cadeo

ILLUME

August 28, 2020

Impact Evaluation

Home Energy Reports Program

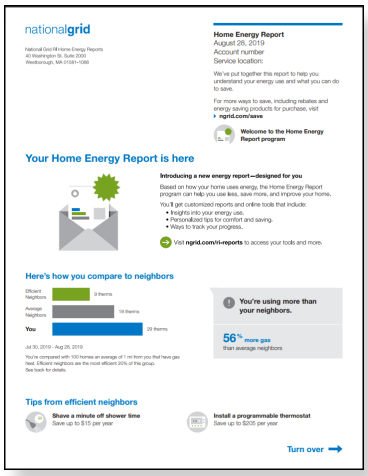
National Grid Rhode Island

Developed For

National Grid
40 Sylvan Road
Waltham, MA 02451

Developed By

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


nationalgrid

Home Energy Report
August 28, 2019
Account number:
Service location:

Your Home Energy Report is here

Introducing a new energy report—designed for you

Here's how you compare to neighbors

You're using more than your neighbors.

Tips from efficient neighbors

Turn over

Executive Summary

The Home Energy Reports (HER) program provides energy education, feedback, and tips to help customers save energy at home. The program uses social norms by comparing customers' energy use to that of similar homes to encourage energy-saving behavior. The program implementer randomly assigns eligible customers to treatment or control groups. Treatment groups receive personalized reports while control groups do not receive materials. The first treatment groups began receiving reports in 2013 with additional groups added in subsequent years. We compare the change in energy use of the treatment groups to control groups to calculate energy savings caused by the program.

Screened group of utility customers (wave)

Randomly split into **two groups**

Treatment Group:
Receives Information

Control Group:
Does Not Receive Information

Treatment Minus Control Equals **Energy Saved**

Why Evaluation?

National Grid uses evaluation to retrospectively assess the performance of its programs and to estimate the savings in future program years. National Grid contracted with the Cadeo-ILLUME team to use monthly billing data to evaluate how much energy the HER program saved from 2017 to 2019 and to recommend planning values National Grid should use until the next evaluation.

	Electric Results	Gas Results
Number of Treatment Customers[1]	270,729	121,419
Average Savings Per Household	106 kWh	7.7 Therms
Savings as Percent of Energy Use	1.4%	0.9%
Total Savings 2017 – 2019[2]	**86,092 MWh**	**2,804,769 Therms**

The HER program continues to produce robust savings for National Grid. Customers who have received reports for longer generally have higher savings. The program also produces a small uplift (1 to 5%) in participation in other National Grid energy efficiency programs.

cadeo ILLUME

[1] Average number of customers, 2017 – 2019 [2] Reported savings remove any savings due to participation in other energy efficiency programs.

Table of Contents

Executive Summary

National Grid contracted with the Cadeo-ILLUME team, third-party energy efficiency program evaluators (hereafter, "we" or "the evaluation team"), to evaluate how much electricity and natural gas the Home Energy Reports (HER) program saved in Rhode Island from 2017 to 2019. The evaluation team used monthly customer billing data to estimate electricity and natural gas savings for the program overall and for specific customer sub-groups.

Program Overview

The HER program distributes paper and email reports and alerts[1] to educate customers about their home energy usage and provide tips for saving energy. National Grid contracts with Oracle (hereafter, "program implementer") to implement the HER program. The program is designed as randomized control trials (RCTs), wherein the program implementer screens populations of customers for eligibility and randomly assigns eligible customers to a **treatment** group (receives HERs and other education) or **control** group (does not receive HERs or other education). Assuming random assignment, treatment and control groups should be equivalent on energy use and other characteristics, and the control group should provide an unbiased baseline for measuring the effects of the program on the treatment group.

The program serves customers with electric, natural gas, and dual-fuel service. Customer groups that start receiving reports at the same time are in the same "wave." In 2017 – 2019, the program included both "Existing Customer" waves and "New Mover" waves. Existing Customer waves have at least 9 to 12 months of billing history, while New Mover waves were comprised of customers who started receiving reports shortly after initiating service with National Grid.[2] In 2019, most HER treatment customers (88%) were part of Existing Customer waves.

Over the life of the program, since 2013, it has treated 444,527 unique residential customer account and premise combinations,[3] representing nearly the entire customer base in Rhode Island.[4]

---

[1] This includes high-bill alerts, and targeted messaging at the highest energy users; discussed in detail in the Program Enhancements section.

[2] New Movers started receiving reports in 2013 and 2014. While they are no longer recent movers during this program cycle, we consider them separately for evaluation purposes due to their shorter pre-treatment billing history and smaller group sizes compared to Existing Customers.

[3] For simplicity throughout the report, we refer to customers rather than customer account premises, but it may be that some customers own multiple homes within the data or moved during the program.

[4] Table 6 from the Energy Information Administration (EIA) reports that National Grid had 386,200 customers in 2018. Some customers own multiple homes or have moved over the seven-year period of the program; the random assignment of customers into treatment and control groups ensures that any potential impacts from customers with multiple homes or those that have moved affect the treatment and control groups equally.

Methodology Overview

The evaluation team used monthly billing data to calculate overall net ex post savings as well as net ex post savings by year and wave.[5] We also assessed savings differences between six customer personas that National Grid assigned based on energy use and demographics.[6]

We report unadjusted and adjusted savings estimates. Adjusted savings estimates exclude savings attributable to participation in other energy efficiency programs so that these savings are not double-counted. The ratio of the adjusted net ex post savings to the implementer-reported savings is the realization rate. National Grid uses realization rates for planning and reporting savings in future program years.

Key Evaluation Findings And Recommendations

From 2017 – 2019, the program achieved adjusted net energy savings of 86,092 MWh and 2,804,768 therms over the three-year period with overall realization rates of 98% for electric savings and 84% for gas savings (Figure 1). Among waves with electric service, the overall realization rate of evaluated net ex post savings to implementer-estimated savings is 108% for Existing Customers and 67% for New Movers. Among waves with gas service, overall realization rates are 92% for Existing Customers and 50% for New Movers **(Table 1)**.[7] Several distinctions between Existing Customers and New Movers contributed to the differences in realization rates. For New Movers, the implementer used a simple difference in post-period usage whereas the evaluation team used a modeling approach to calculate savings. Both the implementer and the evaluation team used a modeling approach for Existing Customers. New Movers have smaller treatment and control group sizes and much more limited pre-treatment billing history, which can contribute to bigger differences between different methods.

> **Recommendation:** For planning purposes, we recommend that National Grid use the weighted average 2017 – 2019 electric realization rates of 108% for Existing Customers and 67% for New Movers. For gas we recommend that National Grid use 92% for Existing Customers and 50% for New Movers. We recommend using separate realization rates for these two groups given their structural and performance differences.

[5] For opt-out programs that are a RCT, savings are by definition net savings.

[6] The program implementer did not differentiate program treatment or messaging by persona.

[7] The program implementer estimates energy savings each month from customer billing data and reports monthly savings to National Grid.

Figure 1. Electric and Gas Savings 2017 – 2019

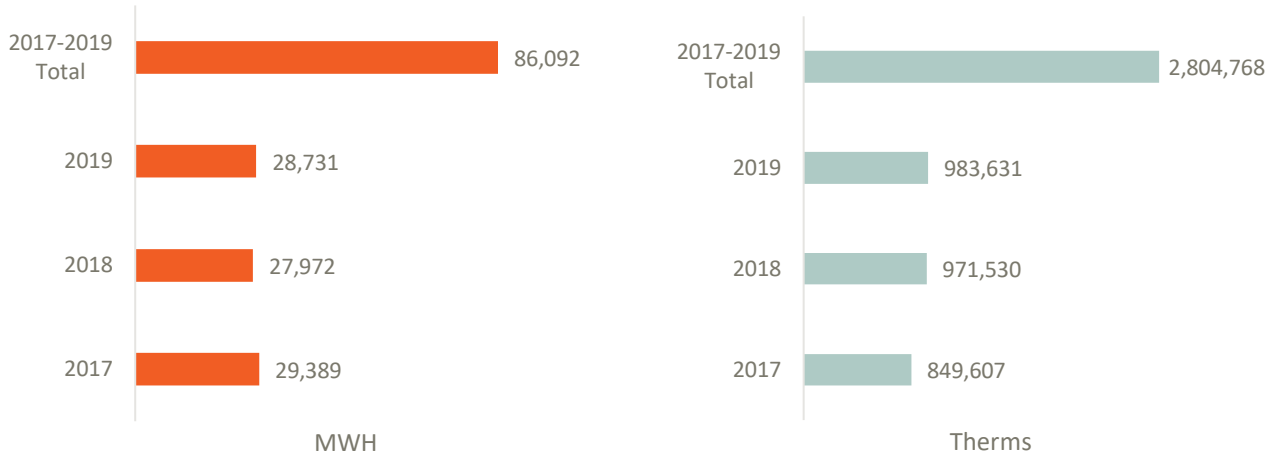


Table 1. Summary Program Results

2017 – 2019 Net Savings	Electric Savings (MWH)		Gas Savings (Therms)	
	Existing Customers	New Movers	Existing Customers	New Movers
Evaluated Ex Post [a]	71,895	14,197	2,493,023	311,745
Implementer-Estimated Ex Post [b]	66,719	21,046	2,700,289	629,629
Realization Rate [c]	**108%**	**67%**	**92%**	**50%**

[a] Evaluated savings that have been adjusted for savings attributable to participation in other energy efficiency programs. These are energy savings attributable to HERs that would not have occurred in the absence of the program.

[b] The program implementer provides monthly savings estimates by wave in a monthly report. National Grid adds up the monthly savings estimates for an annual total.

[c] The ratio of adjusted net ex post savings to implementer-estimated ex post savings.

Savings estimates for New Mover and for some Existing Customer waves and years were not statistically significant. Among Existing Customer waves, savings from older and larger waves were more likely to be statistically significant from 0, while newer waves or those with smaller treatment and control groups were not. As expected, due to the small wave sizes and limited baseline data for New Mover waves, the evaluation team and program implementer's savings estimates for New Mover waves were not statistically significant from 0. However, with an RCT design, the point estimate is still the best unbiased estimate of savings even if it is not statistically significant.

> **Recommendation:** For Existing Customer waves going forward, establish treatment and control group sizes that are large enough to allow for multi-year (five or more years) customer attrition, and also consider updated forecasts or estimates of per-household HER savings.[8] An assessment of prior-

[8] The size of treatment and control groups, the variability of customer consumption, and the magnitude of savings influences statistical significance. For example, waves with lower expected savings (due to, for example, lower baseline usage) or more variable customers may require larger groups for evaluation.

year confidence intervals and statistical significance or a power analysis could inform group size guidelines.

Realization rates fluctuate across waves, years, and evaluation cycles; however, implementer-reported 2017 – 2019 savings generally fall within the evaluation team's unadjusted savings confidence intervals.[9] A combination of factors can cause differences in savings estimates. For example, the program implementer calculated results on a monthly basis while the evaluation team estimated annual models. Tracking program progress monthly has many benefits with the trade-off that final annual evaluated net ex post savings may differ from the summed up monthly results. Additionally, existing wave group sizes shrink through natural attrition, resulting in smaller treatment and control group sizes each program year. As the number of customers in a wave is reduced, so is the statistical power of the model, resulting in larger confidence intervals and potentially fluctuating realization rates. While fluctuating realization rates can make planning more challenging, across all waves and years, implementer-reported savings are generally within the 90% confidence interval of the evaluation unadjusted net ex post savings.

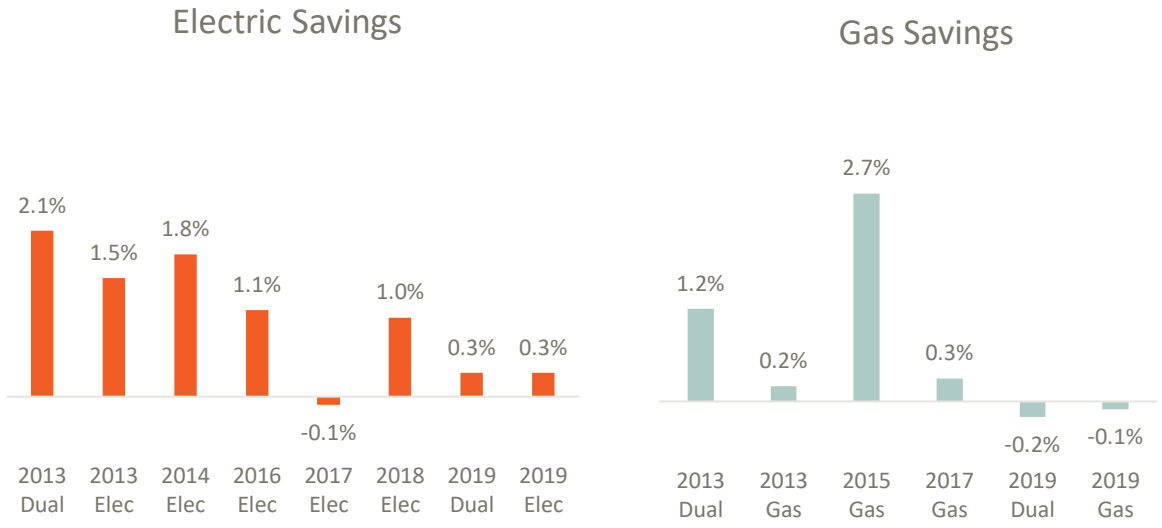
> **Recommendation:** Continue to monitor realization rates and treatment and control group sizes, although there is currently no need to make changes to existing wave configurations. With respect to the implementer's evaluation, measurement, and verification (EM&V) methods, continue to monitor any changes in their approach and consider requesting an annual savings "true-up" (from an annual model) to assess whether the monthly approach may be a potential driver of differences in realization rates.

Among Existing Customer waves with electric service, those who started receiving reports earlier generally have higher and statistically significant electric savings per household compared to later waves (Figure 2). In 2019, the three waves that began in 2013 and 2014 have the highest savings (2.1%, 1.5%, and 1.8%, respectively). The 2016 and 2018 waves have moderate savings (1.1% and 1.0%, respectively) while the 2017 and 2019 waves have very low and not statistically significant savings (-0.1%, 0.3%, and 0.3%, respectively). It is too early to draw conclusions about the 2019 waves since savings for report-based feedback and education programs generally ramp up over time.

Among Existing Customer waves with natural gas service, household natural gas savings fluctuate from year to year and across waves without a clear pattern (Figure 2). For example, in program year 2019, the 2015 Gas and 2013 Dual Fuel waves had the highest savings (2.7% and 1.2%, respectively) while 2013, 2017, and 2019 waves had savings less than 0.5%.

[9] The program implementer does not adjust for nor remove uplift or joint savings achieved through other energy efficiency programs, so their savings estimates are most comparable to unadjusted evaluation results (before evaluation removes uplift savings).

Figure 2. 2019 Electric and Gas Household Percent Savings by Wave



The 201703[10] wave produced low (<0.1%) electricity savings in all three years and low gas savings (<0.5%) in two out of three years of the program cycle; no savings estimates were statistically significant. Other National Grid waves have produced at least 1% of electricity savings by their third year of treatment and at least 0.5% of gas. Notably, this wave has the second lowest baseline electricity consumption and second lowest baseline gas consumption, indicating less opportunity for HER recipients to reduce their consumption. Additionally, the wave has a higher percentage of lower-saving personas compared to waves overall, a higher portion of savings deriving from participation in other energy efficiency programs, and a lower percentage of treatment customers who receive email HERs (eHERs) (53%) compared to the population (58%).

> **Recommendation:** Monitor the 2017 wave for improvement over time. If savings do not improve, National Grid could consider additional efforts to understand and reach this wave such as: (1) surveys or in-depth interviews to better understand the barriers to saving energy and what interventions may be more effective, (2) marketing campaigns to increase the number of email addresses on file which will increase access to eHERs and other program enhancements, and (3) targeted messaging by persona, especially those that tend to have lower savings overall. If the program offers additional program enhancements or new ways to engage, consider setting up an experimental design within the 201703 wave to test for the incremental effects of the effort.

Only 58% of participants received emailed HERS (eHERs). The percentage was even lower when focusing on gas customers – less than 50% of participants in three gas waves received eHERs. Participants who do not have an email address on file also cannot receive high bill alerts (HBAs) and other program

[10] Throughout the report, we use a year-month naming convention, where a treatment wave that began in March 2017 would be referred to as "201703".

messaging. Multiple modes of communication can increase the likelihood customers see the normative messaging and energy saving tips.

> **Recommendation:** To increase engagement with the program, National Grid could consider efforts to collect more email addresses. These efforts could include: (1) messaging on printed reports that explains the benefits of signing up for eHERs, (2) messaging on other National Grid communications, and (3) rewards or incentives for signing up for eHERs or using the online portal.

Treatment group customers participated in other energy efficiency programs more often than control customers. Print HERs and eHERs cross-promote other National Grid energy efficiency programs to highlight ways customers can save more energy and money. Overall, the cross-promotions influenced HER treatment customers to participate in other National Grid program offerings at higher rates than control group customers. Among electric-metered customers, 5.2% (19,679) of treatment customers (19,679 customers) participated in the EnergyWise Single Family program, and an additional 3.5% of treatment customers (13,373 customers) participated in the ENERGY STAR® Products program, cumulatively over the three program years. Among gas-metered customers, 4.2% of treatment customers (8,482 customers) participated in the EnergyWise Single Family program, and 1.8% of treatment customers (3,750 customers) participated in the Residential Gas Heating & Water Heating program cumulatively over the three program years as a result of the HER program. These increases are consistent with report messaging that included information on these programs multiple times over the three-year cycle along with no-cost, behavior-based, energy-saving tips.

