides with evaluation stakeholders prior to deploying them.

Materials Review

Our team also requested key program documents (including both printed materials and digital distributions) for review. This review will provide multiple benefits:

> *Timing:* April-May
>
> *Deliverables:* Summary of materials in final report

- Helps our team become **more familiar with program nuances**. This, in turn, allows us to ask appropriate questions of each set of participants.
- Serves as a resource to **directly investigate statements** made in the interviews. For example, if interviewed field assessors mention the program's materials confuse participants, having and reviewing a copy of the materials allows our team to offer more specific recommendations for improving them.
- Allows us to **identify opportunities to clarify the program information for participants**. Reviewing outward-facing materials with a fresh eye and participants' perspectives can glean valuable insights related to program communication.

Participant Surveys and Interviews

A critical input to every process evaluation is direct input from participants. To provide consistency and facilitate comparison across programs, we will draft a single core survey assessing participant awareness,

> *Timing:* May - June
>
> *Deliverables:* Survey instruments, fielded survey, analysis in final report

satisfaction, demographics, and barriers to implementing program-recommended action. The core questions will also include verification and influence-related questions to feed into impact and net-to-gross evaluation activities. We will build the core survey first and then add modules to investigate the program- and participant specific nuances.

We plan to use web and, to a lesser extent, telephone surveys to reach participants. Web surveys are increasingly popular as the bias continues to decrease and costs far less to administer than a telephone survey. However, this approach is subject to e-mail availability as determined through the data review. In addition, certain customer types, such as older customers and multifamily property owners, may be more likely to respond to a telephone survey. We will therefore follow-up with unresponsive sampled customers via phone.

Sampling

In recent years, National Grid's three programs have annually served over 20,000 housing units across more than 10,000 single family homes and 233 multifamily buildings. To effectively evaluate the process experience for each type of participant (and to support the net-to-gross survey research), we have employed a stratified random sampling approach based on program and participant types.

It is important to recognize that the survey (and subsequent sampling strategy) needs to meet process and impact evaluation needs. Specifically, the survey needs to include questions to verify measure-level installation, retention, and program influence on actions (for net-to-gross), as well as yield insight into improving future programs. These types of questions require measure-level stratification considerations. The sampling strategy also needs to account for population size and number of target respondents. As an example, while the multi-family program served thousands of units, there are considerably fewer building decision-makers (e.g., property managers / owners).

Our proposed approach, summarized in Table 3, will focus on 2019 participants and, at minimum, yield results of at least 10% precision at the 90% confidence level for each program and participant type. Survey 2019 participants will minimize recall bias and ensure our process findings capture any recent changes to the programs' delivery. We have also proposed an additional stratum for the EWSF and EWMF programs, which will allow us to dig deeply into differences between "assessment only" and "major measure" participants and identify opportunities for higher conversion rates.

Table 3. Survey and Interview Sampling

	Homes/Units (Annually)	**Survey/Interview Sample°**
EnergyWise Single Family		
- Assessment only	~6,300	150
- Major measure	~3,700	150
EnergyWise Multifamily		
- Tenant	~4,000	100
- Building Decision-Maker (Assessment only)*	~200	30
- Building Decision-Maker (Major measure)*		30

	Homes/Units (Annually)	Survey/Interview Sample°
Income-Eligible Multifamily**		
- Tenant	~7,000	100
- Building Decision-Maker*	~100	30
Total		**590**

*Interview, not survey

**Our team assumes that all buildings assessed through the Income-Eligible Multifamily program install a major measure.

°Pending completion of data review

Strategies to Maximize Response

Our team will employ three strategies to maximize response rates:

- **Advanced Notification.** We will send sampled customers an advanced email (where available) and a postcard describing the study and requesting their participation. Our efforts for National Grid in Massachusetts have shown that providing customer with advanced notification is an effective means for improving response rates and mitigating non-response bias.
- **Incentives.** In appreciation of their time, and to encourage survey completion, we will offer participants a $10 gift card. Multifamily building contacts, phone interviewed, will get a $50 gift card.
- **Survey design.** We will encourage completion of the full survey by limiting the length to no more than an average of 15 minutes. Further, we offer to complete telephone surveys in Spanish to further mitigate any non-response from Spanish speakers.[5,6,7]

Cycle Time and Attrition Analysis

Using the provided program data, we will calculate the typical time required for a customer to move through the key stages of participation, as well as the overall program timeframe (i.e., from signing up for an assessment to completing the QA/QC process). We will then juxtapose the results of the cycle time analysis with the findings of the participant survey to identify any key points of attrition, or places where participants tend to "fall out" of the current participation process. We will also keep an eye for timeline or dropout rate differences for specific participant sub-segments (geography, income, demographics, home vintage or similar).

As part of this task we also will create a graphical representation of the typical customer participation process for each program. The graphic will include the average time associated with each step and, when relevant, note instances where participants drop out or delays can occur.

Our team will also use this task to assess and report key participation trends over time (total assessments, the percent of participants that installed at least one major measure, etc.) The exact set of historical trends that our team can report will be a function of the program data provided by National Grid and its implementor.

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[5] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

[6] All other non-English languages combined are 3.4%.

[7] A Cadeo team member is a fluent Spanish speaker and capable of translating and administering the English version of the survey in Spanish in real time. This approach minimizes the cost relative to formally translated and offering a Spanish version online, thereby making it possible to offer a Spanish survey option within the constraints of the evaluation budget. The Cadeo team member has previously successfully provided similar translation services on customer energy efficiency surveys.

Task 5. Reporting

We have found that discussing our preliminary findings—in detail—in advance of submitting the official draft report expedites our writing process, reduces stakeholder review iterations, and, most importantly, yields more robust and actionable reports. As such, we plan to present preliminary findings to National Grid and evaluation stakeholders in mid-July (focused on gross and net savings from the impact evaluation) and again in early August (process evaluation.

> *Timing:* Mid-July through mid-September
>
> *Deliverables:* Preliminary findings presentations, draft and final reports (including designed one-page summaries)

Following these presentations, our team will create two retrofit reports—one of EWSF and another that combines EWMF and IEMF—oriented around the key themes and findings identified across evaluation tasks.

The final program report will include a concise, high-level, graphical executive summary of all pertinent information within a few pages, followed by a more detailed narrative. As some information is best presented visually, we will include graphical elements to provide clarity on findings, as well as references and citations for applicable data, phone conversations, non-confidential sources, publications, and other media. To ensure high quality reporting, we will employ the services of our technical editor and graphic designer. Their specialized assistance will ensure that our report is properly and carefully edited and formatted before delivery.

COVID-19 Impact and Contingencies

As a result of COVID-19, the landscape of National Grid's retrofit programs has changed dramatically in recent weeks. At this time, none of the three programs are completing in-person home energy assessments and a significant portion of the programs' implementation team have been furloughed.

It is still possible to evaluate all three programs and provide National Grid with the insight it seeks to inform future delivery of the programs after COVID-19 restrictions lessen. However, the change to status of the programs impacts some of our proposed evaluation activities.

Table 4 outlines, task by task, whether each evaluation activity is impacted, or has the potential to be affected, by the COVID-19 restrictions. In these instances, we note how our team will adjust our plans to meet, to the best of our ability given the circumstances, National Grid's evaluation needs.

Beyond the specific contingencies noted in the table, it is important to note that our team will adhere to National COVID-19 communication and outreach policies and adapt as necessary. We will include National Grid-approved language in all customer and stakeholder outreach and, more in generally, demonstrate sensitivity to the current situation in all our communications.

Table 4. COVID-19 Contingencies

Task	Impacted?	Contingency/Context
Task 1. Data Review and Preparation	No	Relies entirely on previously gathered data
Task 2. Impact Evaluation – All Tasks	No	Relies entirely on previously gathered data; team will exclude any 2020 billing data from billing analysis
Task 3. Net-to-Gross	Potentially	National Grid has approved the team to contact participants for the process survey, which will also inform our net-to-gross analysis (see below for more details related to data collection). If outreach policies change and primary data collection is no longer possible, our team will rely on previous research for similar programs in neighboring states and National Grid territories.
Task 4. Process Evaluation – Stakeholder Interviews	Yes	Since most of assessors and QA/QC staff have been furloughed, the team will limit our initial stakeholder interviews to core National Grid and RISE program managers, who are actively managing the programs. We will our interview with the RISE program managers to, in part, understand their assessor's work situation. If beneficial for their company and team, we may proceed with the assessor interviews. Otherwise, we will revisit completing all remaining stakeholder interviews later in the evaluation timeline.
Task 4. Process Evaluation – Materials Review	No	Relies entirely on previously gathered information
Task 4. Process Evaluation – Participant Surveys & Interviews	Yes	As noted above, our team has permission from National Grid to complete the evaluation's proposed surveys and interviews and plans to proceed as outlined in this plan. To be less intrusive and allow respondents more flexibility, our team will rely more heavily on online surveys. This includes transitioning the MF building owner/manager interviews to online surveys with telephone interview follow-up as needed.
Task 4. Process Evaluation – Cycle Time & Attrition Analysis	No	Relies entirely on previously gathered data
Task 5. Reporting	No	While reporting will happen as planned, the team will document the limitations and implications of COV-19 on evaluation activities and results.

Data Request

The evaluation team submitted a data request for data and program materials to support the evaluation of the three retrofit programs program on March 4th, 2020. To date, National Grid has supplied nearly all of these items.

The data request includes four components:

1. Program data
2. Billing data
3. Program materials
4. Stakeholder contact information

Below, we provide the text of the data request.

Program Data

Please provide the following program data for participants in EnergyWise Single Family, EnergyWise Multifamily, and Income-Eligible Multifamily programs during **2017, 2018, or 2019**. (We will use 2019 participants from each program as the control group in our billing analysis.)

- National Grid Account Number
- National Grid Premise Number
- Information regarding all **measures** installed using **National Grid funding**[8], including:
  - Quantity and efficiency level (e.g., the amount of insulation, in terms of square footage and change in R-value, added in a weatherized attic)
  - Measure-specific installation date(s)
  - Measure-specific estimated (also known as ex ante) savings
- Information about the **home**, including:
  - All relevant information regarding the existing conditions in the home prior to participation (e.g., existing attic insulation R-value prior weatherization)
  - Space Heating Fuel Type (e.g., natural gas, electricity, heating oil, propane, other), including efficiency (if available)
  - HVAC Distribution Type
  - Water Heater Type, including efficiency (if available)
  - Air Conditioning Type (central, room AC, none), including efficiency (if available)
  - Size (square footage)
  - Size (number of units in building/premise)
  - Number of Stories (single or multi-story)
- Information about all **participants**[9], including:
  - Name
  - Address, including ZIP Code

[8] Please also provide similar information—as part of the same dataset or separately—for any energy efficiency measures installed in using non-National Grid funding. This is most likely occurring as part of the Income-Eligible Multifamily program. If provided separately, include the participant's account number so our team can combine this information with National Grid funded measure installations.

[9] For the EnergyWise and Income-Eligible Multifamily programs, please provide this information for the primary program contact at each property (i.e., the owner or manager) as well as the tenants in the individual units that received measures through the program

- Phone
- E-mail
- Owner/Renter Indicator (if available)
- Total occupants (if available)
- Demographic/Income information (if available)
- Information about **program** milestones, including:
- Sign-up/Enrollment Date
- Assessment Date
- Measure-specific Installation Date(s)
- Quality Control Visit Date(s)

Billing Data

Please provide the following fields for all customers that participated in EnergyWise Single Family, EnergyWise Multifamily, and Income-Eligible Multifamily program in **2017, 2018 or 2019**. (If National Grid does not currently have a list of these customers, our team can develop and provide such a list after receiving the program data requested above.)

Since our billing analysis requires a minimum of one year's worth of pre- and post-participation energy consumption records, please provide the billing data for the customer's identified above **from September 1st, 2015 through the present.**

At a minimum, we need the following fields:

- National Grid Account Number
- National Grid Premise Number
- National Grid Rate Schedule
- Master Meter Flag/Identifier
- Billing period dates: start date and end date
- Billing period consumption (kWh consumed for electric, therms consumed for gas)

Regarding format for billing data, if possible, please provide the data as a SAS dataset (sas7dbat file). If not possible, please provide the data in a pipe ("|") delimited text file.

Program Materials

At a minimum, we need the following documents:

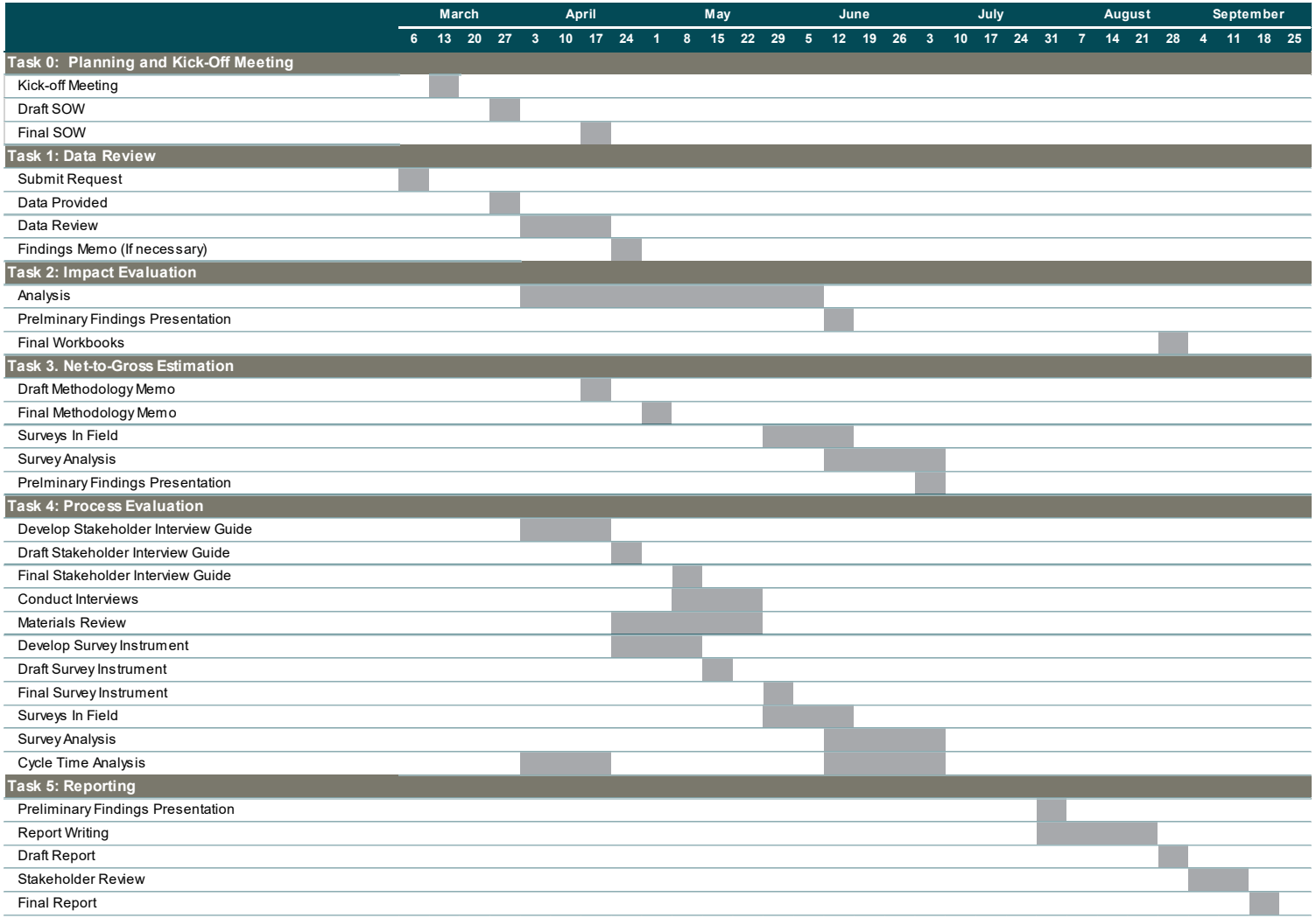
- All marketing and outreach documentation (printed and digital)
- Program documentation, including applications, audit protocols and QA/QC procedures if available

Stakeholder Contact Information

To facilitate interviews, we request contact information (name, role, phone number, and e-mail) for the stakeholders listed for potential process evaluation interviews

Timeline

We will follow the approximate schedule shown below.



Appendix B. Impact Analysis Plan

Memorandum

To: Romilee Emerick and Adam Wirtshafter, National Grid
From: Cadeo and ILLUME
Date: May 22, 2020
Re: EWSF, EWMF, and IES MF Impact Evaluation Analysis Plan

This memo details Cadeo's analysis plan for the impact evaluations of three National Grid residential retrofit programs in Rhode Island: **EnergyWise Single Family (EWSF), EnergyWise Multifamily (EWMF), and Income-Eligible Multifamily (IEMF)**. The scope of our impact evaluation will be program years 2017 and 2018.[1] This analysis plan adds detail to the impact evaluation tasks outlined in our team's overall evaluation work plan for all three programs and leans upon our team's ongoing review of program data recently provided by National Grid.

The analysis plan consists of the following sections:

- Data Sources
- Overarching Approach
- Billing Analysis Details
- Engineering Algorithms Details
- Building Simulation Modeling Details

Data Sources

National Grid has provided the following datasets, which our team will use to inform our impact evaluation activities.[2]

- **Program Data.** These data include basic customer (account number, address, ZIP code) and measure (type, quantity, savings) information for 2017, 2018, and 2019 participants. These data also include some information about pre-existing conditions for each participant. As described in more detail later in the plan, our team will use data regarding 2017 and 2018 participants for all three impact evaluation tasks and data for 2019 participants as a control group for our billing analysis.
- **Supplemental Participant Data.** These data provide additional information regarding the physical structures of participating buildings, as well as mechanical systems. This information includes, but is not limited to: HVAC system types (heating and cooling), heating fuel, water heating fuel and type, building size, building vintage, rent/own status (EWSF only), and building-level ownership type, i.e., condominium or apartment (EWMF and IEMF only).

[1] The concurrent process evaluation will focus on 2019 participants for all three programs.
[2] We also requested and have received other related information – e.g., a do-not-contact list, contact information for market actor interviews, and program materials – that do not relate to impact evaluation activities.

- **Cross-Program Participation Data.** As assessment programs, EWSF and EWMF can serve as a gateway to participating in other, complementary National Grid residential programs.[3] Since it is critical to account for participation in other programs when estimating savings for EWSF and EWMF, we will flag cross-program participants so that we can control for the energy savings from other programs as part of our billing analysis. To enable this, National Grid provided participation data for three of its other residential programs: Natural Gas Heating and Water Heating, Central AC, ENERGY STAR products, and the Home Energy Reports behavioral program.[4]
- **Billing Data.** National Grid provided monthly energy consumption data ranging from January 1, 2012 to December 31, 2019.[5] These data include billed, gas and electric energy consumption for all National Grid Rhode Island's residential customers – including both program participants and program future participants. However, these residential billing data do not fully capture multifamily buildings, which often have common areas or master meters. Thus, we received commercial and industrial rate-class billing data to supplement the residential billing data for multifamily buildings and will aggregate these billing data to a facility level for our analysis.

In addition to the data that National Grid provided, our team acquired contemporaneous, hourly weather data from the National Oceanic and Atmospheric Administration (NOAA) for all NOAA weather stations in Rhode Island. These data will allow the heating and cooling degree days in our billing analysis to be specific to each customer's locale and billing cycles.

