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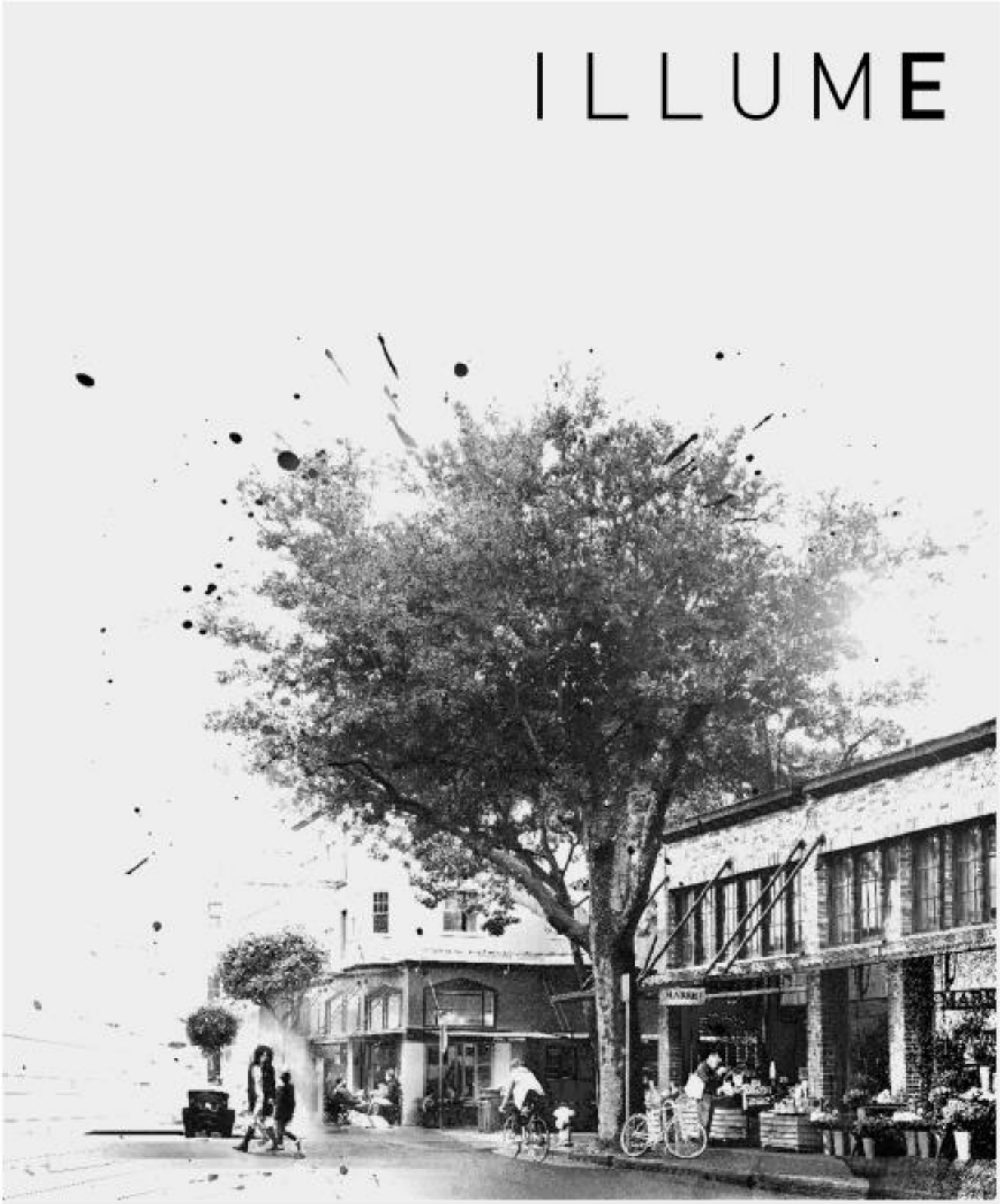

PROJECT

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RHODE ISLAND HOME ENERGY REPORT PROGRAM IMPACT AND PROCESS EVALUATION

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ILLUME Advising is a forward-thinking consulting company at the rare intersection of insight and execution. Founded in 2013 by industry thought-leaders Anne Dougherty and Sara Conzemius, the company has quickly grown to include a deep bench of quantitative and qualitative research experts. ILLUME uses cutting edge research strategies to help build a resilient energy future to enrich lives, improve global health, and ensure a more secure and sustainable future.

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EXECUTIVE SUMMARY

Illume Advising, LLC (ILLUME) is pleased to present National Grid Rhode Island with our impact results for the Rhode Island Home Energy Report Program (the HER program).

I. PROGRAM DESCRIPTION

Through the HER program, National Grid distributes home energy reports by mail. These single-page reports educate residential customers about their home energy usage and provide them with information designed to encourage behavior change. The reports contain information on customers' energy use, tips to save energy, and cross-promotion of other National Grid programs.

The savings generated through National Grid's HER program comprise 29% of the residential electric portfolio and 13% of the total electric portfolio in the 2017 plan. The program has the second largest annual electric savings in the residential sector and the third largest electric savings in the portfolio. In the 2017 gas plan, the HER program comprises 43% of residential gas savings (largest program) and 14% of the entire portfolio (third largest program).

The current program includes a mix of dual fuel, electric-only, and gas-only customers, some of whom are New Movers (recently moved to a different home). All customers with email addresses on file (about 58%) received monthly HERs through email in addition to their paper reports.

II. EVALUATION FINDINGS

The evaluation team conducted a number of activities to measure the savings associated with the program overall as well as subgroups of customers. In addition, the evaluation team assessed the program's design and delivery. The activities for this evaluation included:

- Program process and materials review
- Existing customers[1] HER report impacts assessment
- New Movers[2] impacts assessment
- Electronic HER impacts assessment
- Baseline segmentation impacts assessment
- Secondary research

Below we summarize the key findings from this research, as well as recommendations for any program improvements.

[1] Existing customers are customers with a 12-month billing history that Opower included in the standard program.

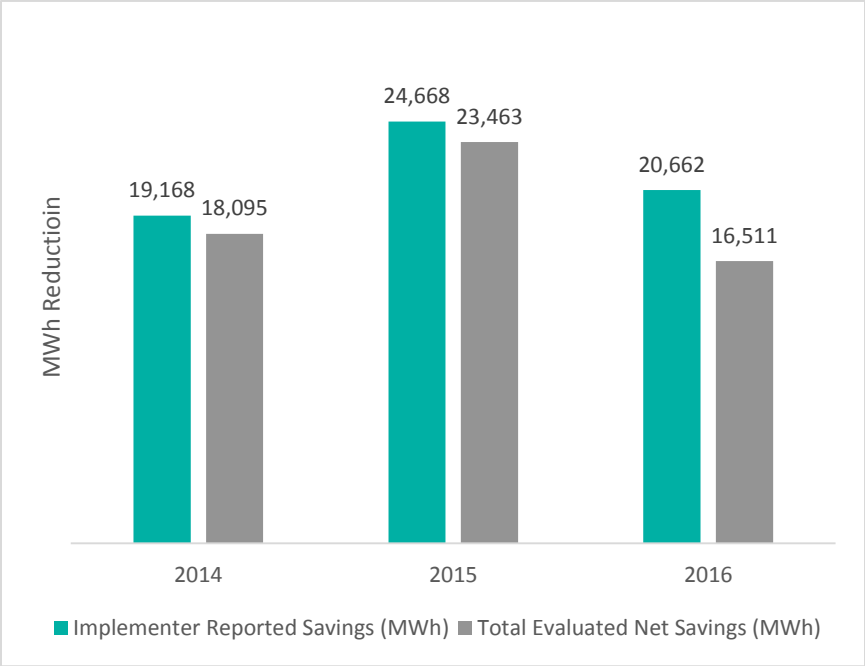
[2] New Movers are new accounts with less than 12 months of billing history. During the period of this evaluation, New Movers received different report messaging and a different schedule of reports.

A. IMPACT FINDINGS

A1. ELECTRIC AND GAS HER IMPACT RESULTS (EXISTING CUSTOMERS)

Through the HER program, National Grid saved 16,511 MWh during program year 2016, for an 80% realization rate across all dual fuel electric and electric only existing customers. The program's realization rate indicates how savings measured by the third-party evaluation vary from the savings measured by the implementation contractor (Opower). Realization rates for electric customers were slightly lower in 2016 than in 2015 or 2014. Figure 1 below displays the evaluated electric savings compared to the measured savings of the program implementation contractor.

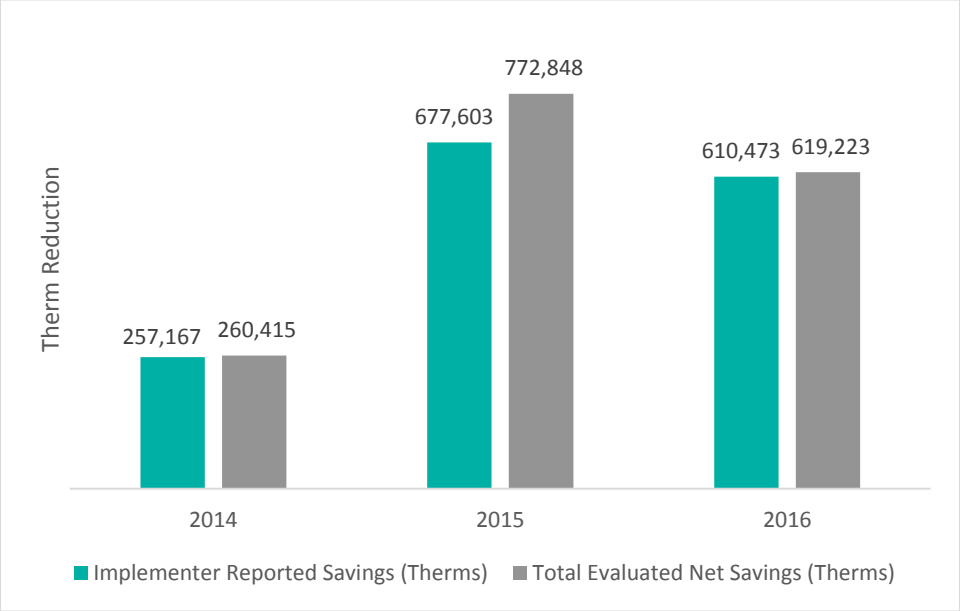
FIGURE 1. ESTIMATED ELECTRIC SAVINGS BY YEAR, CROSS-PROGRAM PARTICIPATION REMOVED*



*2014 results only include the months June-December; January-May were included in a previous evaluation.

Through the HER program, National Grid saved 619,223 therms during program year 2016, achieving a 101% realization rate across all dual fuel gas and gas only existing customers. Realization rates were also over 100% in 2015 and 2014. Figure 2 below displays the evaluated gas savings compared to the measured savings of the program implementer (Opower).

FIGURE 2. ESTIMATED GAS SAVINGS BY YEAR, CROSS-PROGRAM PARTICIPATION REMOVED*

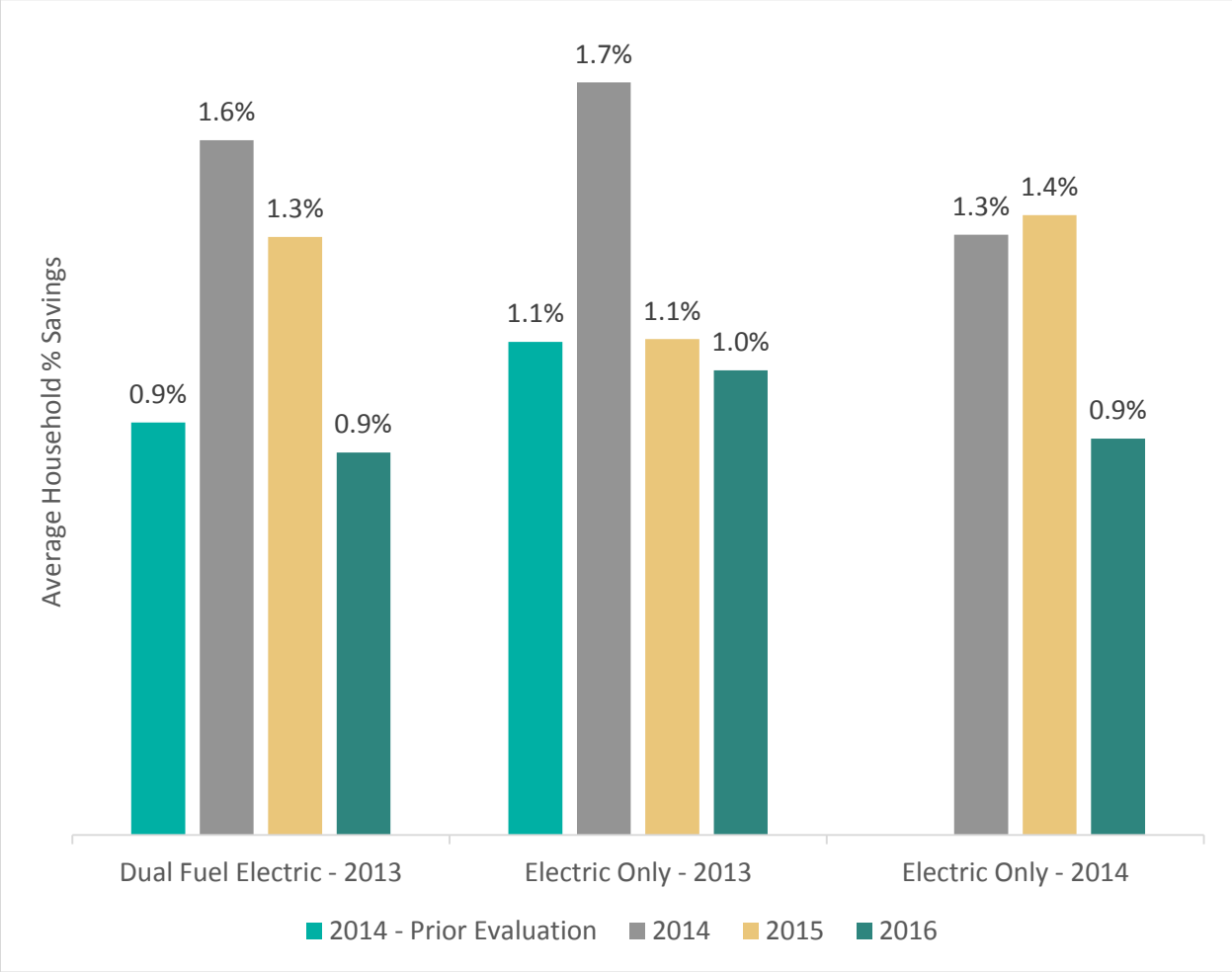


*2014 results only include the months June-December; January-May were included in a previous evaluation.

Recommendation: For planning purposes, use a 2015-2016 weighted average electric realization rate of 88% and gas realization rate of 108%. Numerous factors can cause savings and the alignment of reported and evaluated savings to fluctuate from year to year. The evaluation team recommends using a weighted average realization rate for future planning to minimize variability. The evaluation team does not recommend including 2014 results in this average as only 7 months were included in the 2014 analysis.

Household-level average electric savings may be declining. The evaluation team found that household-level average savings were lower in 2016 than 2015 for two of the three electric waves, although the differences are not statistically significant.

FIGURE 3. ELECTRIC SAVINGS PERCENT BY HOUSEHOLD, BY COHORT AND YEAR – CROSS-PROGRAM PARTICIPATION REMOVED*



*The 2014 prior evaluation included March 2013 through May 2014. The 2014 results from this evaluation include June-December 2014.

> Recommendation: Continue to monitor the average household savings value for electric customers. If a pattern of declining household savings emerges over time, consider additional efforts to increase customer engagement.

A2. CROSS-PROGRAM PARTICIPATION

In addition to savings generated by the HER program, the evaluation team assessed whether treatment customers had increased rates of participation in other energy efficiency programs compared to control group customers. Below we detail our key findings from this research.

Electric-metered customers receiving HERs (treatment customers) were more likely to participate in other energy efficiency programs than control customers. However, there was no measurable participation uplift

in gas programs. Overall, the program produced an incremental increase in program participation of over 1% among electric-metered customers in each of the three program years.[3] In 2016 this resulted in a total increase of 3,181 additional participants in National Grid's residential programs (electric measures) due to the HER program's activities. Customers were most likely to participate in the Energy Wise and ENERGY STAR products programs.