Participation in other energy efficiency programs accounted for 2.2% and 8.6% of unadjusted modeled net energy savings from electric and gas HERs, respectively. To avoid double-counted savings, we removed these savings from the modeled savings estimates for the HER program.

> **Recommendation:** Continue balancing messaging on low- and no-cost energy-saving tips with cross-promotion to encourage participation in other energy efficiency programs because HERs successfully channel customers to other programs. Per regulatory frameworks, the incremental savings are removed from the HER program's savings. Targeted, thoughtful use of energy efficiency program messaging can help customers save energy and boost participation in other programs while limiting the impact on HER program savings.

Program Overview

Program Design

Through the HER program, National Grid provides feedback and education to help customers manage and reduce their energy use at home. Below we describe the program elements and program participation in more detail.

Home Energy Reports

National Grid distributes HERs by mail and email. The mailed reports are single-page print reports designed to educate residential customers about their home energy usage and provide them with information designed to encourage behavior change (see sample, **Figure 3**).

HERs apply a social psychology theory that people will change their behavior in response to normative information and feedback. Social psychology research shows that both descriptive and injunctive norms influence behavior. Descriptive norms illustrate what others commonly do while injunctive norms depict what others commonly approve or disapprove of. When the two norms deviate, people tend to do as others do, suggesting that information on how other households are using energy can encourage energy-saving behavior. Research has shown that simple changes to the language of public service signs, reflecting descriptive norms, can dramatically increase compliance with environmental goals.[11]

In the context of HERs, when customers receive positive feedback about their home energy use compared to other homes, they will be motivated to maintain their lower energy use. Similarly, households who receive feedback that they are using more energy than their similar neighbors will be motivated to reduce their energy use.[12] The goal of the smiling emoji[13] is to counter any rebound effect customers might experience after learning that they used less energy than their neighbors.[14]

Customers with an email address on file (about 58%) also receive eHERs. Customers can choose to opt-out of receiving HERs; however only 1.1% of all treatment customers have opted out of all program communications.

---

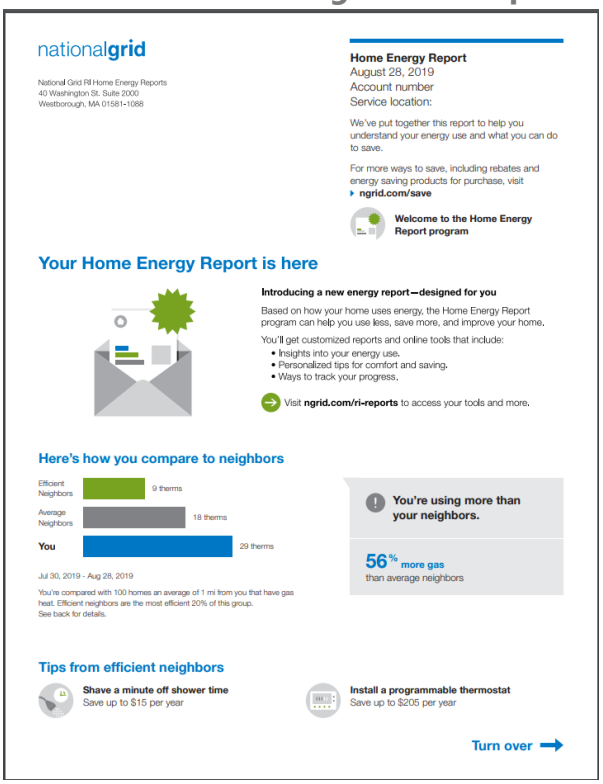
[11] Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. Journal of Consumer Research, 35(3), 472–482. https://doi.org/10.1086/586910.

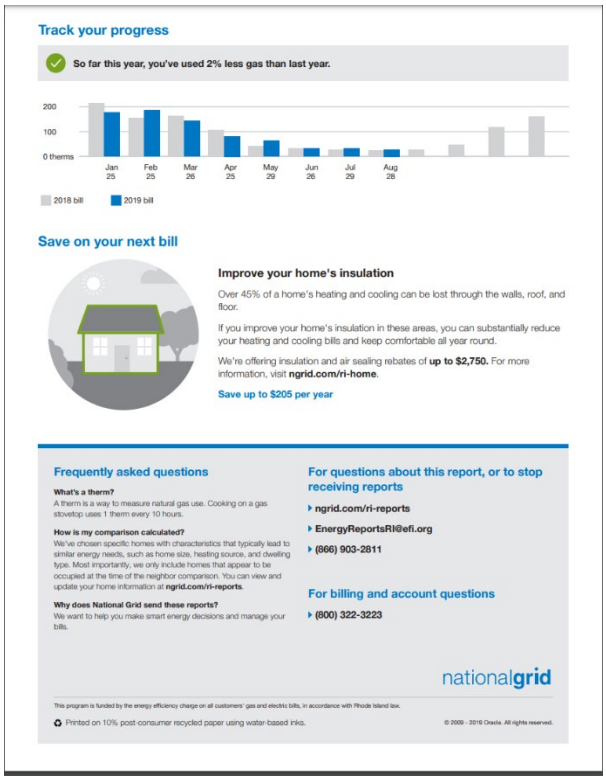
[12] Allcott, Hunt, and Todd Rogers. 2012. How Long Do Treatment Effects Last? Persistence and Durability of a Descriptive Norms Intervention's Effect on Energy Conservation. HKS Faculty Research Working Paper Series RWP12-045, John F. Kennedy School of Government, Harvard University.

[13] In earlier years of the program, reports included smiling and frowning faces to show how energy use compared to "neighbors." Oracle now includes messages about how each household compares to "average" neighbors and "high-efficiency" neighbors, using only smiling face images. Oracle removed the frowning face image to reduce dissatisfied reactions from customers.

[14] Kallgren, Carl, Raymond Reno, and Robert B. Cialdini. (2000). A focus theory of normative conduct: When norms do and do not affect behavior. Personality and Social Psychology Bulletin, 26(8). https://doi.org/10.1177/01461672002610009.

Figure 3. Sample Print Home Energy Report





Report Messaging

During the 2017 to 2019 program cycle, HERs featured a variety of messaging covering different types of encouragement to save energy and cross-promotion of National Grid energy efficiency programs. Most of the messaging focused on no-cost energy-saving tips and encouragement. **Table 2** summarizes the messaging based on type (no-cost vs. purchase), wave-type, and year. Some messages appeared multiple times during the year.

Table 2. Report Messaging

	2017	2018	2019
Electric Only and Dual Fuel Reports			
No-Cost	Home Energy Assessment Home profile Thank you for efforts Thermostat settings Income eligible programs High usage alerts	Turn off lights and computer Thermostat settings Home Profile update Paperless billing Refrigerator/freezer recycling	Thank you for efforts Turn off lights and powerstrips Dust/vacuum coils, AC, light bulbs Lower shades Thermostat settings Use ceiling fan ConnectedSolutions Income eligible solutions EnergyWise Home assessment
Purchase	Wi-fi thermostat		Heat pump water heater Electric heat pump Wi-fi thermostat
Natural Gas			
No-Cost	Income eligible programs High usage alerts Home energy assessment Community-specific (Tiverton/Little Compton) Thermostat settings	Home Profile update Thermostat settings	Turn off lights and powerstrips Thank you for efforts Thermostat settings Income eligible solutions
Purchase	Wi-fi thermostat	Electric heat pump water heater rebate	Wi-fi thermostat

Program Enhancements

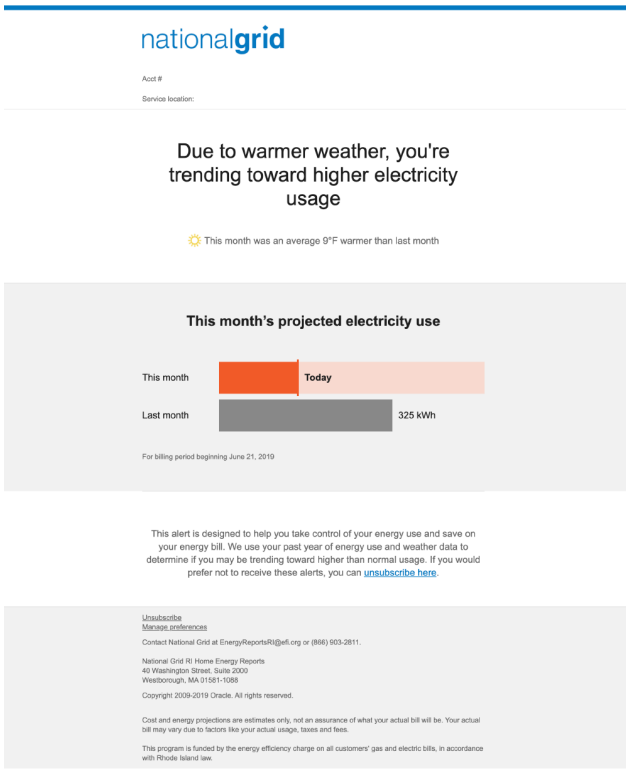
The program added several enhancements during the 2017 to 2019 cycle to increase engagement and savings.

Home Profile Update: eHER messaging encouraged customers to log onto their account and visit the "My Energy Use" page to update key characteristics of their home such as size, heating type, and presence of a pool or fireplace. The program implementer used this information to improve the relevance of the similar homes comparison and to improve tips and feedback.

Seasonal Editions: Print and eHER messaging on one summer and one winter report emphasized preparation and energy savings for the season. The summer report focused on cooling energy use and avoiding high summer bills while the winter report focused on heating energy use and winter heating myths.

High Bill Alerts (HBAs): The program issued high-bill alerts to customers with an email address on file whose current month's usage was trending to exceed the prior month's usage by 30%.[15] The alerts also provided tips for saving energy. Customers on low income rates received information on additional programs available to them through National Grid. Each program year, 18% to 21% of treatment customers received an HBA for their gas or electric service. **Figure 4** shows a sample HBA.

Figure 4. Sample HBA



Target Rank Campaign: The program offered a new experience to the highest electric users who received eHERs. Customers received information about their neighborhood rank along with smaller, more achievable goals to work toward changing their rank. Their eHER showed their monthly progress.

Email Personal Tracker: National Grid added a personal tracker module to the eHERs. The module shows usage over time and allows customers to compare that usage to similar time periods from the previous year. This helps customers see their performance over time and creates a more personalized experience for each customer.

[15] The program implementer uses a statistical model to forecast current month usage based on current month weather and the relationship between weather and usage in the prior year.

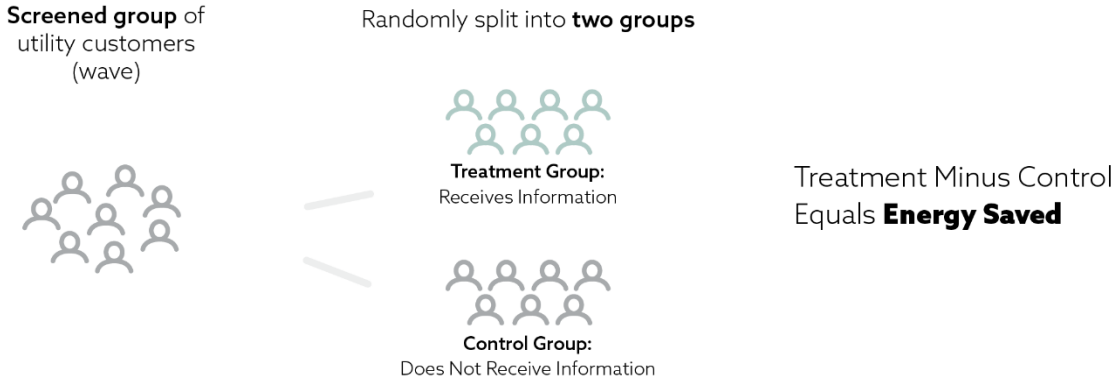
Program Implementation

National Grid contracts with the program implementer to carry out the HER program as randomized control trials (RCTs). The program implementer screens populations of customers for eligibility[16] and randomly assigns those customers to a **treatment** group (receives HERs and other program communications) or **control** group (does not receive any program communications) (see **Figure 5**).

The HER program primarily affects energy use through a wide range of customer behaviors rather than specific end uses. To measure energy savings, the evaluation team looks at whole-home energy use. The RCT design provides the baseline needed to measure whole-home energy savings.

The implementer randomizes the groups which the evaluation team verifies by comparing energy use in the pre-period. Because of the randomization and verification steps, we can also assume that it is likely that the groups are equivalent on other unmeasured characteristics such as interest in saving energy. The randomization and opt-out design limit the threat of selection bias (that customers receiving reports are more predisposed to save energy). The control group acts as a baseline or counterfactual—a stand-in for what would have happened to the treatment group in the absence of the program. The RCT design allows both the implementer and evaluators to estimate program impacts by comparing changes in whole home energy use between the treatment and control groups. Evaluation experts often refer to the RCT as the "gold standard" for behavior program evaluations.[17]

Figure 5. Randomized Control Trial Approach



Source: Cadeo-ILLUME team

For this program, the treatment groups receive a bundle of reports and communications and not every treatment customer receives all program communication. All customers in the treatment groups (except

[16] Customers may be screened out due to inadequate pre-period billing history, extreme values of usage, or rate code.

[17] State and Local Energy Efficiency Action Network. 2012. Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations. Prepared by A. Todd, E. Stuart, S. Schiller, and C. Goldman, Lawrence Berkeley National Laboratory. http://behavioranalytics.lbl.gov.

for the small percentage who opt out) receive printed and mailed HERs. Treatment customers with email addresses on file also receive eHERs and HBAs. The highest electricity users receive the Target Rank report. Because the program implementer does not randomly assign individual program elements like eHERs and HBAs, we cannot estimate the savings of individual elements. We calculate savings for each treatment group which receives a bundle of program elements that may vary by customer.

The 2017 – 2019 program delivered reports to a mix of dual fuel, electric-only, and gas-only National Grid customers. The 2017 – 2019 program included 17 groups of customers (8 electric-only, 5 gas-only, 4 dual-fuel), referred to as "waves." Waves consist of customers who started receiving reports (or serving as a control group) at the same time. Existing Customer waves typically require that customers have a sufficient number (typically 12 months) of billing data to be included in a program (either treatment or control); this is to ensure that waves include customer homes with similar energy consumption patterns, and to ensure that they can be evaluated with a certain amount of statistical certainty.

The New Mover waves began receiving reports shortly after initiating service, so that treatment for these waves began on a rolling basis. These customers also had less billing history (as low as one month) prior to treatment. The first reports sent to New Mover waves encouraged behavior change of customers shortly after moving into a new home. After one year of receiving targeted messaging, the waves now receive the same messaging as Existing Customers. By design, the New Mover initiative targeted customers with limited billing history. Furthermore, the initiative was constrained by the number of customers who move and begin new service within a pre-defined window when treatment begins. As a result, New Mover waves typically have far fewer customers than their Existing Customer counterparts. Due to complications of the design (limited eligible population and difficulty ensuring equivalent groups with limited billing history) the program is not adding additional New Mover waves and may discontinue New Mover waves that have low savings.[18]

Throughout the report, we refer to each wave by their fuel type and the year and month of randomization. For example, 201303 Dual Fuel refers to the wave of dual fuel customers selected in March 2013. In that example, treatment group customers started receiving reports in 2013 and continued to receive reports through 2019. **Table 3** summarizes each wave.

[18] The program discontinued a gas-only New Mover wave due to small group size and poor results. The program implementer is considering discontinuing the 201408 electric-only wave.

Table 3. Wave Details

Fuel	Wave Name	Start Month (First Report)	Number of Treatment Customers[a]	Number of Control Customers[a]	Percent Receiving eHERs[b]	2019 Annual Baseline Energy Use
Existing Customer Waves						
Dual Fuel	201303	Mar 2013	64,227	7,071	65%	6,864 kWh / 967 therms
Dual Fuel	201902	Mar 2019	21,.272	8,147	55%	5,786 kWh / 851 therms
Electric-Only	201303	Mar 2013	68,614	6,366	66%	9,440 kWh
Electric-Only	201403	Jan 2014	27,437	4,957	57%	6,606 kWh
Electric-Only	201608	Sep 2016	9,323	9,292	52%	4,832 kWh
Electric/Dual[c]	201703	Mar 2017	17,384	7,431	53%	4,930 kWh
Electric-Only	201802	Feb 2018	14,528	6,639	60%	7,170 kWh
Electric-Only	201902	Feb 2019	19,041	7,705	53%	5,393 kWh
Gas-Only	201303	Mar 2013	8,364	3,668	41%	911 therms
Gas-Only	201510	Oct 2015	5,249	1,139	49%	863 therms
Gas/Dual[c]	201703	Mar 2017	4,693	1,933	52%	848 therms
Gas-Only	201909	Sep 2019	31,095	8,993	47%	656 therms
New Mover Waves						
Dual Fuel	201304	Jan 2013 – Jul 2014	4,996	573	56%	5,839 kWh / 788 therms
Dual Fuel	201408	Dec 2014 – Jul 2016	8,200	913	58%	5,185 kWh / 828 therms
Electric-Only	201304	Jan 2013 – Jul 2014	8,087	813	56%	6,792 kWh
Electric-Only	201408	Dec 2014 – Jul 2016	14,980	1465	59%	6,055 kWh

[a] Active customer counts included in 2019 evaluated savings.
[b] Percent of treatment customers who received eHERs in 2019.
[c] The 201703 wave was a blended wave, some customers received electric-only reports, some gas-only reports, and some received dual fuel reports.

Glossary of Terms

Throughout the report we refer to different energy savings values based on how they are calculated and reported:

Goal/Planned Savings: Planned or forecasted savings used for program planning purposes.