Impact Evaluation Approach

Our impact evaluation approach will use one or more of the complementary methods below to determine gross, per-unit energy savings for each measure in the EWSF, EWMF, and IEMF programs.

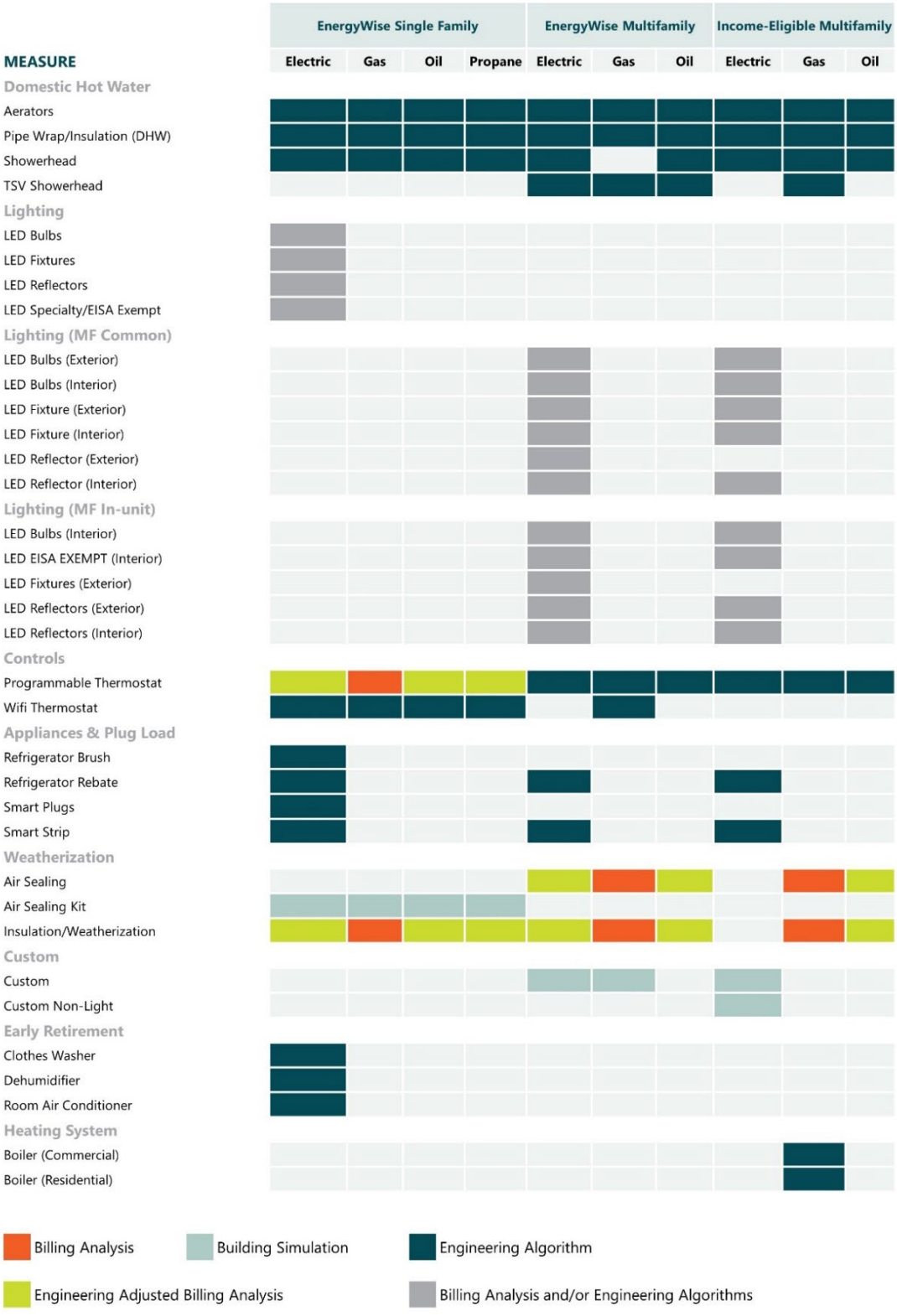
- **Billing Analysis** compares energy consumption from participant billing records, both before and after their participation date, to determine energy savings. Billing analysis is our preferred approach when possible because it, when employed with a well-matched control group, best reflects the actual change in energy usage within participating homes.
- **Building Simulation** uses engineering-drive modeling software to estimate energy savings from program energy efficiency measures, and is best used for the measures that have interactive effects across end-uses (e.g., heat pump water heaters) when billing analysis is not viable (e.g., delivered fuel weatherization).
- **Engineering Algorithms** use calculations specified in Rhode Island Technical Reference Manual (TRM)[6] or other regional studies to calculate bottom-up energy savings. We use National Grid Rhode Island's program data and other appropriate regional studies as inputs for this approach, which is best employed for measures that do not have interactive effects (e.g., faucet aerators)

[3] Our team anticipates that IEMF participants are comprehensively served through that program and, with the likely exception of the Home Energy Reports program, do not cross-participate in other residential programs. However, we will confirm this assumption when combining program databases before proceeding with the billing analysis.
[4] Excludes upstream lighting.
[5] The billing data provided by National Grid will also support our team's concurrent Home Energy Reports (HER) impact evaluation. The HER analysis spans a much longer participation period, which is why National Grid provided consumption data as far back as 2012.
[6] http://rieermc.ri.gov/wp-content/uploads/2019/11/ngrid-ri-2020-trm.pdf

and, again, are not viable for billing analysis (often because the per-unit savings are too small).

The approach that we propose for each measure in our evaluation scope is shown in Figure 1.

Figure 1. Primary Impact Approach by Measure Type, Fuel and Program



Note: Engineering Adjusted Billing Analysis estimates savings by applying an algorithm to billing analysis result

In some cases, we will also explore blending more than one of these approaches to determine energy savings. For example, our team will estimate energy savings from weatherization using the billing analysis, and in doing so, attempt to differentiate between the savings generated by air sealing and each type of insulation (attic, wall, and floor) installed through the retrofit programs.[7] However, it is important to note that reliable results for more granular measure types (i.e., air sealing and attic, wall, floor insulation versus weatherization overall) are not always possible via billing analysis. This is due to several reasons: multicollinearity (i.e. most air sealing participants also install insulation), smaller sample sizes for each insulation type, and a decreased "signal" (measure savings) to "noise" (total household consumption) ratio. Our team will buttress against this possibility by relying on building simulation to offer similar insights into the savings generated by specific types of insulation.

Lighting is another example where our team will consider blending more than one approach to gain additional perspectives on the program's impact. Specifically, our team will assess household-level[8] lighting savings (via billing analysis) to complement—and potentially augment—the granular, lamp-type-specific savings that we will estimate using engineering algorithms. Together, the top-down assessment of total household lighting savings provided by the billing analysis and the bottom-up, lamp-type-specific algorithmic approach will offer our team a well-rounded perspective on the program's lighting measures and a greater chance to observe the impetus behind the evaluated savings.

The remainder of this document describes the three approaches in further detail.

Billing Analysis Details

This section describes our billing analysis in detail. In each subsection, we note where our approach for the single-family participants in EWSF differs from multifamily participants in EWMF and IEMF.

- Applicable Measures
- Treatment Group Selection
- Control Group Selection
- Data Preparation
- Model Specification

Applicable Measures

As described above, our team will use billing analysis to estimate savings for several EWSF, EWMF, and IEMF electric and gas measures.

- **Electric**. Lighting (at the household-level), weatherization (air sealing, wall insulation, floor insulation, attic insulation), and programmable thermostats.
- **Natural Gas**. Weatherization (air sealing, wall insulation, floor insulation, attic insulation), and programmable thermostats.

[7] National Grid does not test the cost-effectiveness of these weatherization types individually, however, additional savings perspective for weatherization types may illuminate where the program is more (or less) successful when weatherizing participant's homes.

[8] Our experience will similar analysis suggests that it is unlikely that the billing analysis will produce statistically significant savings for each of the specific LED lighting measures (i.e., general service, EISA EXEMPT, and reflectors)

We anticipate the billing analysis will have adequate sample size to produce statistically significant results for these measures.[9] Regardless, our team will also use engineering algorithms and/or building simulation to assess savings for each of the billing analysis measures described above. We will use these related results to validate the reliability of our billing analysis findings.

Also, as we describe above, we will aggregate each participant's individual lighting measures and use billing analysis to estimate energy savings for lighting measures as a single group at the household level. Then, the team will use algorithmic approach described later in this document to disaggregate savings to an individual measure level.

Treatment Group Selection

For our electric and natural gas billing analyses, we define treatment groups for the ESWF, EWMF, and IEMF programs as those participants who satisfy the criteria shown in Table 1.

Table 1. Billing Analysis Treatment Group Details

Savings Fuel	Measures	Installation Period	Number of Eligible Participants*
Electric	Lighting (All Types) Weatherization Programmable Thermostats	January 1, 2017 through December 31, 2018	16,402
Natural Gas	Weatherization Programmable Thermostats	January 1, 2017 through December 31, 2018	4,606

* Unique projects that received at least one program measure in 2017 or 2018. Note: the actual billing analysis will use fewer participants due to the billing data screening steps described later in this document.

9 As a rule-of-thumb, we look for +/- 25% precision at 90% confidence when reporting billing analysis results.

For the remainder of this analysis plan, we refer (for each of the three retrofit programs) to the aggregated group of 2017 and 2018 participants as the "treatment group".

Control Group Selection

We also use a control group to account for the impact of macroeconomic factors and other non-programmatic influences on pre- and post-program energy consumption. These factors include, but are not limited to, macroeconomic trends, the movement of people in and out of homes, and fluctuations in per-unit energy costs.

ARE BILLING ANALYSIS RESULTS GROSS OR NET?

Billing analysis produces a result that lies on a spectrum between net and gross savings. The exact location on that spectrum depends on the customers in the control group and the measure in question. Since we are focusing the billing analysis on weatherization, as well as using future participants as our control group, the results of our billing analysis—per the guidance of the Uniform Methods Project—should be considered **gross**. However, if the team uses billing analysis to report savings for lighting measures, the results should be interpreted as **net**.

For this analysis, we will use future participants as a control group for our analysis (i.e., a group of customers that participated in the same programs after the treatment period). As "future" participants, it is unlikely that these customers made many of the energy efficiency improvements offered through the program prior to participating, and thus we assume that our billing analysis results represent gross, rather than net, savings for all non-lighting measures.[10] Because these future participants self-selected into the same program, we assume that they are generally similar (in terms of housing stock, income eligibility, and consumption habits) and offer a reasonable counterfactual for the treatment group. We will validate this assumption as part of our analysis.

For the single family analysis, we define the control group as 2019 EWSF participants (Table 2) who also did not receive EWSF measures in 2017 and 2018. It is critical to note that although these participants later received measures through EWSF, we will only make use of their energy consumption data prior to participation.

Table 2. Billing Analysis Control Group Details, EWSF

Savings Fuel	Measures	Installation Period	Number of Eligible, Future Participants*
Electric	Any Measure	January 1, 2019 through December 31, 2019	11,651
Natural Gas	Any Measure	January 1, 2019 through December 31, 2019	4,749

*The matching and screening processes we describe below will determine exact number of future participants that we can use in the control group.

We will attempt to develop a control group for each of the multifamily programs using a similar approach.

[10] See Chapter 8 (Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol) of The Uniform Methods Project (UMP) for further detail. Available at https://www.nrel.gov/docs/fy17osti/68564.pdf.

However, these programs contain fewer participants, and facility-level participation adds layer of complexity to matching the treatment group to the control group. Should we determine that a control group is not feasible for multifamily program participants, we will use the appropriate billing analysis model specification (described later in this document). Similar to the matched control approach we describe above, this model specification produces gross savings.

Creation of Pre- and Post-Periods

As mentioned above, the treatment group are participants who installed at least one billing analysis relevant measure in 2017 or 2018. However, since treatment participation period is two years long and participants installed program measures at various times during that period, we will create customized pre- and post-periods for each participant.

For each participant, the day before the earliest program installation date (usually the date of their home energy assessment when they had measures such as lighting and aerators directly installed) is the last day of pre-period. Conversely, the day after each participant's last installation date marks the first day of the post-period.

However, billing cycles do not perfectly align with these specific pre- and post-period demarcations so we will define a "blackout" period that ensures clearly defined pre and post periods. The blackout period will include the billing cycle that includes the last day of the pre-period, the first day of the post-period, and every billing cycle in-between. Using the blackout period ensures we will not consider a participant's energy consumption during those billing cycles as part of our analysis. Table 3 below tables provides an example of pre- and post- periods for a specific customer.

Table 3. Example of Pre-Post Period Determination

First Installation	12-month Pre-Period	Latest Installation	12-month Post-Period
February 8, 2017	January 2016 – December 2016	May 28, 2017	July 2017 – June 2018

Data Preparation

Before specifying the billing analysis models, we will conduct the following sequence of data preparation steps:

- Weather Normalization
- Screening Billing Data
- Matching Treatment & Control Groups
- Controlling for Cross-Program Measures
- Multifamily Data Preparation

Weather Normalization

To weather normalize, we use weather data from the weather station closest to each customer's ZIP code. Once we determine the closest weather station, we use daily temperature data from that station to calculate the average daily heating and cooling degree days (HDD and CDD) between the read dates of

each customer billing record.[11] Next, we create a regression model for each treatment and control group customer that estimates their observed average daily consumption as a function of weather at the time (i.e., HDD and CDD during each billing cycle). Lastly, we apply each model's customer-specific coefficients, which describe how that customer's usage responds to different weather, to a "normal" weather year (or typical meteorological year - TMY3). This process yields an estimate of each customer's energy usage during an average weather year.

Screening Billing Data

After identifying the treatment and control group customers, we will apply a set of billing data screening criteria to ensure that our billing analysis model uses clean and accurate consumption data for each time interval. We will exclude customers who meet any the following criteria:

- Unable to link billing and program participation data
- Insufficient pre- or post-billing data (i.e., less than ten months of pre- or post-installation billing data[12])
- Billed consumption does not meet reasonable monthly values (outlier removal - 1st and 99th percentile)
- Large changes in pre- to post- installation period energy consumption; beyond what is potentially attributable to the program (i.e., change of +/- 80% of pre-period consumption).[13]

Matching Treatment & Control Group

After conducting the data screening process described above, we will match each treatment group customer to a future (2019) participant with a similar pre-program energy consumption profile.

Our team will use the quasi-experimental matched control group (MCG) method to identify a specific "best match." The team's MCG approach will use a nearest-neighbor algorithm to match each treatment customer to a specific control group customer. In other words, the MCG approach results in a match between a specific treatment and a specific control group customer based on both customers' energy consumption pattern over the 12 months prior to the treatment customer's participation. Our MCG approach allows for many-to-one selections, that is, a customer in the control group can potentially be the "best match" for more than one customer in the treatment group.

Controlling for Cross-Program Measures

Our team's initial assessment found that 2,062 (6%) of the EWSF participants in the treatment group also participated in one or more of National Grid's other residential programs: Natural Gas Heating and Water Heating, Central AC, and ENERGY STAR products.[14] In addition, we found that 4% and 3% of units that participated in IEMF and EWMF, respectively, cross-participated in one of these same programs. For all

[11] Using 60°F as the base temperature for HDD and 70°F as the base temperature for CDD, which is consistent with UMP's guidance.
[12] This step includes screening for vacancies.
[13] The purpose of this screening step is to eliminate unexplained changes in energy consumption – either increases or decreases - that are inconsistent with program participation. Typically, we expect to drop less than 5% of customers through this step.
[14] IEMF stakeholders notified our team that no measures are installed at participating IEMF facilities using funding from other, non-National Grid efficiency sources (e.g., WAP or LIHEAP).

programs, the team will include cross-participation variables in the billing analysis model to control to ensure the savings from these programs are not conflated with EWSF, EWMF, or IEMF measures.

Aggregate Multifamily Data

We recognize that multifamily programs pose a particular challenge for billing analyses because of the variability in which National Grid records their billing data (dwelling unit, building, or master meter) and the level at which program services are tracked. Our team's early analysis of National Grid's program data indicates that it is tracked at three, interrelated levels (units, buildings, and facilities) and that it will be possible for our team to tie each level to the relevant participant billing data.

We anticipate that we will need to aggregate in-unit and common area billing records to the building or facility level for most participants, but we are optimistic about the viability of billing analysis for the identified subset of multifamily measures. This aggregation process would also include accounting for any measures installed using C&I incentives. However, if these challenges could prove too great and we cannot obtain reliable billing analysis results our team will evaluate these measures using the multifamily BeOpt building simulation models described later in this plan.

Model Specification

Our preferred billing analysis approach is to use a monthly Post Program Regression (PPR) model to estimate average measure-specific savings for the measure and fuels shown in Figure 1. However, the PPR approach requires a control group, which could prove problematic for EWMF and IEMF. Thus, we have also included a pooled fixed effect regression model as an alternative specification for those programs.

Post-Program Regression

Our team will use a PPR model specification for EWSF. We will also use this specification for EWMF and IEMF if we are able to construct a control group.

The general form of our PPR model follows:[15]

$$ADC_{ct} = b_1 Treatment_c + b_2 LagADC_{ct} + \sum_{month\ i} b_{3i} Month_{it} + \sum_{month\ i} b_{4i} Month_{it} * LagADC_{ci} + \sum_{prog\ j} b_{5j} CrossProg_{cj} + e_{ct}$$

Where

- ADC_{ct} = average, daily energy consumption for customer *c* at calendar month *t*
- $Treatment_c$ = 1 if customer *c* is in treatment group, 0 if customer *c* is in control group.
- $LagADC_{ct}$ = average daily consumption from customer *c* during calendar month t of the pre-program period
- $Month_{it}$ = 1 when index i = calendar month t, 0 otherwise. We include this series of 12 terms to capture month-specific effects in our analysis.

[15] If we need to estimate savings for more than one weather-sensitive or base load measure, we will add the appropriate terms for each measure.

- $CrossProg_{cj}$ = 1 if customer c received an energy-efficiency measure from non-EWSF program j.[16]
- e_{ct} is a cluster-robust error term for customer k during billing cycle t. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

In the PPR model above, we derive annual, measure level savings from the coefficient b_1, which represents the average daily savings (kWh for electric, therms for natural gas) attributed due to the program. We may augment the general model shown above with terms that characterize the dwelling (i.e. attached or detached, size) and characterize other EWSF measures that impact same-fuel consumption to augment the general model described above if those terms sufficiently improve how the model fits.

To normalize energy savings that are weather sensitive, we will use customers' ZIP codes to capture customer specific TMY3 weather data. We will get an annual average HDD by using customers in the analysis and use that to extrapolate average daily savings to an annual level.

Pooled Fixed Effects Regression

If we are unable to create a control group for the multifamily programs, we will use an appropriate, alternative model specification for our billing analysis, such as a pooled, fixed effects regression.

Again, the general form of such a model would follow:

$$ADC_{kt} = b_{0k}Part_k + b_{1t}Time_t + \sum_{meas\ i} b_{2i}Measure_{ik}Post_{tk} + \sum_{prog\ j} b_{3j}CrossProg_{jk} + e_{ct}$$

Where

- ADC_{kt} = The average daily usage in kWh for customer k during billing cycle t. This is the dependent variable in the model;
- $Part_k$ is a participant level-fixed effect
- $Time_t$ is a time-period (monthly) level-fixed effect
- $Post_{tk}$= 1 if month t is in customer k's post-program period, 0 otherwise
- $Measure_{ik}$= 1 if customer k is installed measure *i*, 0 otherwise
- $CrossProg_{jk}$ = 1 if customer k received an energy-efficiency measure from cross-program j, 0 otherwise
- ek_t = The cluster-robust error term for customer k during billing cycle t. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

In the model above, we derive annual, measure level savings from the b_2 coefficients, which represent the average daily savings (kWh for electric, therms for natural gas) attributed due to the program. We will adapt this model to add weather-sensitive terms, as needed, for weatherization measures.