In general, report messaging accurately describes program offerings, although may be missing some cross-promotion opportunities. The evaluation team reviewed report examples, program design documents, and marketing module examples provided by Opower. In general, the evaluation team found the HER report examples to be well-designed and clear. However, the team identified a few areas where the reports could more clearly cross-promote programs.

> **Recommendation: Consider including language tying tips and "ways to save" to related energy efficiency programs.** While the reports contain specific marketing modules for energy efficiency programs, there is often no reference to these programs in other sections of the report where energy-saving actions are discussed. For example, when recommending ENERGY STAR appliances, reports could reference the ENERGY STAR products program in the same module.

A3. NEW MOVERS IMPACT RESULTS

As a means of intervening at a critical decision-making point, the HER program targets customers who have recently moved ("New Movers") with specific messaging. The evaluation team examined these customers separately to determine if there are incremental savings from this group of customers. Below are our results.

Due to data limitations, the evaluation team found fluctuating savings estimates with wide confidence intervals for New Movers groups, and advises that results should be interpreted with caution. For 2016, the evaluation team estimated savings of 12,622,293 kWh for dual fuel electric and electric only New Movers groups combined and 65,140 therms for dual fuel gas and gas only New Movers groups combined. For 2015, gas savings estimates were negative, meaning the evaluation team measured an increase in energy use for the New Movers group. Due to smaller sample sizes and limited pre-period data, these estimates have wide confidence intervals that include no savings. As of mid-2017, Opower is discontinuing the New Movers program.

> **Recommendation: If National Grid reinstates the New Movers program in the future, National Grid could consider conducting qualitative research with this group to understand their needs and how they use and understand the reports.** While it is difficult to quantify savings from the reports, qualitative research may help National Grid understand the value of these reports to customers.

[3] This is the number of Opower treatment customers induced to participate in other EE programs (over and above the participation of control customers) divided by the total number of Opower treatment customers, calculated by cohort and year.

Recommendation: Going forward, the evaluation team recommends that National Grid use the impact results from the existing customer (non-New Mover) cohorts for planning purposes for all participants. As Opower is not continuing the New Movers initiative, and previous New Mover participants will receive standard report messaging, the evaluation team feels that the overall realization rates from the existing customer cohorts are most appropriate to use for planning purposes.

A4. ELECTRONIC HOME ENERGY REPORTS (EHERS)

The evaluation team explored the effectiveness of receiving both mailed and emailed reports, compared to receiving only mailed reports. The team's efforts included both analyses with National Grid data as well as secondary research on peer utility offerings. Below are our findings.

The evaluation team's analysis of the benefits of receiving eHERs in addition to paper reports is inconclusive regarding benefits, but suggests eHERs do not harm savings. Since the program did not randomly assign customers to an eHER group, underlying differences between customers who have an email address on file and those who don't may affect savings estimates. In addition, differences in messaging between paper reports and eHERs make it difficult to separate messaging differences from channel delivery differences. Limited peer utility research comparing paper-only to email-only reports (rather than our analysis of email and paper compared to paper only) suggests that paper mailed reports are more effective at encouraging behavior change than emailed reports alone, though this research is not definitive.[4]

Recommendation: If, in the future, National Grid considers launching an email-only cohort, the evaluation team recommends starting with a small pilot RCT study to accurately assess whether email-only reports are more or less effective than paper reports. To do this, the implementation team should randomly assign customers who have email addresses on file to either treatment or control groups. Using a population of customers with emails on file would account for any demographic or behavioral differences that may be inherent to customers who prefer emails as opposed to other forms of communication.

A5. BASELINE SEGMENTATION

Because there can be considerable differences in achieved savings from HER program participants depending on their baseline usage, the evaluation team explored the differences between high and low baseline usage customers within the National Grid data. Below are our results.

For electric-metered customers, the simulations suggest that the program can remove customers with lower baseline usage to save costs while maintaining savings. The evaluation team examined several thresholds of removing low baseline customers to determine the effect on the cost-effectiveness of the program, and found that removing a proportion of the lowest baseline electric customers increased average household savings. However, the evaluation team recognizes that there are more issues to

[4] For example, see: Mitchell et al (2013), Integral Analytics (2012), and Wells and Ossege (2015).

consider when operating a program than simply cost-effectiveness; customers satisfaction, cross-program promotion, and engaging hard-to-reach customers are all reasons to continue to include lower baseline customers. The simulations suggest that removing lower baseline gas customers will likely result in lower savings and higher cost per therm saved.

> Recommendation: If National Grid should decide to target higher baseline electric customers, the evaluation team recommends weighing the costs carefully and making any changes incrementally, starting with customers in the lower tenth percentile for baseline electricity usage. As removing customers from the program will also affect energy efficiency program marketing opportunities, customer touchpoints, gas savings (for duel fuel waves), and possibly customer satisfaction, any changes to current practice should consider these effects.

A6. DEMAND SAVINGS

In order to provide context on how peer utilities estimate and calculate demand savings stemming from HER programs, the evaluation team conducted secondary research on peer utility evaluation reports where demand savings were reported. Below are our findings.

Most of the peer evaluation reports reviewed by the evaluation team did not report demand savings resulting from home energy report programs; for those that did, there was no consensus on approach. Of the 16 reports reviewed, only 6 reported estimated demand savings stemming from an HER program. Evaluations that did calculate demand savings used a variety of methods to calculate demand savings for HER programs, ranging from a simple flat-load assumption, to building modeling, to regression analysis. Utilities also found a wide range of results, ranging from 0.015 kW/household to 0.171 kW/household per year. National Grid Rhode Island's demand assumptions appear to be reasonable as they fall within this range.

> Recommendation: If AMI data are available in the future, the evaluation team recommends using hourly meter data to calculate more precise demand savings estimates. Using AMI or "smart meter" hourly data is the most accurate way to assess the effect of the program on demand. However, this may not always be feasible given the availability of these data. We do not recommend installing meters for this purpose, but if, in the future, most customers have "smart meters," we recommend using the data for analysis of demand savings.

INTRODUCTION

I. OVERVIEW OF THE EVALUATION

Illume Advising, LLC (ILLUME) is pleased to present National Grid with our evaluation of the Rhode Island Home Energy Report program. The program launched in April 2013. An evaluation of the first program year covered the period April 2013 to May 2014. The current evaluation covers impacts during the period June 2014 to December 2016 and assesses processes during the period January 2016 to December 2016.

A. INTRODUCTION TO THE PROGRAM

Through the HER program, National Grid distributes home energy reports (HERs) by mail. These single-page print reports educate residential customers about their home energy usage and provide them with information designed to encourage behavior change. The reports contain the following information:

- A comparison of the customer's energy usage to that of similar homes in their area
- A comparison of the customer's energy usage to that of average homes and efficient homes over the last 12 months to show trends and progress over time
- Energy-saving action steps, including no-cost or low-cost tips
- A month-by-month comparison of the customer's energy usage in the current year to the previous year to show trends and progress over time
- A "marketing" module that changes each month and highlights different National Grid programs and savings opportunities
- Options to (a) opt out of receiving the reports, (b) go online to find more energy-saving solutions, and (c) view home information used in the similar homes comparison.

The HER program savings comprise 29% of the residential electric portfolio and 13% of the total electric portfolio in the 2017 plan. The program has the second largest annual electric savings in the residential sector and the third largest electric savings in the portfolio. In the 2017 gas plan, the HER program comprises 43% of residential gas savings (largest program) and 14% of the entire portfolio (third largest program).

The current program includes a mix of dual fuel, electric-only, and gas-only customers, some of whom are New Movers (recently moved to a different home). All customers with email addresses on file (about 58%) received monthly HERs through email as well as paper reports.

We briefly describe each group below:

Electric Only: The program sends electric only cohorts reports on their electricity consumption only.

Duel Fuel: The program sends dual fuel cohorts information on both their gas and electric use. In September through April, the program includes messaging in reports that focuses more on gas use, while reports sent in summer months target electricity use.

Gas Only: The program sends gas only cohorts reports pertaining only to their gas use. To create the gas only cohort, National Grid first assigned customers with gas and electric use to the dual fuel cohort to maximize the number of dual fuel customers. Then, National Grid targeted a few areas of the state with high gas usage and a high density of gas customers to select customers to comprise the gas only group. A risk with implementing a mixture of gas and electric cohorts is that customers may be selected into the treatment group of one cohort and the control of another. To avoid sending gas reports to customers selected into an electric control group, customers in the targeted gas areas were not eligible to be in the electric only cohort.

New Movers Initiative: Electric Only, Dual Fuel, and Gas Only: The New Movers initiative is composed of customers with recently activated accounts. New Movers are subdivided into dual fuel, gas only, and electric only based on the categorization of the premise into which they moved. The program enrolled customers on a rolling basis; however, reports were mailed in batches after enough customers were accumulated. Going forward, the HER program will no longer be enrolling customers in New Movers cohorts and will not be sending targeting messaging.

New Movers received seven reports in their first year. For the first three months, they received one report per month, and then received reports bimonthly for the remainder of the year. After one year of receiving specific messaging targeted at New Movers, customers began receiving standard home energy reports. Report messaging in the initial reports introduced the customer to National Grid's offerings, and provided additional description about expectations for the home energy reports in general. For instance, in one example New Mover report, the HER defined "All neighbors" and "Efficient neighbors" and another detailed how the Neighbor Comparison is calculated. The reports also contained messaging introducing the new customer to simple energy efficiency ideas such as how energy use changes with the seasons and energy "thieves." The "Ways to Save" section identified easy, inexpensive "quick fixes" and longer term "great investments".

Table 1 summarizes key details of each wave.

TABLE 1. PROGRAM DESCRIPTION AND CUSTOMER COHORTS

FUEL TYPE	GROUP	START MONTH	DESCRIPTION (AVERAGE ENERGY USAGE OF TREATMENT AND CONTROL)	NUMBER OF TREATMENT CUSTOMERS (AS OF DECEMBER 2016)	NUMBER OF CONTROL CUSTOMERS (AS OF DECEMBER 2016)	NUMBER OF PRINT REPORTS IN 2016
DUAL FUEL	Existing Customers	March 2013	7081 KWH, 803 therms	87,513	9,567	7
	New Movers	April 2013	6388 KWH, 767 therms	6,935	805	7
	New Movers	August 2014	5658 KWH, 803 therms	13,725	1,515	7
ELECTRIC ONLY	Existing Customers	March 2013	9746 KWH	88,426	8,298	7
	New Movers	April 2013	7446 KWH	10,654	1,050	7
	Existing Customers	January 2014	6826 KWH	40,279	7,295	7
	New Movers	August 2014	6534 KWH	24,193	2,346	7
	Existing Customers*	September 2016	4964 KWH	13,265	13,302	3
GAS ONLY	Existing Customers	March 2013	767 therms	13,518	5,920	2 in early 2016 and 3 in later 2016
	New Movers**	April 2013	730 therms	2,234	974	0
	Existing Customers	October 2015	730 therms	11,429	2,867	2 in early 2016 and 3 in later 2016

*As of December 2016, this group was in the program for only three months and therefore did not have enough data for impact analysis.

**Stopped receiving reports in January 2016

B. EVALUATION GOALS

National Grid's primary goal for this evaluation was to conduct an impact evaluation of the HER program with a secondary focus on process insights focused on improving the evaluability of the program through design modifications. Specifically, this evaluation addresses the following research areas:

Impact analysis: What are the overall net savings for each wave of participating customers for the period June 2014 to December 2016? How do those savings compare to implementer-reported savings?

Demand savings: How do the per participant demand savings assumptions and approach used in National Grid's program compare to assumptions used in other programs?

Cross-program participation: How do HERs impact participation in other National Grid energy efficiency programs? Does report messaging describe program offerings to encourage customers to participate? How do other utilities address double-counted savings from upstream lighting programs?

Electronic HERs: What is the effect on savings of receiving electronic HERs? What are the implications for program design? What have other utilities found in terms of the effectiveness of electronic HERs?

New Movers: What is the best approach for estimating savings from New Movers waves of customers? What are the implications for savings goals?

Savings segmentation: How might removing low baseline energy users from the program affect overall program savings?

We describe our evaluation approach in greater detail in the following methods section. In addition, Appendix M includes a detailed glossary of key terms and acronyms used in this report.

EVALUATION METHODOLOGY

I. METHODOLOGY OVERVIEW

The evaluation team conducted the following activities for this evaluation:

- Program Process and Materials review
- Existing Customers HER Impacts Assessment
- New Movers Impacts Assessment
- eHER Impacts Assessment
- Baseline Segmentation Impacts Assessment
- Secondary Research

We have included detailed descriptions of methodology and approach for each of the research activities below.

II. PROGRAM PROCESS AND MATERIALS REVIEW

The evaluation team conducted in-depth interviews with the National Grid and Opower staff. In total, the ILLUME team conducted two formal interviews and numerous on-going conversations centered on the following topics:

1) Program goals and objectives, both formal and informal;
2) Program design including changes to the program since the first evaluation and future planned changes;
3) Implementer-reported savings and methodologies;
4) Program processes.

During the interviews, and in subsequent discussions, the evaluation team requested program documentation from National Grid and Opower to review for program background and context. The evaluation team reviewed program design documents, timelines, example reports, and example marketing modules to assess the different messages program participants see across time. The evaluation team used this information to inform the program channeling and lift assessment, and to understand the general report messaging used for New Movers and emailed report recipients.

III. IMPACT APPROACH

The HER program is a set of randomized control trials (RCTs), wherein the treatment and control groups for each wave are randomly drawn from a single group of eligible customers[5], ensuring that the control

[5] One month of billing history for New Movers and 12 months of billing history for all other cohorts.

group is equivalent to the treatment group. In this case, the treatment group receives HERs while the control group does not. The evaluation team measured energy use impacts and addressed other research questions using monthly billing data. We describe our data preparation and analysis steps below.

A. DATA CLEANING

The team identified customer data to exclude from the analysis. We conducted data cleaning in two steps: (1) we removed individual observations of monthly bills; (2) we removed customers based on the completeness of the remaining monthly billing data. The evaluation team excluded observations for the following reasons (1) bills coinciding with the first month a report was received, (2) bills dated after a customer's stated move-out date, (3) bills where a more recent bill was available for the same calendar month (pre-period), (4) fewer than 15 billing days within a given month to determine a monthly average, or (5) greater than 31 billing days within a given month.

After these initial cleaning steps, we then removed customers with fewer than 11 pre-period or 2 program-period months remaining. Finally, we removed outliers with yearly consumption greater or less than 1 order of magnitude of median consumption. We show detailed counts of records excluded in Appendix I. The percentage of treatment and control customers excluded from each cohort/year analysis ranges from 10% (2013 electric only, 2014) to 30% (2013 gas only, 2016).

Across cohorts, we removed similar percentages of treatment and control customers in each data cleaning step: No cleaning steps account for more than a 1.0% difference between treatment and control customers in either number of observations or number of households removed.

Finally, the team linked energy efficiency program tracking data to billing data to calculate participation lift and double-counted savings.

B. EQUIVALENCY CHECKS

Because the treatment and control groups are randomly assigned, pre-treatment energy usage should be equivalent between the groups. To verify this, the evaluation team tested the equivalency of baseline energy use in the year before the treatment group received their first report.

The evaluation team employed three separate methods of evaluating the equivalency of treatment and control energy usage:

- Visual inspection of overlaid plots of monthly mean energy use for treatment and control groups.
- 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 performed these checks both on the participant data as originally assigned, as well as participant data after data cleaning. We checked equivalency after data cleaning as a sensitivity analysis to determine if the removal of customers based on data cleaning steps affected the equivalency of the treatment and control groups.[6]

Each cohort passed the equivalency checks. We include the results of all equivalency tests in Appendix J.

C. REGRESSION ANALYSIS

The team used the post-program regression (PPR) model to estimate savings for the following cohorts of existing customers: Dual Fuel 2013, Electric Only 2013, Gas Only 2013, and Gas Only 2015.