Implementer-Estimated Ex Post Savings: The program implementer provides monthly savings estimates by wave in a monthly report. National Grid adds up the monthly savings estimates for an annual total.

Claimed Savings: Savings reported for the overall HER program in National Grid's annual Energy Efficiency Programs Year-End Reports. Claimed savings are based on implementer-reported savings adjusted by the realization rate from the prior cycle's evaluation report.

Unadjusted Net Ex Post Savings: Savings calculated by the evaluation team by analyzing monthly billing data. These values do not include adjustments for savings attributable to participation in other energy efficiency programs.

Adjusted Net Ex Post Savings: Evaluated savings that have been adjusted for savings attributable to participation in other energy efficiency programs. These are energy savings attributable to HERs that would not have occurred in the absence of the program.

Realization Rate: The ratio of adjusted net ex post savings to implementer-estimated ex post savings. That is, the ratio of savings estimated through the evaluation to savings estimated by the implementer. A value over 100% means the evaluation estimated higher savings than the implementer reported. A value under 100% means the evaluation estimated lower savings.

Planned, Reported and Implementer-Estimated Savings

The savings claimed by the HER program comprised 27% of National Grid's residential annual energy efficiency electric savings in 2017 – 2019 and 56% of the residential annual energy efficiency gas savings as reported in 2017 – 2019 year-end reports. Because the behavior program has a one-year measure life, it comprises a much smaller percentage of lifetime savings: 5% of electric and 6% of natural gas. The HER program is the second-largest residential electric program (in terms of annual energy savings) behind only ENERGY STAR Lighting, and the largest residential gas program.

Goal/planned savings are based on the program implementer's forecast of how many customers they will send reports to each year and the expected per-household savings for each customer. The implementer calculates per-household savings based on prior-year results using models that consider customers' baseline consumption and how long customers have been receiving reports (among other factors).

The number of customers who ultimately receive reports each year can vary from forecasts (based on eligibility, attrition, etc.) and achieved per household savings can also vary. The program implementer provides monthly reports to National Grid with monthly estimates of energy savings for each program wave. The implementer calculates these estimates based on statistical models and publishes standard errors indicating the statistical significance of each wave's monthly estimate. In 2017 – 2019, National Grid estimated savings as the sum of all implementer-estimated monthly estimates for each wave and year (last column of **Table 4**) and claimed savings by applying a realization rate (88% for electric savings and 108% for gas, taken from the prior evaluation cycle) to implementer-estimated savings.[19]

Table 4 shows goal/planned savings, claimed savings (filed in year-end reports), and implementer-estimated ex post savings (actual realized savings prior to any adjustments) by fuel and year. The realization rates we report by wave in the detailed findings below compare evaluated net ex post savings to implementer-estimated ex post savings. National Grid uses realization rates prospectively—claimed savings during 2017 to 2019 used realization rates from the prior evaluation. Future claimed savings will use realization rates from this evaluation.

[19] Rhode Island Home Energy Report Program and Process Evaluation prepared for National Grid, 2017. http://rieermc.ri.gov/wp-content/uploads/2018/03/national-grid-rhode-island-2017-her-program_final.pdf.

Table 4. Goal, Claimed, and Implementer-Estimated Savings

Fuel	Goal/ Planned Savings[a]	Claimed Savings (Year-End Reports)[b]	Implementer-Estimated Ex Post Savings[c]
Electric Savings (MWH)			
2017	26,184	30,451	31,108
2018	25,054	23,527	26,739
2019	24,130	24,938	29,918
TOTAL	***75,368***	***78,916***	***87,765***
Gas Savings (MMBtu)			
2017	59,164	103,087	110,149
2018	77,220	132,562	121,990
2019	115,520	111,117	100,852
TOTAL	***251,904***	***346,766***	***332,992***

[a,b] National Grid's annual Energy Efficiency Programs Year-End Reports contain goal/planned and claimed savings for the overall HER program.

[c] The program implementer provides monthly savings estimates in a monthly report. National Grid adds up the monthly savings estimates for an annual total.

Approach

The evaluation team relied on billing analysis leveraging the experimental design of the program to evaluate the HER program. We used a similar approach to the previous evaluation[20] and consistent with the Uniform Methods Project (UMP) Residential Behavior Protocol.[21] We provide methodology details in the Appendix. We calculated impacts for each wave and year, inclusive of paper reports, eHERs, HBAs, and the Target Rank campaign. We evaluated the savings of the full package of program elements for each wave (rather than specific delivery components) since the program implementer does not assign eHERs, HBAs, or Target Rankings experimentally.

A key feature of the RCT design of the HER program is that the analysis estimates net savings, not gross savings. There is no option for customers to receive the HERs outside of the program and the RCT design limits the threat of selection bias. Thus, there is no free ridership, and no "net-to-gross" adjustment to the billing analysis results are necessary. We refer to the net savings from billing analysis as "unadjusted net savings" to distinguish from final "adjusted net savings" which remove double-counted savings from cross-program participation (uplift).

Customers who receive HERs may participate in other energy efficiency programs (e.g., home energy assessments, rebates) at higher rates than their respective control groups. Program theory suggests that receiving reports with messaging about energy use and cross-program promotions leads to increased participation in other programs. Since other residential programs claim savings[22] (and count all participants and measures), there is a risk of double-counting savings from participation if they are captured in HER net savings and claimed by other programs. Therefore, we also (1) assessed the lift in other program participation due to the behavioral program treatment (participant uplift), and (2) removed the savings co-generated by behavioral and standard programs in order to avoid double-counting savings across the portfolio (savings adjustment). Consistent with industry convention, we remove the co-generated savings from the behavior program. The convention of removing savings from the behavior is intended to avoid double-counting savings, but not to diminish the uplift benefit of HER programs.

Table 5 summarizes the key outputs of the evaluation and the approaches we used. See **Appendix A. Impact Methodology** for additional methodology and **Appendix C. Equivalency Check Results** for equivalency check results.

[20] Rhode Island Home Energy Report Program and Process Evaluation prepared for National Grid, 2017. http://rieermc.ri.gov/wp-content/uploads/2018/03/national-grid-rhode-island-2017-her-program_final.pdf.

[21] Chapter 17: Residential Behavior Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. October 2017 (https://www.nrel.gov/docs/fy17osti/68573.pdf).

[22] Other residential programs use deemed (most common), formula-driven, or custom savings.

Table 5. Summary of Impact Evaluation Methods

Output	Summary Methodology
Equivalency Checks (validate experimental design)	• Conducted a visual inspection of overlaid plots of monthly mean energy use for treatment and control groups • Performed t-tests on monthly differences in mean energy use between treatment and control groups in each month, conducted before and after data cleaning. A significant difference ($p<0.05$) indicates that pre-period usage is dissimilar between groups • Conducted regression analysis of pre-period usage with treatment/control group as an effect. A significant effect ($p<0.05$) of the group category indicates that pre-period usage is dissimilar between groups
Unadjusted Ex Post Savings – Existing Customers	• Merged National Grid monthly billing data with program implementer tracking data • Used Post-Period Regression (PPR) model on treatment and control group billing data to calculate program treatment effect on average daily usage by wave and year • Applied total number of participant days each year to treatment effect to calculate total savings • Ran Linear Fixed Effects (LFER) model as a robustness check
Unadjusted Ex Post Savings – New Movers Initiative	• Merged monthly billing data with program implementer tracking data • Combined New Mover waves within fuel type • Ran a fixed effects model for each year with indicators for post-period, treatment, wave, and month-year • Applied total number of participant days each year to the treatment effect to calculate savings
Uplift Saving (from Cross-Program Participation)	• Identified all downstream National Grid residential program participants among HER treatment and control customers from 2013 to 2019[23] • Calculated incremental participation of treatment customers in other residential energy efficiency programs • Calculated "uplift savings" as pro-rated incremental savings from participation in other energy efficiency programs from 2013 to 2019
Adjusted Ex Post Savings	• Subtracted total uplift savings per wave and year from total unadjusted net ex post savings per wave and year

[23] We exclude upstream lighting programs because data cannot be linked to specific customer accounts. The 2017 evaluation report discussed the potential for upstream lighting double-counted savings due to HER programs based on secondary research; findings are mixed. ILLUME concluded that the cost to conduct primary research comes at a large cost and may not produce statistically significant results.

Electric Results

Below we summarize the electricity savings from the HER program. We summarize natural gas savings in the next section.

Savings and Realization Rates

In **Table 6** we show results by year for Existing Customer and New Mover waves. Across all waves and program years, the HER program achieved 88,064 unadjusted net ex post MWh savings.[24] The program achieved 1,972 MWh (2.24%) of these savings through uplift participation in other programs. Adjusting for these double-counted savings, the program achieved 86,092 adjusted net ex post MWh savings. The **Cross-Program Participation and Uplift Savings** section provides more detail on this process. These savings are slightly lower than the implementer-estimated ex post savings, resulting in a realization rate of 98%.

The Existing Customer waves provide 84% of overall savings and have higher realization rates than the New Mover waves. The **Discussion** section provides more detail on reasons for differences between the evaluation net ex post savings and the implementer-estimated ex post savings. **Appendix D. Wave-Level Results** shows detailed results by wave for the Existing Customer waves.

Table 6. Evaluated Ex Post Electric Savings and Realization Rates

	Evaluated Ex Post Savings			Comparison to Implementer-Estimated Values	
Year	Unadjusted Net Ex Post Savings (MWH)	Uplift Savings (as % of Unadjusted Net)	Adjusted Net Ex Post Savings (MWH)	Implementer-Estimated Ex Post Savings (MWH)	Realization Rate
Existing Customer Waves					
2017	25,602	2.05%	25,078	23,806	105%
2018	22,498	1.87%	22,078	19,781	112%
2019	25,754	3.94%	24,739	23,133	107%
Total	*73,854*	*2.65%*	*71,895*	*66,719*	*108%*
New Mover Waves					
2017	4,324	0.31%	4,311	7,303	59%
2018	5,894	0.00%	5,894	6,958	85%
2019	3,991	0.00%	3,991	6,786	59%
Total	*14,210*	*0.09%*	*14,197*	*21,046*	*67%*
Total	***88,064***	***2.24%***	***86,092***	***87,765***	***98%***

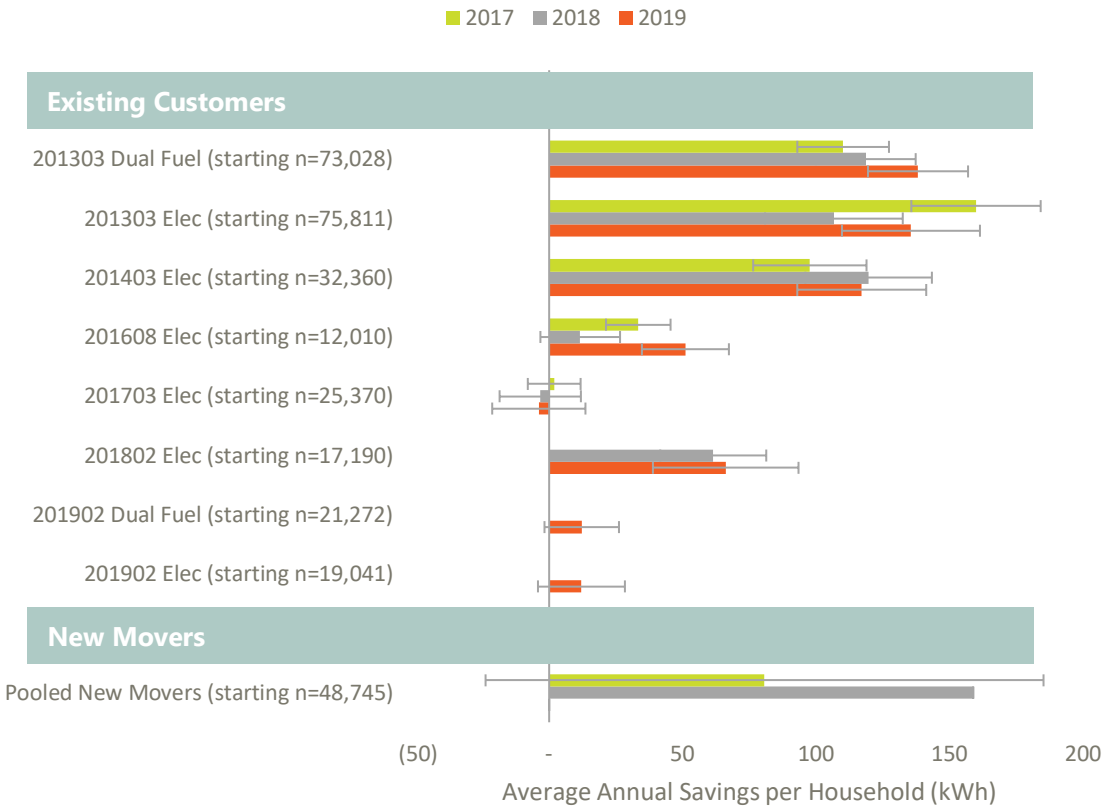
[24] The 90% confidence interval around the savings estimate is 56,340 to 119,787 MWH. The implementer-estimated savings falls within this range.

Average Savings per Household

Billing analysis models produce estimates of average daily per household savings that can be used to estimate average annual savings per household, as well as total program savings. **Figure 6** shows average unadjusted electric per household savings per year as well as the 90% confidence interval around the savings estimate. When confidence intervals range from below zero to above zero, the savings results are not statistically significant at a 90% confidence level, though the point estimates from savings are still the best estimate of program savings and these waves and years are included in total program savings. Savings for Existing Customer waves that started in 2013, 2014, and 2018 were statistically significant in all evaluation years, while the wave starting in 2017 showed mixed results, and neither of the 2019 waves showed statistically significant results. The lack of statistical significance can be related to many factors, including the sizes of the treatment or control groups, baseline consumption, the age/maturity of the wave, the length of the evaluation period (part-year savings are less likely to be statistically significant), and the effectiveness of the program intervention.[25]

[25] HER programs sometime show a pattern of ramping up in the early years and then decaying in later years, though we do not see any decline in savings here.

Figure 6. Average Unadjusted Net Ex Post Savings per Household by Wave, with 90% Confidence Intervals (kWh per Year)*



*The time period for annual per-household savings is the average number of treatment days in the evaluation year (e.g., 2019), considering report timing and customer attrition.

Over the three-year program cycle, average savings per household decreased slightly, driven by lower savings among the waves added in 2019 (**Table 7**).

Table 7. Overall Electric Savings per Household

Year	Number of Evaluated Customers	Average Daily Savings per Household (kWH)	Average Annual Savings per Household (kWH)
2017	271,017	0.30	109.2
2018	261,364	0.29	104.7
2019	278,021	0.28	101.2
Total	***810,402***	***0.29***	***105.0***

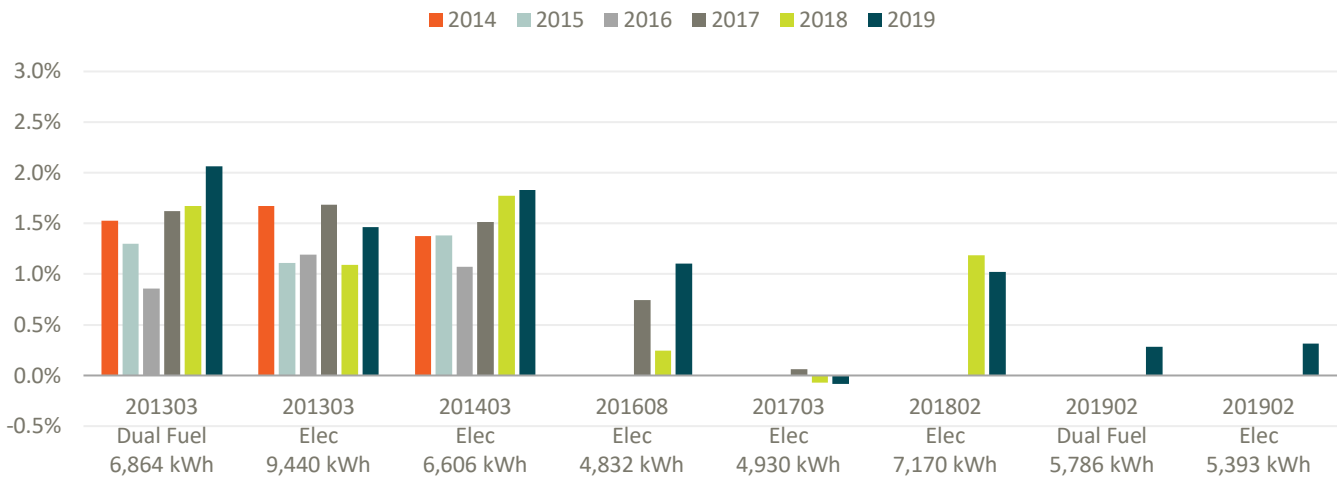
Average Percentage Savings per Household

Behavior programs have often produced larger savings when customers have higher baseline energy use. Baseline annual energy use varies across the program waves. **Figure 7** normalizes energy savings for

baseline energy use by showing unadjusted net savings as a percentage of energy use. We show unadjusted net savings to capture all savings from each wave whether they are from participation in energy efficiency programs or from behavior changes. Newer waves of customers (the 2016, 2017, and 2019 waves), who have lower savings, also tend to have lower baseline energy use. The 2018 wave has higher savings than the other recent waves and also higher baseline energy use.

Figure 7 also includes savings as a percentage of baseline energy use from prior evaluations to show trends in savings from 2014 to 2019. The 2013, 2014, and 2016 waves generally show level or increasing savings over time, and have considerably larger treatment groups than the later waves (**Appendix D. Wave-Level Results**). Furthermore, the earliest waves (2013 and 2014) constitute 58% of program participants, and 95% of the implementer reported savings

Figure 7. Unadjusted Net Ex Post Electric Saving as a Percentage of Baseline Energy Use*



*We include 2019 baseline energy use below the wave name for reference, though the % savings is based on the baseline energy use for each evaluation year.