Engineering Algorithms Details

[16] We will also explore using program-specific cross-program participation variables.

Concurrent with the billing analysis, our team will estimate savings for a subset of EWSF, EWMF, and IEMF measures using the engineering algorithms from the 2020 Rhode Island TRM. To begin, our team identified each measure slated for evaluation using an engineering algorithm to the relevant measure summary within the TRM (Figure 2). This critical first step ensure our team will rely on the appropriate listing in the TRM, which includes many program- and customer-specific measure variations.

Figure 2: TRM Measure/Page Mapping

	EnergyWise Single Family				EnergyWise Multifamily			Income-Eligible Multifamily		
MEASURE	**Electric**	**Gas**	**Oil**	**Propane**	**Electric**	**Gas**	**Oil**	**Electric**	**Gas**	**Oil**
Domestic Hot Water										
Aerators	165	860	175	177	201	883	211	460	927	456
Pipe Wrap/Insulation (DHW)	167	864	191	193	250	893	272	466	939	468
Showerhead	171	862	195	197	254		256	462	935	458
TSV Showerhead					266/268	885/887	264		932/933	
Lighting										
LED Bulbs	155									
LED Fixtures	153									
LED Reflectors	159									
LED Specialty/EISA Exempt	157									
Lighting (MF Common)										
LED Bulbs (Exterior)					213			430		
LED Bulbs (Interior)					229			446		
LED Fixture (Exterior)					215			444		
LED Fixture (Interior)					231			442		
LED Reflector (Exterior)					225					
LED Reflector (Interior)					233			438		
Lighting (MF In-unit)										
LED Bulbs (Interior)					243			448		
LED EISA EXEMPT (Interior)					241			432		
LED Fixtures (Exterior)					237					
LED Reflectors (Exterior)					239			424		
LED Reflectors (Interior)					247			436		
Controls										
Programmable Thermostat	145	856	149	189	260/262	874	217	410/412/414	913	416
Wifi Thermostat	147/183	858	185	187		876				
Appliances & Plug Load										
Refrigerator Brush	163									
Refrigerator Rebate	137				252			398		
Smart Plugs	*									
Smart Strip	161				258			452		
Weatherization										
Air Sealing					205	868	203		907	400
Air Sealing Kit	179	854	139	181						
Insulation/Weatherization	143	866	141	*	209	870	207		909	404
Custom										
Custom					235	872		408		
Custom Non-Light								**		
Early Retirement										
Clothes Washer	*									
Dehumidifier	*									
Room Air Conditioner	*									
Heating System										
Boiler (Commercial)									923	
Boiler (Residential)									919	

**Denotes new measure*
*** Team is awaiting final clarification from National Grid*

Billing Analysis
Building Simulation
Engineering Algorithm
Engineering Adjusted Billing Analysis
Billing Analysis and/or Engineering Algorithms

Next, our team reviewed the energy savings engineering algorithm associated with each measure. For nearly every measure, the TRM includes the same basic gross savings algorithm:

$$Gross_{kWh} = Quantity\ x\ deltakWh$$

For some measures, the TRM also includes a secondary algorithm for calculating *deltakWh*.[17] However, in many cases, the TRM does not and instead references a previously completed evaluation. For example, one showerhead measure (M-254) references the 2012 Massachusetts Low-Income Multifamily Initiative Impact Evaluation completed by The Cadmus Group as the source of the savings value. In instances such as this, our team will locate the referenced evaluation and identified the relevant information to estimate the *deltakWh* term in Rhode Island's TRM.[18] In this case, the aforementioned evaluation used the following algorithms to estimate savings for showerheads:

Shower water energy saved *= shower water use reduction* (Temperature of shower - Temperature of incoming cold water) * conversion to energy/water heater recovery efficiency*

Shower water use (gallons/year) *= household members * showers per capita per day * shower length * proportion of showering activity affected by replacement * as-used water flow rate*

In other instances, the referenced evaluation did not rely on an algorithmic approach, instead using billing analysis or building simulation to estimate savings. When this happens, our team will rely on the Massachusetts TRM[19] or another well-established industry engineering algorithm.

After identifying the appropriate algorithm – as stated in the Rhode Island TRM, a previous evaluation report, or elsewhere – our team will search out relevant algorithm inputs in the program data provided by National Grid. Again, using showerheads as an example, the program included some, but not all of the algorithm inputs (e.g., number of showerheads installed, but not baseline flow rate or hot water setpoint temperature). Our team will rely on a combination of program documentation (which provides guidance to assessors on which showerheads are eligible for replacement) and other well-established, regionally appropriate secondary sources when program data is unavailable.

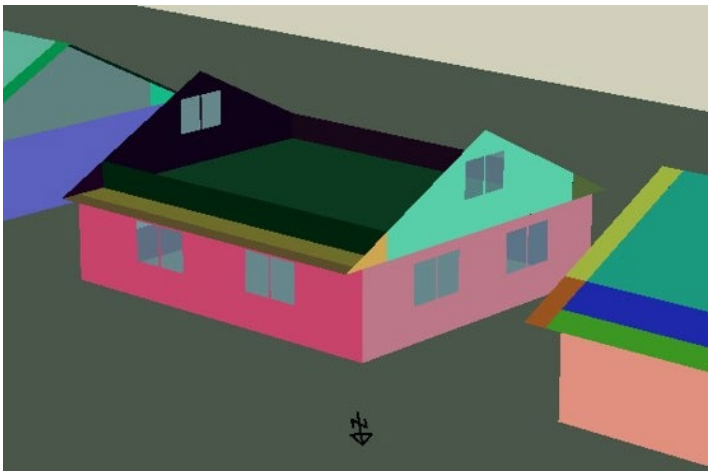
Building Simulation Details

Our team will use building simulation for a small subset of measures that generate (or are subject to) interactive effects and that do not readily lend themselves to billing analysis.

[17] Or *deltaMMBtu* for gas and oil measures
[18] Our team reserves the right to use a different algorithm if we determine the algorithm previously employed is insufficient.
[19] https://www.masssavedata.com/Public/TechnicalReferenceLibrary

For this evaluation, we will use the BEopt building simulation software, which was created by the National Renewable Energy Laboratory and utilizes the Department of Energy's EnergyPlus as its simulation engine. Similar to the engineering algorithm approach described above, our team will utilize as much program-specific participant, household, and measure data as possible as BEopt inputs.

Figure 3: BeOpt Building Shell Rendering of Single Family Prototype Home



We will construct multiple simulation prototypes for each program to account for differences in building configuration, heating systems, heating fuels, and other building characteristics. The following subsections offer more detail for EWSF and EWMF/IEMF.

Modeling EWSF

To model homes that participated in EWSF, we propose to construct at least six models: one building configuration, two heating fuel types (electric and gas[20]), and at least four heating/AC system combinations.[21] We will finalize the exact set of heating and AC system configurations we will model based on the prevalence of each system within the program data. This analysis is ongoing, but we anticipate including baseboard, furnace, boiler, and heat pumps.

We propose to use one building configuration protype to model EWSF program participants: a detached 1.5 story model as can be seen in Figure 3. In this prototype, the home has a finished main floor with a half-finished upstairs/attic area containing kneewalls. We want to prioritize including kneewalls in our model because knee wall insulation is a common EWSF measure, even in homes listed as one story in the program data.[22] The team's decision to model this building prototype as a representative of EWSF homes is further detailed in the following paragraphs.

We looked at three key home characteristics in the EWSF data to inform our building simulation prototypes for the program: number of stories, square footage, and home types. As detailed in Figure 4, we found that 93% of EWSF participants live in one or two-story homes. While stack effect[23] is a critical factor when modeling high-rise buildings, the difference in stack effect in one and two-story homes is

[20] We will also calculate savings for oil and propane heated homes by scaling the results of the natural gas prototype building by the relative heating system efficiencies.

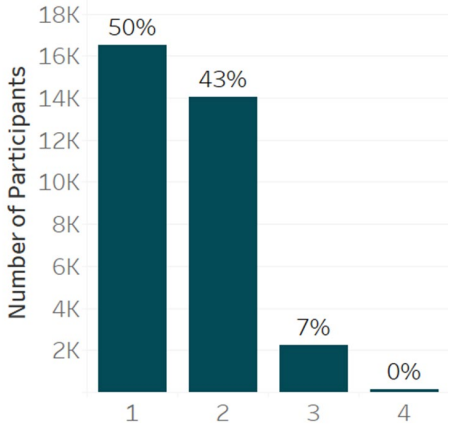
21 The team will address additional combinations of heating/AC systems based on their prevalence in program data. At a minimum, the team expects to model two gas heating systems and two electric heating systems.

[22] 45% of EWSF participants that received kneewall insulation are listed as living in 1 story homes.

[23] Stack effect is when warm air moves upward in a building, resulting in differences in temperature and pressure at different heights within the structure.

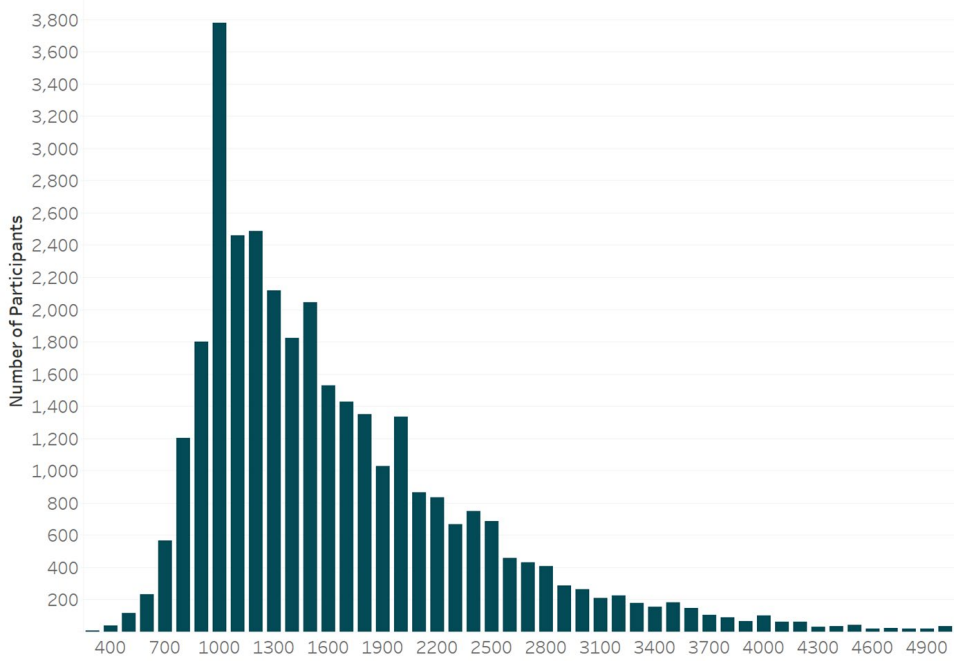
minor. Consequently, our team plans to model a hybrid detached, 1.5 story building with knee walls that reflects the vast majority of EWSF homes.

Figure 4. EWSF Building Number of Stories Characteristics



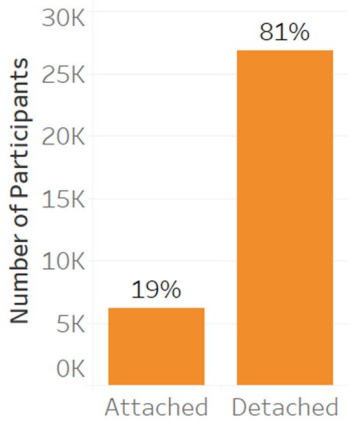
Next, we looked at the square footage of conditioned space to determine if the EWSF participant square footage distributions were uni-modal (which suggests using an overall program average) or multimodal distribution (which would warrant multiple prototype models). As evident in Figure 5, the distribution is unimodal, with an average of 1,684 square feet. In fact, 60% of participating EWSF homes were between 800 and 1,800 square feet.

Figure 5. Square footage of EWSF homes



Finally, we looked at the prevalence of attached vs detached homes. As evident in Figure 6 below, 81% of participants live in detached homes, consistent with our model.

Figure 6. EWSF Building Types Characteristics



Modeling EWMF and IEMF

The team analyzed a number of factors to identify which building characteristics most accurately represent the EWMF and IEMF sample data. Like EWSF, these key characteristics include the number of stories, number of units, square footage and heating system type. The team assessed each of these characteristics for both multifamily programs to determine if our team needed to create program-specific models or if, for some prototypes, an overall multifamily model was appropriate.

We have come to the preliminary conclusion to model at least four prototype buildings to evaluate the EWMF and IEMF programs. One building configuration, at least two fuel types (again, electric and gas), at least 2 heating system types, and potentially different IEMF and EWSF model variations based on other building characteristics (e.g., differing pre-program insulation levels). The team proposes to use one 3 story "low rise" building, which represents the most common multifamily program participant building configurations. Our path to that decision is detailed below.

First, we analyzed the average number of stories in multifamily participant's buildings. As seen in Figure 7 91% and 83% of the buildings that participated in EWMF and IEMF, respectively, were between 2 and 4 stories. Therefore, modelling a 3-story multifamily building will provide accurate estimate savings for the majority of participants in both programs. We also considered modeling a high-rise building configuration to account for taller participating buildings. However, the number of such buildings (even when accounting for total participating units, not buildings) represent a small portion of the total program's participation and is not the highest use of evaluation resources.

Our team is still investigating the appropriate building prototype square footage and number of units for both MF programs. Our data review identified some uncertainties in the EWMF/IEMF building characteristic data (i.e., does the value in the program data reflect entire facilities, individual buildings at those facilities, or tenant spaces). Our team is currently working with National Grid to clarify these values so that we can apply them appropriately.

The team will also continue to explore potential differences between EWSF and IEMF buildings that would suggest creating separate models for each program. While our initial review of the MF data did not find any significant differences, we continue to dig deeper in the program data to identify potential

discrepancies that would warrant either additional models or, at a minimum, using different baseline assumptions within a model (i.e., different pre-program wall insulation levels). Specifically, the team is looking into the hypothesis that IEMF buildings may be different from EWSF buildings in terms of the quality and/or condition of their pre-program building shell or air sealing characteristics. Such differences would not necessarily require a separate building prototype but may warrant program-specific models with separate pre-program/existing conditions assumptions.

Figure 7: EWMF and IEMF Building Characteristics by # of Buildings

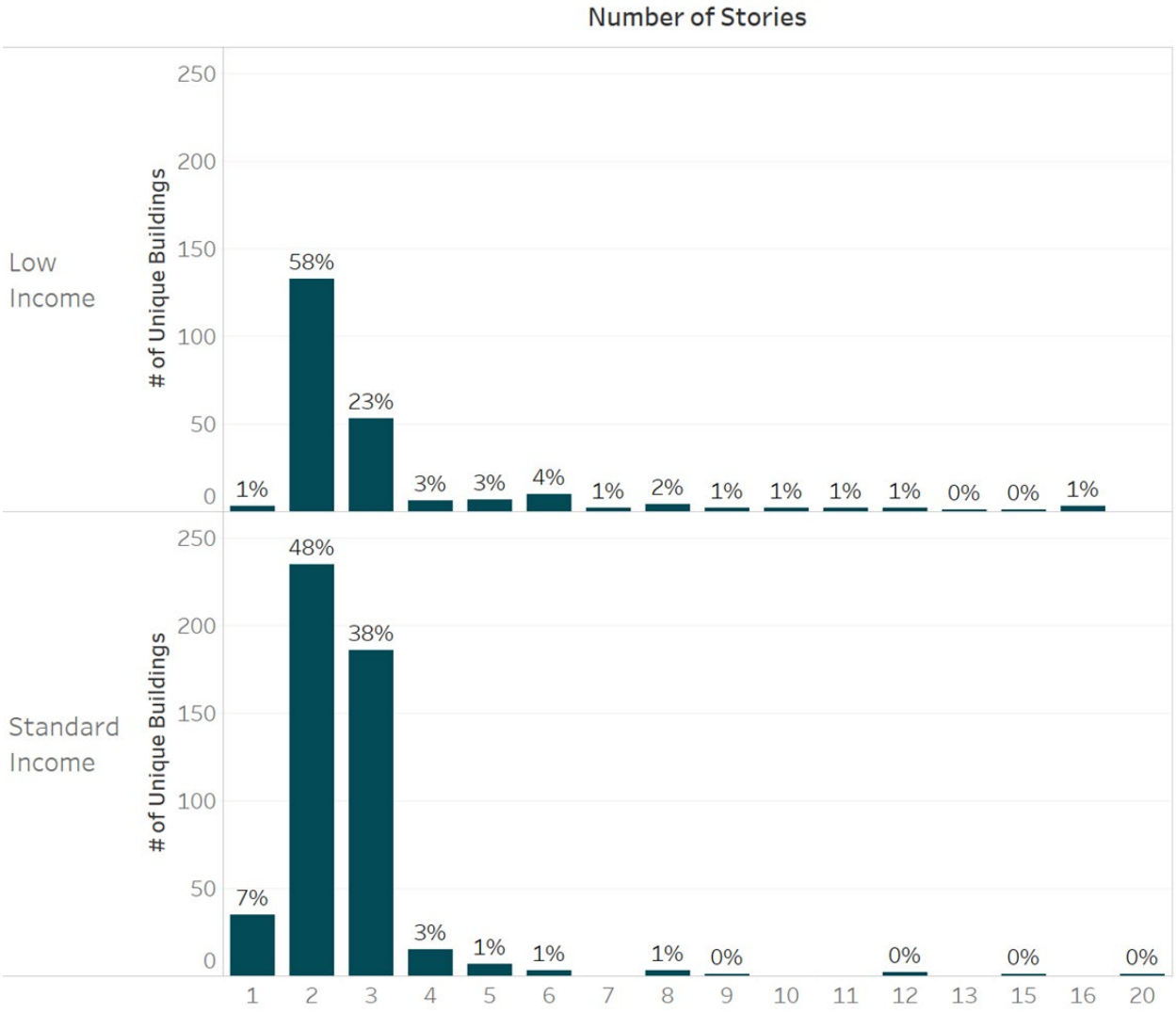
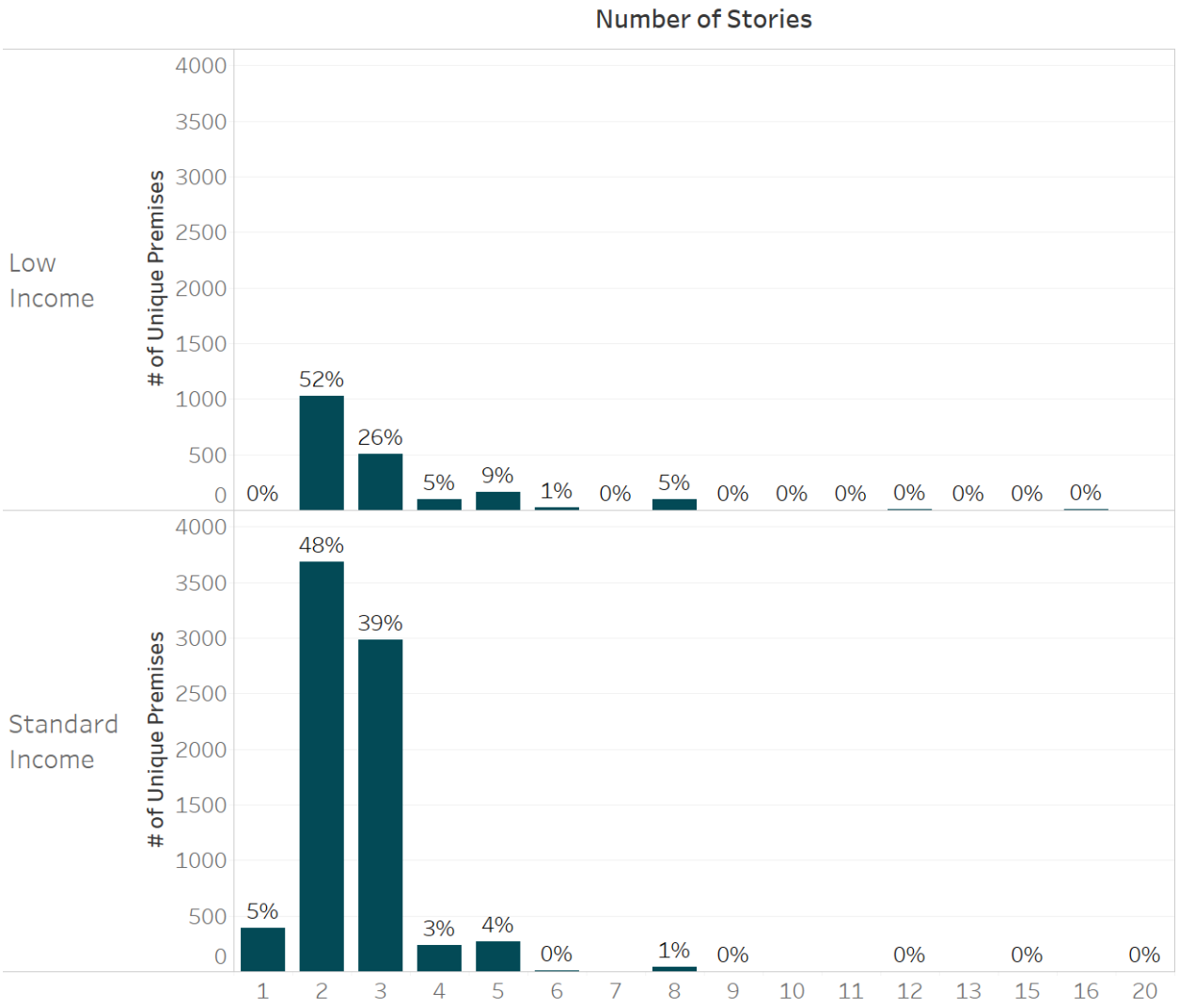