The PPR model combines both cross-sectional and time series data in a panel dataset. This model uses only the post-program 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-program 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 estimate 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,

MODEL 1. PPR MODEL

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

where,

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;

[6] As of December 2016, fewer than 1.4% of treatment customers opted out of any cohort, and the opt-out rate never exceeded more than 0.9% within a given year. We include customers who opt-out in the analysis since we still have access to their billing data. We exclude customers who move out.

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.[7]

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.

The team also estimated program impacts with the Linear Fixed-Effects Regression (LFER). Both approaches should, in principle, produce unbiased estimates of program savings under a wide range of conditions, but the evaluation team reports the PPR results. Based on experience analyzing the impacts of similar programs as well as findings from the academic literature, the savings estimates produced by the PPR approach tend to be more accurate and more precisely estimated than those from the LFER model. However, we also use the LFER model as a 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. This is the same approach that the evaluation team used during the last evaluation cycle. We provide the model specification for the LFER model and a comparison of the treatment effects from each model in the Appendix.

D. NET-TO-GROSS ADJUSTMENTS

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 eliminates the threat of selection bias. Thus, there is no free ridership, and no "net-to-gross" adjustment is necessary.

E. PARTICIPATION LIFT AND SAVINGS ADJUSTMENT METHOD

The HERs sent to treatment customers included energy-saving tips and marketing modules, some of which encouraged customers to participate in other National Grid energy efficiency programs. To assess the interactions between these programs, the evaluation team analyzed both the HER and energy efficiency program participation data for participation overlap.

First, the evaluation team assessed if the HER program increased participation in National Grid's energy efficiency programs by comparing participation rates between control and treatment groups. If participation rates in other residential energy efficiency programs were the same across HER treatment and control groups, the savings estimates for HERs from the regression analysis were already net of savings from the other programs, as this indicates the HER program had no effect on participation in other energy efficiency programs.

[7] 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.

However, if the HER program affected participation rates in other energy efficiency programs by channeling participants into them, then savings detected in the HER billing analysis would include savings also counted by those energy efficiency programs. For instance, if the HER program increased participation in a home retrofit program, the increase in savings could be allocated to either the HER program or the home retrofit program (or some portion to each) but could not be fully allocated to both programs simultaneously.

In addition to using the treatment and control groups to calculate energy savings, the evaluation team used the experimental design to estimate uplift and double-counted savings. As with the energy savings calculations, the control group acts as the counterfactual for both participation and savings from other programs to address two questions and provide an unbiased estimate through the RCT model.

1. **Participation Lift:** Does the statewide program treatment have an incremental effect on participation in other energy efficiency programs (treatment above control)?

2. **Savings Lift and Adjustment:** What portion of savings from the Home Energy Reports program has been obtained through Rhode Island's other energy efficiency efforts?

To answer these questions, we measured the incremental difference between the treatment and control groups in their participation rates and subsequent savings using energy efficiency program databases.

Participant Lift: Using participation flags, we calculated a participation rate for each program year, based on the number of accounts that initiated participation in other tracked energy efficiency programs after the first report date. The analysis includes efficiency programs that track participation by individual or household and does not include upstream programs, such as lighting, that do not capture information on participants.[8] The difference in treatment and control participation in the post-treatment period is participation lift.

Savings Lift and Adjustment: We estimated the savings associated with the participation lift in other National Grid energy efficiency programs, through the following steps:

1. Calculated annual net savings (applying net-to-gross) for all measures installed in the post-period to conform to National Grid's reporting of net savings;

2. Adjusted annual net savings for each measure installation by the number of days per year in which a measure was installed while the account was active in the post-period; doing so is necessary to most accurately estimate the savings that would be captured for the billing analysis.

3. Determined the average annual household net savings from other programs in the post-period for both the treatment and control group. Measure savings in the post-period persisted over time based on measure life provided in program tracking data National Grid provided; and

[8] The energy efficiency programs included in the analysis were: Income eligible single family, Energy Wise Single Family, ENERGY STAR Products ENERGY STAR HVAC, and ENERGY STAR Lighting.

4. Calculated the differences between treatment and control in the post period estimates to identify the incremental savings attributable to other energy efficiency programs.

Once this estimate was determined, we then reduced the overall savings estimated in the billing analysis by the final estimated incremental savings of the treatment group to avoid double counting. We present these results in each of the HER-specific impact savings sections.

F. HER NEW MOVERS IMPACT ANALYSIS METHOD

The New Movers initiative began enrolling participants in June 2013. Program participants were enrolled using a grouped-rolling-basis strategy. Participants did not receive their first reports until there were enough eligible customers for cost-effective batch mailing. With 3.5 years of program history, there is sufficient diversity in enrollment months for the evaluation team to run a pooled model for all participants for a given fuel.

Pooling participants allows us to maximize the treatment and control group sizes since individual New Movers waves are smaller than typical HER waves. For example, control group sizes for all of the waves are less than 10,000 customers, the recommended minimum to achieve a significant treatment effect. The treatment window for each evaluated year covers all 12 months of each program year, from 2014 to 2016. To compensate for the small control group, we combined the waves for each fuel, resulting in a two-year rolling enrollment period. We combined the Dual Fuel and Electric Only groups in the electric analysis, but due to the termination of the reports for Gas Only customers, we did not combine the Dual Fuel and Gas Only groups in the natural gas analysis.

In the previous evaluation, the evaluation team used a cohort-based approach, where the team evaluated each group of customers with the same enrollment month independently and then combined the results. The evaluation team used this approach because customers started receiving reports at different times and had different amounts of pre- and post-period billing data. Now, the higher availability of post-period data allows us to use the fixed-effects approach instead.[9] Nonetheless, we checked the results of this previous approach for all evaluation periods to ensure it was consistent with the fixed-effects approach.

Our pooled model includes a time fixed effect that absorbs the normal variations in energy use across seasons and years, removing the effect of seasonal variations in energy use. We include a categorical variable for the date of first report received, to isolate any effects from rolling enrollment. The remaining terms are: 1) a term that quantifies the difference in baseline energy use between treatment and control; and 2) a term that quantifies the post-treatment difference in energy use between treatment and control. The formal specification is:

$$ADC_{kt} = \beta_{0,t} + \beta_1 Month_{0,k} + \beta_2 Treatment_k + \beta_3 Treatment_k \cdot Post_{k,t} + \varepsilon_{k,t}$$

[9] We do not use the PPR model here since the PPR models requires pre-period billing data from the same month as each post-period month (*$ADClag_{kt}$).* New Movers have limited pre-period billing data.

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
$B_{0,t}$	= The time-specific fixed effects
$Month_{0,k}$	= A categorical variable for the date of first received report for a given customer
$Treatment_k$	= A binary variable taking a value of 1 for customers in the treatment group, and 0 for controls
$Post_{k,t}$	= A binary variable taking a value of 1 when a customer is in the post-treatment period, and 0 in the pre-treatment period

The first report month effect, β_1, adjusts for differences between customers with different enrollment months. The treatment effect, β_2, quantifies baseline difference between treatment and control groups, and should be negligible for equivalent groups in an RCT. 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.

G. EHER IMPACTS METHOD

Treatment customers with an email address on file with National Grid received an electronic HER (eHER) once per month. To assess the incremental impact of receiving an eHER on savings, we expanded our impact model specification to include three additional terms: 1) an indicator of the presence of an email address in National Grid's customer database (about 55% of treatment customers and 36% of control customers); 2) an interaction term to indicate customers that were in the treatment group and received eHERs; 3) an interaction term to control for the differences in savings between high and low baseline energy users. We applied this model to the 2016 data for Duel Fuel Electric 2013, Electric Only 2013, and Dual Fuel Gas 2013.

MODEL 2. EHER PPR MODEL

$$ADC_{kt} = \beta_1 Participant_k + \beta_2 ADClag_{kt} + \sum_j \beta_{3j} Month_{jt} + \sum_j \beta_{4j} Month_{jt} \cdot ADClag_{kt} + \beta_5 ADClag_{kt} \cdot Participant_k + \beta_6 Email_k + \beta_7 EHER_k + \varepsilon_{kt}$$

where,

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;10
$Email_k$	= A binary variable indicating whether customer k has an email address on record (taking a value of 1) or not (taking a value of 0);
$EHER_k$	= An interaction between the treatment indicator and the email indicator, $Participant_k * Email_k$ (taking a value of 1 for treatment customers with email 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.[11]

In this model, β_6 controls for unobserved differences between individuals who do and do not have email addresses on file, while β_7 is the estimate of the eHER.

H. BASELINE USAGE SEGMENTATION METHOD

Research suggests that customers with higher baseline energy use save more energy than customers with lower baseline energy use.[12] While the costs to offer the program to low baseline and high baseline customers are the same, savings may be greater for customers with higher baseline usage. By removing the lowest baseline customers from the program, programs may be able to increase program cost-effectiveness. The evaluation team re-estimated 2016 program savings for three program waves (Dual Fuel Electric 2013; Electric Only 2013; and Dual Fuel Gas 2013) under several scenarios in which we assumed varying proportions of the lowest baseline customers did not receive reports. We defined baseline usage based on customer average daily consumption (ADC) for the year preceding the first report date. The goal of this analysis was to compare simulated savings and costs for different configurations of treatment group customers.

To calculate yearly ADC, the evaluation team limited the analysis in each wave to customers with a minimum of 11 months of pre-period data to maintain the full range of seasonal variation. We then ranked customers by yearly ADC and removed customers in groups from the lowest 5% to the lowest 95% in increments of 10%. For each remaining customer group, we re-ran the PPR model and re-evaluated savings.

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[10] In other words, if there are *T* post-program months, there are *T* monthly dummy variables in the model, with the dummy variable $Month_{tt}$ the only one to take a value of 1 at time t. These are, in other words, monthly fixed effects.

[11] 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.

[12] For example, see: Allcott, Hunt. 2011. "Social Norms and Energy Conservation." Journal of Public Economics, Volume 95, p. 1082–1095.

First, we ran the simulations as if the lowest baseline customers were not part of the program. After determining a reasonable cut-off, we re-ran the billing analysis for all customers in each cohort, but set the low baseline customers' change in energy use to be equal to the control group change in energy use. This assumes that in absence of receiving reports, low baseline energy users in the treatment group will have similar energy use to the control group. Since this is an un-tested assumption, result should be interpreted cautiously.

I. SECONDARY RESEARCH

To gather context for the evaluation results and understand how other HER programs operate, the evaluation team conducted secondary research on peer utility and program administrator behavioral programs. Specifically, the evaluation team focused their review on materials that could inform the following research questions of interest to National Grid:

- Through what methods do other programs calculate peak demand savings and what are typical ranges of savings?
- How do other programs account for cross-program participation with upstream lighting programs?
- Is there any research on which delivery channel (email or mail) leads to higher energy savings?

In total, the team reviewed 16 HER program evaluation reports and three other reports with relevant findings. Six of the reports included a discussion of demand savings, 13 mentioned upstream program savings, and three included a comparison of delivery channels. Appendix H provides a full list of the reports included in our review.

ELECTRIC HER IMPACT FINDINGS

I. ELECTRIC HOME ENERGY REPORT OVERVIEW

Below we present the electric impact results associated with the electric only, dual fuel, New Movers – electric only, and New Movers – dual fuel cohorts.

A. KEY FINDINGS

Below are the key findings resulting from the analysis of electric savings for the HER program.

Overall, the evaluated electric savings were comparable with the Opower reported electric savings. While realization rates fluctuated by year and wave, the combined 2015 and 2016 electric realization rate is 88%.

Electric realization rates are fluctuating over time. The combined 2015 realization rate was 95%, while the combined 2016 realization rate was 80%. The evaluation team believes that this may be driven by smaller control group sizes as customers move out of the program. Smaller group sizes may result in more variability between annual models and monthly estimates.

Household-level average savings may be declining. Household-level average savings were lower in 2016 than 2015 for two of the three electric waves.

Due to data limitations, the evaluation team's estimates of savings for the New Movers groups are not statistically significant. Smaller sample sizes and limited pre-period data impede robust savings estimates.

The HER program appears to be encouraging participation in other energy efficiency programs. Overall, the program produced an incremental increase in program participation of over 1% among electric-metered customers in each of the three program years, resulting in a total increase of 4,003 additional participants in 2015 and 3,181 additional participants in 2016 in Rhode Island's residential programs due to the HER program's activities.[13]

The evaluation team found that most available research acknowledges the difficulty in estimating cross-program participation between HER and upstream lighting programs. This evaluation was unable to estimate any cross-program participation with National Grid's upstream lighting program. Due to the design of upstream programs, it is often difficult to identify participants, making this analysis challenging. Some evaluations use general population research to collect data on participation, but these are expensive and can be subject to biases.

[13] This is the number of Opower treatment customers induced to participate in other EE programs (over and above the participation of control customers) divided by the total number of Opower treatment customers, calculated by cohort and year.

B. ELECTRIC HOME ENERGY REPORT IMPACTS

ELECTRIC SAVINGS AND REALIZATION RATES OVERALL AND BY YEAR

In 2016 National Grids' HER program achieved 16,511 MWH from the combined three waves of existing customers (dual fuel 2013, electric only 2013, and electric only 2014). These savings, which are net of savings from participation in other energy efficiency programs, represent 80 percent of implementer-reported savings. Over the two-year period 2015 to 2016, customers saved 39,974 MWH for a two-year realization rate of 88 percent. Table 2 details the overall evaluated electric savings for the three cohorts of existing customers (not New Movers) compared to the implementer reported savings, by year, as well as calculated realization rates (calculated as evaluated savings divided by implementer reported savings).

TABLE 2. SUMMARY OF SAVINGS AND REALIZATION RATE BY YEAR*

YEAR	TOTAL NET EVALUATED SAVINGS (MWH)**	IMPLEMENTER REPORTED SAVINGS (MWH)	REALIZATION RATE (%)
2014 (Jun – Dec)	18,095	19,168	94%
2015	23,463	24,668	95%
2016	16,511	20,662	80%
2015 & 2016 Total	**39,974**	**45,330**	**88%*** **

*2016 electric only cohort was excluded from evaluation since it had only three months of program participation, all other cohorts were evaluated for each year.
**Savings are net of participation in other energy efficiency programs.
*** The combined realization rate is a weighted average across years.