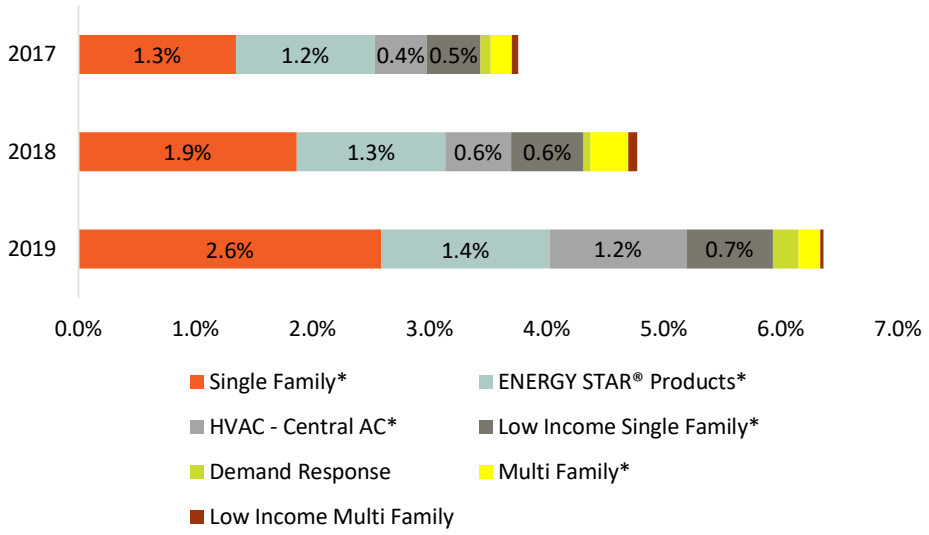
Cross-Program Participation and Uplift Savings

The HER program produced incremental program participation in several National Grid energy efficiency programs. **Figure 8** shows participation lift[26] in programs with electric-saving measures by year for all electric and dual-fuel waves (Existing Customers and New Movers). The largest lift in program participation occurred in Energy Wise Single Family (5.2% incremental participation, cumulative over three years) and ENERGY STAR Products (3.5% incremental participation, cumulative over three years), and HVAC-Central AC (1.9% cumulative over three years). This aligns with report language which included messaging to sign up for a free EnergyWise home energy assessment and messaging for rebates on wi-fi

[26] Participation lift is the percent of customers in the treatment group who participated in programs that is incremental to the participation rate by control group customers. This concept is explained more fully in Appendix A.

thermostats (which National Grid offers through the Energy Wise Single Family and HVAC-Central AC programs).

Figure 8. Participation Lift for Programs with Electric Savings Measures (across all waves)[a]



[a] We include the demand response program in the uplift analysis but do not make any savings adjustments due to the program. *Denotes that the treatment group participation was statistically significantly higher than the control group participation over the three-year evaluation period, $p<0.95$.

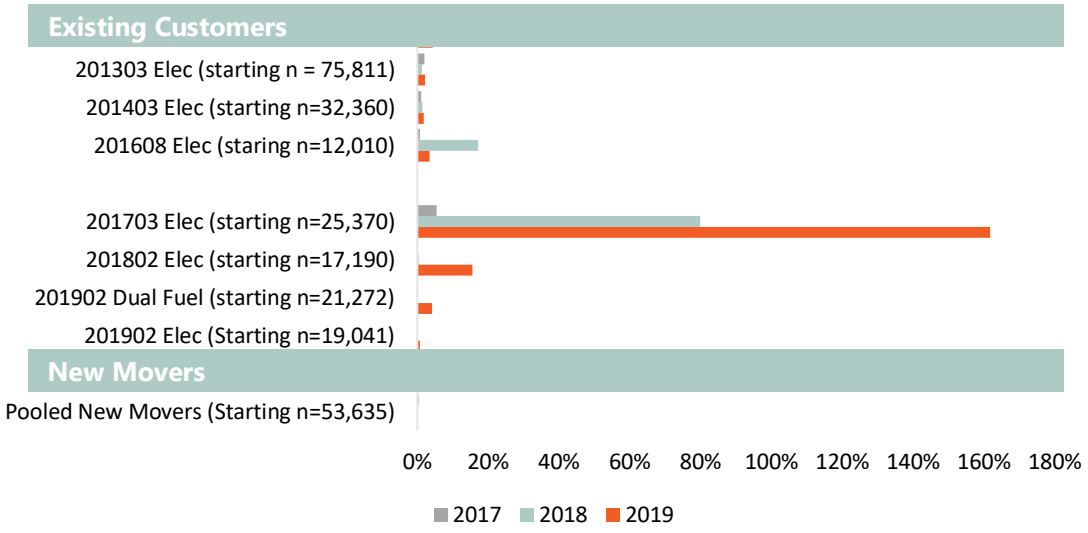
The net unadjusted ex post savings estimates generated through the billing analysis include savings influenced by the program (from behaviors or other changes in the home), and also savings from customer participation in other National Grid energy efficiency programs. To account for savings generated (and claimed) through participation in other programs, we calculate the total savings attributable to other program participation at the wave and year level and subtract that from the savings estimated through the billing analysis. We provide further detail on this method in the **Cross-Program Participation and Double-Counted Savings Adjustments** section of Appendix A.

Figure 9 shows the percentage of unadjusted net savings (from billing analysis) that are attributable to participation in other programs. For Existing Customer waves, about 2.2% of net unadjusted savings was already counted by other energy efficiency programs.[27] Although these savings are partially attributable to the HER program they are removed from evaluated savings to avoid double-counting. Uplift savings as a share of unadjusted net program savings are slightly lower for New Mover waves. Note that the 201703

[27] Differences in treatment and control savings attributed to other programs are significantly different at the 95% confidence interval when aggregated by the evaluation year. Savings differences are too small to attain statistical power when evaluated at the individual program or treatment wave level. However, since these comparisons are leveraging the RCT by comparing treatment and control group participation, these are still the best estimates of savings due to participation in other programs and we remove them from the unadjusted net savings.

Elec wave had very small savings before adjusting for participation in other programs. The savings due to other energy efficiency program participation are larger than overall savings for that wave.

Figure 9. Electric Uplift Savings as a Percentage of HER Program Net Unadjusted Ex Post Savings[a]



[a] For waves/year combinations with no adjustment, either there was no difference in participation between treatment and control groups or the control group had higher participation in which case we did not adjust the savings. Higher participation by the control group results in an upward adjustment of savings for the wave. Since the goal is to remove savings that might be double counted in another program, applying an upward adjustment is not needed.

Upstream Lighting Programs

Upstream lighting programs allow customers to purchase energy efficient lighting at a reduced cost at the point of sale. The program sponsor negotiates agreements on price with retailers, distributors, or manufacturers so that customers do not have to complete any paperwork or rebate forms to receive the reduced price. Consequently, programs do not track individual purchasers so we cannot compare purchases between treatment and control groups. Given this, evaluators use different methods to understand the differences in upstream purchases between treatment and control groups. One way is primary data collection through surveys, interviews, and home assessments, and store-intercept interviews. Each of these methods can be expensive and may introduce bias into the results.

In a recent secondary literature review presented to the Michigan utilities, an evaluation team found 10 evaluations of HER programs from 2013 to 2018 that addressed the effects of upstream lighting.[28] Five of these evaluations relied on surveys (three phone, one online, one in person), one relied on an onsite home inventory, three on secondary literature, and one used a deemed savings factor. The onsite inventory found the highest rate of double counted savings at 2.6%. Three reported no difference in purchases between treatment and control customers. Others ranged from -0.9 kWh/household/year to 11.1

[28] *Avoiding the Double-Counting of Savings in Michigan's Behavioral EWR Programs: Current Practice & Future Options.* April 16, 2019. https://www.michigan.gov/documents/mpsc/Avoiding_Double_Counting_-_20190416_652854_7.pdf

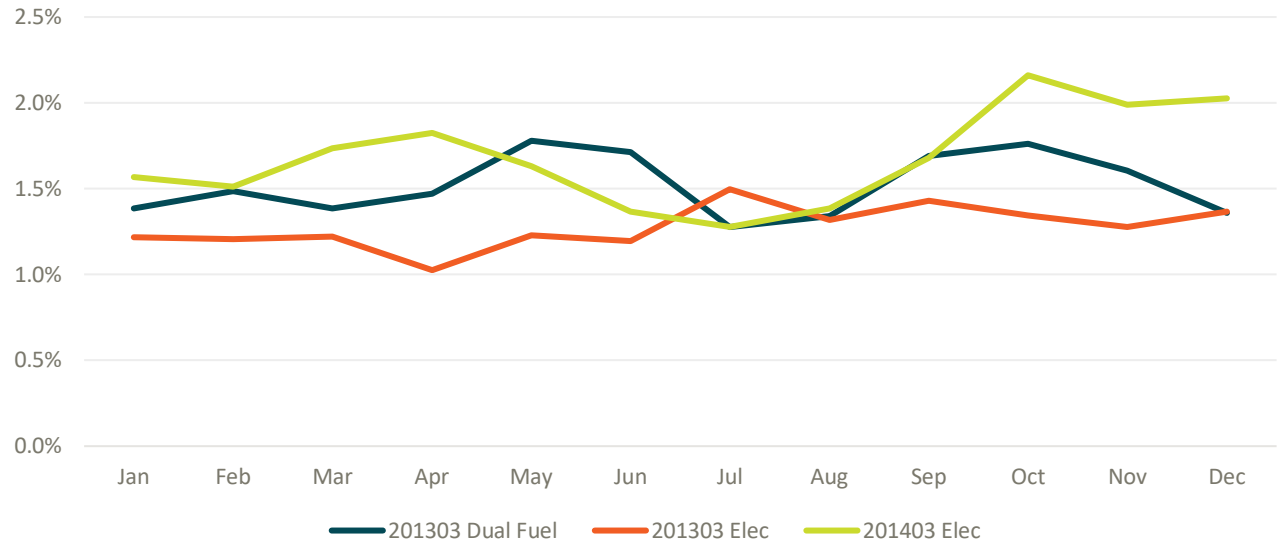
kWh/household/year. Pennsylvania applies a deemed savings rate for double counting in upstream programs that ranges from 0.75% – 3%. The evaluators presenting to Michigan utilities concluded that most efforts to calculate the double counting rate of upstream programs result in 0% or negative results or the differences are statistically insignificant. Based on the experience of these other programs, we do not recommend making any adjustments to account for upstream lighting programs.

Savings by Month

Average electric savings (2017 to 2019) fluctuated by month with different trends for different waves. **Figure 10** shows average monthly savings for three waves. We include only waves that showed consistent, statistically significant savings over the three-year period.

The monthly savings are not statistically significantly different from other months within each wave and patterns are different across waves, limiting the conclusions we can draw. For example, 201303 Dual Fuel and 201403 Elec have similar patterns with peak savings in October and a second peak in spring (April for 201403 Elec and May for 201303 Dual Fuel). Both waves also have their lowest savings in July. However, 201303 Elec has the opposite pattern with flatter average savings across the year with a peak in July and lowest savings in April.

Figure 10. Unadjusted Monthly Electric Saving



Savings by Personas

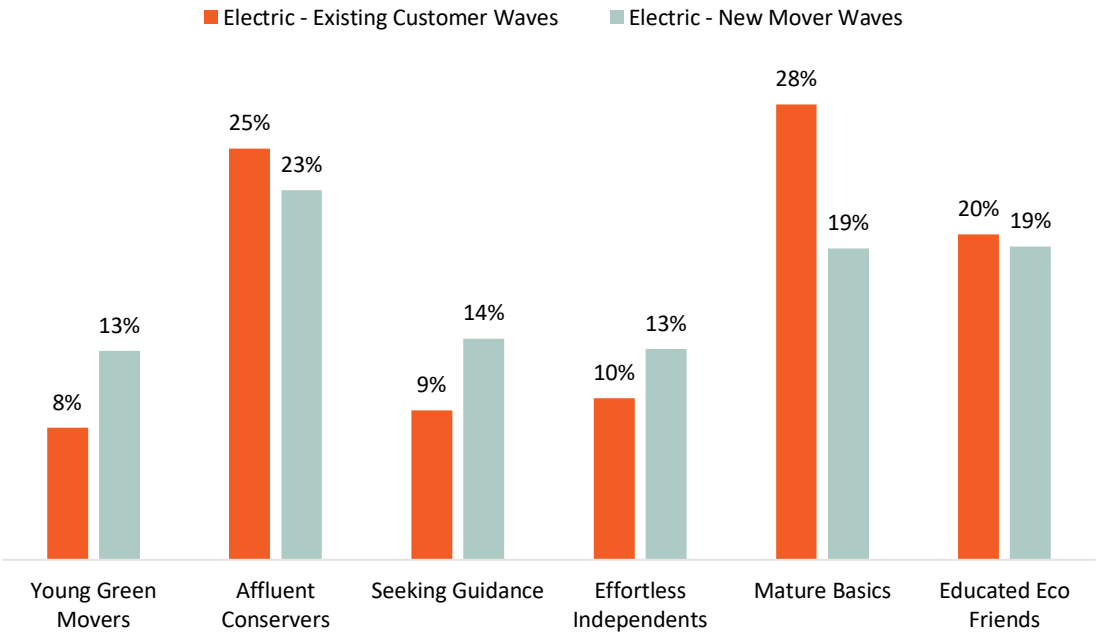
National Grid assigned one of six personas to each electric and natural gas account (Educated Eco-Friend, Affluent Conserver, Seeking Guidance, Young Green Mover, Mature Basic, Effortless Independent).[29]

[29] See Appendix E for descriptions of personas.

Personas are based on energy use patterns, demographic characteristics (age, income), and customers' perceived needs regarding energy and conservation as assessed through customer surveys and market research efforts. National Grid updates the persona assignments as they receive more information about customers from additional surveys and market research efforts. Although National Grid associated customers with these personas, they did not differentiate program treatment or messaging based on these personas.

Among HER program customers with electric service, the most common personas overall are Mature Basics and Affluent Conservers (about 27% and 25%, respectively). The persona distribution is slightly different between Existing Customer waves and New Mover waves, with more Young Green Movers and fewer Mature Basics in the New Mover waves (see **Figure 11** for overall distribution and **Appendix E: Personas Descriptions & Distribution** for distribution by wave).

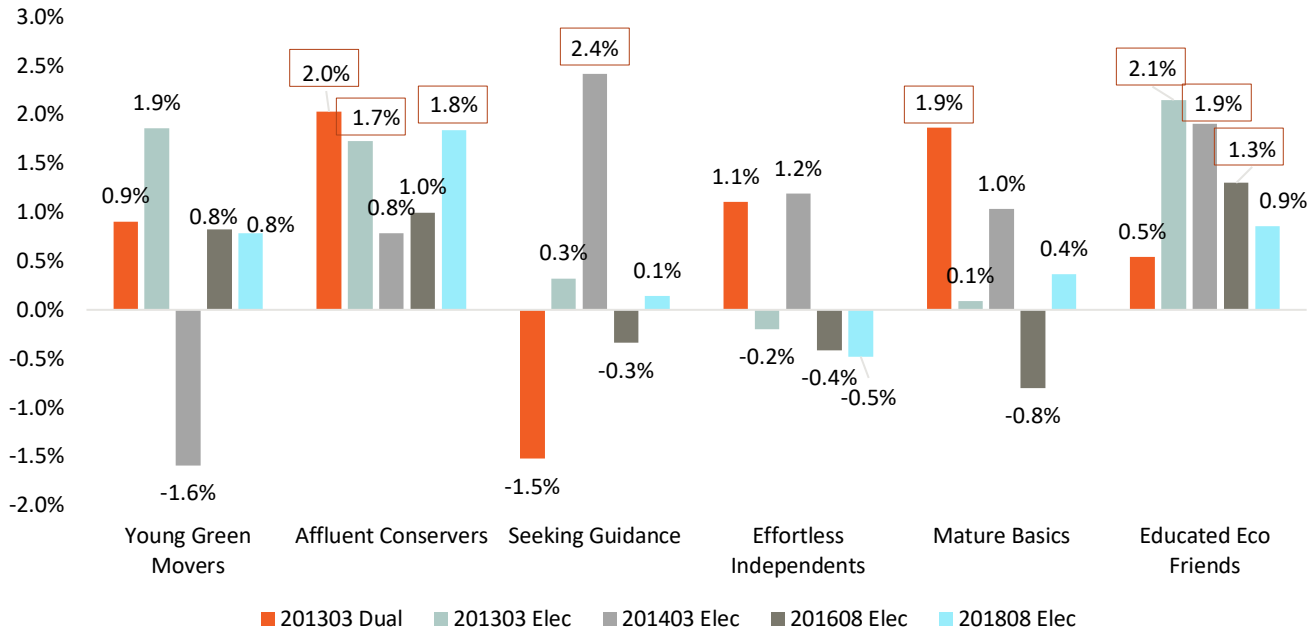
Figure 11. Customer Personas among HER Program: Electric Waves



Differences in savings by persona suggest that the report messaging is more impactful for some customers than others. **Figure 12** shows the percentage of kWh savings by persona and treatment wave, relative to each persona and waves' baseline consumption.[30] Figure 13 shows the percentage of kWh savings by persona aggregated across each evaluated treatment wave. The Affluent Conservers and Educated Eco Friends show positive savings in each of the five evaluated treatment waves and are the only two personas with statistically significant savings when aggregated across waves.