Figure 8: EWMF and IEMF Building Characteristics by # of Units (Premises)



Appendix C.
Net-to-Gross Methodology Memo

Memorandum

To: Romilee Emerick and Adam Wirtshafter, National Grid
From: Cadeo and ILLUME
Date: May 1, 2020
Re: Net-to-Gross Methodology for EWSF and EWMF in Rhode Island

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National Grid contracted with Cadeo and ILLUME (the evaluation team) to evaluate their EnergyWise Single Family and Multifamily programs in Rhode Island. The evaluation includes measuring net-to-gross (NTG) for the programs. This document contains the evaluation team's proposed approach.[1]

As detailed below, the team applied the NTG method published in the 2020 Illinois Statewide Technical Reference Manual (TRM) for Energy Efficiency, Version 8.1 (available here). In the absence of a Rhode Island-specific NTG approach, our team identified the Illinois approach as the most appropriate alternative; it's a comprehensive NTG framework that follows industry standards for measuring free-ridership and spillover, while striking a reasonable balance between analytical rigor and survey length.[2]

The result of this research will be measure category level (e.g., in-unit lighting) NTG ratios that our team will apply to the evaluated gross savings for all measures (e.g., in-unit LED lamps, reflectors, and fixtures) within that category.

In this memo, we discuss, in detail, each element shown in the basic NTG formula shown below:

NTG = 1 – (Free-ridership + Participant Spillover)

Program Information

National Grid Rhode Island's EnergyWise Single Family (EWSF) program offers no-cost energy assessments for single-family homes (defined as one-to-four-unit buildings). During the assessment, an energy specialist directly installs certain energy-saving products free of charge and visually inspects the home for further energy saving equipment recommendations. The energy specialist produces a report documenting the findings of the assessment and recommendations, which the energy specialist discusses with the customer at the end of the assessment. Customers may be eligible for up to $4,000 in rebates toward the cost of insulation, air sealing, and appliances.

National Grid Rhode Island's EnergyWise Multifamily (EWMF) program operates similarly, providing multifamily buildings (defined as five-or-more-unit buildings) includes home energy assessments, direct-install measures and rebates on in-unit and common area energy efficiency measures, typically 75% of cost, up to a threshold of $2,000 depending on the measure. Multifamily properties that receive National Grid electric, gas, or dual-fuel are eligible to participate, although direct install and rebated measures differ depending on the fuel type. Direct install measures include in-unit lighting common area lighting,

[1] The evaluation team will not be conducting NTG for the Income Eligible Multifamily program, assuming a NTG ratio of 100% (as is common practice for income eligible programs.)
[2] The team explored the possibility of using the standardized approach currently being developed in Massachusetts but determined the approach would not be finalized soon enough to meet the timeline for these evaluations.

smart strips, thermostats, air sealing, showerheads and aerators and refrigerators. Rebated measures include common area lighting, insulation, demand controllers, and outdoor reset controllers.

Proposed Net-to-Gross Method

The evaluation team will provide net savings, reflecting both free-ridership and participant spillover at the measure category level (e.g., in-unit lighting). All measures within that category (i.e., in-unit LED lamps, reflectors, and fixtures) will share the same NTG value. The study will use a self-report survey, administered in conjunction with the process evaluation, to collect NTG-related data from recent EWSF and EWMF participants.

The evaluation team proposes using the NTG approach detailed in the state of Illinois' TRM in sections 4.5 (Single Family Home Energy Audit) and 4.6 (Multi-Family Protocol). This methodology gives credit for all the influential components of the program, including the information and education provided through the energy assessment and the rebates.

In order to measure the impact of the separate components of both EWSF and EWMF, including the energy assessment, no-cost direct install measures, and rebated measures, the evaluation team will include sections of the survey battery tailored to match the customer's specific experience. The Illinois TRM recommends two approaches, one for the direct installation of free low-cost measures (i.e., direct install measures installed during the assessment) and a second approach for rebate measures, such as air sealing and insulation.

It is essential that the individuals we survey are familiar with the decisions for participation, installations, and any program-related follow-up actions. The target respondent is most apparent and easily identified for EWSF, as it tends to be the person of record in the tracking data. For EWMF, there may be multiple participants that the team will need to contact. For common area and building shell components, the appropriate "participant" for the survey is the property manager and/or building owner; for in-unit measures, such as efficient lighting, surveys could include residents (tenants or owners) as well as property managers/building owners. The evaluation team will identify the correct respondents based on program staff interviews and review of the tracking data. The team will also verify the contact person was the primary decisionmaker through the survey screening process.

Free-ridership

As noted above, the free ridership battery will have separate modules for direct install and rebated measures and includes a separate NTG algorithm for each. These batteries and algorithms reflect the fact that rebated measures require a more complex decision-making process, and therefore need a more rigorous process than direct install measures. We have noted these measure type differences, where relevant, in the text below.

There are three basic components to the free-ridership question series**: Program Influence Score, No Program Score,** and **Consistency Checks**.

1. Program Influence Score

The Program Influence (PI) score, which is only relevant for rebated measures (not direct install measures), assesses the participant's perception of the influence of various program elements—including the assessment and rebate—on their decision to install the recommended rebated measure. The algorithm provides the program credit by using the maximum rating provided by the respondent to any one area of program influence. This approach acknowledges that a variety of program components can influence customer decision-making in different ways.

The team will ask surveyed participants questions related to program influence score such as:[3]

> *Please rate the importance of each factor that may have influenced your decision to have energy efficient product(s[4]) installed at this property through the program. Use a scale from 0 to 10 where 0 means "not at all important" and 10 means "extremely important".*
>
> - *The [REBATE/DISCOUNT] received for [PROGRAM MEASURE].*
> - *Recommendations from the assessor/contractor/National Grid representative*
> - *Information from the National Grid Multifamily program or other marketing materials*
> - *The no-cost project management and installation*
> - *Recommendation from someone else [follow-up: did they participate in the past?]*

The team will calculate the PI score as:

Program Influence Score (PI) *= Max (program-related influence ratings)*

2. No Program Score

The No Program (NP) score, calculated for both direct installation and rebated measures, captures the program counterfactual, i.e., the participants' likely decisions absent the program. As is standard practice in NTG studies and documented within the Uniform Methods Project protocols on common practices for estimating net savings[5], this score considers the following three components: **timing, efficiency,** and **quantity.**

Exactly how the team will ask NP questions will vary depending on specific measure the participant installed, but the questions will look like the examples below and focus on measuring timing, efficiency, and quantity, all on a 0-10 scale (where 0 is not at all likely and 10 is extremely likely):

Timing (T)

- *What is the likelihood that you would have installed an item of any efficiency within 6-12 months, had you not received it through the program?[6]*

Efficiency (E)

- *Without the program, what is the likelihood that you would have installed equipment of the same level of high efficiency as the unit installed had you not received them for free through the audit? (For direct install measures)*
- *Without the program, what is the likelihood you would have installed equipment of the same level of efficiency? (For rebated measures)*
- *Without the program, what is the likelihood you would have installed [measure]?*

(Q)uantity

- *What is the likelihood that you would have installed fewer measures / performed less weatherization without the program?*

---

[3]The program influence rating for the rebate is adjusted if the participant said they decided to purchase the equipment before learning about the rebate.

[4] Note that the survey will be programmed to ask about the specific, appropriate measure for a given participant

[5] https://www.nrel.gov/docs/fy17osti/68578.pdf

[6] The team will use 6 months for less expensive items, such as direct install measures, and 12 months for more expensive or rebated item

The team will calculate the NP score as follows. The elements address free-ridership, with the lower values representing lower free-ridership. The algorithm therefore takes the minimum value, providing credit in the area most influential. The algorithm then divides the value by 10 to calculate a ratio, or percentage, which will be used to calculate the free-ridership ratio

$$\textbf{No Program Score (NP}FR\textbf{)} = Min\,(T, E, Q)/10$$

3. Consistency Check

It is possible that some surveyed participants will provide responses that are inconsistent (i.e., the PI score does not indicate free-ridership, while the NP score does). While these batteries have been implemented in many jurisdictions, it is possible that participants can misinterpret the closed-ended questions and/or that the questions posed do not capture the full range of program influences.

To account for these issues, the evaluation team will include open-ended questions about program influences, which will serve as consistency checks for the PI and NP responses. The evaluation team has found that the consistency check questions rarely change the free-ridership results, but can be invaluable for providing additional context for the results.

All participants

- *Finally, in your own words, can you tell me how influential the program was in your decision to install this / these measures at the time you did? Consider all the areas discussed in this survey.*

For direct install recipients with inconsistent results

- *Prior to the audit, had you purchased any [measure]? Y/N*
- *IF YES AND NP <7: Before receiving the audit, why didn't you purchase additional on your own without the program? [OPEN END]*
- *IF NO AND NP >6: Given that you have not purchased before, why were you likely to purchase on your own without the program? [OPEN END]*

The evaluation team will assess all responses to open-ended questions and exclude respondents with responses that cannot be resolved through review of individual questions. The evaluation team will document the number of and reason for any exclusions in the report.

Consolidating Results to Calculate Free-Ridership

For participants that pass the consistency screening check, the team will calculate free-ridership for rebated measures by averaging the No Program and Program Influence scores and use the No Program score for direct install measures.

The following figures illustrate how the various scores are operationalized to calculate NTG for single family and multifamily programs evaluated in Illinois. These figures are excerpted directly from the Illinois TRM.

Figure 1: Free-ridership Summary: Direct Install/No Cost Measures

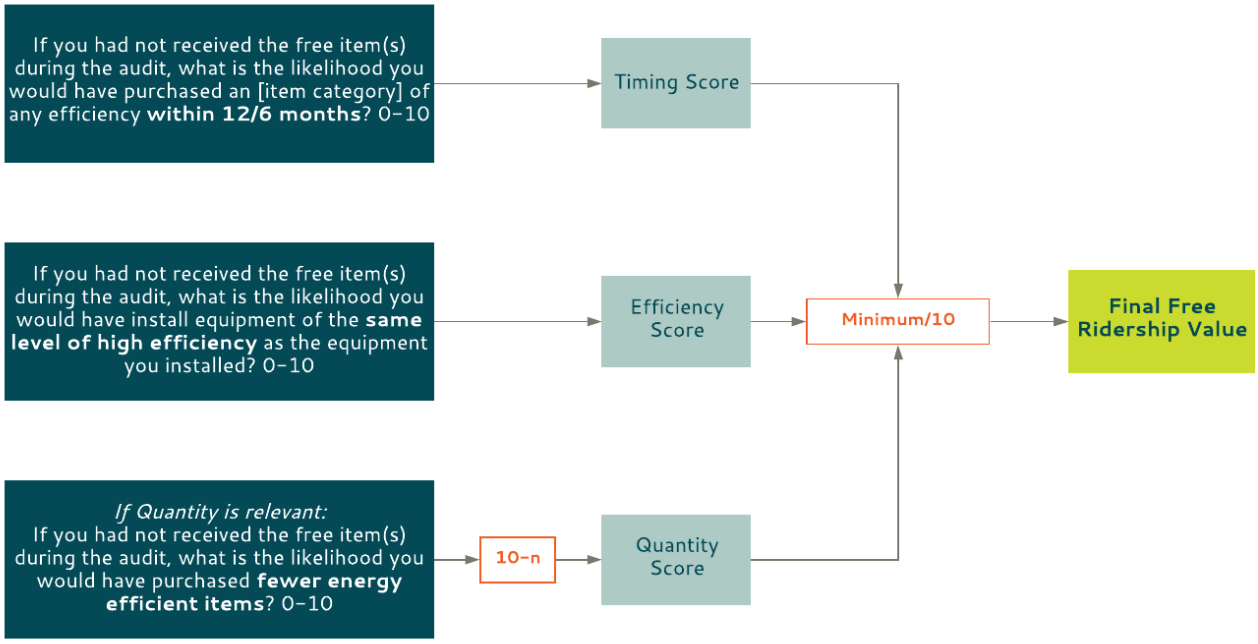
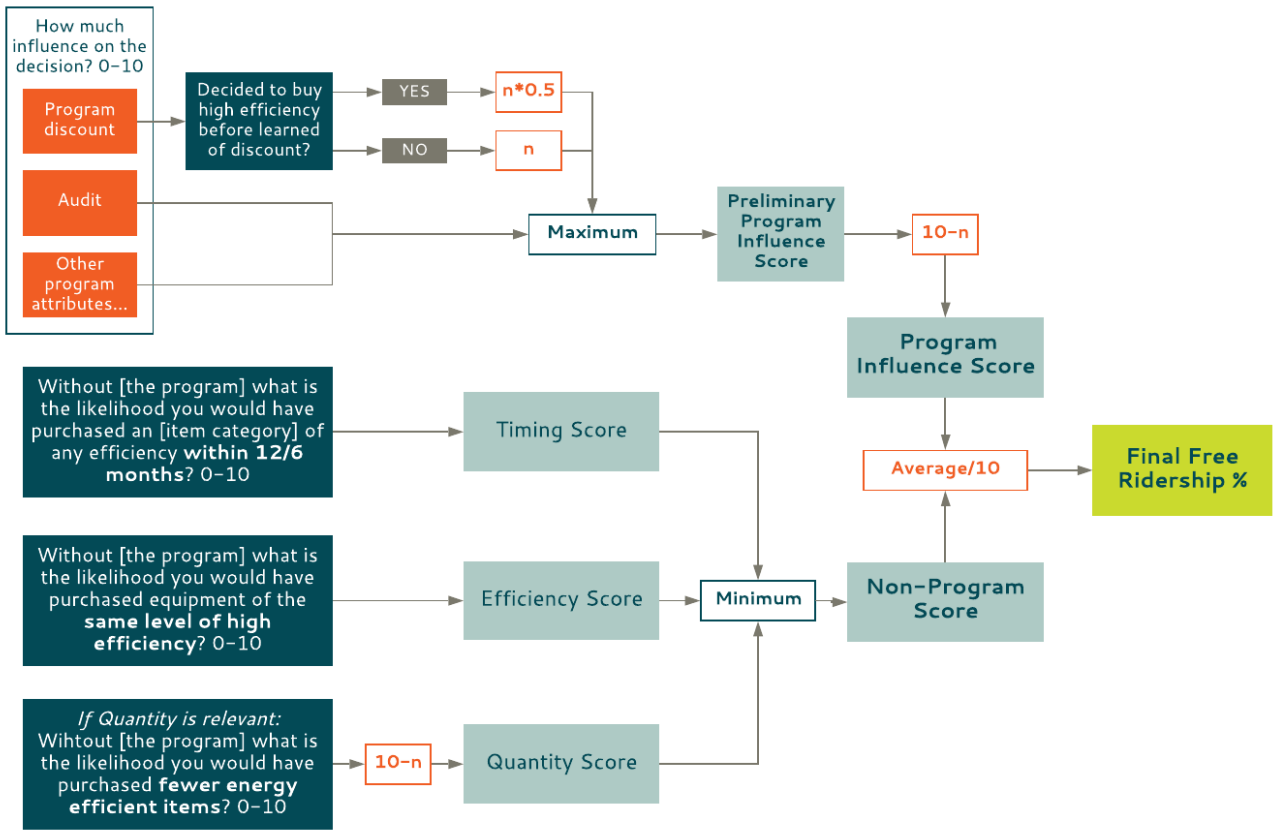


Figure 2: Free-ridership Summary: Rebated/Major Measures



Spillover

The evaluation team will also use the participant survey to calculate participant spillover, i.e., additional energy efficiency actions taken by the participant as a result of their participation. The approach detailed within this section aligns with the approaches used and outlined in both the Illinois TRM and the most recent Massachusetts Multifamily Impact and NTG evaluation[7].

The survey first asks questions to assess what was installed and could potentially qualify for spillover savings. As examples (note question wording will be programed to match participant experience as appropriate):

- *What did you install since your participation in the program?*
- *Did you receive a rebate for that installation?*
    a. *If did not receive a rebate, but they say the program is high-efficiency, and falls within specific areas that National Grid offers rebates, the survey could also ask why the respondent did not receive a rebate for that measure. This type of consistency check question can reveal if they tried but it did not qualify (thereby disqualifying the measure) and/or reveal process-related information that can be valuable to know).*

Any measures where the respondent indicates they received a rebate are disqualified, and subsequent questions are not asked for these measures.

From there, the battery uses a simplistic approach to assess program influence on spillover, basing the analysis on two questions for each measure mentioned in the prior question. Aligning with the free-ridership approach, the battery accounts for importance (or, influence) and the counterfactual intention, as shown below.

Measure Attribution Score 1

- *How important was your experience with the [PROGRAM] on your decision to install these efficient products on your own? [Scale from 0-10 where 0 is "not at all important" and 10 is "extremely important"].*

Measure Attribution Score 2

- *If the [PROGRAM] did not exist, how likely is it that you would still have installed these energy efficient products on your own? (Scale from 0 to 10, where 0 means WOULD NOT have installed the equipment and 10 means definitely WOULD have installed the equipment)*

This approach then combines the responses from these two attribution scores to create a spillover score which accounts for both importance and intention, providing equal weight to each.