ELECTRIC REALIZATION RATES BY WAVE AND YEAR

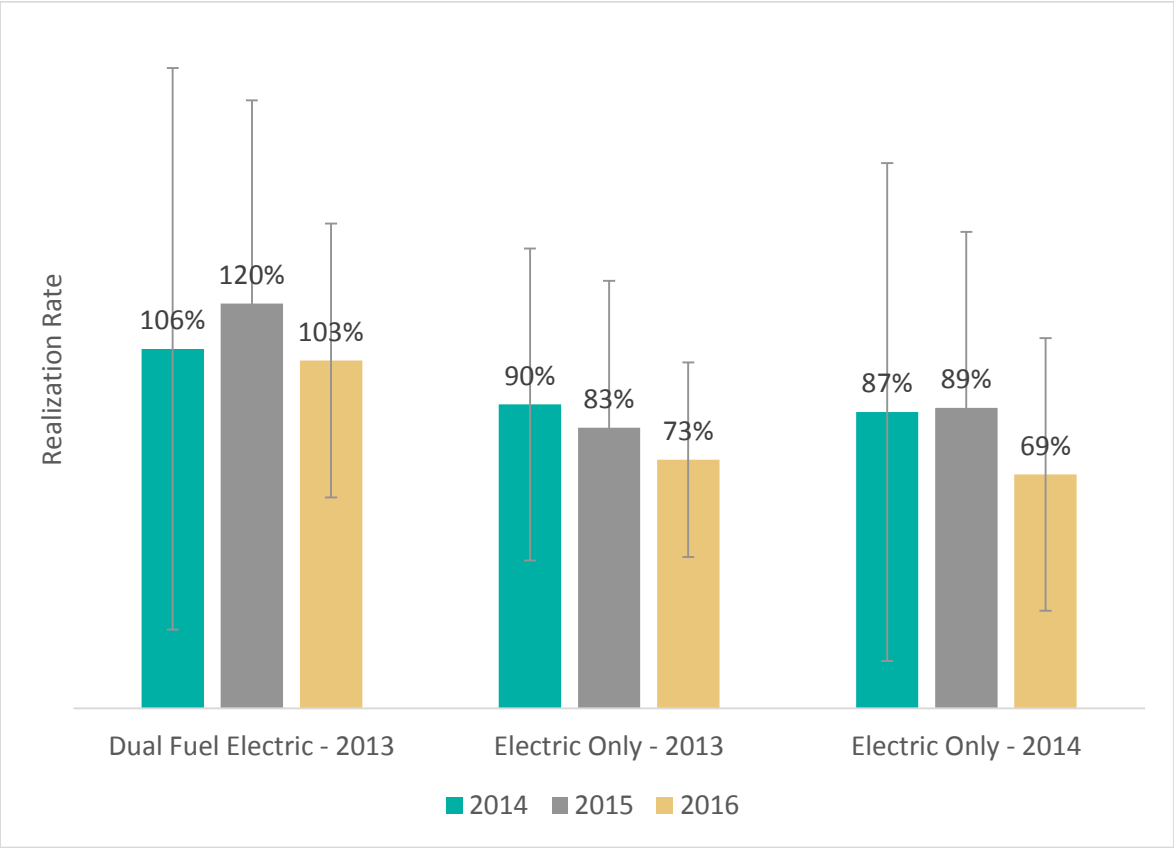
For program year 2016, realization rates by wave ranged from 69 percent to 120 percent (see Figure 4), though confidence intervals cross the 100 percent line. Evaluation savings may differ from implementer-reported savings due several factors:

1) Time periods: Implementer savings are reported monthly and monthly values are summed into an annual total. Evaluation savings are based on annual models. Monthly values will have more variation from month to month particularly where group sizes (treatment or control) are smaller.
2) Models: The evaluation used the industry-standard PPR model also used for the last HER program evaluation. The implementer uses a slightly different model that includes terms for average daily usage in winter months and summer months and imputes missing values.
3) Data cleaning: The evaluation team 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. Our data cleaning steps are consistent with industry standards and the previous evaluation. Differences in these steps may have more impact on waves with smaller treatment or control group sizes. The evaluation team conducted a sensitivity test and ran the PPR models with no data cleaning steps and found similar or lower realization rates, from which we conclude our data cleaning is not systematically biasing our results against the implementer-reported results.

4) **Attrition:** Differences between evaluator and implementer approaches may have more impact over time as groups become smaller through attrition. Attrition as of December 2016 (due to customers moving) ranges from 21% for the electric only 2013 cohort to 44% for the gas only 2014 cohort.

Notably, other evaluations also found a range of realization rates. For example, the evaluation team's previous National Grid Rhode Island evaluation (completed in 2015) found realization rates of 108% (electric, dual fuel) and 93% (electric only) when comparing our third party evaluated savings to the program implementer savings. Similarly, the National Grid Massachusetts HER program evaluation[14] reported realization rates ranging from 77 percent to 101 percent.

FIGURE 4. ELECTRIC REALIZATION RATES BY COHORT AND YEAR – CROSS-PROGRAM PARTICIPATION REMOVED*



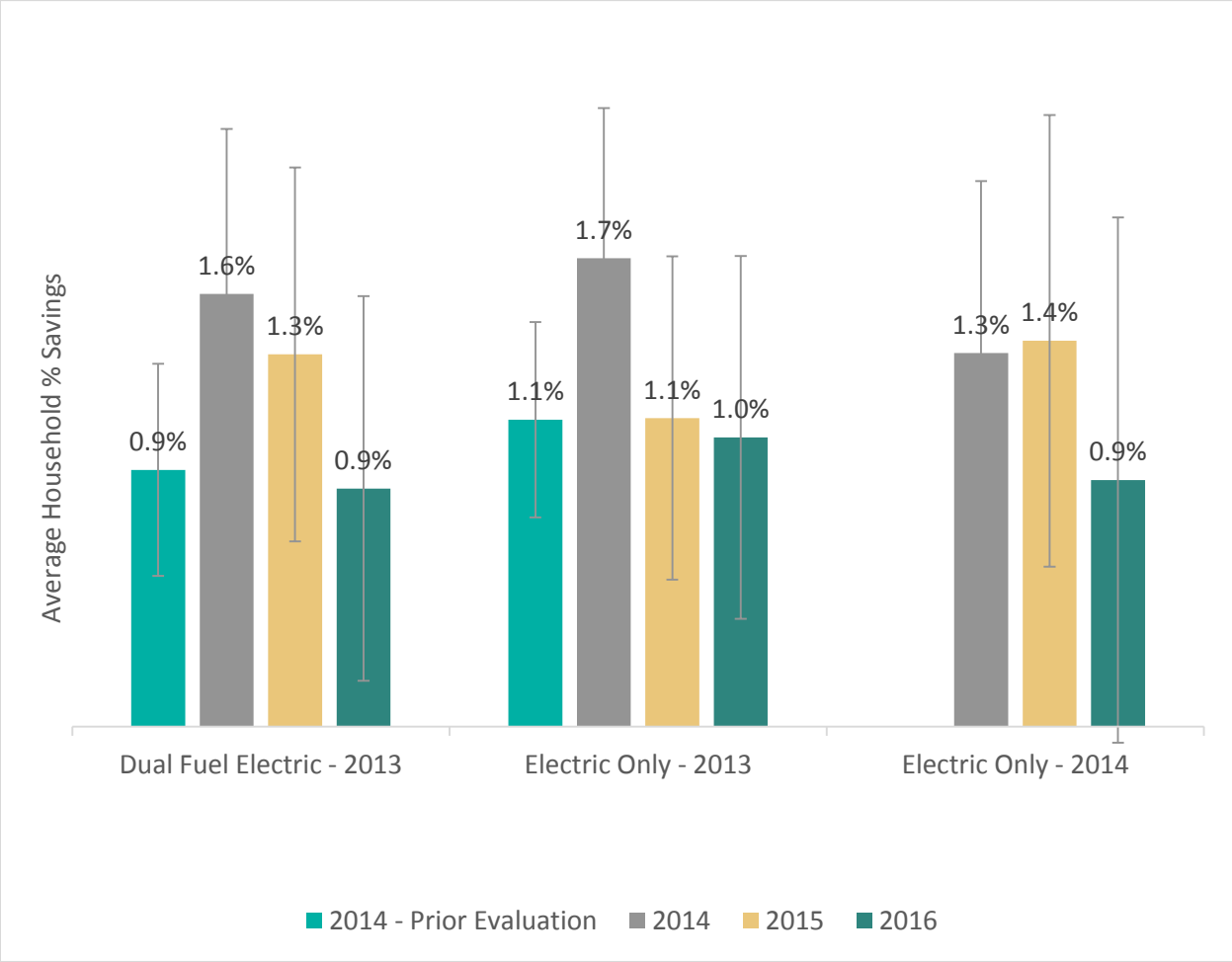
*2014 results only include June-December – January-May results were included in a previous evaluation report

[14] Detailed tables of results for both of these evaluations are included in Appendix C.

ELECTRIC HOUSEHOLD SAVINGS BY WAVE AND YEAR

The evaluation team found that the average savings per household in the National Grid HER program has fluctuated over the four years of the program (see Figure 5) with 2016 savings either flat or trending downward, though the differences are not statistically significant. The programs' measured savings per household can be affected by many factors including messaging, opportunities for treatment customers to save energy, and the widespread availability of energy efficient lighting.

FIGURE 5. ELECTRIC SAVINGS PERCENT BY HOUSEHOLD, BY COHORT AND YEAR – CROSS-PROGRAM PARTICIPATION REMOVED*



*The 2014 Prior Evaluation included March 2013 through May 2014. The 2014 results from this evaluation include June-December 2014.

C. ELECTRIC HOME ENERGY REPORT IMPACTS - NEW MOVERS INITIATIVE

The evaluation team found statistically insignificant savings for the electric New Movers in 2016. We present the results below, but given the large confidence intervals and small overall savings these results

should be interpreted with caution. Importantly, as of mid-2016 the program implementer is discontinuing the New Movers initiative. Given this change, the evaluation team does not recommend using these results for future planning, and instead recommends using the overall electric realization rates for program planning going forward.

The evaluation team estimated savings of 12,622 MWh for New Movers in 2016 (Table 3). Electric impact findings for the New Movers are statistically insignificant due confidence intervals that are much wider than for the existing customers wave. Statistically insignificant savings suggest that error in measurement exceeds the value of the estimate. Both the rolling enrollment, which weakens the benefits of evaluating cohorts, and the small control group sizes contribute to the wide confidence intervals.

TABLE 3. EVALUATED AND IMPLEMENTER-REPORTED SAVINGS FOR ALL NEW MOVERS ELECTRIC GROUPS*

YEAR	TOTAL EVALUATED SAVINGS (KWH)**	IMPLEMENTER REPORTED SAVINGS (KWH)
2014 (June-December)	3,381,081	6,830,076
2015	5,355,682	7,045,879
2016	12,622,293	8,824,885
Total	21,359,056	22,700,840

*The results presented within this table are not statistically significant and should be interpreted with caution.
**Savings are net of savings due to participation in other EE programs ("double-counted" savings).

In Appendix A, we present detailed electric savings results for the three evaluated years of the New Movers program.

D. OVERALL ELECTRIC PARTICIPATION LIFT AND SAVINGS FINDINGS

The evaluation team estimated the extent to which the HER program is driving increased participation in other National Grid energy efficiency programs. In addition to encouraging behavior changes to save energy, the HERs that customers receive include information on energy efficiency offerings, often tailored to applicability and time of year. For example, in 2016, gas customers received reports with information on the cost to replace their furnace or boiler with a link to National Grid's energy efficiency programs for rebates.

OVERALL PROGRAM UPLIFT

Overall, the HER program produced an incremental increase in program participation of over 1% among electric-metered customers in each of the three program years, resulting in a total increase of 3,914 additional participants in 2014, 4,004 additional participants in 2015, and 3,181 additional participants in 2016 in Rhode Island's residential programs due to HERs.

Table 4 below details the participation lift between electric-metered treatment and control customers. for electric only, dual fuel, and New Mover cohorts. The table shows total participation uplift for each program year (2014, 2015, 2016).

TABLE 4. ELECTRIC-METERED CUSTOMER PARTICIPATION RATES (TREATMENT VS. CONTROL) AND OVERALL PROGRAM LIFT

	2014		2015		2016	
	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT
Treatment group size (n)	51,341	342,713	47,570	310,987	42,699	274,680
Participants in other EE programs	1,283	12,478	1,529	14,000	1,304	11,570
Participation rate	2.50%	3.64%	3.21%	4.50%	3.05%	4.21%
Difference in Participation Rate	1.14%		1.29%		1.16%	
P-value of difference	<0.01		<0.01		<0.01	
Incremental Participants		3,914		4,004		3,181

*Incremental Participants is equal to difference in participation rate times treatment group size.

PROGRAM-SPECIFIC UPLIFT

In 2016, the largest lift in program participation occurred in Energy Wise Single Family (68 percent of incremental participation) and ENERGY STAR Products (13 percent of incremental participation). In 2016, the incremental participation in Energy Wise Single Family accounted for 25% of all participation in that program. Table 5 details the program lift by program, with the exception of the upstream buy down program. We discuss this program is in section D1 below.

TABLE 5. PARTICIPATION LIFT FOR PROGRAM WITH ELECTRIC-SAVING MEASURES*

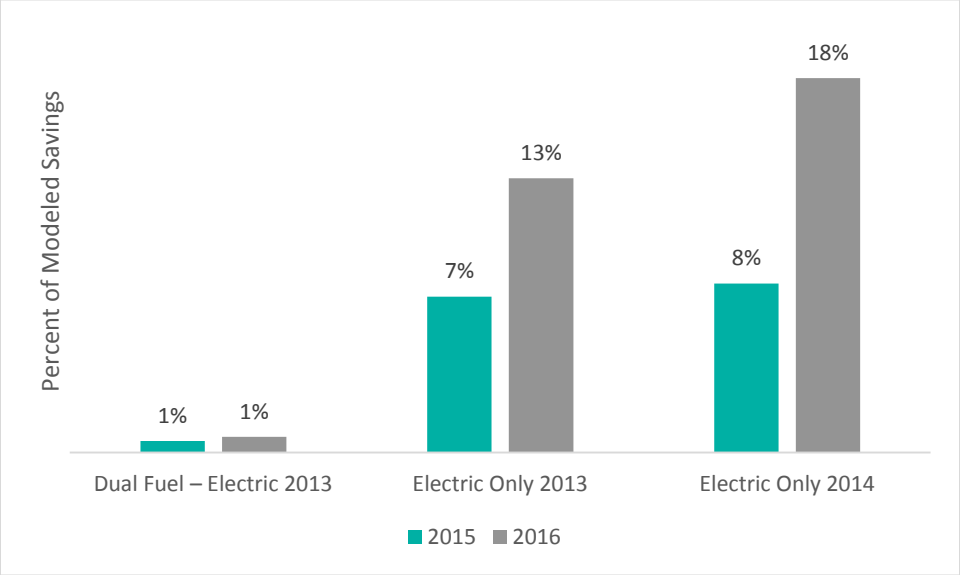
	2014	2015	2016
Income Eligible Single Family			
Participation lift (%)	0.05%	0.17%	0.13%
Incremental participants	166	538	355
ENERGY STAR Products			
Participation lift (%)	0.40%	0.26%	0.15%
Incremental participants	1363	799	402
Energy Wise Single Family			
Participation lift (%)	0.57%	0.74%	0.79%
Incremental participants	1951	2293	2176
ENERGY STAR HVAC			
Participation lift (%)	0.10%	0.07%	0.08%
Incremental participants	329	228	226
ENERGY STAR Lighting**			
Participation lift (%)	0.03%	0.05%	0.01%
Incremental participants	104	145	22

*Overall participation lift for program including participation in electricity saving measures.
**Includes the mail-in rebate program only and does not include any bulbs purchased through the retail buy-down program. Bulbs purchased through the buy-down program are not tracked by participant.

LIFETIME SAVINGS THROUGH PARTICIPATION UPLIFT

Electric measures installed as a result of the program have measure lives ranging from four to twenty-five years, therefore generating savings for many years into the future, not just the first-year savings accounted for in the impact findings. Appendix E displays the average net household electric savings from measures installed because of the HER program, cumulative over each program year. These results suggest the long-term impact of using reports to encourage customer to make investments in energy efficient equipment and shell improvements for their homes. We removed these cumulative savings from the program modeled savings to arrive at the final adjusted savings attributable to the HER program. FIGURE 6 shows the percentage of modeled (from the billing analysis) savings that are attributable to participation in other programs for each cohort for 2015 and 2016. The portion of modeled savings attributable to other energy efficiency programs ranges from 1 percent to 18 percent.

FIGURE 6. SHARE OF MODELED SAVINGS ATTRIBUTABLE TO OTHER PROGRAMS



D1.ACCOUNTING FOR CROSS-PROGRAM PARTICIPATION IN UPSTREAM LIGHTING PROGRAMS

As noted above, the program lift analysis did not include National Grid's upstream lighting program and we do not recommend assessing double-counted savings from upstream programs at this time.

Upstream lighting programs are programs where utilities work directly with manufacturers, distributors, and/or retailers to offer built-in discounts on energy-efficient products, rather than paying incentives directly to their customers. Because of this design, these programs do not track detailed participation data such as customer names and billing account numbers, which are typically available for utility rebate programs. Consequently, we cannot identify HER recipients who participated in an upstream lighting program.

Overall, most evaluation reports reviewed did not conduct primary research to estimate double counted upstream program savings. As noted in an evaluation of PG&E's HER program[15], the cost to conduct a field survey to estimate these savings is considerable and the lack of statistical significance may not warrant the investment. Among the thirteen evaluation reports we reviewed, seven reports did not try to estimate double-counted savings for upstream programs, with one evaluation citing: "Careful estimation

[15] Freeman, Sullivan & Co. 2013. Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010-2012 Program.

of the upstream program joint savings is not the norm in HER program evaluations." [16] Table 6 summarizes the methods used in the evaluations we reviewed.

Among evaluations that did estimate upstream savings, we found large differences in the per household estimates, as shown in Table 7.