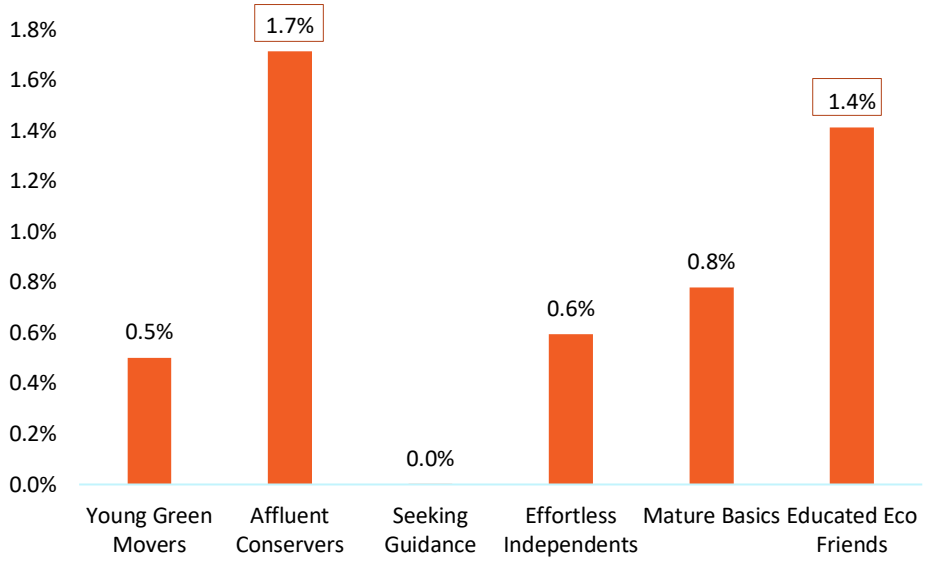
[30] We selected treatment waves which displayed significant wave-level savings in the impact evaluation (201303 Dual, 201303 Elec, 201403 Elec, 201608 Elec, and 201802 Elec). To attain higher statistical power, we pooled each wave's billing data across all three years of the evaluation period (2017 – 2019). See **Appendix A: Personas Analysis** for detailed methodology.

Figure 12. Persona-Level Savings: Electric Waves [a]



[a] Boxes indicate a value is statistically significant, p<0.90.

Figure 13. Persona-Level Savings: Electric Aggregated [a]



[a] Boxes indicate a value is statistically significant, p<0.90.

Looking closer at the daily savings values, the Affluent Conservers group generated a higher unadjusted average daily savings than the highest unadjusted net ex post value (0.45 kWh/day, 201303 Elec in 2017) in three of the five evaluated treatment waves (**Table 8**). The Affluent Conservers have a comparatively

high baseline energy consumption, so that a 2% energy savings results in a higher net savings value per household.

Table 8. Unadjusted Daily kWh Savings by Persona Group and Treatment Wave

Persona Group	201303 Dual	201303 Elec	201403 Elec	201608 Elec	201802 Elec
Young Green Movers	0.20	0.49	-0.34	0.12	0.18
Affluent Conservers	0.57*	0.58*	0.21	0.18	0.54*
Seeking Guidance	-0.41	0.10	0.65*	-0.06	0.04
Effortless Independents	0.25	-0.05	0.26	-0.06	-0.11
Mature Basics	0.47*	0.03	0.25	-0.13	0.09
Educated Eco Friends	0.13	0.63*	0.44*	0.20*	0.21

*Statistically significant, $p<0.10$.

Gas Results

Below we summarize overall and wave-level natural gas savings from the HER program.

Savings and Realization Rates

Table 9 shows results by year for Existing Customer and New Mover waves. Across all waves and program years, the HER program achieved 3,069,982 unadjusted net ex post therm savings.[31] The program achieved 8.6% of these savings through uplift participation in other programs. Adjusting for these double-counted savings, the program achieved 2,804,769 adjusted net ex post therm savings. These savings are lower than the implementer-estimated ex post savings, resulting in a realization rate of 84%.

The Existing Customer waves provide 89% of overall savings and have higher realization rates than the New Mover waves. The **Discussion** section provides more details on reasons for differences between the evaluation net ex post savings and the implementer-estimated ex post savings.

Table 9. Evaluated Ex Post Gas Savings and Realization Rates

	Evaluated Ex Post Savings			Comparison to Implementer-Estimated Values	
Year	Unadjusted Net Ex Post Savings (Therms)	Uplift Savings (as % of Unadjusted Net)	Adjusted Net Ex Post (Therms)	Implementer-Estimated Ex Post Savings (Therms)	Realization Rate
Existing Customer Waves					
2017	731,601	7%	682,430	853,426	80%
2018	1,026,581	8%	948,049	1,016,532	93%
2019	961,481	10%	862,543	830,331	104%
Total	2,719,663	8%	2,493,023	2,700,289	92%
New Mover Waves					
2017	173,402	4%	167,177	248,069	67%
2018	38,573	39%	23,481	203,370	12%
2019	138,344	12%	121,088	178,190	68%
Total	350,319	11%	311,745	629,629	50%
Total	***3,069,982***	***9%***	***2,804,769***	***3,329,918***	***84%***

Average Savings per Household

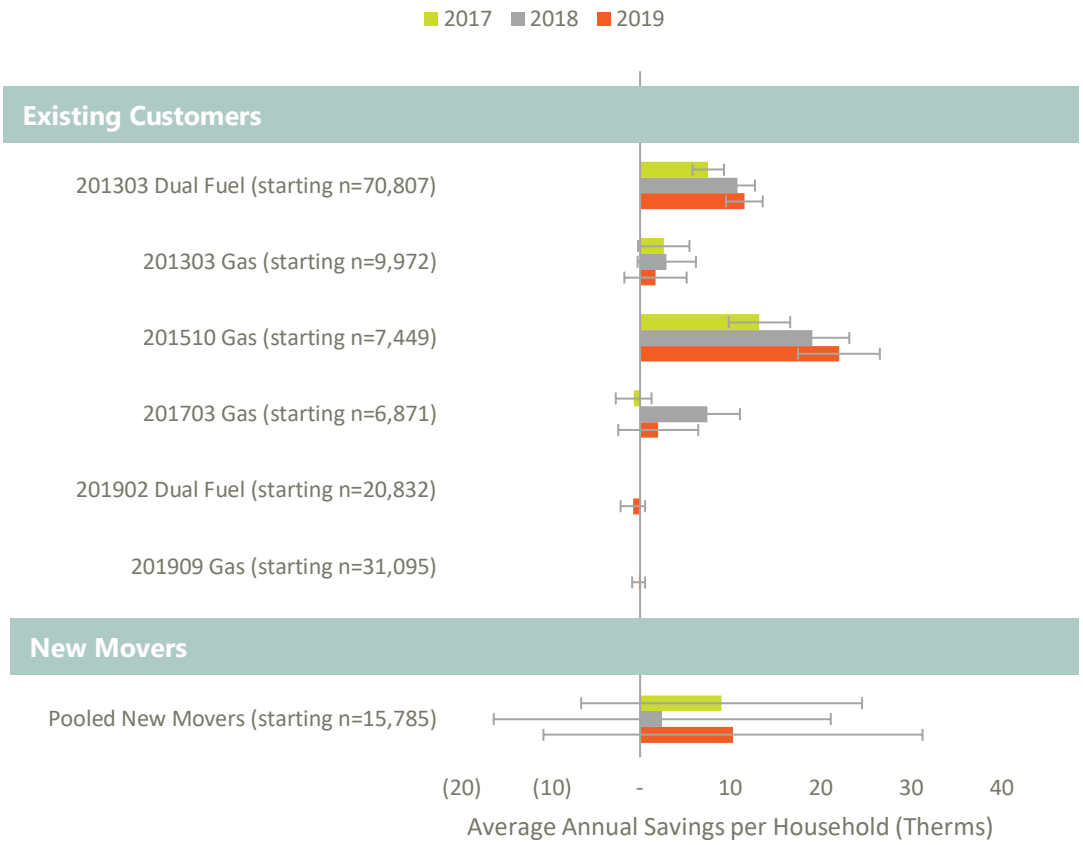
Figure 14 shows average unadjusted net savings per household per year, as well as the 90% confidence interval around the savings estimate. As with the electric analysis above, when confidence intervals range

[31] The 90% confidence interval around the savings estimate is 1,456,089 to 4,683,875 therms. The implementer-estimated savings falls within this range.

from below zero to above zero, the savings results are not statistically significant at a 90% confidence level. In these instances, the point estimates from savings are still the best unbiased estimates of program savings and we include these waves and years in total program savings.

Two Existing Customer waves achieved statistically significant savings in all three evaluation years: the dual-fuel wave that started in 2013 (201303 Dual Fuel) and the gas-only wave that started in 2015 (201510 Gas). Savings were not statistically significant for the gas-only Existing Customer waves that started in 2013 and 2017, nor for the newer Existing Customer waves that started in 2019. The 201303 and 201703 gas waves have positive, though small, point estimates of savings for most years. These small savings combined with relatively small group size contribute to the estimates not being statistically significant. The 2019 waves have very small treatment effects, which is often found in the early months of a new wave with savings expected to ramp up over time.[32]

Figure 14. Average Unadjusted Net Ex Post Savings per Household by Wave, with 90% Confidence Intervals (Therms per Year)*



*The time-period for annual per-household savings is the average number of treatment days in the evaluation year (e.g., 2019), considering report timing and customer attrition.

[32]Khawaja, Sami M., and James Stewart (Winter 2014/2015). Long-Run Savings and Cost-Effectiveness of Home Energy Report Programs. http://www.cadmusgroup.com/wpcontent/uploads/2014/11/Cadmus_Home_Energy_Reports_Winter2014.pdf.

Over the three-year program cycle, overall average savings per household remained steady. While older waves had increased savings in 2019, this was offset by lower savings among waves starting in 2017 and 2019 (see **Table 10**).

Table 10. Overall Gas Savings per Household

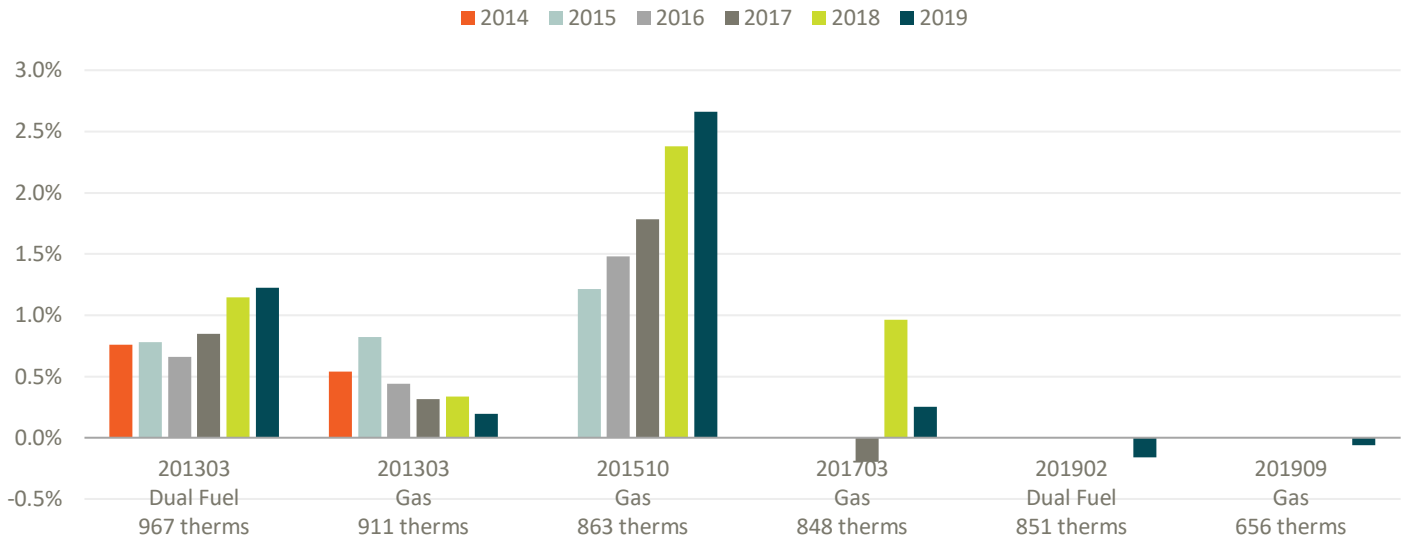
Year	Number of Evaluated Customers	Average Daily Savings per Household (Therms)	Average Annual Savings per Household (Therms)
2017	114,157	0.020	7.13
2018	102,914	0.024	8.78
2019	145,915	0.021	7.56
Total	***362,986***	***0.023***	***8.53***

Average Percentage Savings per Household

Figure 15 normalizes energy savings for baseline energy use by showing unadjusted net savings as a percentage of energy use. We show unadjusted net savings to capture all savings from each wave whether they are from participation in energy efficiency programs or from behavior changes. We do not see a clear pattern between baseline gas use and gas savings.

Figure 15 also includes savings as a percentage of baseline energy use from prior evaluations to show trends in savings from 2014 to 2019. The 201303 Dual Fuel, the 201510 Gas, and 201703 Gas waves show generally increasing savings over time. The 201703 Gas wave started with negative savings in the first year, suggesting that 2019 waves that are starting with negative savings in the first year may improve in future years.

Figure 15. Unadjusted Net Ex Post Electric Saving as a Percentage of Baseline Energy Use[a]



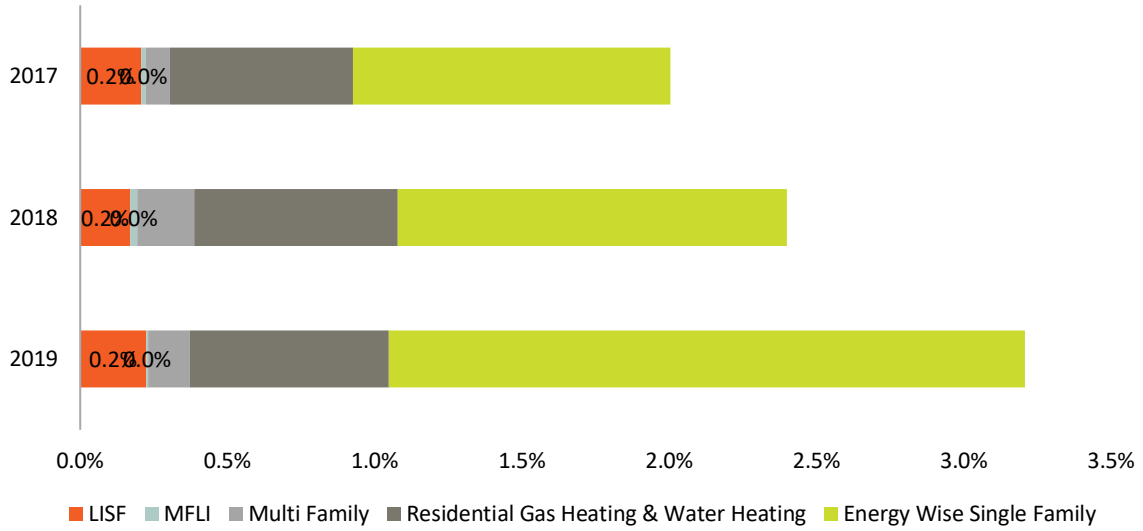
[a] We include 2019 baseline energy use below the wave name for reference, though the % savings is based on the baseline energy use for each evaluation year.

Cross-Program Participation and Uplift Savings

The HER program produced incremental program participation in two National Grid energy efficiency programs that claimed gas savings: EnergyWise Single-Family (4.2% incremental participation, cumulative over three years) and Residential Gas Heating & Water Heating (1.8% incremental participation, cumulative over three years). **Figure 16** shows participation lift[33] in programs with gas-saving measures by year, for all gas and dual fuel waves (Existing Customers and New Movers). The uplift results align with messaging provided on the reports (see **Table 2**). From 2017 – 2019, report language included messaging on home energy assessments through the Energy Wise program and Wi-Fi thermostats (included in several programs including Energy Wise and the Heating and Water Heating program).

[33] This is the percent of customers in the treatment group who participated in programs that is incremental to the participation rate by control group customers. This concept is explained more fully in Appendix A.

Figure 16. Participation Lift for Programs with Gas Savings Measures (Across all Waves)



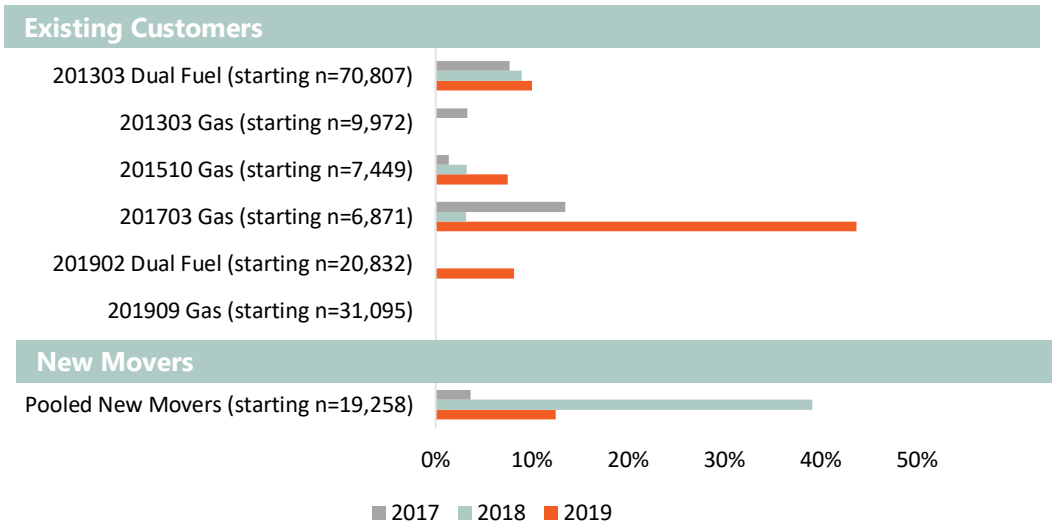
*Denotes that the treatment group's participation was significantly higher than the control group's over the three-year evaluation period at the 95% confidence interval.