Spillover Score = (Measure Attribution Score 1 + (10 – Measure Attribution Score 2))/2

This approach takes a threshold approach to assigning savings. A spillover score of at least 5 indicates program influence and attributes spillover savings when that threshold is met. In other words, if the spillover score is greater than 5.0, the energy impacts associated with that higher efficiency measure are attributable to the program. If the spillover score is less than 5.0, then the energy impacts are not attributable to the program.

[7] http://ma-eeac.org/wordpress/wp-content/uploads/RES-44_Multi-family-Program-Impact-Evaluation_FINAL_SO-Rates-Updated.pdf

$$\textbf{Total Spillover Savings} = \sum \quad savings\ for\ measures\ with\ attribution \geq 5$$

Finally, the evaluation team will calculate a program-level spillover rate in two steps. First, the team will calculate a participant-level spillover rate using the participant-specific data, calculated as:

$$\textbf{Participant Spillover Rate} = \textbf{Total Spillover Savings / Total Savings}$$

The analysis will then calculate a final, savings weighted spillover weight to represent the population-level spillover.

The evaluation team recommends only assigning spillover savings for measures that are included in National Grid's Technical Reference Manual (TRM) and/or where evaluated savings are reported as part of this study. Doing so will provide the most defensible results and ensure the relative savings values align with what is claimed in these Rhode Island programs.

Finally, the evaluation team recognizes that before qualifying a measure for savings it is important to validate efficiency levels as best as possible. Participants may say a measure is efficient, but in fact it is not. As noted earlier, the survey will assess whether they attempted to apply for a rebate for the measure; applying and not receiving the rebate is an indicator that the measure may not have qualified for efficiency reasons. The survey will also include confirmation questions to assess efficiency qualification. The Massachusetts Program Administrators used the question below, which we plan to include for this evaluation. We will refine this question and categories during the survey design process.

How did you know that the product(s) you installed were energy efficient?"

Response option	***Indicates efficiency***
Efficiency rating or label of equipment, such as ENERGY STAR logo	*Yes*
Equipment dealer/retailer said it was efficient	*Yes*
Personal experience	*No*
Met utility rebate requirements	*Yes*
Did not rely on any specific type of information	*No*
Don't know	*No*
Other (record)	*Evaluated individually*

Appendix D. Additional NTG Details

Table 1. Program Influence on Timing

Measure Category	n	0	1	2	3	4	5	6	7	8	9	10
Appliances & Plug Load	163	18%	26%	11%	9%	7%	7%	5%	6%	5%	2%	4%
Controls	40	25%	3%	3%	10%	13%	15%	5%	8%	8%	3%	10%
Domestic Hot Water	52	19%	23%	10%	10%	6%	13%	4%	6%	2%	0%	8%
Lighting	155	7%	3%	7%	3%	5%	11%	9%	9%	17%	5%	25%
Weatherization	151	20%	27%	21%	10%	3%	4%	3%	3%	3%	1%	5%
Overall	**561**	**16%**	**18%**	**12%**	**8%**	**6%**	**9%**	**5%**	**6%**	**8%**	**2%**	**11%**

Questions F2 & F6. If you had not received [measure] as part of your assessment, what is the likelihood you would have purchased a(n) [measure] within 6/12 months of your assessment?

Table 2. Program Influence on Quantity*

Measure Category	n	0	1	2	3	4	5	6	7	8	9	10	NA
Appliances & Plug Load	163	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	99%
Controls	40	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	98%
Domestic Hot Water	52	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	98%
Lighting	155	7%	9%	3%	7%	3%	11%	4%	9%	8%	7%	13%	19%
Weatherization	151	21%	20%	4%	3%	3%	5%	4%	9%	9%	9%	13%	1%
Overall	**561**	**8%**	**8%**	**2%**	**3%**	**2%**	**4%**	**2%**	**5%**	**5%**	**4%**	**7%**	**50%**

Questions F3 & F7. If you had NOT received the item(s) during the assessment, what is the likelihood you would have installed FEWER of the item(s)/less [sampled major measure]?
*Asked only when possible to install fewer or less of the sampled measure.

Table 3. Importance of Program in Decision to Install*

Measure Category	Rebate or Discount	Recommendation from Energy Specialist	Information provided during assessment	Program Materials or website	Recommendation from someone else
Weatherization	8.8	8.0	8.1	5.4	3.9

Question F8. Please rate the importance of each factor that may have influenced your decision to install the [MEASURE NAME]. Please use a scale of 0 to 10, where 0 is "not at all influential" and 10 is "extremely influential."
*Asked for major measures only.

Table 4. No Program Scores – Minimum of Timing or Quantity

Measure Category	n	0	1	2	3	4	5	6	7	8	9	10	Mean
Appliances & Plug Load	163	18%	26%	11%	9%	7%	7%	6%	6%	5%	1%	4%	3.0
Controls	40	25%	3%	3%	10%	13%	15%	5%	8%	8%	3%	10%	4.3
Domestic Hot Water	52	21%	23%	10%	10%	6%	13%	4%	6%	2%	0%	6%	3.0
Lighting	155	17%	8%	14%	8%	5%	14%	5%	7%	5%	6%	11%	4.3
Weatherization	151	27%	27%	21%	8%	3%	5%	3%	2%	1%	2%	2%	2.0
Overall	**561**	**21%**	**19%**	**14%**	**9%**	**6%**	**9%**	**4%**	**5%**	**4%**	**3%**	**6%**	**3.2**

*Lower score means greater program attribution.

Table 5. Program Influence Scores – Major Measures Only

Measure Category	n	0	1	2	3	4	5	6	7	8	9	10	Mean
Weatherization	151	1%	0%	0%	0%	0%	1%	2%	3%	6%	18%	69%	9.4

*Higher score means greater program attribution.

Appendix E: Program Manager Interview Guide

National Grid Rhode Island
Residential Retrofit—Process Evaluation
Program Manager & Lead Vendor Interview Guide

Introduction

Thank you for taking the time to talk with us today. Our work requires having a solid understanding of the programs we are evaluating. There are no right or wrong answers, this is simply to help us gain a better understanding of the program.

We have four goals for this interview:

- To understand how the program works overall
- To gather information about your experience with the program, including successes and challenges you have had
- To find out about changes you are considering, or intend to make, to the program
- To learn what you would like to learn from this evaluation that will help you go forward with this program.

We expect this interview to take about 90 minutes. We'd like to record this interview to refer to our notes later. Is that okay with you? Do you have any questions for us before we begin?

Roles and Responsibilities

Let's begin by talking about your roles and responsibilities.

1. Can you briefly describe your role in implementing the **[ENERGY WISE SF, ENERGY WISE MF, INCOME-ELIGIBLE MF]** program?

2. Please describe the broader set of stakeholders that help deliver the program, as well as their roles. Probe/listen for:
   - Lead vendor and in-home assessors
   - Installation contractors
   - QA/QC
   - Other residential efficiency programs
   - [**INCOME-ELIGIBLE MF**: CAPs or RI DHS – marketing/income verification]

3. How do team members communicate? Probe/listen for:
   - Is there an expected method or frequency in communication?
   - How is this working overall? Do you have the right information at the right time?
   - Any opportunities for improvement?

4. Are there any other important program stakeholders you rely on to market or deliver the program?

5. Do you have enough help? In what areas could you use more support?

Program Planning and Goals

6. We know there are energy savings goals for these programs. Are there other primary goals for the **[ENERGY WISE SF, ENERGY WISE MF, INCOME-ELIGIBLE MF]** program we should be aware of?

7. How do you track progress towards these goals?

8. Are there any other objectives, maybe softer or internal targets?

9. How did the program do relative to its participation and savings goals, as well as any of these softer/internal targets, in 2017, 2018, and 2019?

10. What's happening with the program right now due to COVID-19?

11. Has participation tended to differ for certain customer or building types (for example, by ethnicity, primary language, renter vs. owner, home type, geography)? Why do you think that is?

12. Prior to the changes caused by COVID-19, what, in general, was going particularly well with the program?

13. Again, prior to the changes caused by COVID-19, what program aspects were you struggling with and/or working to improve?

14. In the process of planning for this evaluation we reviewed filing documents and noted some specific enhancements that were planned. I was hoping we could talk through them and you could let me know the status of each. (Probe as relevant)

    EnergyWise (both SF and MF)
    - A substantial participation goal increase
    - An enhanced landlord incentive (up to 100%)
    - Efforts to launch a residential energy score/asset rating
    - An online assessment, which customers could access directly

    MF (EWMF and IEMF)
    - An overall review of multifamily marketing
    - A shift in goals towards custom projects and air source heat pumps as lighting savings continue to decline
    - A consideration of a tiered incentive approach designed to get more units to participate
    - An effort to provide greater choice to the condominium market

    IEMF
    - Increased outreach to CDCs

15. Have you made any changes to program processes in the last year or so?

16. Looking ahead, can you tell me about any changes underway for 2020? Probe/listen for:
    - Any changes in marketing approach?
    - What about measures?
        - What measures are you considering for 2020? What measures are you not considering for 2020? What is the rationale behind these considerations?
        - How do you anticipate the program changing in another year, two years? (specifically on the program in a post-lighting future).
    - Any expansion or reduction in eligibility?
    - Any changes specific to multifamily buildings? Rental properties?
    - What about the income eligibility process?
        - Can you walk me through how this typically works?
        - How are/aren't income qualification procedures working? (Probe to understand if these are a barrier to program participation and if so, what is being done to address this.)
        - How, if at all, could these procedures be improved?
        - Can you please describe any differences in income qualification procedures between homeowners versus renters?

17. How do you track and manage program data? Probe/listen for:
    - Who is involved in this process?
    - How well do you think the current data collection process is working?
    - Have you had any issues with data accuracy or completeness?
    - How is the data tracking system working (for all parties involved)?

Customer Participation & Experience

Now I'd like to talk through some details of the program.

18. Let's start with recruitment and sign up. I understand that customers can sign up for a home energy assessment in a variety of ways, such as online, by phone, or through a local CAP agency (for income-eligible customers).

    Can you talk me through how participants get started in the program? Probe/listen for:
    - Are there any other ways customers sign up?
    - How do most participants enter the program?
    - Do you offer sign-up in multiple languages?
    - One of the scheduling scripts we've reviewed indicates that customers are asked how they heard about the program. What is the most common source of program awareness?
    - What happens after a customer enrolls (i.e., confirmation email; reminder email; phone calls; day of assessment communications)
    - How far out are assessments scheduled?
    - What kind of cancellation rate have you seen?

19. Next, can you briefly walk me through a typical home assessment? Probe/listen for:
    - What does the typical assessment look like?
    - Do you use one assessor or two?

- How long do assessments typically last? How often do they exceed that?
- In your opinion, do assessors have enough time in each participant's home?
- How many assessments does each assessor typically complete in a day?
- How is the assessment report provided? Is it produced right away and reviewed with the customer, or is it sent as a follow up?

20. I have a few questions about the measures installed on-site or left with customers. I understand that the directly installed items include ENERGY STAR®-certified LED bulbs, faucet aerators, low-flow showerheads, smart strips, and programmable thermostat.
    Probe/listen for:
    - Are there any other direct install measures?
    - Are there program limits on number of direct install measures that a customer can receive?
    - Does the program replace CFLs with LEDs?
    - What measures, if any, are left behind for the customer to install?
    - Are any of the direct install measures particularly popular or unpopular? Why do you think that is?
    - Are there specific challenges related to any of the measures?

21. Next, let's talk about deeper retrofit measures, like insulation and air and duct sealing, replacing old appliances, and upgrading heating, cooling and water heating systems.
    Probe/listen for:
    - What percent of participants typically receive recommendations for these measures?
    - What are the most common retrofit measures recommended? Why is that?
    - About what percent act on the recommendation?
    - Why do you think that is?
    - Can you describe how coordination works with WAP, LIHEAP, and any other state or federal programs and funding?
    - Which programs do you coordinate with?
    - How does this process look – for you and for the customer?

22. My next question is about health and safety issues, as well as pre-weatherization barriers. Are there any recurring health or safety barriers that prevent customers from taking action?
    Probe/listen for:
    - What do you consider to be a health and safety issue? (indoor air quality, pests, asbestos, radon, etc.)
    - What specific tests are completed to identify these health and safety issues in the home? Can you describe the process for this? (how do customers pass or fail the indoor air quality test? Is this different from the combustion safety test?)
    - Do all customers receive a health and safety screening? (do all customers receive an initial assessment and then the health and safety screening if there appears to be an opportunity for weatherization; do these occur simultaneously?)
    - How frequently do health and safety issues arise?
    - When these issues are identified, how are they addressed?

- From the materials we have, it looks like health and safety barriers are tracked (i.e., knob and tube wiring, asbestos, unvented gas heater, etc.). Can you describe how the process for tracking these issues in the home?

23. Beyond these barriers, what do you think is preventing more participants from installing these deeper retrofit measures?
    - What is the program's process for follow-up with participants that do not take action right after their assessment?
    - **[Multifamily Only]** How does this process work for multifamily buildings? How are your interactions different between tenants (in-unit opportunities) and building owners/managers (common area opportunities)?

24. I was hoping you could talk about the HEAT loans' impact on participation. Probe/listen for:
    - About percent of participants get a HEAT loan?
    - Do you think the HEAT loan is driving greater/deeper participation?
    - Do participating lenders market the program (i.e., encourage their customers to get an assessment)?

25. I understand that customers may have the option to select a participating contractor or be assigned one by the program. Can you tell me a little bit about the participating contractors, what type of expertise do they have?
    - What portion of customers are assigned a contractor by the program (versus selecting their own)?
    - What's the process for a contractor to become eligible?

Marketing

26. Please describe the marketing and outreach activities deployed for this program. Probe/listen for:
    - What aspects is National Grid responsible for?
    - What marketing activities is RISE responsible for?
    - What are the most common marketing activities?
    - Are there different efforts to reach different audiences?
    - If so, how does that work? Do you have different campaigns or strategies marketing to, for example, landlords versus tenants?

27. How effective do you think current marketing is? Probe/listen for:
    - Why do you say that?
    - [If necessary] How do you assess marketing effectiveness?
    - Which strategies have been most effective? Least effective?
    - Who is not being reached? What strategies have you used to try to reach these folks?
    - Do you market in multiple languages?

QA/QC, Program Data and Tracking

28. Can you describe the program's QA/QC procedures? Probe/listen for:
    - What does RISE do? (How many, training, certifications?)
    - What does CMC (the third-party QA/QC vendor) do? (How many, training, certifications?)
    - What portion of projects receive a QA/QC inspection (by each and overall)?
    - How do you track and report QA/QC related results and data?
    - How do you handle QA/QC issues when they arise? (Probe to understand if issues arise repeatedly).
    - How does the QA/QC process factor into contractor assignments?

29. From your perspective, how well is the current QA/QC processes—and related data capture and reporting—working? Probe/listen for:
    - What is working particularly well?
    - What could be improved?
    - What persistent issues, if any, have arisen from your QA/QC work?
    - How are these resolved?

Wrap-up

30. Given your experience, what do you think prevents eligible customers from participating in the program?

31. What information are you most hoping to get out of this process and impact evaluation?

32. In the past, have you received evaluation results? How have you used those results (i.e., in program planning)?

Thank you very much for taking the time to talk with us today. Your contribution is a very important part of the process. Do you mind if we follow-up with you if any additional questions arise?

Appendix F: Stakeholder Interview Guide

National Grid Rhode Island
Residential Retrofit—Process Evaluation
Program Stakeholder Interview Guide

Context

This interview guide is designed to facilitate telephone interviews with four key populations of program stakeholders critical to the effective delivery of the EnergyWise Single Family, EnergyWise Multifamily, and Income-Eligible Multifamily retrofit programs:

- **In-home Assessors**. RISE employees responsible for conducting thorough assessments of participant homes, installing no-cost measures, completing combustion safety tests, and preparing assessment reports.
- **Installation Contractors**. Independent construction professionals responsible for completing weatherization upgrades and other improvements as identified by the assessment reports.
- **Internal QA/QC Inspectors**. RISE employees who accompany installation contractors, providing oversight and real-time quality assurance.
- **Third-party QA/QC Auditors**. CMC auditors responsible for assessing project quality post-installation.

This interview guide assumes the data collected will be qualitative and that interviewers will probe fully to understand responses to questions. The guide includes a few initial questions that will be asked of everyone as well as modules for each group that focus more on their specific role delivery National Grid's retrofit programs. [Note that the research team will create a table mapping interview questions to key research topics when we finalize the question numbering and prepare a final draft.]

Introduction

National Grid contracted with my company [Cadeo/Illume] to evaluate its residential retrofit programs. We are primarily focused on how the programs operated in 2019.

Thank you for taking the time to talk with us today. Our work depends on the input and insights from those engaged to deliver this program to Rhode Island residents. There are no right or wrong answers, this conversation is designed to help us gain a better understanding of the program. Also, everything you share is confidential. We will report the findings of our interviews in aggregate and anonymously.

We have two goals for this interview:

- To better understand how the program is delivered
- To gather information about your experience with the program, including successes and challenges you have had

We expect this interview to take 30-45 minutes. We'd like to record this interview to refer to our notes later. Is that okay with you? Do you have any questions for us before we begin?

Your Role [Ask All]

Let's begin by talking about your roles and responsibilities.

A1. Our work includes the single family and multifamily EnergyWise programs, as well as the Income Eligible Multifamily program. Which of these programs do you work on?

INTERVIEWER NOTE: If the interviewee works across multiple programs, ask them to primarily focus on the program that they work on the most. However, also encourage them to mention when their response would be meaningfully different for another program. To encourage this, periodically prompt them to note key differences across programs by asking, for example, "Is this any different for IEMF?"

A2. And, can you briefly describe your primary responsibilities for **[EWSF, EWMF, INCOME-ELIGIBLE MF]**?

On-Site Assessors

Let's start at the beginning of the process.

B1. How are assessments assigned and communicated to you?
B2. How far out are assessments typically scheduled?
B3. When do you first communicate directly with a customer?
B4. What kind of cancellation rate have you experienced? Any common reasons?
B5. Please briefly walk me through a typical assessment, what does it look like? [**FOR MULTIFAMILY**, probe to understand how the process works for both the common area and in-unit assessments.]
B6. [**FOR MULTIFAMILY**] What is the process, including timeline, for planning and scheduling out assessments and direct installations? (If not covered, probe to understand how units are sampled for assessment, and tenant notification and interactions.)
B7. About how many assessments do you complete in a typical week? And about how much time does each assessment take? [**FOR MULTIFAMILY**, if not covered, differentiate between building level assessments vs. unit level]
B8. When and how is the assessment report provided? (Probe for: Is it produced right away and reviewed with the customer, or is it sent as a follow up?) [**FOR MULTIFAMILY,** differentiate between building level report vs. unit level.]
B9. What takes the most time during an assessment?
B10. Are there aspects of the assessment where you wish you could spend more time?

We know that COVID-19 has greatly affected the program, and that many elements are in flux. We are interested in hearing about COVID-19 related changes a little later in our discussion. For now, let's start by discussing how the program was designed to run - and how you delivered it in 2019 and the first few months of 2020.

To start, I have a few questions about the measures that RISE directly installs during the assessment.

B11. What kind of screening is required to install a programmable or Wi-Fi thermostat, showerhead or faucet aerator?
B12. In what situations would measure(s) be left behind for a customer to install or use later?
B13. Thinking about these Instant Savings Measures—which are most popular? Which are more challenging to get installed? Are any of the direct install measures particularly popular? Why is that?
B14. How important are free LEDs in encouraging customers to sign up for an assessment? What do you think happens if lighting is eventually removed or plays a lesser role in the program?