TABLE 6. SUMMARY OF METHODS

METHOD	NUMBER OF EVALUATIONS
Not possible to estimate double-counted savings for programs lacking customer-level data	7
Primary research (customer surveys)	3
Secondary research (leveraged customer surveys of similar utility)	2
Primary research (door-to-door field survey)	1

TABLE 7. SUMMARY OF UPSTREAM SAVINGS ADJUSTMENTS

UTILITY	REPORT DATE	METHOD	KWH PER HOUSEHOLD
Seattle City Light	5/30/2014	Leveraged another survey	Year 1: 0.86 Year 2: 1.59 Year 3: 2.32 Year 4: 5.47
Puget Sound Energy	1/15/2014	Conducted surveys	Current: 7.3 Suspended 18.0
National Grid New York	4/25/2013	Conducted surveys	0.1
Pacific Gas and Electric	10/24/2014	Field survey	11.06
Southern California Edison	6/18/2014	Leveraged another survey	5.91
Rocky Mountain Power	5/30/2014	Conducted surveys	0 (no significant difference in CFL purchase)

Studies that use customer surveys typically use utility customer general population surveys, screening for customers who recall purchasing discounted lighting in the past. The evaluation reports and guidance documents we reviewed suggested the following limitations for survey research on this topic:

> **Expense**: With low response rates and intensive screening needed, these surveys are often expensive and time-consuming to achieve the necessary sample size

[16] DNV-GL. 2014. Home Electricity Report Program 2013 Impact Evaluation

Small effect sizes: Individual differences in the number of upstream measure purchases between treatment and control subjects may be small, meaning a large number of subjects must be surveyed to detect the program effect[17]

- A PSE survey called 600 households in both the treatment and control groups and the estimates were not statistically significant[18]

Bias:

- As these are general population surveys, they typically do not achieve very high response rates and may be subject to selection bias[19]
- Surveys ask customers to recall the number and/or price of bulbs purchased which can be unreliable due to recall bias, and customers may not even be aware they participated in an upstream program

Interactions between behavior and equipment: Treatment customers may turn off lights more frequently which may affect propensity to purchase and savings from energy efficient bulbs.

Availability of energy efficient bulbs: Many stores display LEDs prominently, making them accessible choices for all utility customers.

The SEE Action report notes that there is a need for additional research that explores other evaluation approaches and strategies for identifying potentially double-counted savings for programs that do not have customer-level data but does not include any suggestions. A DNV KEMA[20] report included suggestions from PG&E for the following two potential data-intensive methodologies:

1. Using interval data disaggregation to identify whether there is a discernible difference between the appliance signatures identified between treatment and control households.
2. Comparing energy demand between treatment and control households to identify the time of day that the energy savings observed in treatment households occurs.

While these methodologies are promising, when we compare the expense of these intensive data analysis methods against the likely small differences between treatment and control customers, we do not recommend assessing double-counted savings from upstream lighting programs.

D2.PROGRAM MARKETING MATERIALS REVIEW

As part of the review of program documents, the evaluation team reviewed numerous examples of home energy reports to conduct a high-level assessment of content and messaging. As one specific focus, the evaluation team reviewed cross-program marketing modules targeted at increasing energy efficiency program participation.

[17] https://energy.gov/sites/prod/files/2015/02/f19/UMPChapter17-residential-behavior.pdf
[18] DNV-GL. 2014. Home Electricity Report Program 2013 Impact Evaluation.
[19] https://www4.eere.energy.gov/seeaction/system/files/documents/emv_behaviorbased_eeprograms.pdf
[20] DNV KEMA, Inc. 2013. Review of PG&E Home Energy Reports Initiative Evaluation.

Overall, the evaluation team found the report examples and the marketing modules and schedule well-laid out and clear. However, the team also made a few observations about potential considerations to increase cross-program participation. Overall, the evaluation team saw some opportunity to integrate program promotion with the energy-saving tips provided in the reports. Some examples are:

- *National Grid ENERGY STAR product incentives*- Several report examples encouraged customers to consider investing in ENERGY STAR products. Though the collateral provides information for how customers can learn more about ENERGY STAR, the material does not provide information about National Grid's ENERGY STAR rebates.
- *Home Energy Assessment*- This program could be cross-referenced in any "Ways to Save" tips that discuss programmable or wifi thermostats and setback adjustments, since this program provides a free programmable thermostat.
- *Refrigerator Recycling program*- An example of a "Smart Purchase" included in some example reports is purchasing an ENERGY STAR refrigerator. If customers purchase a new refrigerator, it is a prime opportunity to encourage them to dispose of their previous refrigerator. There may be an opportunity to cross-promote the Refrigerator Recycling program (or provide a link or contact information) whenever an ENERGY STAR refrigerator is used as an example of a "Smart Purchase."

In addition, the evaluation team felt that there could be more context around the level of investment wherever "tips" are included. The print HER tips are categorized as either a "Quick Fix", "Smart Purchase" or a "Great Investment." However, not all "quick fixes" equate to inexpensive changes, although they may be "quick" in terms of installation. For instance, one "Quick Fix" is purchasing a new ENERGY STAR appliance; this might not be seen as a "Quick Fix" but more of a "Great Investment" to certain customers depending on their disposable income.

GAS HER IMPACT FINDINGS

I. GAS HOME ENERGY REPORT OVERVIEW

Below we present the natural gas impact results associated with the gas only, dual fuel, New Movers – gas only, and New Movers – dual fuel cohorts.

A. KEY FINDINGS

Below are the key findings resulting from the analysis of gas savings for the HER program.

Overall, the evaluated gas savings were slightly higher than the Opower reported gas savings. While there was some variation in realization rates by year and cohort, the overall gas realization rate was 101 percent for 2016 and 108 percent for 2015 and 2016 combined.

Due to data limitations, the evaluation team's estimates of savings for the New Movers groups are not statistically significant. Smaller sample sizes and limited pre-period data impede robust savings estimates.

The HER program may be less successful at encouraging participation in gas programs and measures than electric measures. The evaluation team found that control customers had higher rates of participation in other EE programs. This may be due to several factors, including: (1) a pre-existing difference between treatment and control customers in program participation, where treatment customers participated at a higher rate in the pre-period than their control group customers, reducing their opportunities to participate in the post-period; (2) fewer total gas-focused actions to take through existing Rhode Island programs; and (3) fuel uncertainty where customers take action to save energy after receiving a report, but it may be related to electricity rather than gas.

B. GAS HOME ENERGY REPORT IMPACTS

GAS SAVINGS AND REALIZATION RATES OVERALL AND BY YEAR

In 2016, National Grids' HER program achieved 619,223 therms from the combined three waves of existing natural gas customers (dual fuel 2013, gas only 2013, and gas only 2015). These savings, which are net of savings from participation in other energy efficiency programs, represent 103 percent of implementer-reported savings.

Over the two-year period 2015 to 2016, customers saved 1,392,071 therms for a two-year realization rate of 108 percent. Table 8 details the overall evaluated gas savings for the three waves of existing customers (not New Movers) compared to the implementer reported savings, by year, as well as calculated realization rates (calculated as evaluated savings divided by implementer reported savings).

TABLE 8. SUMMARY OF SAVINGS AND REALIZATION RATE BY YEAR

Year	Total Evaluated Net Savings (Therms)*	Implementer Reported Savings (Therms)	Realization Rate (%)
2014 (June-December)	260,415	257,167	101%
2015	772,848	677,603	114%
2016	619,223	610,473	101%
2015 and 2016 Total	1,392,071	1,288,076	108%

*Savings are net of savings due to participation in other EE programs ("double-counted" savings).

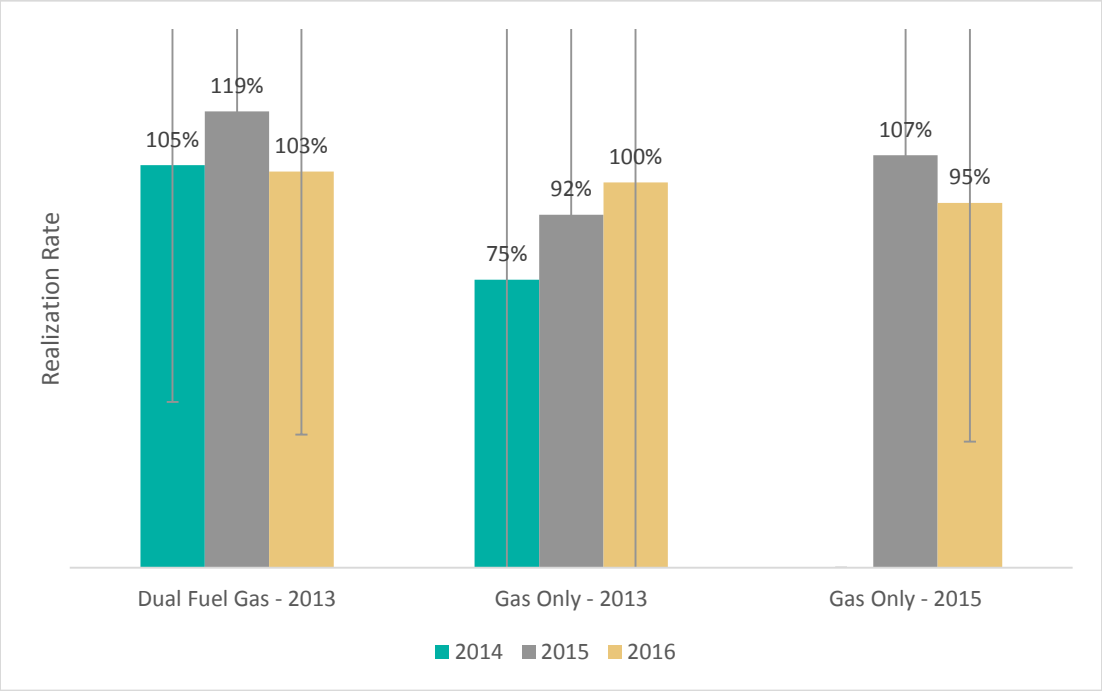
GAS REALIZATION RATES BY WAVE AND YEAR

For program year 2016, realization rates by wave ranged from 95 percent to 103 percent.

FIGURE 7 FIGURE 7 shows the average realization rates by cohort and year. For context, the evaluation team examined the results from the previous National Grid Rhode Island evaluation, completed in 2015, as well as a 2014 National Grid Massachusetts HER program evaluation[21]. Compared to the 2017 Rhode Island results detailed below, realization rates from these other evaluations were slightly lower. The overall gas realization rate for the National Grid Massachusetts evaluation was 98%, with realization rates by cohort ranging from 85% to 157%. The 2015 Rhode Island evaluation realization rates were somewhat lower, with realizations rates of 93% (gas, dual fuel) and 89% (gas only).

[21] Detailed tables of results for both of these evaluations are included in Appendix C.

FIGURE 7. GAS REALIZATION RATES BY COHORT AND YEAR– CROSS-PROGRAM PARTICIPATION REMOVED*

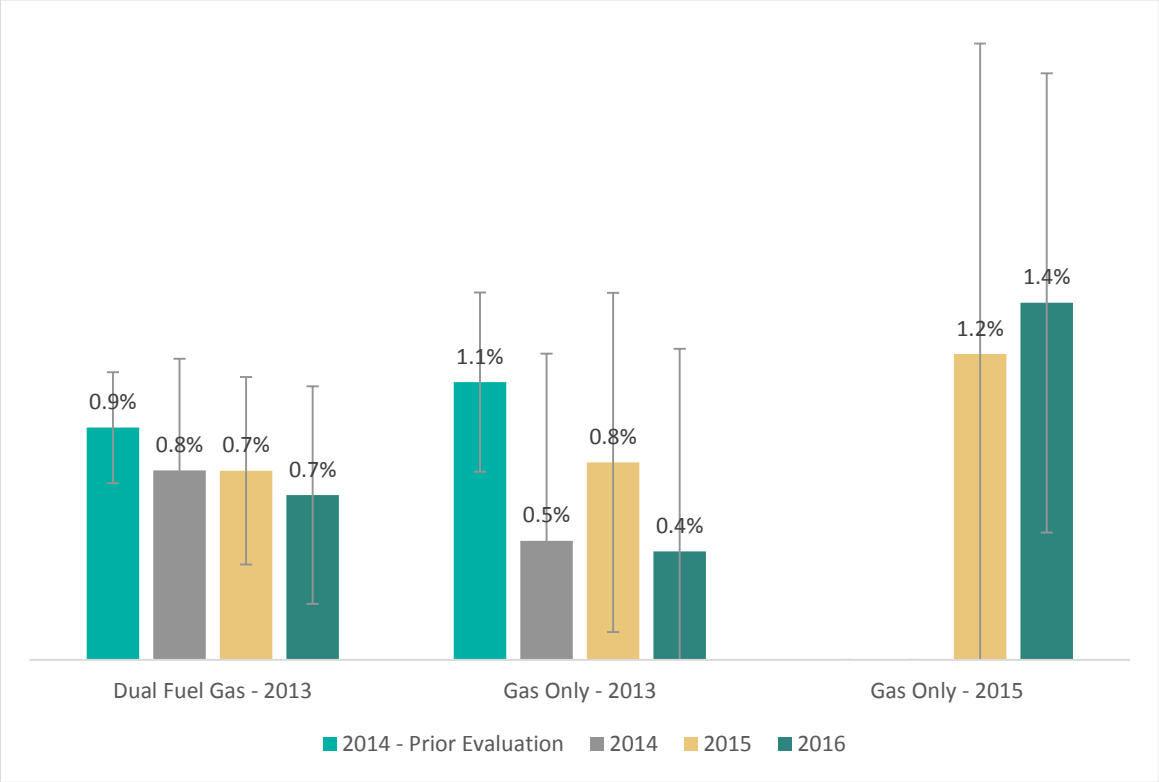


*2014 results only include June-December; January-May results were included in a previous evaluation report.

GAS HOUSEHOLD SAVINGS BY WAVE AND YEAR

Additionally, the evaluation team also compared the average percent of gas savings by household, across cohorts and years, as shown in Figure 8 below. We found fluctuating household percent savings over the years of the program. Overall, results are in line with the National Grid Massachusetts findings, where the majority of average household percent savings by cohort ranged from 0.82% to 1.49% for gas.

FIGURE 8. GAS SAVINGS PERCENT BY HOUSEHOLD, BY COHORT AND YEAR*



*The 2014 prior evaluation included March 2013 through May 2014. The 2014 results from this evaluation include June-December 2014.

C. GAS HOME ENERGY REPORT IMPACTS – NEW MOVERS

The evaluation team did not find reliable savings estimates for the natural gas New Movers participants. There were fewer participants in the natural gas New Movers cohorts than in the New Movers electric cohorts, which similarly resulted in wide confidence intervals. Additionally, there were other confounding factors. We could not combine the Gas Only group with the Dual Fuel group due to marked differences in resulting savings estimates. In addition, National Grid stopped sending reports to the Gas Only cohort at the end of 2015. As a result, estimates of treatment effects are small and not statistically significant.

Given the extremely wide estimates on the confidence intervals for some periods, these results show that it will be impossible to obtain measurable savings with the current cohort sizes. In order to achieve measurable savings, a gas New Movers cohort with rolling enrollment would have to save 5% in a given year, when typical savings values for the standard cohorts are roughly 1%.

As noted, the program implementer has discontinued the New Movers initiative as of mid-2016. Given this change, the evaluation team does not recommend using these results for future planning, and instead recommends using the overall gas realization rates for program planning going forward.

TABLE 9. EVALUATED AND IMPLEMENTER-REPORTED SAVINGS FOR ALL NEW MOVERS NATURAL GAS GROUPS

Year	Total Evaluated Savings (therms)*	Implementer Reported Savings (therms)
2014	-36,387	75,562
2015	-219,465	-32,883
2016	65,140	225,645
Total	-190,712	268,325

*These results are not statistically significant and should be interpreted with caution.