The net unadjusted ex post savings estimates generated through the billing analysis include savings influenced by the program (from behaviors or other changes in the home), and also savings from customer participation in other National Grid energy efficiency programs. To account for savings generated (and claimed) through participation in other energy efficiency programs, we calculated the total savings that can be attributed to other program participation at the wave and year level and subtracted that from the savings estimated through the billing analysis. We provide further detail on this method in the **Cross-Program Participation and Double-Counted Savings** Adjustments section of **Appendix A. Impact Methodology**.

Figure 17 shows the percentage of unadjusted net savings (from billing analysis) that are attributable to participation in other programs. For Existing Customer waves, about 8.6% of net unadjusted savings was already counted by other energy efficiency programs[34], and although these savings are partially attributable to the HER program, they are removed from evaluated savings to avoid double-counting. Uplift savings as a share of unadjusted net program savings are slightly higher for the 201703 Dual/Gas wave and for New Mover waves, primarily driven by smaller average daily savings (treatment effect) compared to other waves and not because of larger savings adjustments.

[34] Differences in treatment and control savings attributed to other programs are significantly different at the 95% confidence interval when aggregated by the evaluation year. Savings differences are too small to attain statistical power when evaluated at the individual program or treatment wave level. However, since these comparisons are leveraging the RCT by comparing treatment and control group participation, these are still the best estimates of savings due to participation in other programs and we remove them from the unadjusted net savings.

Figure 17. Gas Uplift Savings as a Percentage of HER Program Unadjusted Net Ex Post Savings[a]



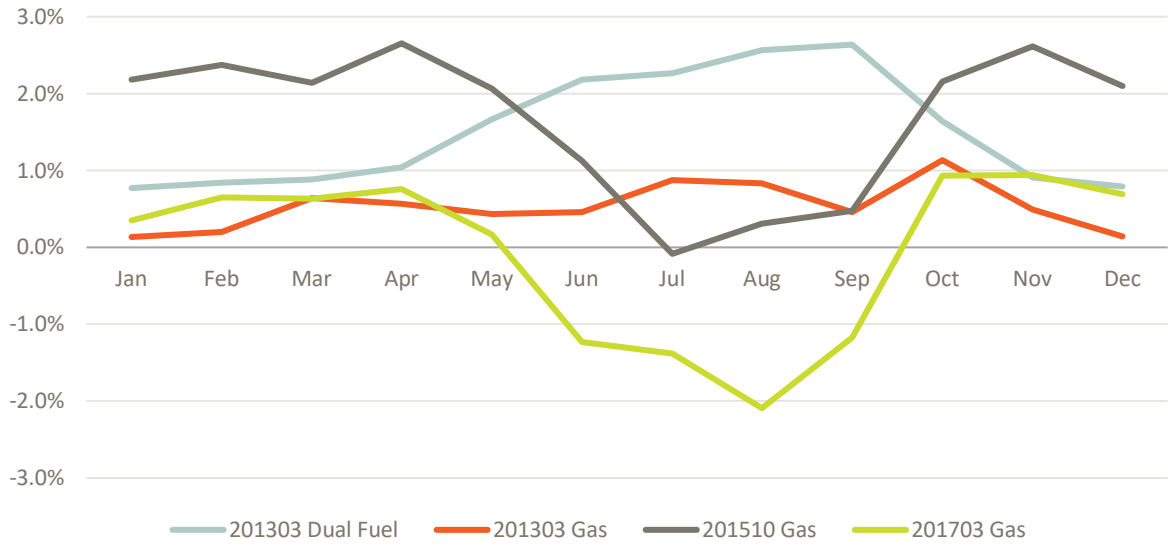
[a] For waves/year combinations with no adjustment, either there was no difference in participation between treatment and control groups or the control group had higher participation in which case we did not adjust the savings. Higher participation by the control group results in an upward adjustment of savings for the wave. Since the goal is to remove savings that might be double counted in another program, applying an upward adjustment is not needed.

Savings by Month

Averaged over the three-year period, 2017 to 2019, natural gas savings fluctuated by month and wave. **Figure 18** shows average monthly savings for the 2013 to 2017 waves, leaving off the 2019 waves that only have data for part of 2019.

The monthly savings are not statistically significantly different from other months within each wave, limiting the conclusions we can draw. The monthly savings trends show two different patterns. The 201510 Gas and the 201703 Gas waves both show peak savings in November and April and lowest savings in the summer (July for 201510 Gas and August for 201703 Gas). The 201303 Dual Fuel wave shows peak savings in August and September and lowest savings in January and December. The 201303 Gas wave is similar with a peak in October and lowest savings in January and December but has less variation from month to month than the other waves.

Figure 18. Unadjusted Monthly Natural Gas Saving



Savings by Personas

The most common persona among HER customers with gas service overall is Mature Basics (about 30% of gas customers). The persona distribution is slightly different between Existing Customer waves and New Mover waves, with more Young Green Movers in the New Mover waves (see **Figure 19** for overall distribution and **Appendix E: Personas Descriptions & Distribution** for distribution by wave).

Figure 19. Customer Personas in the HER Program: Gas Waves

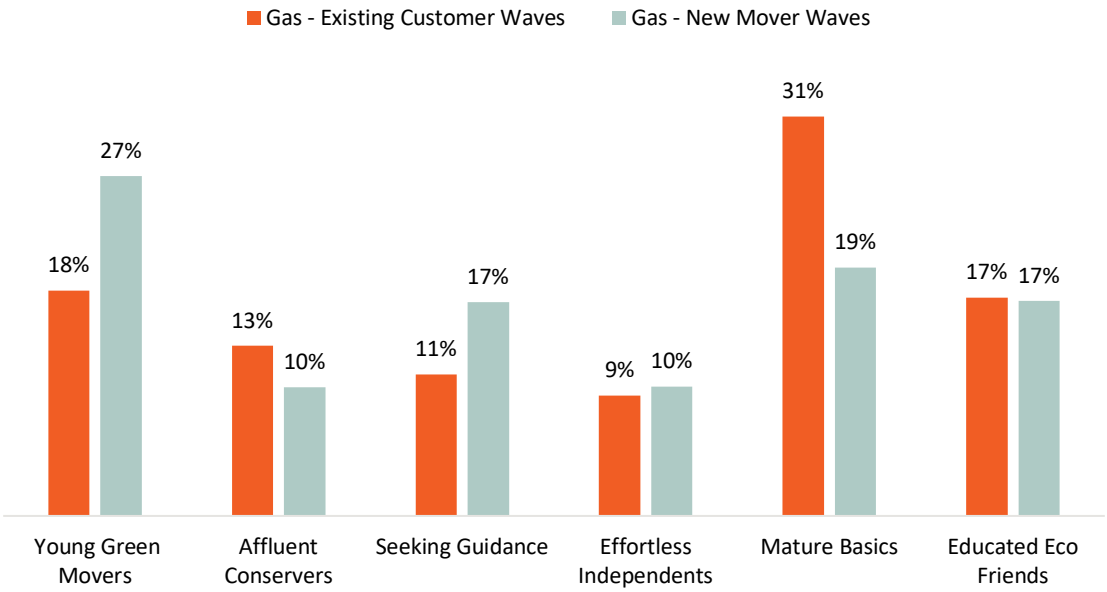
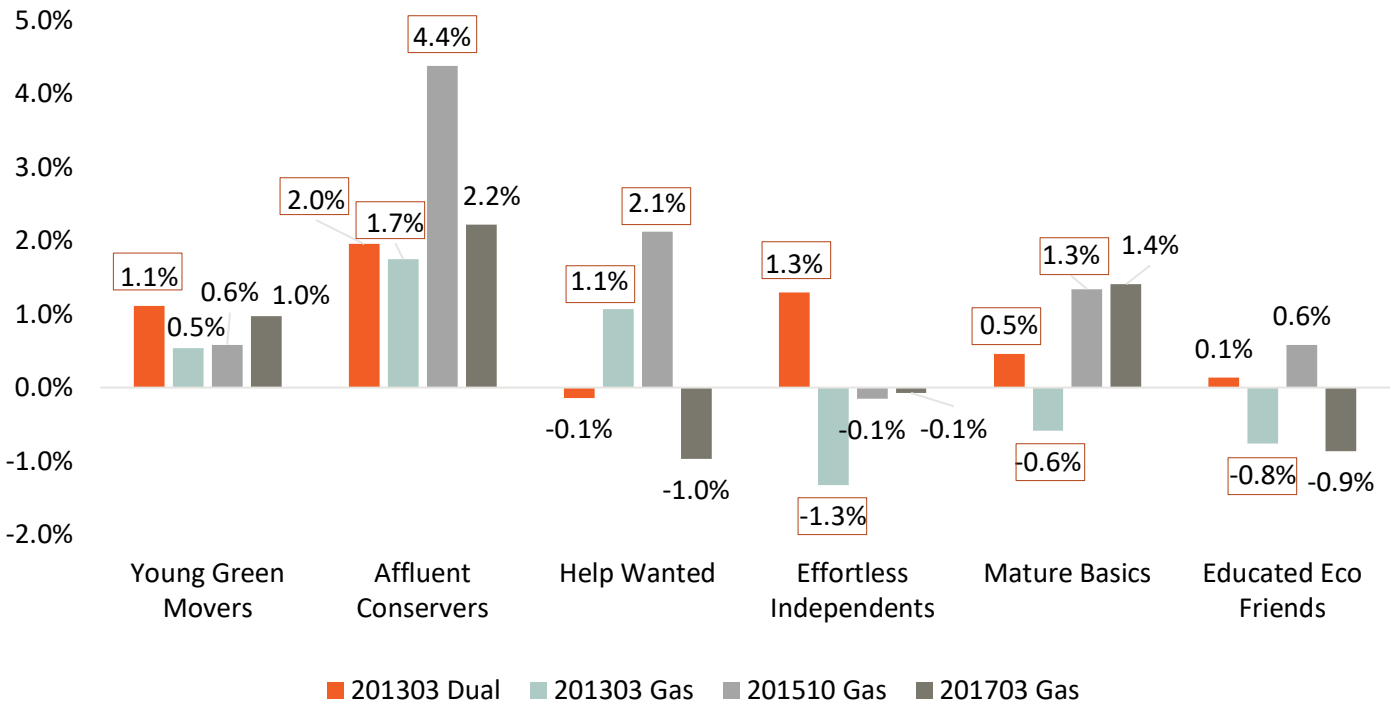


Figure 20 shows the percentage of therm savings by persona and treatment wave, relative to each persona and wave's baseline consumption.[35] **Figure 21** shows the percentage of therm savings by persona aggregated across each evaluated treatment wave. As with electric customers, the Affluent Conservers exhibit positive savings in each of the evaluated treatment waves and the highest aggregated savings. The Young Green Movers persona is the only other group to show positive savings in each of the evaluated treatment years, though only one year is significant. Each of the other four personas exhibit considerable variability across each of the respective treatment waves, with each having at least one wave demonstrating negative savings.

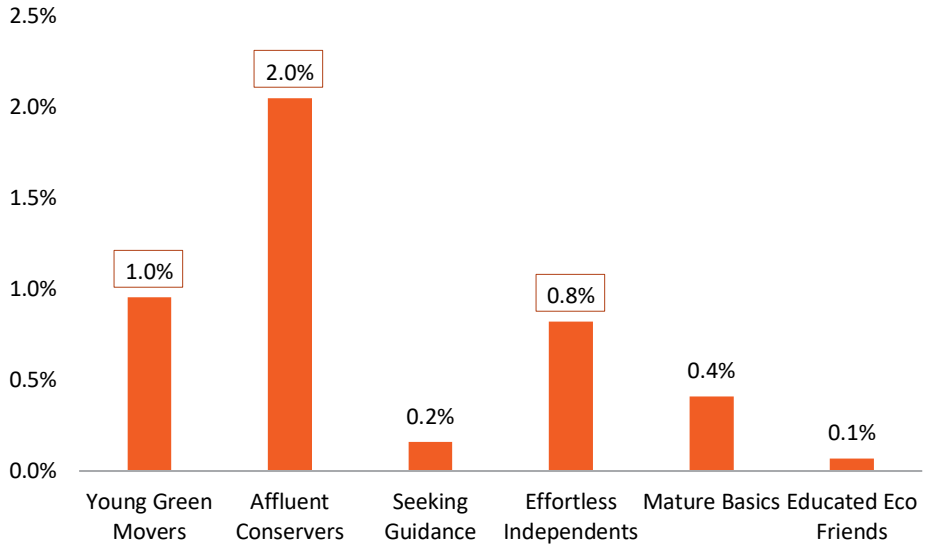
Figure 20. Persona Level Savings: Gas Waves [a]



[a]Boxes indicate a value is statistically significant, p<0.90

[35] For this analysis, we only selected treatment waves which displayed significant wave-level savings in the impact evaluation (201303 Dual, 201303 Gas, 201510 Gas, and 201703 Gas). To attain higher statistical power, we then pooled each wave's billing data across all three years of the evaluation period (2017 – 2019). See Appendix A: Personas Analysis for full methodology details.

Figure 21: Persona Level Savings: Gas Aggregated [a]



[a] Boxes indicate a value is statistically significant, p<0.90.

In three of the four evaluated treatment waves the Affluent Conservers group generated higher average daily savings than the highest savings found in the impact analysis (0.064 therms per day from the 2019 results of the 201510 Gas wave) (**Table 11**). As with electricity use, the Affluent Conservers have a comparatively high baseline energy consumption, so that energy savings proportional to the other waves results in a higher net savings value per household.

Table 11. Daily Therm Savings by Persona Group and Treatment Wave

Persona Group	201303 Dual	201303 Gas	201510 Gas	201703 Gas
Young Green Movers	0.037*	0.017	0.017	0.026
Affluent Conservers	0.074*	0.063*	0.148*	0.067
Seeking Guidance	-0.005	0.039*	0.072*	-0.029
Effortless Independents	0.043*	-0.040*	-0.004	-0.002
Mature Basics	0.017*	-0.020*	0.043*	0.040
Educated Eco Friends	0.005	-0.025	0.018	-0.024

*Statistically significant, p<0.90.

Summary

If National Grid is interested in improving or optimizing savings by persona, future customer research to understand (1) each persona's orientation to energy and savings, and (2) each persona's engagement with, and reactions to, HERs and various messaging strategies should be considered. If research shows opportunities for differentiated messaging, National Grid could consider modifying report language by persona. To quantify the effect of persona-specific messaging, we recommend an experimental design within one or more of the larger waves.

Discussion

Below we discuss in more depth some of the findings related to realization rates and reasons for fluctuations in realization rates.

Realization Rates

The realization rates of adjusted net ex post savings to implementer-estimated ex post savings for Existing Customer waves were 108% for electric savings and 92% for natural gas savings for 2017 – 2019. The program implementer's estimated savings falls within the evaluation unadjusted net ex post savings confidence intervals for all 14 gas year waves, and 14 of 19 electric year waves. This indicates strong alignment between the program implementer's monthly savings estimation approach for Existing Customer waves and the evaluation approach of annual billing analysis.

The realization rates for New Mover waves (with less historical billing data and smaller wave sizes) were 67% for electric savings and 50% for gas savings for 2017 – 2019. In addition to smaller wave sizes, the evaluation team opted for a different approach to calculating New Mover savings than the implementer by using a model that combined data across New Movers. The implementer used a simple difference approach applied to each wave.

Current and past evaluations show that realization rates can fluctuate from year to year. Differences in the composition of the waves (older waves lose customers and new waves are added) can lead to differences in realization rates across evaluation cycles. Annual realization rates for 2017 to 2019 range from 82% to 113% across electric and gas results for Existing Customer waves. The 2013 – 2014 evaluation found a 99% realization rate for electric savings across two waves. The 2015 and 2016 evaluation found an 88% electric realization rate and a 108% gas realization rate across three waves. The 2017 evaluation report also noted the highly variable 2014 realization rates among National Grid waves in Massachusetts which ranged from 77% to 145%.

Evaluated net ex post savings may differ from implementer-reported savings due several factors:

Analysis time periods: The implementer reports savings monthly and National Grid sums monthly values into an annual total. The evaluation team evaluates the program with models that include data from every month of the pre- and post-period. Monthly savings will have more variation from month to month, particularly where group sizes (treatment or control) are smaller. **Table 12** shows the number of monthly estimates provided by the implementer and the portion that were statistically significant.

Table 12. Statistically Significant Monthly Savings Estimates 2017 – 2019

	Electric Savings		Gas Savings	
Fuel	**Number of Monthly Estimates [b]**	**% Statistically Significant [a]**	**Number of Monthly Estimates**	**% Statistically Significant**
Existing Customers	223	46%	157	41%
New Movers	144	29%	72	13%
Total	***367***	***39%***	***229***	***32%***

[a] We use $p<0.10$ as our criteria for statistical significance.

[b] Waves that started prior to 2017 will have 36 monthly estimates for 2017 to 2019. Waves that started after 2017 will have fewer, depending on start date.