What about retrofit measures…

B15. How do you determine if additional insulation is needed? What about whether air or duct sealing is necessary, or determining if an appliance or heating/cooling system is inefficient? What is the assessment process and threshold for recommending upgrades?

B16. In about what portion of assessments do you find opportunities to add insulation? Is there a specific type/location that is most common? What about air and duct sealing? Appliance replacement? Heating or cooling system replacement? [**FOR MULTIFAMILY:** Does this differ by program?]

B17. What are the challenges to convincing participants to install the measures you recommend? What approaches do you use to convince them?

B18. **[FOR MULTIFAMILY]** What additional complexities do you face with condominiums? Can you talk about how your process differs when interacting with condo association representative and/or boards/homeowner associations?

B19. In your opinion, what is the most important component of the program in encouraging customers to move forward (information from the assessment, cost sharing, financing, contractor scope and recommendations)?

B20. How would you describe interest in the HEAT Loan?

- What information do you typically provide?
- What questions do they tend to have?

B21. **[FOR MULTIFAMILY]** Can you also talk about your process for identifying and recommending custom measures?

B22. Do you typically prepare an assessment report on site or send it afterwards?

B23. We know that the recommendations are documented in the assessment provided to customers, how do you track or follow up on them?

B24. In about what portion of your assessments do you feel customers are already aware of and planning to install recommended measures?

B25. Which measures are most commonly mentioned by customers as already planned for?

B26. What recommendations would you say tend to be new information for participants—something they did not know about or consider prior to the assessment?

B27. Why do you think participants decide not to follow through on recommendations for these measures?

B28. Do you have ideas for ways to get more participants to act on these recommendations?

We have a few questions about health, safety, and pre-weatherization barriers.

B29. In what scenarios would an assessment exclude combustion safety or other health and safety screening? (For example, would screenings be done in a home without weatherization opportunity?)

B30. How frequently do health and safety issues arise? Which are the most prevalent? And how frequently do they keep you from completing the work [deferring work]? **[If work in both EWMF and IEMF]** Please describe the differences you see between income eligible and non-income-eligible buildings.

B31. When these issues are identified, how are they documented and communicated to customers?

B32. How do customers typically react? Do they understand the issues? What questions do they typically ask?

B33. What is the program's process for following-up with participants that do not take action – either to resolve a pre-weatherization barrier or simply to act on a recommended upgrade?

B34. How well do you think that process works? Do you see any opportunities for improvement?

I understand that the program made some changes recently.

B35. **[EWSF ONLY]** Did you provide home energy scores to any residents in 2019? If yes:

- How did that work?
- What type of response did you receive from the home energy score?
- Do you think something encouraged customers to move forward?

B36. Did any of your assessments include access to the 100% landlord incentives? If yes:

- How did that work?
- What type of response did you receive to this opportunity?
- Do you think the higher landlord incentive encouraged customers to move forward?

Two overarching questions before we talk about recent COVID-related changes.

B37. Again, prior to COVID-19, what do you think is working best about the assessment process overall?

B38. And, are there any changes you'd like to see in any part of the assessment process once the program is back in the field?

Let's wrap up with a few questions about adjustments to the program as a result of COVID-19.

B39. How has COVID-19 affected your work with the program?

B40. Have you completed any remote or virtual audits? If yes:

- What works well about these virtual audits? What components do not work as well?
- Have you received any feedback from customers about the experience?
- Do you see a place for virtual assessments, long-term, as one pathway to deliver the program?

Thank you so much for your time today, those are all my questions.

Installation Contractors

C1. How long have you been involved with National Grid's energy efficiency programs in Rhode Island?
C2. How did you learn about the program(s)?
C3. What was your experience becoming an approved contractor for the program?
C4. What percent of your total business do program jobs represent?
C5. What portion of program-associated projects are assigned to you versus those where the customer selected you as their contractor? [**FOR MULTIFAMILY**, How typical is it to competitively bid on multifamily projects?]

We know that COVID-19 has greatly affected the program and likely your business, and that many elements are in flux. We are interested in hearing about COVID-19 related changes a little later in our discussion. For now, let's start by discussing program jobs you worked on in 2019 and the first few months of 2020.

C6. Can you walk me through a typical job?
C7. What types of unexpected issues do you run in to?
C8. What is the simplest type of project? The most complicated?
C9. **[IF WX CONTRACTOR]** How/when do you test air leakage? How do you handle jobs near minimum ventilation guidelines? Do you do both air and duct sealing?
C10. Are you also engaged in projects where you are mitigating health and safety barriers?
C11. What types of health and safety barriers do you most frequently work on (for example, knob & tube wiring, mold and mildew, mechanical ventilation, or adjustments to combustion equipment)?
C12. How could the program better address H&S barriers??
C13. What is it like to work with a RISE inspector present for program-associated projects? Tell me about how you coordinate your work on projects.
C14. Have you had any interaction with the program's independent QC contractors? (In what scenarios?)
C15. Has your involvement with the program changed how you sell or install weatherization for customers outside the program? If so, what has changed and why?

Two, final overarching process questions before we talk about recent COVID-related changes.

C16. What is working best about the program from your perspective?
C17. What would you like to see changed?

Let's wrap up with a few questions about adjustments to the program as a result of COVID-19.

C18. How specifically has COVID-19 affected your work with the program?

C19. Are there any long-term implications on your involvement in the program because of COVID-19?

Thank you so much for your time today, those are all my questions.

Before we go – let's work out the best way to get you your $50 incentive.

RISE Inspectors

D1. Please describe your role at the customer's project site, what are you typically responsible for?
D2. About how many projects do you attend in a typical week?
D3. Do you visit every job? If not, how do you determine which project sites to inspect?
D4. What is the process for adding - or removing - contractors for the qualified contractor list?

We know that COVID-19 has greatly affected the program and likely your business, and that many elements are in flux. We are interested in hearing about COVID-19 related changes a little later in our discussion. For now, let's start by discussing program jobs you worked on in 2019 and the first few months of 2020.

D5. How do you interact with contractors at the project site?
D6. How do you communicate any issues identified during the process, and with whom?
D7. Are there particular issues that consistently arise?
D8. How do you, or the program more generally, remediate these persistent issues?
D9. Do you systematically track issues, and if so how?
D10. From your perspective, how well is the inspection processes working?
D11. What could be improved?

Let's wrap up with a few questions about adjustments to the program as a result of COVID-19.

D12. How has COVID-19 affected your work with the program?
D13. Are there any long-term implications of COVID-19 on how you think the program should be delivered?

Thank you so much for your time today, those are all my questions. Your contribution is a very important part of the process.

Would it be okay to follow up again if any additional questions arise?

CMC QA/QC Auditors

We know that COVID-19 has greatly affected the program and likely your business, and that many elements are in flux. We are interested in hearing about COVID-19 related changes a little later in our discussion. For now, let's start by discussing program jobs you worked on in 2019 and the first few months of 2020.

E1. At what stage(s) is a project eligible to be selected for QA/QC? (Does it vary?)
E2. How are projects selected for QA/QC?
E3. Are there particular types of projects or contractors that are prioritized for QA/QC? If so, why?
E4. How long does an inspection usually take?
E5. How many QA/QC visits do you complete in a typical week?

E6. Please walk me through your process, what are the typical components of a QA/QC inspection?
E7. What type of information do you collect on-site through inspection?
E8. Does this include post-participation air infiltration rates? If not, do any of the other program stakeholders (RISE or the contractor) "test out" after weatherizing?
E9. Can you tell me about your interactions with the customers? Do you schedule directly with them?
E10. What type of information do you collect from the customer?

E11. How do you typically interact with RISE assessors and/or program staff?
E12. What about installation contractors, in what scenarios would you interact with them?
E13. Are there any recurring issues that you identify during your inspections? If so, what are they and why do you think that is?
E14. What happens when QA/QC issues arise? How are they resolved?
E15. How do you think National Grid and those that deliver the program (RISE and contractors) can better mitigate the more prevalent QA/QC issues (either through design, delivery, or support).
E16. How do you track and report your QA/QC results?
E17. From your perspective, how well is the current QA/QC processes—and related data capture and reporting—working?
E18. What is working particularly well?
E19. What could be improved?

Let's wrap up with a few questions about adjustments to the program as a result of COVID-19.

E20. How has COVID-19 affected your work with the program?

E21. Are there any long-term implications of COVID-19 on how you think the program should be delivered?

Thank you so much for your time today, those are all my questions. Your contribution is a very important part of the process. Would it be okay to follow up again if any additional questions arise?

Appendix G: Participant Survey

National Grid Rhode Island: Residential Retrofit

EnergyWise Single Family - Participant Survey

E-mail

SENDER: National Grid Research

EMAIL SUBJECT: Share your experience with National Grid – Get $10!

Hello **<Customer Name>**,

Our records indicate that you received a Home Energy Assessment in 2019 as part of National Grid's EnergyWise program.

We are interested in hearing about your experience with your home's energy assessment, any no-cost energy efficiency services you received, as well as any weatherization work that may have been completed on your home.

Please take a short 15-minute survey using the link provided below.

We understand that this is a difficult and strenuous time. Your input is valuable to us. Please respond by {Date].

As a thank you for completing the survey, you'll be able to choose a $10 Amazon e-gift card or a $10 Visa gift card. Gift cards are limited and offered only while supplies last.

<Survey Link>

Si prefiere tomar esta encuesta en español, por favor llamenos al numero: (202) 506-4487.

National Grid is here for you in during the COVID-19 outbreak. Learn more about how we are supporting the health and safety of customers and employees here.

Thank you for helping us improve our program especially during this unprecedented time.

Sincerely,
EnergyWise Services Team
National Grid

EMAIL FOOTER

If you would like to verify the legitimacy of this research, please contact Romilee Emerick at National Grid by calling (781) 907-3709.

If you prefer not to receive National Grid survey invitations by email, you can unsubscribe here: <insert link>.

Cadeo, an independent research firm, is conducting this research on behalf of National Grid and using Qualtrics to gather feedback from program participants. This message was sent by Cadeo, 1660 L St NW, Suite 216, Washington, DC 20036.

Introduction

Your responses to this survey will help us improve energy efficiency programs for customers like you.

Our questions about your experience with the EnergyWise Home Energy Assessment program, which provides free in-home energy assessments and directly installs LED lights, power strips, showerheads, and other low-cost energy saving equipment. The program also provides a set of customized recommendations, like adding insulation, for reducing your home's energy consumption.

To thank you for your time, we will e-mail you a $10 Amazon e-gift card or mail a $10 Visa gift card within 1-2weeks of completing the survey. You can choose which option you prefer at the end of the survey.

As we navigate through the challenges of the COVID-19 pandemic, we'd also like to take this opportunity to thank you for being a valued customer.

Let's get started…

Awareness and Participation

1. According to our records, your home received an home energy assessment in **[MONTH/YEAR].** Do you recall receiving an in-home energy assessment?
    1. Yes
    2. No **[Thank and terminate]**
    98. Don't know **[Thank and terminate]**

2. Were you present for the home energy assessment?
    1. Yes
    2. No **[Thank and terminate]**
    98. Don't know **[Thank and terminate]**

3. Below is a list of reasons people get a home energy assessment. For each reason, please indicate if it was very important, somewhat important, or not at all important in your decision to get an assessment… **[RANDOMIZE OPTIONS]**

Item	**Very Important [3]**	**Somewhat important [2]**	**Not at all important [1]**	**Not applicable [99]**

To learn more about how I use energy in my home

To learn how to reduce energy costs/save energy

To get free light bulbs/LEDs

To access incentives for weatherization (e.g., insulation and air sealing) improvements

To improve home comfort

To improve the air quality in my home (or another health reason)

Because my landlord or property manager decided to

Another reason? **[Fillable field]**

4. Did you take an online home energy assessment before scheduling your in-home assessment?
    1. Yes
    2. No
    98. Don't Know

[If Q4=1]

5. Based on your experience with the online assessment, please rate your agreement or disagreement with the following statements.

	Strongly Agree [5]	**Somewhat Agree [4]**	**Neither Agree nor Disagree [3]**	**Somewhat Disagree [2]**	**Strongly Disagree [1]**	**Not applicable [99]**
The online assessment was easy to complete						
The online assessment helped me to identify opportunities to improve the energy efficiency of my home						
The online assessment encouraged me to move forward with my onsite assessment						

6. **[IF ANY RESPONSES = Somewhat Disagree or Strongly Disagree]** Please tell us more about why you disagree. **[Fillable Field]**

7. We want to understand your experience getting a home energy assessment. Please rate your agreement or disagreement with the following statements.

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]	Not applicable [99]
The scheduling process was straightforward						
The time it took to complete my home's energy assessment was reasonable						
The Energy Specialist who conducted the assessment was pleasant to interact with						
The Energy Specialist was able to answer my questions						

8. **[IF ANY RESPONSES = Somewhat Disagree or Strongly Disagree]** Please tell us more about why you disagree. **[Fillable Field]**

9. After the assessment did you receive a personalized report (also called an "action plan" or "contract scope") detailing next steps for how to save energy in your home?
    1. Yes
    2. No **[skip to Q12]**
    98. Don't know **[skip to Q12]**

[If Q9=1]

10. Please indicate the extent to which you agree or disagree with the statements below:

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]	Not applicable [99]

The report clearly identified the opportunities to improve the efficiency of my home (e.g., insulating and air sealing your home)

The report clearly outlined the next steps I should take for each opportunity

The report helped me prioritize the opportunities identified

The report provided clear information on the costs of the improvements, including the portion covered by National Grid incentives

11. **[IF ANY RESPONSES to Q10 = Somewhat disagree or Strongly Disagree]** Please tell us more about why you disagree. **[Fillable Field/OPEN RESPONSE]**

[IF Program Record= HEAT LOAN RECEIVED YES]

According to program records, you received a HEAT Loan as part of completing your project.

12. What did you use the HEAT loan to do? **[Select all that apply].** **[Randomize options]**
    1. Address health and safety repairs or pre-weatherization requirements
    2. Complete my weatherization project
    3. Install an efficient heating, cooling or how water system
    4. Complete a larger, more comprehensive project than I would have otherwise
    5. Complete project sooner than I would have otherwise
    97. Other **[Fillable Field/OPEN RESPONSE]**
    98. Not sure
13. How satisfied were you with the HEAT Loan process over all?
    1. Not at all satisfied
    2. Slightly satisfied
    3. Moderately satisfied
    4. Very satisfied
    5. Completely satisfied

14. **[If Q13= 1]** Please tell us more about why you were not satisfied with the HEAT Loan process, **[Fillable field/Open response]**
15. Are there any changes that would have made the HEAT loan process work better for you?
    1. Yes
    2. No
    98. Not sure
16. **[IF YES]** What would have made the HEAT loan process work better for you?

[Fillable Field/OPEN RESPONSE]

[IF Program Record= NO HEAT LOAN RECIEVED]

17. As part of the assessment did you receive information on the 0% HEAT Loan that National Grid offers through qualified lenders?
    1. Yes
    2. No **[skip to Q20] tested**
    98. Don't know **[skip to Q20]**

[IF Q17=1]

18. Why did you decide not to obtain a HEAT Loan? [Check all that apply]
    1. I did not need financing
    2. I did not think I would or did not qualify
    3. I had access to other financing

[IF Q17=2 or 98]

19. Would you have been interested in financing options to complete your project?
    1. Yes
    2. No
    98. Don't know

20. Did the assessment identify any health and safety issues or repairs that needed to be resolved before you could act on the program's recommended efficiency improvements?
    1. Yes
    2. No **[skip to Q24]**
    98. Don't know **[skip to Q24]**

[If Q20=1]

21. What health and safety or home repair requirements were identified? **[RANDOMIZE OPTIONS.]**

Check all that apply

[1] Combustion safety, combustion gases, or gas leak

[2] Heating system, water heater, or oven carbon monoxide

[3] Knob and tube wiring

[4] Moisture, mold, or draft issues

[5] Mechanical ventilation

[97] Something else:

22. Did you address the issues identified?
    1. Yes, I addressed them all **[Skip to Q24]**
    2. I addressed some of them
    3. No, I didn't address any of them
    98. Not sure **[Skip to Q24]**

[If Q22=2 or 3]

23. What prevented you from completing all the health and safety or repair requirements? Select all that apply. **[Randomize options]**
    1. Upfront/out of pocket cost too large
    2. The energy savings were too small given the estimated project cost
    3. There were too many recommendations to consider
    4. I wasn't sure how to resolve the issue
    5. Work was invasive or inconvenient
    6. Didn't have time
    7. I didn't need to have the work done
    8. Complications related to COVID19 outbreak
    97. Other **[Fillable field]**

24. **[If Q20=1]** What, if anything, could the program have done to help you address these health and safety barriers? **[Fillable field]**

25. According to our records, you received the following energy saving equipment in your home as part of your home energy assessment. Is that correct?

Yes	No	Not Sure
[1]	**[2]**	**[98]**

[IF Lighting=YES] LED Light bulbs or fixtures

[IF Domestic Hot Water=YES] Faucet Aerators, Showerheads, Pipe Wrap

[IF Appliances & Plug Load=YES] Smart Power Strips

[IF Controls=YES] Programmable or Smart (WiFi) thermostat

Something else:

[If Q24 Appliance & Plug load = Yes]

26. Did you install your smart power strip(s) after your home energy assessment?
    1. Yes
    2. No
    98. Don't know

[If Q26 = 1]

27. What does the installed smart strip(s) control?
    1. Entertainment system (TV's, gaming systems, cable boxes)
    2. Office/Desk (Home office setup, computers, monitors, desk lamp)
    3. Something else (Kitchen, garage, etc.)

28. Please rate your agreement with the following statements.

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]
[IF Q25 Lighting=YES] I am satisfied with the LED light bulbs					
[IF Q25 Domestic Hot Water=YES] I am satisfied with the Faucet Aerators, Showerheads, or Pipe Wrap.					
[IF Q25 Appliances & Plug Load=YES and Q26 = YES] I am satisfied with the Smart Power Strip(s) I received.					
[IF Q25 Controls=YES] I am satisfied with the Programmable or Smart (WiFi) thermostat					

29. Have you removed any of the items you received?
    1. Yes

2. No **[Skip to Q33]**
98. Don't know **[Skip to Q33]**

[If Q29=1]

30. Which items have you removed? **[Program with check box to indicate.]**

Item	Select all that apply
LED lightbulbs	
Faucet aerators	
Showerheads	
Pipe wrap	
Smart power strip	
Programmable or Smart (wifi) thermostat	

[If Q29=1]

31. Please indicate whether you removed all the items, some of the items, or are not sure how many you removed.

Item	Did you remove all of them? Yes **[1]**	Did you remove some of them? Enter number of items removed	Not sure how many you removed? Not sure **[98]**
LED lightbulbs			
Faucet aerators			
Showerheads			
Pipe wrap			
Smart power strip			
Programmable or Smart (wifi) thermostat			

[If Q29=1]

32. Why did you remove the item(s)? [**Fillable field**].

33. Please rate your agreement or disagreement with the following statements.

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]	Not applicable [99]
Overall, I am satisfied with how the home energy assessment went.						

34. **[IF ANY RESPONSES TO Q33 = Somewhat OR Strongly Disagree]** Please tell us more about why you were dissatisfied with the assessment. **[Fillable Field]**

35. National Grid is considering conducting in-home assessments virtually. In virtual assessments, a live Energy Specialist would assess your home using video conferencing technology. Please rate your agreement or disagreement with the following statements.