D. OVERALL GAS PARTICIPATION LIFT AND SAVINGS FINDINGS

OVERALL PROGRAM UPLIFT

Overall (treatment and control) natural gas customers have a smaller increase in program participation (when measured as a group) than electric customers and natural gas treatment customers have a smaller increase than natural gas control customers. This may be due to several factors, including: (1) a pre-existing difference between treatment and control customers in program participation, where treatment customers participated at a slightly higher rates in the pre-period (3.7%) than their control group customers (2.9%), reducing their opportunities to participate in the post-period; (2) fewer total gas-focused actions to take through existing Rhode Island programs; and 3) fuel uncertainty where customers may take action in response to receiving a report, but the action may affect electricity use.

TABLE 10. GAS-METERED PROGRAM PARTICIPATION RATES AND OVERALL PROGRAM LIFT (TREATMENT VS. CONTROL)

	2014		2015		2016	
	Control	Treatment	Control	Treatment	Control	Treatment
Treatment group size (n)	26,986	165,494	23,747	147,725	19,498	126,641
Participants in other EE programs	101	278	87	277	92	286
Participation rate	0.37%	0.17%	0.37%	0.19%	0.47%	0.23%
Difference in Participation Rate	-0.21%		-0.18%		-0.25%	
P-value of difference	<0.01		<0.01		<0.01	
Incremental Participants	(341)		(264)		(312)	

*Incremental Participants is equal to difference in participation rate times treatment group size.

PROGRAM-SPECIFIC UPLIFT

Table 11 below details the program lift by program. As discussed above, the evaluation team was unable to measure any program uplift for gas measures from the HER program.

TABLE 11. PARTICIPATION LIFT FOR PROGRAMS WITH GAS-SAVING MEASURES

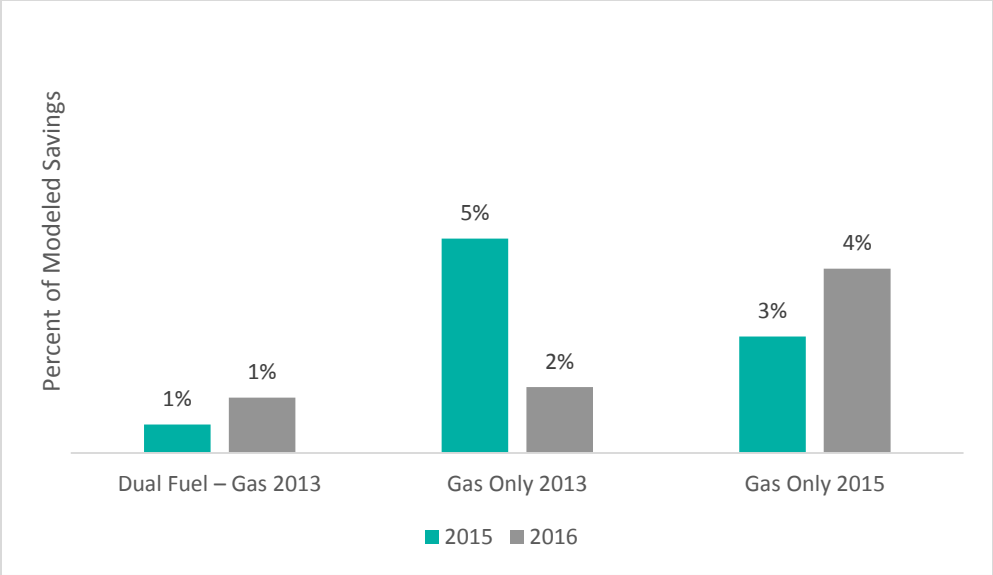
	2014	2015	2016
Income Eligible Single Family			
Participation lift (%)	-0.04%	-0.04%	-0.05%
Incremental participants	-66	-57	-69
Energy Wise Single Family			
Participation lift (%)	-0.08%	-0.10%	-0.12%
Incremental participants	-127	-143	-151
ENERGY STAR HVAC			
Participation lift (%)	-0.09%	-0.04%	-0.07%
Incremental participants	-149	-64	-91

*Overall participation lift for program including participation in natural gas saving measures.

LIFETIME SAVINGS THROUGH PARTICIPATION UPLIFT

Natural gas measures installed by customers have measure lives ranging from seven to twenty-five years, therefore generating savings for many years into the future, not just the first-year savings accounted for in the impact findings. Appendix E displays the average net household electric savings from measures installed because of the HER program, cumulative over each program year. These results suggest the long-term impact of using reports to encourage customer to make investments in energy efficient equipment and shell improvements for their homes. We removed these cumulative savings from the program modeled savings to arrive at the final adjusted savings attributable to the HER program. Figure 9 shows the percentage of modeled (from the billing analysis) savings that are attributable to participation in other programs for each cohort for 2015 and 2016. The portion of modeled savings attributable to other energy efficiency programs ranges from 1 percent to 5 percent.

FIGURE 9. SHARE OF MODELED SAVINGS ATTRIBUTABLE TO OTHER PROGRAMS



ELECTRONIC HER FINDINGS

I. ELECTRONIC HER OVERVIEW

For customers with existing email addresses, the program sends both an electronic (emailed) HER report as well as paper (mailed) reports throughout the year. In 2016, customers received twelve monthly eHERs and seven printed reports. To explore whether there are measurable differences between participants who receive electronic reports compared to only mailed reports, the evaluation team reviewed eHER program materials, existing research, and modeled the incremental effect of receiving the eHER.

A. KEY FINDINGS

Below are key findings resulting from this research.

There is limited existing research on the effectiveness of email compared to mailed HER delivery channels. Three studies concluded that paper/mailed HERs are more effective, but email reports have not been robustly studied. [22]

Customers with email addresses on file use more energy. In both the treatment and control groups, customers with an email address on file used more energy in the baseline period than customers without an email address on file.

Assessing incremental savings from the eHERs has limitations as the groups are not experimentally designed. In two out of the six waves, treatment and control customers are not equivalent after they are split into email/no email groups. In the remaining waves, the effect of eHERs ranges from very small to large. As the program did not randomly assign customers to receive eHERs, there may be other differences which may affect energy use between those that prefer to communicate with their utility via email and those that do not. We do not recommend generalizing these results to other cohorts.

Our analysis of the impact of eHERs on electric and gas savings suggests there is no negative impact of receiving eHERs in addition to paper reports, but is inconclusive on whether there is a positive impact of receiving both formats.

B. ELECTRONIC HER DETAILED RESULTS

B1. PROGRAM MESSAGING

The program sends monthly electronic HERS (eHERs) to treatment customers with an email address on file. The evaluation team reviewed examples of eHERs. The eHER used a more streamlined and concise

[22] Integral Analytics. 2012. Impact & Persistence Evaluation Report: SMUD Home Energy Report Program.
Mitchell, David and Chesnutt, Thomas. 2013. Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports.
Wells, Angela and Ossege, Ashlie. 2015. Assessing the Impact of Communication Channel on Behavior Changes in Energy Efficiency.

format than the paper report. In addition, the eHER used different messaging in the marketing modules. Most messaging for paper HERs included language on saving money and energy, whereas messaging within eHERs more often referenced saving money, without mentioning energy savings. For example, the reports used different language to promote the EnergyWise Audit program:

- "Discover your home's energy efficiency potential" (print HER)
- "How much can your home save?" (eHER).

While these concepts are certainly related, they may resonate differently with customers. Since eHERs and paper reports use different messaging, differences in savings between customers receiving and not receiving eHERs may result from either the delivery channel or the message.

B2. EHER SECONDARY RESEARCH

The evaluation team reviewed 18 HER-type program evaluations, but only three reports discussed eHERs. All three reports concluded that the paper reports produced greater savings than email reports.

The authors of a SMUD eHER program evaluation[23] reported that the paper reports resulted in three times more energy savings than email reports. Additionally, evaluators of a Home Water Report[24] pilot for East Bay Municipal Utility District found that on average, households receiving paper reports saved about 1% of mean household use more than households receiving email reports.

South Carolina Electric and Gas studied the effects of both solicitation type and report delivery channel for an opt-in HER program. [25] The program recruited participants through email or direct mail and offered customers the option to receive ongoing reports via email or mail. The group solicited by direct mail that received mailed reports achieved much higher energy-savings than the other groups.

While all three studies found that the paper reports provided greater savings, the authors cautioned that other factors such as the cost of each channel, avoided costs, and availability of email addresses should be considered when choosing a delivery channel.

B3. EHER IMPACT ANALYSIS

Treatment customers in the National Grid HER program receive eHERs as a supplement to paper reports: No waves receive only eHERs. Consequently, the evaluation team modeled the effect of paper and eHERs combined compared to paper-only. The team could not model the effectiveness of paper-only reports compared to eHERs as in the studies cited above.

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[23] Integral Analytics. 2012. Impact & Persistence Evaluation Report: SMUD Home Energy Report Program.

[24] Mitchell, David and Chesnutt, Thomas. 2013. Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports.

[25] Wells, Angela and Ossege, Ashlie. 2015. Assessing the Impact of Communication Channel on Behavior Changes in Energy Efficiency.

EMAIL GROUP SIZE AND EQUIVALENCE

Customers with email addresses are not consistently distributed across the treatment and control groups. Treatment customers are more likely to have an email address on file than control group customers, however, messaging on the HERs likely prompted treatment group customers to log on and provide an email address. Furthermore, on average, both treatment and control customers with an email address on file have higher baseline electricity use and, except for one wave, higher baseline gas use as well (see Table 12). Our findings have limited generalizability, and, and noted in the recommendations section, we recommend setting up a study to specifically study the relative impact of email versus mail reports.

TABLE 12. COMPARISON OF CUSTOMERS WITH AND WITHOUT EMAIL

Wave	% of Customers with Email Address on File		Baseline Average Daily Consumption (Std Dev)			
	Treatment	Control	Treatment - Email	Control – Email	Treatment - No Email	Control – No Email
ELECTRIC			kWh			
Dual Fuel Electric	60%	39%	22.1 (15.0)*	23.0 (15.1)	18.0 (13.9)*	19.5 (15.1)
Electric Only 2013	61%	44%	28.8 (18.2)	29.2 (17.6)	26.7 (17.3)	27.2 (17.6)
Electric Only 2014	53%	41%	20.4 (15.4)	21.2 (16.6)	17.4 (16.2)	17.6 (16.6)
GAS			Therms			
Dual Fuel Gas	60%	39%	2.24 (2.2)	2.27 (2.2)	2.20 (2.3)	2.23 (2.2)
Gas Only 2013	39%	39%	2.34 (2.4)*	2.17 (2.4)	1.94 (2.3)*	2.11 (2.4)
Gas Only 2015	51%	44%	2.23 (2.4)	2.25 (2.4)	2.23 (2.3)	2.23 (2.4)

*Treatment group is statistically different from control group, p<0.10.

EHER IMPACTS ON SAVINGS

Our analysis of the impact of eHERs on electric and gas savings is inconclusive. We do not have evidence of any positive or negative impact of receiving eHERs in addition to paper reports. For the electric only 2013 cohort there is a small effect for receiving eHERs while for electric only 2014 and dual fuel gas 2013, the effect is large. For two waves, the treatment and control groups are not equivalent when split into email and no email groups. This suggests that differences in energy usage between email and non-email customers and differences in energy savings between higher baseline and lower baseline use customers cannot be fully captured by the available data (indicators of email and measures of baseline use). Other characteristics of customers that correlate with differences between customers who do and do not have email addresses on file with their utility may also affect energy savings. These characteristics may include age, income, and education level.

TABLE 13. EFFECT OF EHER ON SAVINGS FOR PROGRAM YEAR 2016

Wave	Overall Treatment Effect: % Savings per Household (Confidence Interval)	eHER Portion % Savings per Household
ELECTRIC		
Dual Fuel Electric 2013	Treatment/control groups not equivalent when split into email/no email	
Electric Only 2013	1.19% (0.65%)	0.15%
Electric Only 2014	1.07% (0.94%)	2.67%
GAS		
Dual Fuel Gas 2013	0.66% (0.43%)	0.55%
Gas Only 2013	Treatment/control groups not equivalent when split into email/no email	
Gas Only 2015	1.48% (0.91%)	-0.07%

SEGMENTATION ANALYSIS FINDINGS

I. SEGMENTATION ANALYSIS OVERVIEW

Past industry research suggests that customers with higher baseline energy use who receive HERs save more energy than customers with lower baseline usage. The evaluation team re-analyzed 2016 billing data to simulate program results for scenarios in which low baseline energy users do not receive reports and to assess the possible impact on program costs per energy saved.

A. KEY FINDINGS

For electric-metered customers, the simulations suggest that the program can stop treating customers with lower baseline usage to save costs while maintaining savings. However, stopping treatment for some customers will also affect energy efficiency program marketing opportunities, customer touchpoints, gas savings (for duel fuel waves), equity of program funding and delivery, and possibly customer satisfaction. The evaluation team recommends weighing these considerations carefully and making any changes incrementally, starting with customers in the lower tenth percentile for baseline electricity usage.

For gas-metered customers, the simulations suggest that program savings will decrease and cost per therm will increase by 35% if any customers stop receiving treatment. Stopping treatment for some customers is unlikely to improve the cost-effectiveness of the program and will result in loss of electric savings.

B. SEGMENTATION ANALYSIS DETAILED RESULTS

B1. ELECTRIC COHORTS

The team first ran scenarios to simulate program savings if the program had not included customers with low baseline usage. The team's scenario analysis suggests that for the 2013 electric only and 2013 dual fuel electric cohort, a program without customers in the lowest 15th or 25th percentile would achieve program savings greater than actual 2016 program results (see Appendix G).[26] Program savings estimates are larger without the lowest baseline customers since customers with the lowest baseline usage increase their energy use, on average. While the program costs per MWh saved continue to improve with the exclusion of more customers, the evaluation team does not recommend removing large numbers of customers for the following reasons:

- Removing large numbers of customers will result in smaller treatment group and control group sizes which may impact the stability of savings estimates and confidence intervals in future years.
- Actual treatment group and control group sizes will be smaller in future years as customers move out of the program.
- Removing customers will reduce opportunities for energy efficiency program messaging and customer touchpoints for National Grid. It may also affect customer satisfaction.

[26] The evaluation team also ran scenarios with PY2015 data and found similar patterns.

- Removing customers from the duel fuel electric 2013 wave will also reduce gas savings from this group.

The team ran additional scenarios to simulate possible results if the program stopped treating the lowest 15% baseline energy users. In this scenario, we assumed treatment customers in that group would have energy usage patterns similar to the control group. However, we should treat this assumption cautiously since we do not know if this group's past energy usage patterns (increasing energy use) will persist or if the group will, indeed, behave more like the control group. Table 14 shows the simulated savings and costs for the dual fuel electric and electric only 2013 cohorts.

TABLE 14. SEGMENTATION RESULTS – ELECTRIC

SCENARIO METRICS	DUAL FUEL ELECTRIC		ELECTRIC ONLY 2013	
	BASELINE (All Customers Treated)	SIMULATION (No treatment for lowest 15%)	BASELINE* (All Customers Treated)	SIMULATION (No treatment for lowest 15%)
Average Savings per Day per Household (kWh) for Treated Customers	0.17	0.18	0.32	0.33
Annualized per Household Savings (kWh) for Treated Customers	62.1	65.7	116.8	120.5
Total Evaluated Net Savings (MWh) for Treated Customers	5,122	5,419	10,248	10,573
Total Treated Customers	82,486	72,793	87,744	75,592
Total Control Customers	9,022	9,022	8,236	8,236
Estimated Cost for Treated Customers	$653,289	$576,521	$694,932	$598,688
Estimated $ spent / MWh saved for treated customers	$127.55	$106.39	$67.81	$56.62

B2. DUAL FUEL GAS 2013

For the dual fuel 2013-gas wave, stopping treatment of low baseline customers will reduce program costs, but also reduce savings. Unlike electric-metered customers, gas-metered customers with lower baseline usage do not tend to save energy rather increase energy usage. Consequently, the cost per

therm for the program would increase 35 percent if the program stopped treating the lowest 15th percentile customers (based on baseline usage). It is unlikely dropping gas customers will improve program cost effectiveness.