Models: The evaluation used the industry-standard PPR model that was also used for the previous National Grid HER program evaluation for Existing Customer waves. The implementer uses a slightly different model that includes terms for average daily usage in winter months and summer months and imputes missing values. For New Movers, the evaluation used a pooled model while the implementer used a simple post-period difference between treatment and control group energy use. This difference in approach can lead to larger differences in results. The evaluation team opted to pool New Movers due to the small size of the control groups (less than 2,500 per wave) and limited pre-period data, which suggested non-equivalency between the treatment and control groups. Pooling the New Movers provided more statistical power in the regression model. Employing a regression model rather than a simple post-period difference allowed us to use the available pre-period data to adjust for pre-existing differences between the treatment and control groups.

Data cleaning: As evaluators, we may use slightly different data cleaning steps such as different criteria for what we consider "extreme" energy usage or number of months of pre-period data required. Differences in these steps may have more impact on waves with smaller treatment or control group sizes.

Attrition: Differences between evaluator and implementer approaches may have more impact over time as groups become smaller through attrition. For example, the 201303 Dual Fuel wave has lost about 19% of treatment customers since its start in 2019 and the 201608 Elec wave has lost 25% of treatment customers in a shorter time period.

Statistical significance and group size: Savings estimates from evaluation models were not consistently statistically significant. Though the point estimates of savings from evaluation models are our best estimate of realized savings, wider confidence intervals reflect greater uncertainty. For Existing Customer waves, savings from earlier waves and larger waves (considering treatment and control sizes) were more likely to be statistically significant at a 90% confidence level. The lack of statistical significance could be related to many factors, including the sizes of the treatment or control groups, baseline consumption (or other selection criteria), the age/maturity of the wave (HER savings ramp up over several years), the length of the evaluation period (part-year savings are less likely to be statistically significant), and the effectiveness of the program intervention. **Table 13** shows customer counts during this evaluation period

(either 2017, or later waves' start date), the ratio of control to treatment customers, and statistical significance. Nearly all Existing Customer waves have control groups of less than 10,000 customers, and three of four gas waves started around 5,000 customers or less; these numbers decrease throughout the evaluation period due to natural attrition.

While control group sizes are shrinking due to attrition, they do not appear to be impacting the evaluability of any of the treatment waves, and we do not recommend making any changes to mitigate the effect of shrinking group size at this time. For this cycle, the waves with the smallest control group sizes generally have statistically significant results. For example, 201303 Elec and 201403 Elec have the smallest control group sizes but demonstrated statistically significant savings in every year evaluated. Likewise among gas waves, the 201510 Gas wave has the smallest control group, but also has statistically significant savings in every year.

While fluctuating realization rates can make planning more challenging, implementer-reported savings are generally within the 90% confidence interval of the evaluation unadjusted net ex post savings. While control group sizes are shrinking, the waves with the smallest control groups sizes have the most stable realization rates. Tracking program progress monthly has many benefits with the trade-off that final annual evaluated net ex post savings may differ from the summed up monthly results.

Table 13. Existing Customer Waves: Treatment and Control Counts and Statistical Significance of 2017-2019 Evaluation Model Results

Wave	Treatment Customer Count (Maximum) [a]	Control Customer Count (Maximum) [a]	Ratio of Control to Treatment Counts	Statistical Significance of 2017 – 2019 Savings	Realization Rate (Elec/Gas)
Existing Customer Waves					
201303 Dual Fuel	82,098	9,119	11%	Yes	113%/94%
201902 Dual Fuel [b]	24,752	9,479	38%	No[c]	806%/60%
201303 Elec	83,268	7,872	9%	Yes	106%
201403 Elec	36,430	6,710	18%	Yes	97%
201608 Elec [b]	12,931	12,938	100%	2 of 3 years	79%
201703 Elec/Dual [b]	30,137	12,661	42%	No	-232%
201802 Elec	21,840	9,926	45%	Yes	133%
201902 Elec [b]	24,646	9,948	40%	No[c]	-175%
201303 Gas	12,494	5,622	45%	No	71%
201510 Gas	8,819	2,220	25%	Yes	97%
201703 Gas/Dual	8,910	3,750	42%	1 of 3 years	84%
201909 Gas [d]	38,985	11,233	29%	No[c]	-26%
New Mover Waves					
Elec Combined	11,123	1,110	10%	No	67%
Gas Combined	24,131	2,365	10%	No	45%

[a] Implementer-reported customer counts at the beginning of the 2017 – 2019 evaluation period (maximum monthly customer counts for evaluation period)

[b] For electric savings, the 2016, 2017, and both 2019 waves have low savings and so a small difference between adjusted net ex post savings and implementer-estimated savings results in a more extreme (high or low) realization rate. The 2016 to 2019 waves

contribute less than 5% of the total savings for the Existing Customer waves, which means they contribute very little to the overall realization rate.

[c] We only evaluated a partial year for 2019 since these waves started in 2019. Considering typical savings ramp-up and partial year savings it is not surprising that savings were not statistically significant.

[d] The 2019 Gas wave has an unusually low realization rate due to the low overall savings and the difference in direction of savings between the adjusted net ex post savings and the implementer-estimated savings. However, this wave started in September 2019 so contributed very little savings to the three-year cycle.

Appendix A. Impact Methodology

The team leveraged the experimental design to estimate energy impacts using monthly billing data. In this section we detail our data cleaning and analysis methodologies.

Data Cleaning

Prior to analysis we cleaned the billing and energy efficiency program participation data. Billing data cleaning steps identified the customer data that was excluded from the analysis. Reasons for excluding a monthly observation included: insufficient billing days within a given month to determine a monthly average, statistical outliers (monthly values greater than 10 times the mean value for all customers within that treatment wave for the specific month), a later pre-period observation was available in the same calendar month, a monthly post-period observation did not have a corresponding observation in the pre period (or vice versa), or a treatment customer not having received reports. We dropped customers from the model if they had an insufficient amount of pre- or post-period data to be included in the models. The data cleaning steps filtered similar percentages of treatment and control group customers. We provide a table showing accounts removed in **Appendix B. Data Disposition**. Note that while we removed some accounts from the statistical modeling, we apply the results of the modeling to all accounts active in each program year.

Equivalency Checks

The HER program is a randomized control trial (RCT) in which the program implementer randomly assigns individual customers to the treatment group (i.e., they receive HERs) or the control group (i.e., they do not receive HERs). Because of the randomization, pre-treatment energy use should be equivalent between the groups. We performed an equivalency check of the energy usage patterns of the treatment and control groups of each wave in the year preceding their start to confirm that they had equivalent pre-treatment energy use.

We checked the waves as originally assigned and with move-outs and any ineligible customers removed using two methods of evaluating the equivalency of treatment and control energy usage:

- **T-tests** on monthly differences in mean energy use between treatment and control groups in each month. A significant difference ($p<0.05$) indicates that pre-period usage is dissimilar between groups.
- **Regression analysis** of pre-period usage with treatment/control group as an effect. A significant effect ($p<0.05$) of the group category indicates that pre-period usage is dissimilar between groups.

We provide detailed results from the equivalency checks in **Appendix C. Equivalency Check Results**.

Impact Evaluation

Below, we describe the impact evaluation methodologies we used to estimate program savings. Our impact evaluation approach is similar to the approach used in the previous evaluation and consistent with the Uniform Methods Project (UMP) Residential Behavior Protocol.[36]

The analysis leverages the experimental design to calculate impacts for the full program which includes paper reports, email reports, high bill alerts, and other program elements. All treatment customers receive paper reports (unless they opt out) and customers with an email address on file also receive email reports and might receive high bill alerts. Since the waves are not experimental designs by delivery mechanism, the modeling shows savings of the package of program elements and not of any specific elements.

We used two models to estimate program impacts for Existing Customers: **Post-Period Regression** (PPR), also referred to as the lagged dependent variable model) and **Linear Fixed-Effects Regression** (LFER). Both approaches should produce unbiased estimates of program savings under a wide range of conditions; however, the evaluation team reports the PPR results, consistent with the prior evaluations and industry standards. We use the LFER model as a secondary, robustness check. Although the two models are structurally different, assuming the RCT is well-balanced with respect to the drivers of energy use, the two models should produce similar program savings estimates, which will increase our confidence in our evaluated savings. This is the same approach that the evaluation team used during the last evaluation cycles. Below we describe each model in more detail.

Post Period Regression

The PPR model combines both cross-sectional and time series data in a panel dataset. This model uses the post-period data, with lagged energy use for the same calendar month of the pre-program period acting as a control for any small systematic differences between the participant and control customers. In particular, energy use in calendar month *t* of the post period is framed as a function of both the participant variable and energy use in the same calendar month of the pre-program period. The underlying logic is that systematic differences between participants and controls will be reflected in differences in their past energy use, which is highly correlated with their current energy use. The version we estimated includes monthly fixed effects and interacts these monthly fixed effects with the pre-program energy use variable. These interaction terms allow pre-program usage to have a different effect on post-program usage in each calendar month. Formally, the model is,

$$ADC_{kt} = \beta_1 Participant_k + \beta_2 ADClag_{kt} + \sum_j \beta_{3j} Month_{jt} + \sum_j \beta_{4j} Month_{jt} \cdot ADClag_{kt} + \varepsilon_{kt}$$

where:

[36] Chapter 17: Residential Behavior Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. October 2017 (https://www.nrel.gov/docs/fy17osti/68573.pdf).

ADCkt = The average daily usage in kWh or therms for customer k during billing cycle t. This is the dependent variable in the model;

Participant$_k$ = A binary variable indicating whether customer k is in the participant group (taking a value of 1) or in the control group (taking a value of 0);

ADClag$_{kt}$ = Customer k's energy use in the same calendar month of the pre-program year as the calendar month of month t;

Monthjt = A binary variable taking a value of 1 when j=t and 0 otherwise;

ε_{kt} = The cluster-robust error term for customer *k* during billing cycle *t*. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.[37]

In this model, β_1 is the estimate of average daily energy savings due to the program. Program savings are the product of the average daily savings estimate and the total number of participant-days in the analysis. We calculate household-level percentage savings by dividing the treatment effect by baseline average daily energy use (kwh or therm) per household.

Linear Fixed-Effects Regression

As with the PPR model, the LFER model combines both cross-sectional and time-series data. The regression compares the pre- and post-program energy usage of participants to those in the control group to identify the effect of the program. The purpose of the customer-specific fixed effect is to capture all systematic cross-customer variation in electric energy usage that is not captured by the model. Like the lagged usage variable in the PPR model, the fixed effect represents an attempt to control for any small systematic differences between the treatment and control customers that might occur in the data despite the randomization. Formally, the LFER model is,

$$ADC_{kt} = \beta_{0k} + \beta_1 Post_t + \beta_2 Treatment_k Post_t + \varepsilon_{kt}$$

where:

ADC_{kt} = *The average daily usage in kWh for customer k during billing cycle t. This is the dependent variable in the model;*

$Post_t$ = *A binary variable indicating whether bill cycle t is in the post-program period (taking a value of 1) or in the pre-program period (taking a value of 0);*

$Treatment_k$ = *A binary variable indicating whether customer k is in the participant group (taking a value of 1) or in the control group (taking a value of 0);*

[37] Ordinary Least Squares (OLS) regression models assume that the data are homoscedastic and not autocorrelated. If either of these assumptions is violated, the resulting standard errors of the parameter estimates are incorrect (usually underestimated). A random variable is heteroscedastic when the variance is not constant. A random variable is autocorrelated when the error term in one period is correlated with the error terms in at least some of the previous periods.

ε_{kt} = *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 this model, β_2 is the estimate of average daily energy savings due to the program. Program savings are the product of the average daily savings estimate and the total number of participant-days in the analysis.

New Movers

Because of (1) limited pre-program data for most New Movers, and (2) rolling enrollment, traditional evaluation methods for HERs such as wave-specific PPR and LFER models are not appropriate for the New Mover waves. The evaluation team modeled savings by pooling customer waves within fuel type and modeling energy with a fixed effects model. The implementer reported savings based on a simple difference between treatment group usage and control group usage in each post-period month. This method is valid in an RCT with groups that were equivalent in the pre-period. While it may be the case that these waves were balanced via RCT at launch, by the start of this evaluation period (2017) uneven attrition between the treatment and control groups has caused these waves to come out of balance. The limited pre-billing data available suggest that the treatment and control groups included in this evaluation period may not be equivalent in the pre-period. **Table 14** shows the differences in average daily consumption for the New Mover waves. Since the treatment effect for behavior programs is often only in the 1% to 2% range, a difference between treatment and control groups that is consistently larger can bias the results.

Table 14. New Movers Pre-Period Average Daily Consumption

Fuel	Wave Name	Number of Treatment Customers 2017	Number of Control Customers 2017	Average Daily kWH Treatment	Average Daily kWH Control	Percent Difference	Average Daily Therms Treatment	Average Daily Therms Control	Percent Difference
New Mover Waves									
Dual Fuel	201304	7,159	844	14.6	15.4	-4.7%	2.04	2.14	-4.7%
Dual Fuel	201408	13,666	1,510	14.0	14.1	-0.7%	2.12	2.06	2.8%
Electric	201304	11,123	1,110	17.3	18.0	-3.9%			
Electric	201408	24,131	2,365	16.3	16.0	-0.5%			

Table 14 also shows the approximate group sizes. The control group is about 10% the size of the treatment group with control groups less than 2,400 customers.

To address these two complications (lack of pre-period equivalence and small group sizes) we used a pooled model approach to estimate energy savings. We selected this model out of several variants as the model with better fit statistics that accounts for differences by wave with wave indicators and differences by month (with rolling enrollment customers within a wave have different pre-period data available) with monthyear indicators.

To adjust for the slightly different proportions of treatment to control group customers by wave, we weighted control observations in proportion to their respective treatment group's share of the overall New Mover program.

Formally, the model is

$$ADC_{kt} = \beta_0 MonthYear_t + \beta_1 Wave_{0,k} + \beta_2 Post_k + \beta_2 Treatment_k + \beta_3 Treatment_k \cdot Post_{k,t} + \varepsilon_{k,t}$$

where:

ADC_{kt}	= The average daily usage in kWh or therms for customer *k* during billing cycle *t*. This is the dependent variable in the model.
$MonthYear_{,t}$	= Series of dummy variables for the calendar-month (to allow for a time trend)
$Wave_k$	= Dummy variables for customer's specific treatment wave
$Treatment_k$	= A binary variable taking a value of 1 for customers in the treatment group, and 0 for control
$Post_{k,t}$	= A binary variable taking a value of 1 when a customer is in the post-treatment period, and 0 in the pre-treatment period
$\varepsilon_{k,t}$ =	Error term

The post-treatment effect, β_3, quantifies the effect of receiving home energy reports in terms of the net daily reduction in energy use (either kWh or therms) for a given treatment customer.

Cross-Program Participation and Double-Counted Savings Adjustments

The HER program may encourage cross-participation in National Grid energy efficiency programs. The evaluation team calculated this participation lift in other programs by calculating the difference between the percentage of active treatment and control customers who participated in one of National Grid's other (non-HER) energy efficiency programs in each year of this evaluation cycle. We report on participation lift for 2017 to 2019 to understand the effects of the program during the current cycle.

Participation lift in current and past cycles can result in double-counted savings. HER billing analysis estimates the overall savings between treatment and control groups in any given year which will include any cumulative savings from participation lift. These double-counted savings (counted in the HER billing analysis and by the other energy efficiency programs) will be present in the savings from the billing analysis (unadjusted net ex-post savings). The evaluation team estimated and removed cumulative savings from participation uplift to arrive at the final adjusted net ex-post savings attributable to the HER program.

We calculated double-counted savings through the following steps **for each wave for each treatment year**: 1) calculate the average daily per customer (over all wave customers) kWh or therm savings attained through participation in other National Grid energy efficiency programs for the treatment and control group, 2) find the difference in average daily energy savings attributed to participation in other programs between treatment and control customers, and 3) multiply that difference by the total number of days for which customers received treatment, adjusting for measure life (see next paragraph). This converts the average daily per customer double-counted savings to wave-level savings for the year. This number is the incremental savings attributed to differential participation in energy efficiency programs for that wave and year.

Measures installed as a result of participation uplift have measure lives ranging from four to twenty-five years, generating multi-year savings. Incremental measures installed in 2013-2016 may result in continued uplift savings; likewise, savings from incremental measures installed in 2017 may have continued into 2018-2019. To account for the measure life of measures installed by HER participants (treatment and control), this analysis used historical program participation data (before 2017), as well as program participation data for the current evaluation period (2017-2019). The evaluation team referenced each measure's "measure life" to arrive at the number of days the measure generated savings while the customer's account was still active. The average daily savings value was then applied to every day for which a customer's account was still active, and the measure was still generating savings. These are the values included in the average daily energy savings.

Savings by Month

To compare savings by month, we used the implementer-estimated monthly savings values. While implementer-estimated values do not align identically to the evaluated savings, we are using the monthly results from the waves generally with the largest savings and the more consistent realization rates. The implementer monthly values allow us to quickly compare months and pool months across waves and across years to look for patterns in savings.

Personas Analysis

We modified the regression models used in the impact evaluation to produce separate savings estimates for each persona (rather than an overall savings estimate). This required "breaking apart" our wave-level savings estimates, so it was important to begin with as much statistical power (as many observations as possible) in the models. To improve the statistical power of models and our ability to detect savings by persona segment, we implemented the following steps:

We selected Existing Customer waves for evaluation that showed statistically significant savings in impact evaluation models (we do not report model waves with weaker results). We do not include

New Movers since the New Movers results were not statistically significant. We included the following waves:

- Electric Savings: 201303 Dual, 201303 Elec, 201403 Elec, 201608 Elec, and 201802 Elec
- Gas Savings: 201303 Dual, 201303 Gas, 201510 Gas, and 201703 Gas

We pooled observations of each wave across each of years 2017-2019 into a single model for each selected wave. This provide more statistical power to detect savings within sub-group.