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]	Not applicable [99]
In my opinion, a virtual assessment is an attractive option.						
Virtual assessments seem safer right now than in-home assessments.						

F. Free Ridership

[FR SET PROGRAMMED FOR UP TO TWO SAMPLED MEASURES]

[DIRECT INSTALL MEASURE COUNTERFACTUAL]

We have some questions about items installed at your home during the assessment.

F1. **[IF SAMPLED MEASURE=LED]** In the year prior to the assessment, had you purchased any LED bulbs?

1. Yes
2. No

F2. **[ALL SAMPLED MEASURES]** If you had **NOT** received **[measures]** as part of your assessment, what is the likelihood you would have purchased a(n) **[measures]** **within 6 months** of your assessment? Please use a scale of 0 to 10, where 0 is "not at all likely" and 10 is "extremely likely."

[Show 0-10 scale, with end-point labels]

[ASK IF SAMPLED MEASURE INSTALLED QUANTITY>1]

F3. If you had **NOT** received the item(s) during the assessment, what is the likelihood you would have installed **FEWER** of the item(s)?

[Show 0-10 scale, with end-point labels]

[ASK IF SAMPLED MEASURE=LED, F1=1 AND Error! Reference source not found.**< 7)]**

F4. Given that you had purchased LED bulbs before receiving the assessment, why is it unlikely that you would purchase additional LED bulbs on your own without the program? **[OPEN END]**

[ASK IF SAMPLED MEASURE=LED, F1=2 AND Error! Reference source not found.**>6)]**

F5. Given that you have not purchased LED bulbs before receiving the assessment, why is it likely that you would purchase LED bulbs on your own without the program? **[OPEN END]**

[If Sampled Measures are both direct installs]

F2a. **[ALL SAMPLED MEASURES]**

If you had **NOT** received **[measures]** as part of your assessment, what is the likelihood you would have purchased a(n) **[measures]** **within 6 months** of your assessment?

[Show 0-10 scale, with end-point labels]

F3a. **[ASK IF SAMPLED MEASURE INSTALLED QUANTITY>1]**

If you had **NOT** received the item(s) during the assessment, what is the likelihood you would have installed **FEWER** of the item(s)?

[Show 0-10 scale, with end-point labels]

F10a. **[Weatherization =0]** In your own words, please explain how the program influenced you to install the energy efficient item(s) at the time you did. **[Fillable field]**

[MAJOR MEASURE/WX COUNTERFACTUAL]

[ASK IF MAJOR MEASURE=TRUE]

Our records indicate that you installed **[SAMPLED MEASURE]** in your home following your home energy assessment.

36. **MAJOR MEASURE (Excluding Refrigerator Rebate)** How did you choose your contractor?
    1. I chose a contractor off the approved list
    2. The program recommended/assigned me a contractor
    97. Other **[Fillable field]**
    98. Not sure

37. **[IF MAJOR MEASURE = WEATHERIZATION]** We want to understand your experience insulating your home. Please rate your agreement or disagreement with the following statements.

	Strongly Agree [5]	Somewhat Agree [4]	Neither Agree nor Disagree [3]	Somewhat Disagree [2]	Strongly Disagree [1]	Not applicable [99]
The time that passed between my assessment and when work on my home started was reasonable						
The contractor/crew that insulated my home was professional						
I am satisfied with the quality of work completed on my home						
I noticed a decrease in my energy bill						

38. **[IF ANY RESPONSES TO Q37 = Strongly disagree OR Somewhat disagree]** Please tell us more about why you disagree. **[Fillable Field]**

F6. Without the program, what is the likelihood you would have installed **[SAMPLED MAJOR MEASURE]** **within 12 months of** your Assessment? Please use a scale of 0 to 10, where 0 is "not at all likely" and 10 is "extremely likely."

[Show 0-10 scale, with end-point labels]

F7. Without the program, what is the likelihood you would have installed **LESS** [**SAMPLED MAJOR MEASURE**]?

[Show 0-10 scale, with end-point labels]

PROGRAM INFLUENCE [ONLY MAJOR MEASURE]

F8. Please rate the importance of each factor that may have influenced your decision to install the **[MEASURE NAME].** Please use a scale of 0 to 10, where 0 is "not at all influential" and 10 is "extremely influential." [Programming note: Not sure = 98, Not applicable = 99.]

1. The rebate or discount I received for **[MEASURE NAME]**
2. Recommendation from the Energy Specialist
3. Information provided during the assessment
4. Program materials or website
5. Recommendation from someone else

F9. **[ASK IF** Error! Reference source not found.**=5]** Did the person who gave you a recommendation participate in the EnergyWise Single Family program in the past?

1. Yes
2. No

F10. **[Weatherization=1]** In your own words, please explain how the program influenced you to install the energy efficient item(s) at the time you did? **[Fillable field]**

[IF AUDIT ONLY]

39. Did your energy specialist recommend insulation or other weatherization work for your home?
    1. Yes
    2. No
    98. Don't Know

[If Q39=1]

40. Did you complete the recommended work on your home?
    1. Yes
    2. No
    98. Don't Know

[If Q40=2 or 98]

41. What prevented you from making the energy efficiency changes recommended after your assessment? Select all that apply. **[Randomize options]**
    1. Upfront/out of pocket cost too large
    2. The energy savings were too small given the estimated project cost
    3. There were too many recommendations to consider
    4. Work was invasive or inconvenient
    5. I wasn't sure how to move forward
    6. Didn't have time
    7. Didn't need the work done
    8. Complications related to COVID19 outbreak
    97. Other **[Fillable Field]**
    98. Not sure

[If Q41 = 8]

42. Can you tell us more about how COVID19 prevented you from making energy efficiency changes to your home? **[Fillable Field]**.

43. **[If Q41<97]** What could the program have done to help you overcome these barriers to making recommended changes? **[Fillable Field]**.

S. Spillover

S1. Since your participation in the EnergyWise Single Family program, have you installed any ADDITIONAL energy efficient products?

1. Yes
2. No **[SKIP TO OVERALL SATISFACTION/DEMOGRAPHICS]**

98. [Not Sure]

S2a. **[ASK IF S1=1]** What additional energy efficient products did you install? (Select all that apply)

1. LED Lighting
2. Clothes Washer
3. Electric Clothes Dryer
4. Gas Clothes Dryer
5. Low Flow Faucet Aerator
6. Low Flow Showerhead
7. Programmable Thermostat
8. Smart or Wifi Thermostat
9. Smart Strip Plug Outlet
10. Refrigerator

11. Freezer
12. Dishwasher
13. Dehumidifier
14. Central A/C
15. Furnace
16. Boiler
17. Air Source Heat Pump
18. Ductless Heat Pump
19. Electric Water Heater
20. Gas Water Heater
21. Solar Water Heater
22. Heat Pump Water Heater
23. Other Water Heater (propane, fuel oil, etc.)
24. Insulation
25. Low-e Storm Windows
26. Doors

97. [Other][Specify]

S2b. **[IF S2a=1, S2a=5, S2a=6, S2a=7, S2a=8, S2a=9, S2a=24, S2a=25, S2a=26]** How many did you install? **[NUMERIC ENTRY]**

S3. **[IF S2aa< 98]** You indicated that you installed the following energy efficient products after your EnergyWise assessment. Please indicate if you received a rebate from National Grid to help offset the cost.

Received a rebate?

1. Yes 2. No 98.Not sure

[List each item selected in S2aa]

[PROGRAMMING NOTE: For any measures where 0=1 (they received a rebate) remove from selected items in S2aa and do not display in subsequent questions]

S4. **[IF ANY 0=2 ASK]** Why didn't you receive a rebate for the item(s) you installed?

1. Did not know rebate was available
2. Applied for rebate but item did not qualify
3. Did not think rebate amount was worth the effort
4. Did not apply because item did not qualify for a rebate

97. [Other][Specify]
98. [Not Sure]

S5. **[IF S2aa< 98]** On a scale of 0 to 10, where 0 indicates "not at all influential" and 10 indicates "extremely influential" how influential, if at all, was your experience with the EnergyWise Single Family program in your decision to install these efficient product(s) for which you did not receive a rebate on your own?

[PROGRAMMING NOTE: Display 0 to 10 rating scale for each of the items selected in S2a]

1. **[IF S2a=1]** LED Lighting
2. **[IF S2a=2]** Clothes Washer
3. **[IF S2a=3]** Electric Clothes Dryer
4. **[IF S2a=4]** Gas Clothes Dryer
5. **[IF S2a=5]** Low Flow Faucet Aerator
6. **[IF S2a=6]** Low Flow Showerhead
7. **[IF S2a=7]** Programmable Thermostat
8. **[IF S2a=8]** Smart Thermostat
9. **[IF S2a=9]** Smart Strip Plug Outlet
10. **[IF S2a=10]** Refrigerator
11. **[IF S2a=11]** Freezer
12. **[IF S2a=12]** Dishwasher
13. **[IF S2a=13]** Dehumidifier
14. **[IF S2a=14]** Central A/C
15. **[IF S2a=15]** Furnace
16. **[IF S2a=16]** Boiler
17. **[IF S2a=17]** Air Source Heat Pump
18. **[IF S2a=18]** Ductless Heat Pump
19. **[IF S2a=19]** Electric Water Heater
20. **[IF S2a=20]** Gas Water Heater
21. **[IF S2a=21]** Solar Water Heater
22. **[IF S2a=22]** Heat Pump Water Heater
23. **[IF S2a=23]** Other Water Heater (propane, fuel oil, etc.)
24. **[IF S2a=24]** Insulation
25. **[IF S2a=25]** Low-e Storm Windows
26. **[IF S2a=26]** Doors
27. **[IF S2a=97] Display S2"Other" response text**

S6. **[IF S2aa<98]** On a scale of 0 to 10, where 0 indicates "not at all likely" and 10 indicates "extremely likely" how likely is it that you still would have installed the efficient product(s) on your own if the EnergyWise Single Family program did not exist? **[RECORD 0-10; 98=Don't Know for each]**

[PROGRAMMING NOTE: Display 0 to 10 rating scale for each of the items selected in S2a]

1. **[IF S2a=1]** LED Lighting
2. **[IF S2a=2]** Clothes Washer
3. **[IF S2a=3]** Electric Clothes Dryer
4. **[IF S2a=4]** Gas Clothes Dryer
5. **[IF S2a=5]** Low Flow Faucet Aerator
6. **[IF S2a=6]** Low Flow Showerhead
7. **[IF S2a=7]** Programmable Thermostat
8. **[IF S2a=8]** Smart Thermostat
9. **[IF S2a=9]** Smart Strip Plug Outlet
10. **[IF S2a=10]** Refrigerator
11. **[IF S2a=11]** Freezer
12. **[IF S2a=12]** Dishwasher
13. **[IF S2a=13]** Dehumidifier
14. **[IF S2a=14]** Central A/C
15. **[IF S2a=15]** Furnace
16. **[IF S2a=16]** Boiler
17. **[IF S2a=17]** Air Source Heat Pump
18. **[IF S2a=18]** Ductless Heat Pump
19. **[IF S2a=19]** Electric Water Heater
20. **[IF S2a=20]** Gas Water Heater
21. **[IF S2a=21]** Solar Water Heater
22. **[IF S2a=22]** Heat Pump Water Heater
23. **[IF S2a=23]** Other Water Heater (propane, fuel oil, etc.)
24. **[IF S2a=24]** Insulation
25. **[IF S2a=25]** Low-e Storm Windows
26. **[IF S2a=26]** Doors
27. **[IF S2a=97] Display B2"Other" response text**

S7. **[IF S2aa< 98]** For each item installed, please specify how you knew that the product(s) you installed were energy efficient? (Select all that apply) **[PROGRAMMING NOTE: Randomize list and allow respondents to select all that apply (1-98) for each of the measures displayed]**

1. Efficiency rating or label of equipment, such as an "ENERGY STAR®" logo
2. Equipment dealer/retailer said it was energy efficient
3. Personal experience
4. Met utility rebate requirements
5. Third party report, such as Consumer Reports
6. Recommendations from the contractor/installer
7. Did not rely on any specific type of information
8. Internet/website

97. [Other][Specify]
98. [Not Sure]

1. **[IF S2a=1]** LED Lighting
2. **[IF S2a=2]** Clothes Washer
3. **[IF S2a=3]** Electric Clothes Dryer
4. **[IF S2a=4]** Gas Clothes Dryer
5. **[IF S2a=5]** Low Flow Faucet Aerator
6. **[IF S2a=6]** Low Flow Showerhead
7. **[IF S2a=7]** Programmable Thermostat
8. **[IF S2a=8]** Smart Thermostat
9. **[IF S2a=9]** Smart Strip Plug Outlet
10. **[IF S2a=10]** Refrigerator
11. **[IF S2a=11]** Freezer
12. **[IF S2a=12]** Dishwasher
13. **[IF S2a=13]** Dehumidifier
14. **[IFS2a=14]** Central A/C
15. **[IF S2a=15]** Furnace
16. **[IF S2a=16]** Boiler
17. **[IF S2a=17]** Air Source Heat Pump
18. **[IF S2a=18]** Ductless Heat Pump
19. **[IF S2a=19]** Electric Water Heater
20. **[IF S2a=20]** Gas Water Heater
21. **[IF S2a=21]** Solar Water Heater
22. **[IF S2a=22]** Heat Pump Water Heater
23. **[IF S2a=23]** Other Water Heater (propane, fuel oil, etc.)
24. **[IF S2a=24]** Insulation

25. **[IF S2a=25]** Low-e Storm Windows
26. **[IF S2a=26]** Doors
27. **[IF S2a=97] Display S2"Other" response text**

S8. **[IF INSTALLED WATER HEATER: S2a=19 OR S2a=20 OR S2a=21 OR S2a=22 OR S2a=23]** What type of water heater(s) did the new water heater(s) replace?

1. Electric water heater
2. Gas water heater
3. Solar water heater
4. Heat pump water heater
5. Fuel oil water heater
6. Propane water heater
98. Don't know
99. Not applicable

S9. **[IF ASHP or DHP: S2a=17 OR S2a=18]** What type of heating system did the new air source heat pump or ductless heat pump replace?

98. Electric furnace
99. Gas furnace
100. Fuel oil furnace
101. Propane furnace
102. Electric boiler
103. Gas boiler
104. Fuel oil boiler
105. Propane boiler
106. Other **[Fillable field]**
98. Don't know
99. Not applicable

S10. **[IF INSTALLED TSTAT: IF S2a=7 or S2a= 8]** What does the thermostat you installed control?

1. Heating
2. Air conditioning
3. Both heating and air conditioning

97. [Other][Specify]
98. [Not Sure]

OVERALL SATISIFACTION

44. Thinking about your overall experience with this program, how would you rate your satisfaction? Would you say you are…
    1. Not at all satisfied
    2. Slightly satisfied
    3. Moderately satisfied
    4. Very satisfied
    5. Completely satisfied

45. **[If Q44=1 or 2]** Please tell us more about why you were not satisfied or only slight satisfied with your experience with this program, **[Fillable field/Open response].**

46. Would you recommend the program to family or friends?
    1. Yes
    2. No

47. Did your experience in the program change your perception of National Grid?
    1. Yes, favorably
    2. Yes, negatively
    3. No

48. Do you have any recommendations for how National Grid could improve the program? **[Fillable field/Open response]**

Demographics

Finally, we'd like to wrap up with a few questions about your household.

49. Including yourself, how many total people reside in your home?
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6 or more

Income1-6. What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household.**[Programmed based on Q49 and State median income]**

1. Below **$A**
2. Between **$A** and **$B**
3. Between **$B** and **$C**
4. Greater than **$C**

99. Prefer not to answer

50. What is the highest level of education that you have completed so far?

1. Less than high school diploma or equivalent
2. High school diploma or equivalent
3. Technical or business school certificate/2-year college degree/some college
4. 4-year college degree/bachelor's degree
5. Graduate or professional degree/masters or PhD

99. Prefer not to answer

Home Characteristics

51. Which of these options best describes you?

1. I owned and lived in the home at the time of the energy assessment
2. I owned the home at the time of the assessment, but someone rented it from me
3. I did not own the home and was renting it from someone else

97. Other **[Fillable Field]**

52. **[IF Q51 = 2]** Who initiated participation in the program?

1. I did
2. My renter, who then brought me into the process.

97. Other **[Fillable Field]**

53. **[IF Q51 = 3]** Who initiated participation in the program?

1. I did
2. My landlord/property manager, who then brought me into the process.

97. Other **[Fillable Field]**

Closing

We appreciate your feedback about your experience with the EnergyWise program. May we contact you via email or phone with any additional follow-up questions we may have?

1. Yes
2. No

Incentive Logistics

Thank you for your time and thoughts! Select the email address where you would like your Amazon gift card to be sent OR if you prefer a card to be mailed to you, please include your mailing address:

1. The email address used for this survey
2. A different email address: **[Fillable Field]**
3. I prefer a card to be mailed by post to this address: **[Fillable Field]**
   NOTE: mailed cards are Visa gift cards (instead of Amazon)

Appendix H: Additional Participant Survey Results

Appendix H: Additional Participant Survey Results

Q3 - Below is a list of reasons people get a home energy assessment. For each reason, please indicate if it was very important, somewhat important, or not at all important in your decision to get an assessment...

#	Question	Not at all important		Somewhat important		Very Important		Total
1	To learn more about how I use energy in my home	9%	24	35%	100	56%	158	282
2	To learn how to reduce energy costs/save energy	2%	6	14%	40	84%	240	286
3	To get free light bulbs/LEDs	34%	93	46%	126	19%	53	272
4	To access incentives for weatherization (e.g., insulation and air sealing) improvements	2%	5	18%	53	80%	229	287
5	To improve home comfort	4%	11	26%	72	70%	196	279
6	To improve the air quality in my home (or other health reason)	14%	35	34%	89	52%	136	260
7	Because my landlord or property manager decided to	22%	6	22%	6	56%	15	27
8	Another reason?	7%	2	13%	4	80%	24	30

To learn more about how I use energy in my home

#	Question	Major Measure	Assessment Only	Total
3	Very Important	25%	75%	158
2	Somewhat important	23%	77%	100
1	Not at all important	18%	82%	24

To learn how to reduce energy costs/save energy

#	Question	Major Measure	Assessment Only	Total
3	Very Important	24%	76%	240
2	Somewhat important	21%	79%	40
1	Not at all important	15%	85%	6

To get free light bulbs/LEDs

#	Question	Major Measure	Assessment Only	Total
3	Very Important	21%	79%	53
2	Somewhat important	27%	73%	126
1	Not at all important	21%	79%	93

To access incentives for weatherization (e.g., insulation and air sealing) improvements

#	Question	Major Measure	Assessment Only	Total
3	Very Important	26%	74%	229
2	Somewhat important	14%	86%	53
1	Not at all important	8%	92%	5

To improve home comfort

#	Question	Major Measure	Assessment Only	Total
3	Very Important	26%	74%	196
2	Somewhat important	21%	79%	72
1	Not at all important	8%	92%	11

To improve the air quality in my home (or other health reason)

#	Question	Major Measure	Assessment Only	Total
3	Very Important	28%	72%	136
2	Somewhat important	21%	79%	89
1	Not at all important	15%	85%	35

Because my landlord or property manager decided to

#	Question	Major Measure	Assessment Only	Total
3	Very Important	33%	67%	15
2	Somewhat important	15%	85%	6
1	Not at all important	15%	85%	6

Another reason?