TABLE 15. SEGMENTATION RESULTS – DUAL FUEL GAS

SCENARIO METRICS	DUAL FUEL GAS	
	BASELINE (All Customers Treated)	SIMULATION (No treatment for lowest 15%)
Average Savings per Day per Household (therms) for Treated Customers	0.015	0.010
Annualized per Household Savings (therms) for Treated Customers	5.48	3.65
Total Evaluated Net Savings (therms) for Treated Customers	432,619	288,149
Total Treated Customers	78,945	70,280
Total Control Customers	8,650	8,650
Estimated Cost for Treated Customers	$231,308	$233,627
Estimated $ spent / therm saved for treated customers	$0.60	$0.81

DEMAND SAVINGS RESEARCH

I. DEMAND SAVINGS OVERVIEW

To estimate their demand (kW) savings from the HER program, National Grid Rhode Island applies a multiplier of 0.00016 kW per kWh saved for winter and a multiplier of 0.0001168 for summer. In response to concern from stakeholders about the magnitude of these assumptions, the evaluation team compared National Grid assumptions to 16 peer utility and program administrator HER and behavioral programs. Appendix H provides a full list of the reports included in our review.

A. KEY FINDINGS

Below are the key findings resulting from our review of peer utility and program administrator evaluation reports.

Most evaluation reports did not report demand savings resulting from home energy report programs. Of the 16 reports reviewed, only 6 reported estimated demand savings stemming from an HER program.

For utilities where the evaluator did estimate demand savings, savings ranged from 0.015 kW per household to 0.171 kW per household. Evaluators used a variety of methods to calculate demand savings for home energy report programs, ranging from a simple flat-load assumption, to building modeling, to regression analysis.

B. DETAILED RESULTS

Unlike results for energy savings, there does not appear to be a reliable, consistent result for demand savings from HERs. Of the 16 HER program evaluation reports reviewed, only six reported peak demand savings for the home energy report program. In one report, the authors recommended evaluating demand savings in the future and the remaining nine reports did not include demand savings for the HER program and did not discuss the reasons for the exclusion.

Table 16 summarizes the method used for estimating demand savings and the reported demand savings estimates from evaluation reports and the Massachusetts TRM. As detailed below, claimed and planned demand savings ranged from 0.015 kW per household to 0.171 kW per household.

TABLE 16. KW PER HOUSEHOLD

UTILITY	METHOD	SAVINGS TYPE	KW PER HH
Midwest Utility 1	Multiplier from cost-effectiveness modeling	Verified gross	0.015
National Grid Rhode Island	Multiplier	Winter peak	0.018*
Eversource	Max of summer and winter peaks	Deemed planning values	0.020
FirstEnergy Ohio Companies	Flat load assumption	Verified gross	0.020
National Grid (Massachusetts)	Max of summer and	Deemed	0.030

	winter peaks	planning values	
Southern California Edison	Regression analysis	Ex-post	0.037
Midwest Utility 2	Multiplier from cost-effectiveness modeling	Verified gross	0.039
Sacramento Municipal Utility District	Building simulation	Not specified	0.080
PPL Electric	Regression analysis	Ex-post verified	0.171

*The evaluation team estimated this number based on the 2016 evaluated electric only 2013 cohort savings per household of 0.31 kWh. National Grid Rhode Island uses a winter demand multiplier of 0.00016 per kWh. Therefore: annual kW per household = 365*0.31*0.00016.

Evaluators and program planners do not apply a consistent approach for calculating demand savings. Evaluators used a variety of methods to estimate the demand savings associated with the HER programs. The list below provides more detail on the methods used:

- Midwest Utility 1 – The evaluators multiplied the verified energy savings obtained through the regression analysis by the ratio of the utility's previous program year reported coincident demand savings (from cost-effectiveness modeling) to the previous program year's reported energy savings.
- Eversource and National Grid (MA) – The Massachusetts TRM provides deemed unit savings based on the maximum of estimated winter on-peak demand reduction (5:00 to 7:00 pm on non-holiday weekdays in December and January) and summer on-peak demand reduction (1:00 to 5:00 non-holiday weekdays in June, July, August). Seasonal on-peak demand reductions are derived from Demand Impact Model, an Excel-based model developed by The Cadmus Group to estimate seasonal and coincident peak demand savings of energy-efficient measures.
- FirstEnergy Ohio Companies – The evaluators assumed that demand reductions associated with HERs have a flat hourly profile and therefore divided the daily energy savings estimates by 24.
- Southern California Edison (2014) – First, the evaluators made a preliminary estimate by applying an average residential class load factor to the estimated kWh savings. Then, they calculated final peak load savings for the program using interval data for participants and control customers to leverage the experimental design. They calculated kW savings by comparing peak demand between treatment and control customers between the hours of 2:00 and 5:00 on the three consecutive hottest days of the year (September 4 to 6). The evaluators used the 3-day heat wave as defined by DEER.
- Midwest Utility 2 – The evaluation team used the utility's reported estimates of coincident demand savings produced by the utility's cost-effectiveness tool which derives demand savings by using residential seasonal load shape factors to distribute a program's reported annual energy savings estimates across the different months of the year. The utility selected the demand savings value from the cost-effectiveness tool for the HER program in the third quarter of the previous program year and applied a coincidence factor to that value to obtain the reported coincident demand savings value for the HER Program. To apply this same algorithm to the verified results, the evaluator then multiplied each verified energy savings value for the program by the ratio of the HER Program's previous program year reported demand savings to reported energy savings to obtain the estimated coincident demand savings values.
- Sacramento Municipal Utility District – The evaluators used building energy simulation modeling to develop unit energy and peak kW savings values for cooling, heating and HVAC system fan end-uses. The end-use kW savings were applied to building characteristics data to develop demand savings values by measure and end use for each of the 800 surveyed households. From

this engineering analysis, the kW/kWh ratio was calculated and multiplied by the estimated annual kWh savings.

- PPL Electric – The evaluators used regression analysis of hourly electricity use with hour fixed effects to estimate the average demand reduction in the top 100 hours of PPL Electric's system demand.

APPENDIX

APPENDIX A. DETAILED ELECTRIC REGRESSION RESULTS

OVERALL ELECTRIC RESULTS

TABLE A1. HOME ENERGY REPORT ELECTRIC SAVINGS - 2016

	Dual Fuel – Electric 2013	Electric Only 2013	Electric Only 2014
First Report Date	Apr-13	Apr-13	Jan-14
Total Evaluated Participants	82,477	87,744	36,689
Baseline Usage: Average Daily kWh (Std Dev)	19.60 (11.6)	27.22 (13.9)	18.69 (12.8)
Net Savings (kWh per HH per day)	0.17	0.32	0.20
90% Confidence Interval Lower Bound	0.03	0.15	0.02
90% Confidence Interval Upper Bound	0.31	0.50	0.38
Model R-Squared	0.85	0.86	0.83
Net Program Savings from PPR (% per HH)	0.86%	1.19%	1.07%
Incremental Savings from Other Programs (% per HH)	0.006%	0.154%	0.190%
Final Adjusted Net Savings (% per HH)	0.85%	1.04%	0.88%
Final Adjusted Net Savings (kWh per HH per day)	0.17	0.28	0.17
Total Adjusted Net Savings (MWH)	5,262	8,914	2,335
Implementer Reported Savings (MWH)	5,125	12,155	3,382
Realization Rate	103%	73%	69%

TABLE A2. HOME ENERGY REPORT ELECTRIC SAVINGS - 2015

	Dual Fuel – Electric 2013	Electric Only 2013	Electric Only 2014
First Report Date	Apr-13	Apr-13	Jan-14
Total Evaluated Participants	88,746	93,010	40,977
Baseline Usage: Average Daily kWh (Std Dev)	19.84 (11.7)	27.95 (14.9)	19.07 (13.4)
Net Savings (kWh per HH per day)	0.27	0.33	0.29
90% Confidence Interval Lower Bound	0.13	0.17	0.13
90% Confidence Interval Upper Bound	0.40	0.49	0.44
Model R-Squared	0.87	0.88	0.85
Net Program Savings from PPR (% per HH)	1.3%	0.01	0.02
Incremental Savings from Other Programs (% per HH)	0.007%	0.088%	0.119%
Final Adjusted Net Savings (% per HH)	1.33%	1.11%	1.38%
Final Adjusted Net Savings (kWh per HH per day)	0.267	0.309	0.263
Total Adjusted Net Savings (MWH)	8,973	10,316	4,174
Implementer Reported Savings (MWH)	7,508	12,455	4,705
Realization Rate	120%	83%	89%

TABLE A3. HOME ENERGY REPORT ELECTRIC SAVINGS – JUNE TO DECEMBER 2014

	Dual Fuel – Electric 2013	Electric Only 2013	Electric Only 2014
First Report Date	Apr-13	Apr-13	Jan-14
Total Evaluated Participants	92,434	95,953	43,851
Baseline Usage: Average Daily kWh (Std Dev)	20.31 (12.0)	27.90 (13.7)	18.86 (13.2)
Net Savings (kWh per HH per day)	0.31	0.50	0.26

90% Confidence Interval Lower Bound	0.19	0.35	0.15
90% Confidence Interval Upper Bound	0.43	0.65	0.38
Model R-Squared	0.90	0.91	0.90
Net Program Savings from PPR (% per HH)	0.02	0.02	0.01
Incremental Savings from Other Programs (% per HH)	-0.025%	0.110%	0.049%
Final Adjusted Net Savings (% per HH)	1.55%	1.68%	1.34%
Final Adjusted Net Savings (kWh per HH per day)	0.318	0.467	0.252
Total Adjusted Net Savings (MWH)	6,246	9,519	2,331
Implementer Reported Savings (MWH)	5,887	10,615	2,666
Realization Rate	106%	90%	87%

NEW MOVERS ELECTRIC RESULTS

TABLE A4. HOME ENERGY REPORT ELECTRIC SAVINGS – NEW MOVERS

Treatment Period	Jan 2014 - Dec 2014	Jan 2015 - Dec 2015	Jan 2016 - Dec 2016
First Report Date (average)	Nov 2014	Dec 2014	Dec 2014
Total Evaluated Participants	19,172	21,490	43,033
Baseline Usage (average daily kWh)	17.4	18.1	17.9
Net Savings (kWh per HH per day)	0.291	0.363	0.576
Net Program Savings from LFER (% per HH)	1.68%	2.00%	3.22%
90% Confidence Interval Lower Bound	6.21%	6.42%	6.68%
90% Confidence Interval Upper Bound	-2.86%	-2.42%	-0.25%
Final Adjusted Net Savings (% per HH)	1.68%	2.00%	3.22%
Final Adjusted Net Savings (kWh per HH per day)	0.291	0.363	0.576
Total Adjusted Net Savings (kWh)	3,381,081	5,355,682	12,622,293

APPENDIX B. DETAILED GAS REGRESSION RESULTS

OVERALL GAS RESULTS

TABLE B1. HOME ENERGY REPORT GAS SAVINGS - 2016

	Dual Fuel – Gas 2013	Gas Only 2013	Gas Only 2015
First Report Date	Apr-13	May-13	Oct-15
Total Evaluated Participants	78,947	11,765	8,197
Baseline Usage: Average Daily Therms (Std Dev)	2.30 (2.1)	2.19 (2.1)	2.09 (1.9)
Net Savings (therms per HH per day)	0.02	0.01	0.03
90% Confidence Interval Lower Bound	0.01	-0.01	0.01
90% Confidence Interval Upper Bound	0.03	0.03	0.05
Model R-Squared	0.94	0.91	0.93
Net Program Savings from PPR (% per HH)	0.66%	0.44%	1.48%
Incremental Savings from Other Programs (% per HH)	0.009%	0.007%	0.064%
Final Adjusted Net Savings (% per HH)	0.65%	0.43%	1.41%
Final Adjusted Net Savings (therms per HH per day)	0.015	0.010	0.030
Total Adjusted Net Savings (therms)	467,368	42,904	108,952
Implementer Reported Savings (therms)	453,009	42,779	114,686
Realization Rate	103%	100%	95%

TABLE B2. HOME ENERGY REPORT GAS SAVINGS - 2015

	Dual Fuel – Gas 2013	Gas Only 2013	Gas Only 2015
First Report Date	Apr-13	May-13	Oct-15
Total Evaluated Participants	84,792	13,182	8,416
Baseline Usage: Average Daily Therms (Std Dev)	2.57 (2.61)	2.44 (2.6)	2.47 (1.4)
Net Savings (kWh per HH per day)	0.02	0.02	0.03
90% Confidence Interval Lower Bound	0.01	0.00	0.00
90% Confidence Interval Upper Bound	0.03	0.04	0.06
Model R-Squared	0.95	0.93	0.93
Net Program Savings from PPR (% per HH)	0.01	0.01	0.01
Incremental Savings from Other Programs (% per HH)	0.005%	0.042%	0.034%
Final Adjusted Net Savings (% per HH)	0.75%	0.78%	1.21%
Final Adjusted Net Savings (therms per HH per day)	0.019	0.019	0.030
Total Adjusted Net Savings	648,603	103,019	21,226
Implementer Reported Savings	545,775	112,066	19,761
Realization Rate	119%	92%	107%

TABLE B3. HOME ENERGY REPORT GAS SAVINGS – JUNE TO DECEMBER 2014

	Dual Fuel – Gas 2013	Gas Only 2013
First Report Date	Apr-13	May-13
Total Evaluated Participants	88,144	14,032
Baseline Usage: Average Daily Therms (Std Dev)	1.62 (1.7)	1.53 (1.7)
Net Savings (kWh per HH per day)	0.01	0.01
90% Confidence Interval Lower Bound	0.01	0.00

90% Confidence Interval Upper Bound	0.02	0.02
Model R-Squared	0.94	0.92
Net Program Savings from PPR (% per HH)	0.76%	0.54%
Incremental Savings from Other Programs (% per HH)	0.006%	0.068%
Final Adjusted Net Savings (% per HH)	0.75%	0.47%
Final Adjusted Net Savings (therms per HH per day)	0.012	0.007
Total Adjusted Net Savings	237,419	22,996
Implementer Reported Savings	226,519	30,648
Realization Rate	105%	75%

NEW MOVERS GAS RESULTS

TABLE B4. HOME ENERGY REPORT GAS SAVINGS – DUAL FUEL NEW MOVERS (THERMS)

	2014 Dual Fuel	2015 Dual Fuel	2016 Dual Fuel
Treatment Period	Jan 2014 - Dec 2014	Jan 2015 - Dec 2015	Jan 2016 - Dec 2016
First Report Date	Nov 2014	Nov 2014	Nov 2014
Total Evaluated Participants	7,569	8,504	14,995
Baseline Usage (average daily therms)	2.2	2.2	2.0
Net Savings (therms per HH per day)	0.001	-0.030	0.008
Net Program Savings from PPR (% per HH)	0.06%	-1.34%	0.40%
90% Confidence Interval Lower Bound	6.90%	7.65%	5.57%
90% Confidence Interval Upper Bound	-6.78%	-10.33%	-4.76%
Final Adjusted Net Savings (% per HH)	0.06%	-1.34%	0.40%
Final Adjusted Net Savings (therms per HH per day)	0.001	-0.030	0.008
Total Adjusted Net Savings (therms)	6,055	-172,100	65,140

TABLE B5. HOME ENERGY REPORT GAS SAVINGS – GAS ONLY NEW MOVERS (THERMS)

	2014 Gas Only	2015 Gas Only
Treatment Period	Jan 2014 - Dec 2014	Jan 2015 - Dec 2015
First Report Date	Oct 2013	Oct 2013
Total Evaluated Participants	3,815	2,487
Baseline Usage (average daily therms)	2.0	2.3
Net Savings (therms per HH per day)	-0.023	-0.035
Net Program Savings from PPR (% per HH)	-1.11%	-1.55%
90% Confidence Interval Lower Bound	16.38%	6.67%
90% Confidence Interval Upper Bound	-18.60%	-9.77%
Final Adjusted Net Savings (% per HH)	-1.11%	-1.55%
Final Adjusted Net Savings (therms per HH per day)	-0.023	-0.035
Total Adjusted Net Savings (therms)	-42,442	-47,365

APPENDIX C. COMPARATIVE HER ANALYSIS RESULTS

2015 NATIONAL GRID RHODE ISLAND RESULTS

TABLE C1. 2015 RHODE ISLAND EVALUATION HOME ENERGY REPORT ELECTRIC SAVINGS (KWH)