Combining data from all three years, we modeled savings for each wave using a PPR with categorical variables for each Persona.

Formally, the model is:

$$ADC_{kt} = \beta_1 ADClag_{kt} + \sum_j \beta_{2j} Month_{jt} + \sum_j \beta_{3j} Month_{jt} \cdot ADClag_{kt} + \varepsilon_{kt}$$

$$+ \alpha_1 YoungGreen_k + \gamma_1 YoungGreen_k \cdot Treatment_k$$

$$+ \alpha_2 AffluentConserve + \gamma_2 AffluentConserve_k \cdot Treatment_k$$

$$+ \alpha_3 HelpWanted_k + \gamma_3 HelpWanted_k \cdot Treatment_k$$

$$+ \alpha_4 EffortlessInd_k + \gamma_4 EffortlessInd_k \cdot Treatment_k$$

$$+ \alpha_5 MatureBasics_k + \gamma_5 MatureBasic_k \cdot Treatment_k$$

$$+ \alpha_6 EducatedEco_k + \gamma_6 EducatedEco_k \cdot Treatment_k$$

where:

ADC_{kt}	= The average daily usage in kWh or therms for customer k during billing cycle t. This is the dependent variable in the model
$ADClag_{kt}$	= Customer k's energy use in the same calendar month of the pre-program year as the calendar month of month t
$Month_{jt}$	= A binary variable taking a value of 1 when j=t and 0 otherwise
$Persona_k$	= A binary variable indicating whether customer k is in the Persona segment (taking a value of 1) or no (taking a value of 0)
$Treatment_k$	= A binary variable indicating whether customer k is in the participant group (taking a value of 1) or in the control group (taking a value of 0);
ε_{kt}	= The cluster-robust error term for customer *k* during billing cycle *t.* Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

The alpha coefficients (α) of the Persona indicators capture any systematic differences in consumption between Personas independent of program treatment. The gamma coefficients (γ)

of the Persona indicators interacted with a Treatment indicator capture average HER program savings associated with each persona in the treatment group – i.e., a Persona's average treatment effect.

We calculated a confidence interval around each Persona's average treatment effect and assessed whether there are statistically significant differences between segments.

As a check on the modeled estimates, we also calculated difference-in-differences savings for each persona, by calculating average consumption of treatment and control groups in the pre-program and post-program periods.

Appendix B. Data Disposition

Table 15 shows the number of accounts removed from the data before we modeled the data for savings.

Table 15. Data Disposition by Wave and Year

	2017		2018		2019	
	Treatment	Control	Treatment	Control	Treatment	Control
Electric Savings						
201303 Dual Fuel						
Starting Accounts	79,383	8,737	75,393	8,331	71,886	7,897
% Accounts Removed	8%	8%	9%	9%	11%	10%
Ending Accounts	73,028	8,040	68,367	7,544	64,227	7,071
201303 Elec						
Starting Accounts	81,219	7,601	78,254	7,303	75,537	7,025
% Accounts Removed	7%	7%	8%	8%	9%	9%
Ending Accounts	75,811	7,083	72,142	6,718	68,614	6,366
201403 Elec						
Starting Accounts	35,112	6,351	32,703	5,921	30,670	5,564
% Accounts Removed	8%	8%	9%	10%	11%	11%
Ending Accounts	32,360	5,853	29,681	5,358	27,437	4,957
201608 Elec						
Starting Accounts	12,559	12,569	11,004	11,101	10,016	10,040
% Accounts Removed	4%	4%	5%	6%	7%	7%
Ending Accounts	12,010	12,012	10,417	10,446	9,323	9,292
201703 Elec						
Starting Accounts	29,177	12,291	22,772	9,656	18,823	8,008
% Accounts Removed	13%	13%	6%	6%	8%	7%
Ending Accounts	25,370	10,704	21,416	9,113	17,384	7,431
201802 Elec						
Starting Accounts			20,753	9,436	15,408	7,006
% Accounts Removed			17%	18%	6%	5%
Ending Accounts			17,190	7,779	14,528	6,639
201902 Dual Fuel						
Starting Accounts					23,954	9,168
% Accounts Removed					11%	11%
Ending Accounts					21,272	8,147
201902 Elec						
Starting Accounts					23,726	9,570
% Accounts Removed					20%	19%

Ending Accounts					19,041	7,705
Pooled New Movers						
Starting Accounts	53,697	5,517	43,182	4,453	37,209	3,859
% Accounts Removed	2%	2%	2%	2%	3%	3%
Ending Accounts	52,438	5,401	42,151	4,359	36,195	3,757
Natural Gas Savings						
201303 Dual Fuel						
Starting Accounts	79,154	8,695	75,240	8,302	71,702	7,882
% Accounts Removed	11%	11%	12%	12%	13%	13%
Ending Accounts	70,807	7,756	66,350	7,290	62,486	6,852
201303 Gas						
Starting Accounts	11,744	5,155	10,903	4,797	10,153	4,464
% Accounts Removed	15%	15%	17%	17%	18%	18%
Ending Accounts	9,972	4,387	9,083	3,990	8,364	3,668
201510 Gas						
Starting Accounts	8,459	2,105	7,102	1,790	6,104	1,540
% Accounts Removed	12%	12%	13%	14%	14%	14%
Ending Accounts	7,449	1,853	6,171	1,544	5,249	1,319
201703 Gas						
Starting Accounts	8,636	3,642	6,638	2,754	5,415	2,230
% Accounts Removed	20%	21%	12%	11%	13%	13%
Ending Accounts	6,871	2,873	5,839	2,442	4,693	1,933
201902 Dual Fuel						
Starting Accounts					23,938	9,176
% Accounts Removed					13%	13%
Ending Accounts					20,832	7,995
201909 Gas						
Starting Accounts					36,937	10,653
% Accounts Removed					16%	16%
Ending Accounts					31,095	8,993
Pooled New Movers						
Starting Accounts	19,269	2,142	15,816	1,741	13,513	1,517
% Accounts Removed	1.1%	1.3%	2.2%	2.0%	2.3%	2.1%
Ending Accounts	19,058	2,114	15,471	1,706	13,196	1,485

Appendix C. Equivalency Check Results

This section contains the detailed results of the equivalency check. For the modeled equivalency comparison, the treatment and control groups are equivalent when the coefficient on the treatment term is not statistically significant. Overall, the tests support the equivalence of the treatment and control groups for each year of the analysis.

Table 16. Electric Modeled Equivalency Results

	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Dual Fuel 201303				
Original Treatment and Control Groups[a]	-0.19	0.11	-1.68	0.09
2019 Modeled Treatment and Control Groups[b]	-0.24	0.15	-1.61	0.11
Dual Fuel 201902				
Original Treatment and Control Groups	-0.06	0.23	-0.26	0.80
2019 Modeled Treatment and Control Groups	0.00	0.13	0.02	0.98
Electric Only 201303				
Original Treatment and Control Groups	0.05	0.15	0.33	0.74
2019 Modeled Treatment and Control Groups	-0.03	0.18	-0.18	0.86
Electric Only 201403				
Original Treatment and Control Groups	0.02	0.13	0.18	0.86
2019 Modeled Treatment and Control Groups	0.00	0.17	0.02	0.98
Electric Only 201608				
Original Treatment and Control Groups	0.04	0.14	0.26	0.80
2019 Modeled Treatment and Control Groups	-0.01	0.14	-0.09	0.93
Electric Only 201703				
Original Treatment and Control Groups	0.14	0.26	0.55	0.58
2019 Modeled Treatment and Control Groups	0.08	0.15	0.51	0.61
Electric Only 201802				
Original Treatment and Control Groups	-0.12	0.36	-0.32	0.75
2019 Modeled Treatment and Control Groups	-0.09	0.19	-0.46	0.65
Electric Only 201902				
Original Treatment and Control Groups	0.19	0.34	0.54	0.59
2019 Modeled Treatment and Control Groups	0.00	0.15	0.02	0.98

[a] Original treatment and control groups compares pre-period energy use of the treatment and control groups as initially assigned in the first year of the wave.

[b]2019 Modeled Treatment and Control Groups compares the pre-period energy use of the treatment and control group customers included in the modeling for 2019 results. Customers who moved or had insufficient are not included. The evaluation team also checked equivalency for 2017 and 2018 but include one year here due to space considerations.

Table 17. Natural Gas Modeled Equivalency Results

	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Dual Fuel 201303				
Original Treatment and Control Groups [a]	-0.02	0.01	-1.18	0.24
2019 Modeled Treatment and Control Groups [b]	-0.02	0.02	-1.35	0.18
Dual Fuel 201902				
Original Treatment and Control Groups	0.01	0.02	0.22	0.82
2019 Modeled Treatment and Control Groups	0.02	0.01	1.15	0.25
Gas Only 201303				
Original Treatment and Control Groups	-0.01	0.02	-0.63	0.53
2019 Modeled Treatment and Control Groups	-0.01	0.03	-0.34	0.73
Gas Only 201510				
Original Treatment and Control Groups	0.02	0.03	0.66	0.51
2019 Modeled Treatment and Control Groups	0.04	0.04	1.07	0.28
Gas Only 201703				
Original Treatment and Control Groups	0.05	0.04	1.23	0.22
2019 Modeled Treatment and Control Groups	0.01	0.03	0.46	0.65
Electric Only 201909				
Original Treatment and Control Groups	-0.01	0.02	-0.30	0.76
2019 Modeled Treatment and Control Groups	0.00	0.01	-0.08	0.94

[a] Original treatment and control groups compares pre-period energy use of the treatment and control groups as initially assigned in the first year of the wave.

[b] 2019 Modeled Treatment and Control Groups compares the pre-period energy use of the treatment and control group customers included in the modeling for 2019 results. Customers who moved or had insufficient are not included. The evaluation team also checked equivalency for 2017 and 2018 but include one year here due to space considerations.

Appendix D. Wave-Level Results

This section contains results for each electric, gas and dual fuel Existing Customer wave treated in 2017-2019.

Electric Results

Wave-level electric realization rates are highly variable starting with the 2016 wave. The 2016, 2017, and both 2019 waves have low savings so a small difference between adjusted net ex post savings and implementer-estimated savings results in a more extreme (high or low) realization rate. The 2016 to 2019 waves contribute less than 5% of the total savings for the Existing Customer waves, which means they contribute very little to the overall realization rate.

Table 18. Existing Customers: Electric Results

Wave	Treatment n [a]	Control n[a]	Average Daily Baseline Con-sumption (kWh)[a]	Equivalency Check Results[b]	2017-2019 Adjusted Net Ex Post (MWH)[c]	2017-2019 Implementer-Estimated Net Ex Post (MWH)[c]	Realization Rate [d]
Existing Customer Waves							
201303 Dual Fuel	82,098	9,119	19.5	36 of 36	26,697	23,541	113%
201303 Elec	83,268	7,872	26.6	36 of 36	31,533	29,134	106%
201403 Elec	36,430	6,710	18.5	36 of 36	30,929	11,102	97%
201608 Elec	12,931	12,938	13.3	36 of 36	10,788	1,344	79%
201703 Elec/Dual	30,137	12,661	13.5	36 of 36	1,057	118	-233%
201802 Elec	21,840	9,926	19.6	24 of 24	(275)	1608	133%
201902 Dual Fuel	24,752	9,479	15.8	12 of 12	2,132	35	799%
201902 Elec	24,646	9,948	14.9	12 of 12	280	(163)	-176%
Total	**316,102**	**78,653**	**19.8**	**228 of 228**	**73,048**	**66,719**	**108%**

[a] Implementer-reported customer counts at the beginning of the 2017-2019 evaluation period (maximum monthly customer counts for evaluation period).

[b] Number of monthly pre-period equivalency checks that passed, based on customers included in the billing analysis models. We checked pre-period equivalency for each set of customers included in each program year. See Appendix C for full results.

[c] Net adjusted results after removing double-counted savings from incremental participation in other EE programs.

[d] Ratio of adjusted net ex post savings to implementer-estimated net ex post savings.

Gas Results

Wave-level gas realization rates are very similar across the 2013 Dual Fuel, 2015 Gas and 2017 Gas waves. The 2019 Gas wave has an unusually low realization rate due to the low overall savings and the difference in direction of savings between the adjusted net ex post savings and the implementer-estimated savings. However, this wave started in September 2019 so contributed very little savings to the three-year cycle. With a longer post-period we expect more realization rates more in line with other waves.

Table 19. Existing Customers: Gas Results

Wave	Starting Treatment n[a]	Starting Control n[a]	Average Daily Baseline Consumption (Therms)[a]	Equivalency Check Results[b]	2017-2019 Adjusted Net Ex Post (Therms)[c]	2017-2019 Implementer -Estimated Net Ex Post (Therms)[c]	Realization Rate[d]
Existing Customer Waves							
201303 Dual Fuel	82,098	9,119	2.6	33 of 36	2,029,531	2,168,900	94%
201303 Gas	12,494	5,622	2.5	36 of 36	78,910	111,504	71%
201510 Gas	8,819	2,220	2.3	36 of 36	364,587	374,646	97%
201703 Gas/Dual	8,910	3,750	2.0	36 of 36	46,774	55,980	84%
201902 Dual Fuel	24,752	9,479	1.8	12 of 12	(20,716)	(34,414)	60%
201909 Gas	38,985	11,233	2.9	12 of 12	(6,062)	23,674	-26%
Total	**176,058**	**41,423**	**2.5**	**165 of 168**	**2,493,023**	**2,700,289**	**92%**

[a] Implementer-reported customer counts at the beginning of the 2017-2019 evaluation period (maximum monthly customer counts for evaluation period)

[b] Number of monthly pre-period equivalency checks that passed, based on customers included in the billing analysis models. We checked pre-period equivalency for each set of customers included in each program year. See Appendix C for full results.

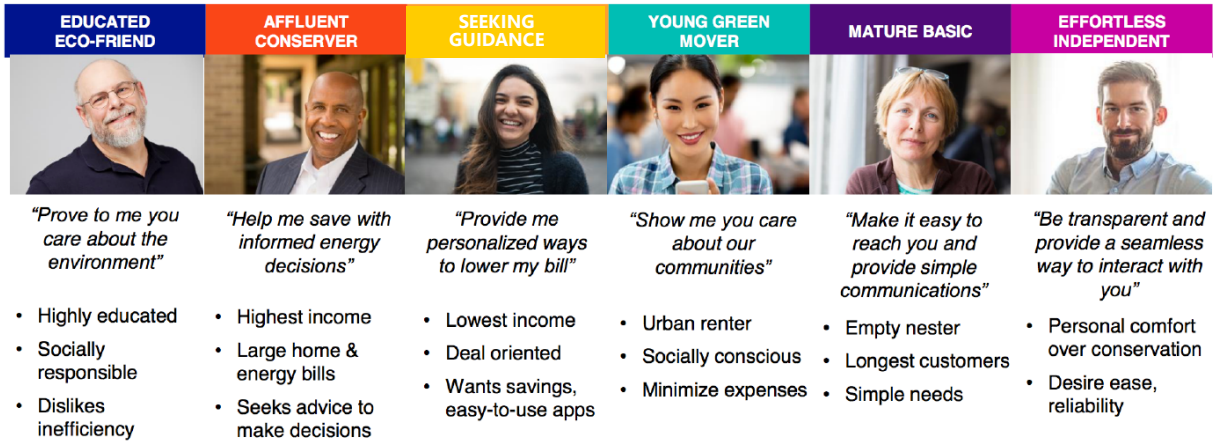
[c] Net adjusted results after removing double-counted savings from incremental participation in other EE programs.

[d] Ratio of adjusted net ex post savings to implementer-estimated net ex post savings.

Appendix E: Personas Descriptions & Distribution

National Grid segmented customers into six personas to use for messaging, marketing, and product and service offerings. **Figure 22** describes the key characteristics of each persona. **Table 20** and **Table 21** show the distribution of personas by wave.

Figure 22. Personas Descriptions



Source: National Grid

Table 20. Personas Distributions: Customers with Electric Service

	Young Green Movers	Affluent Conservers	Seeking Guidance	Effortless Independents	Mature Basics	Educated Eco Friends
Existing Customers						
201303 Dual	4%	26%	7%	10%	29%	24%
201303 Elec	1%	40%	5%	4%	32%	19%
201403 Elec	4%	22%	9%	9%	30%	25%
201408 Dual	18%	16%	16%	14%	18%	17%
201608 Elec	8%	17%	7%	16%	27%	26%
201703 Elec/Dual	17%	14%	12%	18%	22%	18%
201802 Elec	14%	19%	17%	11%	24%	15%
201902 Dual	25%	11%	18%	14%	19%	14%
201902 Elec	22%	11%	14%	16%	26%	11%
New Movers						
201304 Dual	15%	20%	15%	14%	16%	20%
201304 Elec	8%	29%	10%	12%	19%	22%
201408 Elec	18%	16%	16%	14%	18%	17%
Total	***9%***	***25%***	***10%***	***10%***	***27%***	***20%***

Table 21. Personas Distributions: Customers with Gas Service

	Young Green Movers	Affluent Conservers	Seeking Guidance	Effortless Independents	Mature Basics	Educated Eco Friends
Existing Customers						
201303 Dual	8%	16%	9%	9%	38%	21%
2013030 Elec	15%	12%	13%	11%	34%	15%
201403 Elec	22%	12%	15%	10%	24%	18%
201408 Dual	30%	8%	18%	12%	20%	13%
201608 Elec	34%	7%	17%	10%	20%	12%
201703 Elec/Dual	23%	14%	10%	9%	29%	15%
New Movers						
201304 Dual	26%	12%	16%	10%	17%	19%
201408 Dual	27%	9%	17%	10%	20%	16%
Total	***18%***	***13%***	***12%***	***9%***	***30%***	***17%***