#	Question	Major Measure	Assessment Only	Total
3	Very Important	24%	76%	24
2	Somewhat important	12%	88%	4
1	Not at all important	21%	79%	2

Q4 - Did you take an online home energy assessment before scheduling your in-home assessment?

#	Answer	%	Count
1	Yes	8%	23
2	No	59%	171
98	Don't know	32%	93
	Total	100%	287

Q5 - Based on your experience with the online assessment, please rate your agreement or disagreement with the following statements.

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Total
1	The online assessment was easy to complete	0%	0	0%	0	15%	3	41%	9	44%	9	22
2	The online assessment helped me to identify opportunities to improve the energy efficiency of my home	0%	0	8%	2	16%	3	46%	10	31%	7	21
3	The online assessment encouraged me to move forward with my onsite assessment	0%	0	0%	0	9%	2	39%	8	53%	10	20

Q7 - We want to understand your experience getting a home energy assessment. Please rate your agreement or disagreement with the following statements.

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Not Applicable		Total
1	The scheduling process was straightforward	1%	3	0%	0	6%	18	20%	57	73%	207	0%	0	285
2	The time it took to complete my home's energy assessment was reasonable	1%	2	0%	1	5%	14	20%	58	73%	209	0%	0	284
3	The Energy Specialist who conducted the assessment was pleasant to interact with	0%	0	1%	2	2%	6	7%	20	90%	255	0%	0	284
4	The Energy Specialist was able to answer my questions	0%	0	0%	1	3%	8	15%	43	82%	231	0%	0	283

Q9 - After the assessment did you receive a personalized report (also called an "action plan" or "contract scope") detailing next steps for how to save energy in your home?

#	Answer	%	Count
1	Yes	99%	270
2	No	1%	4
	Total	100%	274

Q10 - Please indicate the extent to which you agree or disagree with the statements below:

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Total
1	The report clearly identified the opportunities to improve the efficiency of my home (e.g., insulating and air sealing your home)	0%	0	0%	0	2%	5	17%	47	81%	217	269
2	The report clearly outlined the next steps I should take for each opportunity	1%	2	1%	2	2%	5	20%	54	77%	205	268
3	The report helped me prioritize the opportunities identified	0%	0	1%	3	6%	15	21%	56	72%	189	263
4	The report provided clear information on the costs of the	1%	2	2%	5	4%	10	18%	48	76%	202	267

improvements, including the portion covered by National Grid incentives											

Q12 - According to program records, you received a HEAT Loan as part of completing your project. What did you use the HEAT loan to do? Select all that apply.

#	Answer	%	Count
1	Address health and safety repairs or pre-weatherization requirements	12%	5
2	Complete my weatherization project	31%	14
3	Install an efficient heating, cooling or hot water system	26%	12
4	Complete a larger, more comprehensive project than I would have otherwise	10%	4
5	Complete project sooner than I would have otherwise	13%	6
97	Other	5%	2
99	Not sure	4%	2
	Total	100%	44

#	According to program records, you received a HEAT Loan as part of completing your project. What did you use the HEAT loan to do? Select all that apply. - Selected Choice	Count
1	According to program records, you received a HEAT Loan as part of completing your project. What did you use the HEAT loan to do? Select all that apply. - Selected Choice	27

Q13 - How satisfied were you with the HEAT Loan process over all?

#	Answer	%	Count
1	Not at all satisfied	8%	2
2	Slightly satisfied	14%	4
3	Moderately satisfied	24%	6
4	Very satisfied	11%	3
5	Completely satisfied	42%	11
	Total	100%	26

Q15 - Are there any changes that would have made the HEAT loan process work better for you?

#	Answer	%	Count
1	Yes	30%	8
2	No	44%	12
98	Not sure	25%	7
	Total	100%	27

Q17 - As part of the assessment did you receive information on the 0% HEAT Loan that National Grid offers through qualified lenders?

#	Answer	%	Count
1	Yes	60%	94
2	No	40%	62
	Total	100%	156

Q18 - Why did you decide not to obtain a HEAT Loan? Select all that apply.

#	Answer	%	Count
1	I did not need financing	59%	47
2	I did not think I would or did not qualify	22%	17
3	I had access to other financing	19%	16
	Total	100%	80

#	Question	Major Measure		Assessment Only		Total
1	I did not need financing	33%	15	67%	32	47
2	I did not think I would or did not qualify	13%	2	87%	15	17
3	I had access to other financing	14%	2	86%	13	16

Q19 - Would you have been interested in financing options to complete your project?

#	Answer	%	Count
1	Yes	21%	34
2	No	64%	105
98	Don’t know	15%	24
	Total	100%	164

Q20 - Did the assessment identify any health and safety issues or repairs that needed to be resolved before you could act on the program’s recommended efficiency improvements?

#	Answer	%	Count
1	Yes	36%	92
2	No	64%	163
	Total	100%	255

Q21 - What health and safety or home repair requirements were identified? Select all that apply.

#	Answer	%	Count
97	Something else?	14%	17
4	Moisture, mold, or draft issue	23%	28
5	Mechanical ventilation	17%	20
3	Knob and tube wiring	20%	24
2	Heating system, water heater, or oven carbon monoxide	18%	21
1	Combustion safety, combustion gases, or gas leak	7%	8
	Total	100%	117

Q22 - Did you address the issues identified?

#	Answer	%	Count
1	Yes, I addressed them all	68%	62
2	I addressed some of them	18%	17
3	No, I didn’t address any of them	14%	13
98	Not sure	0%	0

Total	100%	92

Q23 - What prevented you completing all the health and safety or repair requirements? Select all that apply.

#	Answer	%	Count
5	Work was invasive or inconvenient	11%	5
1	Upfront/out of pocket cost too large	18%	9
3	There were too many recommendations to consider	0%	0
2	The energy savings were too small given the estimated project cost	18%	8
97	Other	25%	12
4	I wasn't sure how to resolve the issue	8%	4
7	I didn’t need to have the work done	7%	3
6	Didn’t have time	4%	2
8	Complications related to COVID19 outbreak	11%	5
	Total	100%	48

Q25 - According to our records, you received the following energy saving equipment in your home as part of your home energy assessment. Is that correct?

#	Question	Yes		No		Total
1	LED bulbs	96%	253	4%	10	263
2	Faucet Aerators, Showerheads, or Pipe Wrap	46%	40	54%	46	86
3	Smart Power Strips	95%	251	5%	12	264
4	Programmable or Smart (Wifi) thermostat	92%	75	8%	6	81
5	Something else:	31%	32	69%	73	105

Q26 - Did you install your smart power strip(s) after your home energy assessment?

#	Answer	%	Count
1	Yes	88%	215
2	No	12%	30
	Total	100%	245

Q27 - What did the installed smart strip(s) control? Select all that apply.

#	Answer	%	Count
1	Entertainment system (TV's, gaming systems, cable boxes)	49%	139
2	Office/Desk (Home office setup, computers, monitors, desk lamp)	46%	130
3	Something else (Kitchen appliances, garage setup, etc.)	5%	14
	Total	100%	284

Q28 - Please rate your agreement with the following statements.

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Total
1	I am satisfied with the LED Light bulbs that I received	2%	5	2%	6	2%	5	10%	26	83%	209	252
2	I am satisfied with the Faucet Aerators, Showerheads, or Pipe Wrap I received	1%	0	0%	0	4%	2	29%	11	66%	26	40
3	I am satisfied with the Smart Power Strip(s) I received	1%	3	5%	11	2%	4	18%	39	74%	158	215
4	I am satisfied with the Programmable or Smart (WiFi) thermostat I received	6%	5	1%	1	2%	2	14%	10	77%	57	75

Q29 - Have you removed any of the items you received?

#	Answer	%	Count
1	Yes	11%	31
2	No	89%	252
	Total	100%	283

Q30 - Which items have you removed?

#	Answer	%	Count
1	LED lightbulbs	47%	16
3	Showerheads	1%	0
4	Pipe wrap	0%	0

5	Smart power strips	48%	16
6	Programmable or Smart (wifi) thermostat	4%	1
	Total	100%	34

Q31#1 - Please indicate whether you removed all the items, some of the items, or are not sure how many yo... - Did you removed some of them?

Q31#1 - Did you removed some of them?

#	Field	Minimum	Maximum	Mean	Count
1	LED lightbulbs - (Enter number of items removed)	1	20	3	13
2	Faucet Aerators - (Enter number of items removed)	1	1	1	2
3	Showerheads - (Enter number of items removed)	1	1	1	0
4	Pipe wrap - (Enter number of items removed)	0	0	0	0
5	Smart power strips - (Enter number of items removed)	1	1	1	9
6	Programmable or Smart (wifi) thermostat - (Enter number of items removed)	1	1	1	1

Q31#2 - Please indicate whether you removed all the items, some of the items, or are not sure how many yo... - Did you remove all of them?

#	Question	Yes		Total
1	LED lightbulbs	100%	5	5
2	Faucet Aerators	0%	0	0
3	Showerheads	100%	0	0
4	Pipe wrap	0%	0	0
5	Smart power strips	100%	8	8
6	Programmable or Smart (wifi) thermostat	100%	1	1

Q31#3 - Please indicate whether you removed all the items, some of the items, or are not sure how many yo... - Not sure?

#	Question	Not sure		Total
1	LED lightbulbs	100%	2	2
2	Faucet Aerators	0%	0	0
3	Showerheads	0%	0	0
4	Pipe wrap	0%	0	0

5	Smart power strips	100%	2	2
6	Programmable or Smart (wifi) thermostat	0%	0	0

Q33 - Please rate your agreement or disagreement with the following statement. - Overall I am satisfied with how the home energy assessment went.

#	Answer	%	Count
1	Strongly disagree	1%	3
2	Somewhat disagree	2%	6
3	Neither agree nor disagree	3%	8
4	Somewhat agree	22%	63
5	Strongly agree	72%	208
99	Not Applicable	0%	0
	Total	100%	287

Q35 - National Grid is considering conducting in-home assessments virtually. In virtual assessments, a live Energy Specialist would assess your home using video conferencing technology. Please rate your agreement or disagreement with the following statements.

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Total
1	In my opinion, a virtual assessment is an attractive option.	25%	69	22%	63	22%	63	23%	64	8%	23	281
2	Virtual assessments seem safer right now than in-home assessments.	5%	14	8%	23	21%	60	32%	91	34%	96	284

Q36 - How did you choose your contractor?

#	Answer	%	Count
1	I chose a contractor off the approved list	16%	11
2	The program recommended/assigned me a contractor	78%	53
97	Other	4%	3
98	Not sure	1%	1
	Total	100%	67

Q37 - We want to understand your experience insulating your home. Please rate your agreement or disagreement with the following statements.

#	Question	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Not applicable		Total
1	The time that passed between my assessment and when work on my home started was reasonable	3%	2	8%	5	4%	3	24%	16	61%	41	0%	0	67
2	The contractor/crew that insulated my home was professional	2%	1	3%	2	1%	1	12%	8	81%	55	1%	0	67
3	I am satisfied with the quality of work completed on my home	4%	3	5%	3	1%	1	16%	11	74%	49	1%	0	67
4	I noticed a decrease in my energy bill	5%	4	3%	2	23%	15	32%	21	35%	23	3%	2	67

Q39 - Did your energy specialist recommend insulation or other weatherization work for your home?

#	Answer	%	Count
1	Yes	77%	167
2	No	21%	45
98	Don’t Know	2%	5
	Total	100%	217

Q40 - Did you complete the recommended work on your home?

#	Answer	%	Count
1	Yes	33%	53
2	No	66%	107
98	Don’t Know	1%	2
	Total	100%	162

Q41 - What prevented you from making the energy efficiency changes recommended after your assessment? Select all that apply.

#	Answer	%	Count
1	Upfront/out of pocket cost too large	19%	28
2	The energy savings were too small given the estimated project cost	2%	3
3	There were too many recommendations to consider	4%	7
4	Work was invasive or inconvenient	8%	12
5	I wasn't sure how to move forward	11%	17
6	Didn't have time	10%	15
7	Didn't need the work done	2%	3
8	Complications related to COVID19 outbreak	14%	22
97	Other	28%	42
98	Not sure	1%	2
	Total	100%	150

Q44 - Thinking about your overall experience with this program, how would you rate your satisfaction? Would you say you are…

#	Answer	%	Count
1	Not at all satisfied	1%	2
2	Slightly satisfied	8%	22
3	Moderately satisfied	13%	37
4	Very satisfied	40%	114
5	Completely satisfied	39%	110
	Total	100%	285

Q46 - Would you recommend the program to family or friends?

#	Answer	%	Count
1	Yes	97%	277
2	No	3%	10
	Total	100%	287

Q47 - Did your experience in the program change your perception of National Grid?

#	Answer	%	Count
1	Yes, favorably	72%	205
2	Yes, negatively	2%	6
3	No	26%	75
	Total	100%	287

Q49 - Including yourself, how many total people reside in your home?

#	Answer	%	Count
2	2	46%	129
1	1	18%	51
3	3	16%	44
4	4	12%	34
5	5	5%	15
6	6 or more	4%	11
	Total	100%	284

#	Question	Major Measure		Assessment Only		Total
1	1	22%	11	78%	40	51
2	2	24%	31	76%	99	129
3	3	28%	12	72%	32	44
4	4	30%	10	70%	23	34
5	5	21%	3	79%	12	15
6	6 or more	12%	1	88%	10	11

Income1- What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 1 household member

#	Answer	%	Count
1	Below $34,800	21%	11
2	Between $34,800 and $46,350	14%	7
3	Between $46,350 and $69,550	16%	8

4	Greater than $69,550	25%	13
99	Prefer not to answer	25%	13
	Total	100%	51

#	Question	Major Measure		Assessment Only		Total
1	Below $34,800	21%	2	79%	8	11
2	Between $34,800 and $46,350	31%	2	69%	5	7
3	Between $46,350 and $69,550	17%	1	84%	7	8
4	Greater than $69,550	21%	3	79%	10	13
99	Prefer not to answer	21%	3	79%	10	13

Income2 - What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 2 household members

#	Answer	%	Count
1	Below $39,750	5%	6
2	Between $39,750 and $53,000	5%	6
3	Between $53,000 and $79,500	20%	26
4	Greater than $79,500	48%	63
99	Prefer not to answer	22%	29
	Total	100%	129

#	Question	Major Measure		Assessment Only		Total
1	Below $39,750	15%	1	85%	5	6
2	Between $39,750 and $53,000	44%	3	56%	3	6
3	Between $53,000 and $79,500	24%	6	76%	20	26
4	Greater than $79,500	23%	14	77%	48	63
99	Prefer not to answer	24%	7	76%	22	29

Income3 - What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 3 household members

#	Answer	%	Count
1	Below $44,750	5%	2
2	Between $44,750 and $59,600	14%	6
3	Between $59,600 and $89,400	26%	11
4	Greater than $89,400	43%	19
99	Prefer not to answer	12%	5
	Total	100%	44

#	Question	Major Measure		Assessment Only		Total
1	Below $44,750	21%	0	79%	2	2
2	Between $44,750 and $59,600	21%	1	79%	5	6
3	Between $59,600 and $89,400	27%	3	73%	8	11
4	Greater than $89,400	30%	6	70%	13	19
99	Prefer not to answer	35%	2	65%	3	5

Income4 - What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 4 household members

#	Answer	%	Count
1	Below $49,700	10%	3
2	Between $49,700 and $66,250	3%	1
3	Between $66,250 and $99,350	25%	8
4	Greater than $99,350	28%	9
99	Prefer not to answer	34%	11
	Total	100%	34

#	Question	Major Measure		Assessment Only		Total
1	Below $49,700	0%	0	100%	3	3
2	Between $49,700 and $66,250	100%	1	0%	0	1
3	Between $66,250 and $99,350	21%	2	79%	7	8

4	Greater than $99,350	47%	4	53%	5	9
99	Prefer not to answer	27%	3	73%	8	11

Income5 - What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 5 household members

#	Answer	%	Count
1	Below $53,700	0%	0
2	Between $53,700 and $71,550	17%	3
3	Between $71,550 and $107,300	20%	3
4	Greater than $107,300	62%	9
99	Prefer not to answer	0%	0
	Total	100%	15

#	Question	Major Measure		Assessment Only		Total
1	Below $53,700	0%	0	0%	0	0
2	Between $53,700 and $71,550	35%	1	65%	2	3
3	Between $71,550 and $107,300	44%	1	56%	2	3
4	Greater than $107,300	10%	1	90%	8	9
99	Prefer not to answer	0%	0	0%	0	0

Income6 - What was your total annual household income in 2019 (before taxes)? Please include income generated by all members of your household. - 6+ household members

#	Answer	%	Count
1	Below $57,650	15%	2
2	Between $57,650 and $76,850	29%	3
3	Between $76,850 and $115,250	15%	2
4	Greater than $115,250	26%	3
99	Prefer not to answer	15%	2
	Total	100%	11

#	Question	Major Measure		Assessment Only		Total
1	Below $57,650	0%	0	100%	2	2
2	Between $57,650 and $76,850	0%	0	100%	3	3
3	Between $76,850 and $115,250	0%	0	100%	2	2
4	Greater than $115,250	44%	1	56%	2	3
99	Prefer not to answer	0%	0	100%	2	2

Q50 - What is the highest level of education that you have completed so far?

#	Answer	%	Count
1	Less than high school diploma or equivalent	1%	4
2	High school diploma or equivalent	11%	32
3	Technical or business school certificate/2-year college degree/some college	19%	55
4	4-year college degree/bachelor’s degree	32%	91
5	Graduate or professional degree/masters or PhD	30%	87
99	Prefer not to answer	6%	18
	Total	100%	287

#	Question	Major Measure		Assessment Only		Total
1	Less than high school diploma or equivalent	21%	1	79%	3	4
2	High school diploma or equivalent	18%	6	82%	27	32
3	Technical or business school certificate/2-year college degree/some college	25%	14	75%	42	55
4	4-year college degree/bachelor’s degree	21%	19	79%	72	91
5	Graduate or professional degree/masters or PhD	27%	23	73%	63	87
99	Prefer not to answer	35%	6	65%	12	18

Q51 - Which of these options best describes you?

#	Answer	%	Count
1	I owned and lived in the home at the time it of the energy assessment	92%	264
2	I owned the home at the time of the assessment, but someone rented it from me	2%	6
3	I did not own the home and was renting it from someone else	4%	11

97	Other	1%	4
	Total	100%	286

#	Question	Major Measure		Assessment Only		Total
1	I owned and lived in the home at the time it of the energy assessment	25%	66	75%	199	264
2	I owned the home at the time of the assessment, but someone rented it from me	15%	1	85%	5	6
3	I did not own the home and was renting it from someone else	12%	1	88%	10	11
97	Other	21%	1	79%	3	4

Q52 - Who initiated participation in the program? - Landlords

#	Answer	%	Count
1	I did	100%	6
2	My renter, who then brought me into the process	0%	0
97	Other	0%	0
	Total	100%	6

#	Question	Major Measure		Assessment Only		Total
1	I did	15%	1	85%	5	6
2	My renter, who then brought me into the process	0%	0	0%	0	0
97	Other	0%	0	0%	0	0

Q53 - Who initiated participation in the program? - Renters

#	Answer	%	Count
1	I did	63%	7
2	My landlord/property manager, who then brought me into the process	37%	4
97	Other	0%	0
	Total	100%	11

#	Question	Major Measure		Assessment Only		Total
1	I did	6%	0	94%	7	7
2	My landlord/property manager, who then brought me into the process	21%	1	79%	3	4
97	Other	0%	0	0%	0	0