	Dual Fuel- Electric	Electric Only
Treatment Period	April 2013 - May 2014	April 2013 - May 2014
First Report Date	2-Apr-13	2-Apr-13
Total Evaluated Participants	114,228	105,139
Baseline Usage (average daily kWh)	19.23	27.87
Net Savings (kWh per HH per day)	0.18	0.31
Net Program Savings from PPR (% per HH)	0.92%	1.10%
90% Confidence Interval Lower Bound	0.54%	0.75%
90% Confidence Interval Upper Bound	1.30%	1.45%
Incremental Savings from Other Programs (% per HH)	0.002%	0.06%
Final Adjusted Net Savings (% per HH)	0.92%	1.04%
Final Adjusted Net Savings (kWh per HH per day)	0.18	0.29
Total Adjusted Net Savings (kWh)	7,781,637	12,284,906
Implementer Reported Savings	7,183,012	13,149,758
Realization Rate	108%	93%

SOURCE: 2015 NATIONAL GRID RHODE ISLAND HER PROGRAM EVALUATION, ILLUME

TABLE C2. 2015 RHODE ISLAND EVALUATION HOME ENERGY REPORT GAS SAVINGS (THERMS)

	Dual Fuel - Gas	Gas Only
Treatment Period	Apr 2013 - May 2014	Sep 2013- May 2014

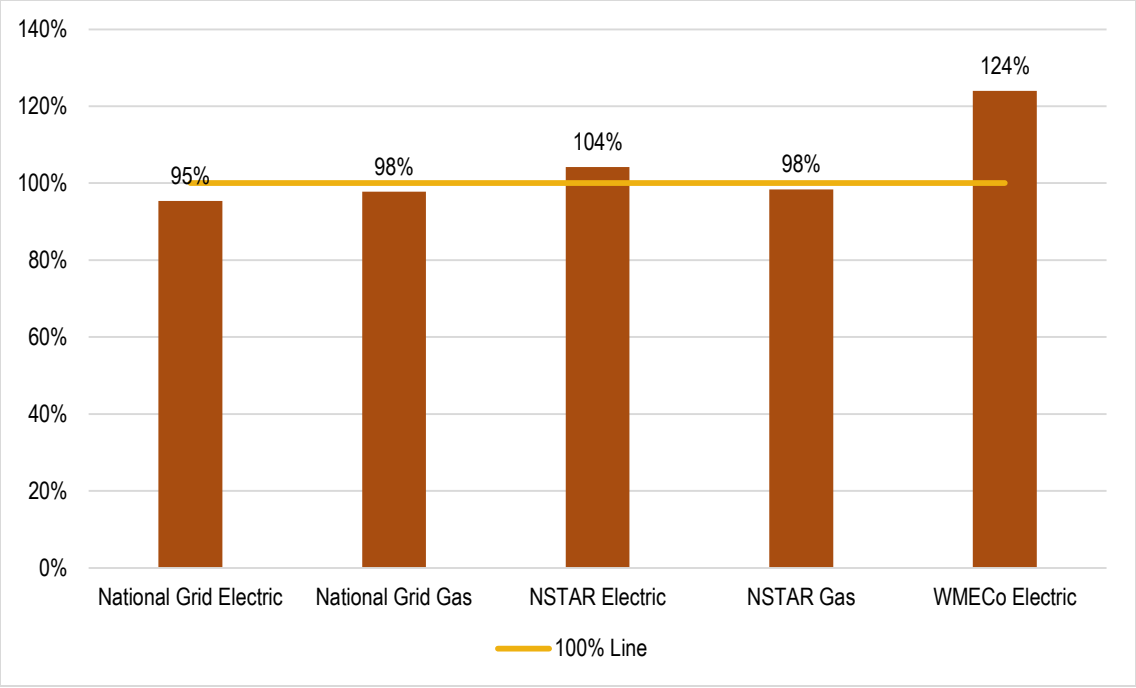
	Dual Fuel - Gas	Gas Only
First Report Date	02-Apr-13	09-Sep-13
Total Evaluated Participants	114,228	16,191
Baseline Usage (average daily therms)	2.4115	3.3387
Net Savings (therms per HH per day)	0.0083	0.0224
Net Program Savings from PPR (% per HH)	0.34%	0.67%
90% Confidence Interval Lower Bound	0.12%	0.31%
90% Confidence Interval Upper Bound	0.56%	1.02%
Incremental Savings from Other Programs (% per HH)	0.001%	0.02%
Final Adjusted Net Savings (% per HH)	0.34%	0.66%
Final Adjusted Net Savings (therms per HH per day)	0.01	0.02
Total Adjusted Net Savings (therms)	359,233	84,031
Implementer Reported Savings	386,995	94,330
Realization Rate	93%	89%

SOURCE: 2015 NATIONAL GRID RHODE ISLAND HER PROGRAM EVALUATION, ILLUME

2014 NATIONAL GRID MASSACHUSETTS RESULTS

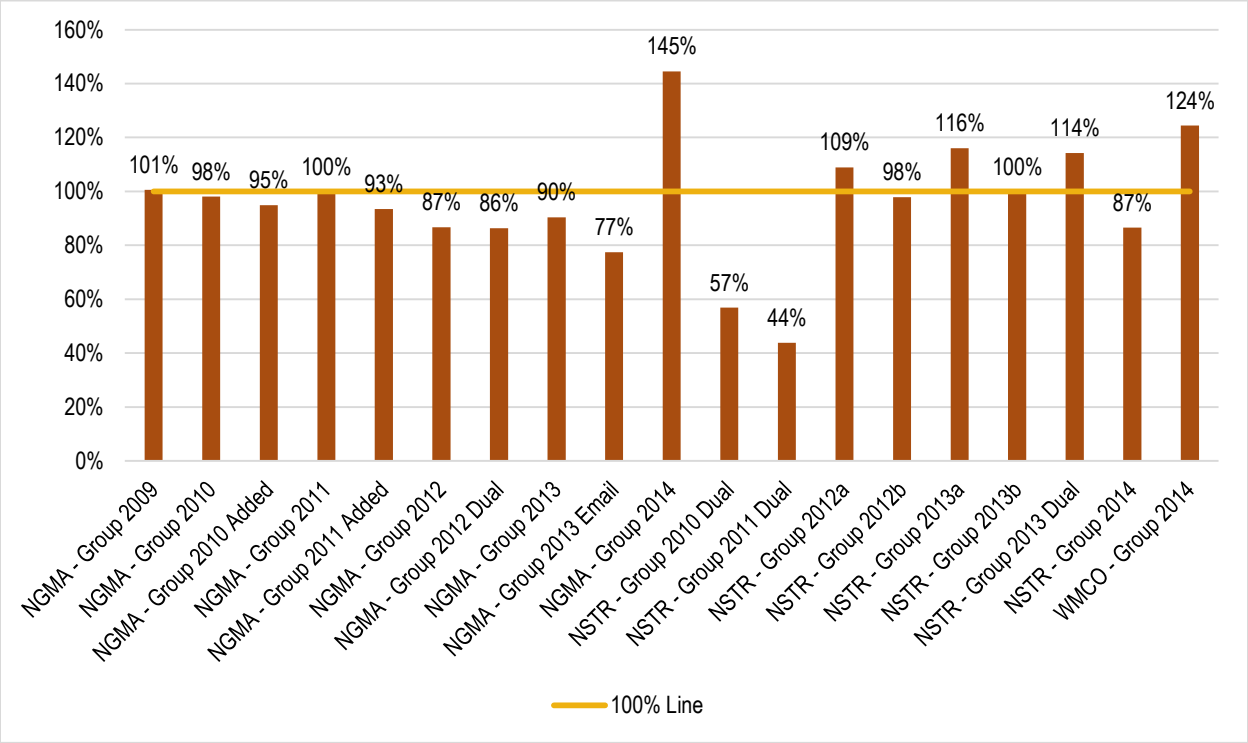
2014 NATIONAL GRID MASSACHUSETTS RESULTS

FIGURE C1. NATIONAL GRID MA: AGGREGATE SAVINGS ESTIMATE RATIO BEFORE CHANNELING ADJUSTMENT, BY PA AND FUEL-TYPE



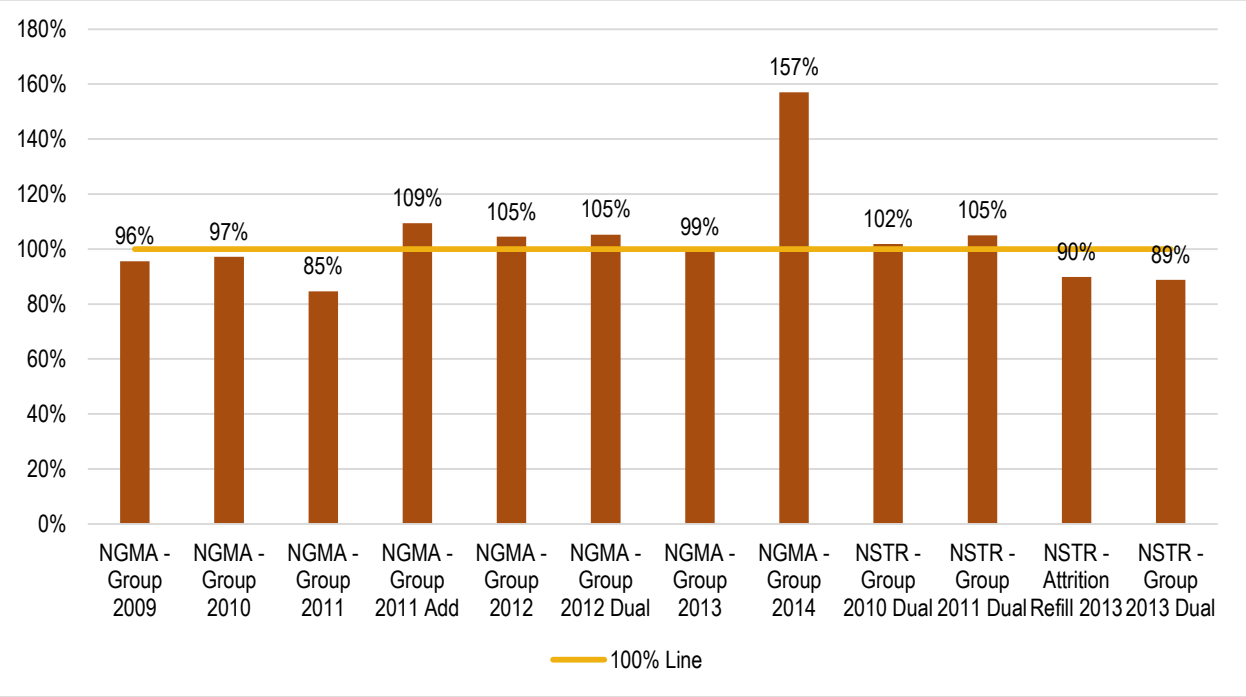
SOURCE: 2014 NATIONAL GRID MASSACHUSETTS HER PROGRAM EVALUATION, NAVIGANT AND ILLUME

FIGURE C2. NATIONAL GRID MA: ELECTRIC SAVINGS ESTIMATE RATIOS AFTER CHANNELING ADJUSTMENT, BY COHORT



SOURCE: 2014 NATIONAL GRID MASSACHUSETTS HER PROGRAM EVALUATION, NAVIGANT AND ILLUME

FIGURE C3. NATIONAL GRID MA: GAS SAVINGS ESTIMATE RATIOS AFTER CHANNELING ADJUSTMENT, BY COHORT



SOURCE: 2014 NATIONAL GRID MASSACHUSETTS HER PROGRAM EVALUATION, NAVIGANT AND ILLUME

TABLE C3. NATIONAL GRID MA: SAVINGS ESTIMATES AFTER CHANNELING ADJUSTMENT, BY COHORT

PA	Cohort Name	Fuel-Type	Total Number of Participants	TRM Baseline Usage (kWh/MMBtu)	Modelled Baseline Usage (kWh/MMBtu)	Average Annual Savings per Customer (kWh/MMBtu)*	Percentage Savings*	Total Savings (kWh/MMBtu)*
NGRID	Group 2009	Electric	24,005	11,233	10,669	252.85	2.37%	5,116,541
NGRID	Group 2010	Electric	65,170	12,370	11,815	186.68	1.58%	11,993,567

NGRID	Group 2010 Added	Electric	23,805	15,232	14,682	340.62	2.32%	6,772,880
NGRID	Group 2011	Electric	99,446	9,638	9,415	236.32	2.51%	18,673,469
NGRID	Group 2011 Added	Electric	60,605	6,121	5,986	93.99	1.57%	4,184,350
NGRID	Group 2012	Electric	86,898	6,126	6,003	135.41	2.20%	1,430,655
NGRID	Group 2012 Dual	Electric	12,621	6,239	6,155	93.64	1.56%	5,974,252
NGRID	Group 2013	Electric	324,002	8,036	8,053	105.50	1.31%	28,469,571
NGRID	Group 2013 Email	Electric	46,105	-	7,082	35.41	0.50%	1,443,224
NGRID	Group 2014	Electric	94,874	7,093	7,303	65.72	0.90%	4,033,771
NGRID	Group 2009	Gas	24,790	127.20	139.97	2.09	1.49%	43,727
NGRID	Group 2010	Gas	75,911	31.28	147.01	2.75	1.87%	172,435
NGRID	Group 2011	Gas	100,321	92.90	103.25	1.16	1.12%	86,660
NGRID	Group 2011 Add	Gas	25,673	19.44	86.94	1.03	1.19%	19,356
NGRID	Group 2012	Gas	86,279	81.00	86.73	1.54	1.77%	96,009
NGRID	Group 2012 Dual	Gas	13,416	84.20	95.91	1.05	1.09%	11,553
NGRID	Group 2013	Gas	149,442	76.18	82.67	0.74	0.89%	89,334
NGRID	Group 2014	Gas	49,741	-	112.27	0.92	0.82%	14,558
NSTAR	Group 2010 Dual	Electric	18,660	-	8,127	16.25	0.20%	124,152
NSTAR	Group 2011 Dual	Electric	8,451	-	7,031	39.37	0.56%	132,707
NSTAR	Group 2012a	Electric	55,857	13,027	13,041	281.68	2.16%	15,381,055
NSTAR	Group 2012b	Electric	17,033	11,388	11,085	228.36	2.06%	3,761,491
NSTAR	Group 2013	Electric	37,801	8,423	11,869	153.11	1.29%	5,467,905
NSTAR	Group 2013b	Electric	65,798	-	6,427	71.98	1.12%	4,448,962
NSTAR	Group 2013 Dual	Electric	20,991	-	6,876	107.95	1.57%	915,705
NSTAR	Group 2014	Electric	8,637	-	6,780	53.56	0.79%	2,868,936
NSTAR	Gas Group 2010 Dual	Gas	24,345	102.2	128.92	2.08	1.61%	39,059
NSTAR	Gas Group 2011 Dual	Gas	24,689	89.6	114.51	1.90	1.66%	35,002
NSTAR	Attrition Refill 2013	Gas	38,411	65.5	90.73	0.67	0.74%	21,771
NSTAR	Gas Group 2013 Dual	Gas	20,943	-	73.66	0.78	1.06%	13,693

WMECo	Group 2014	Electric	113,782	-	7,645	67.28	0.88%	6,661,450

Source: Evaluation team analysis

*All savings estimates are after channeling adjustment.

SOURCE: 2014 NATIONAL GRID MASSACHUSETTS HER PROGRAM EVALUATION, NAVIGANT AND ILLUME

APPENDIX D. DETAILED PARTICIPATION LIFT RESULTS

TABLE D1. ELECTRIC PARTICIPATION LIFT DETAIL

Program	Treatment Year	Group size (n)		EE Program Participants		Participation Rate		Difference in Participation Rate	p-value of Difference	Incremental Participants
		Control	Treatment	Control	Treatment	Control	Treatment			
Income Eligible Single Family	2014	51,341	342,713	195	1,468	0.38%	0.43%	0.05%	0.114	166
	2015	47,570	310,987	191	1,787	0.40%	0.57%	0.17%	0.000	538
	2016	42,699	274,680	260	2,028	0.61%	0.74%	0.13%	0.003	355
ENERGY STAR Products	2014	51,341	342,713	386	3,940	0.75%	1.15%	0.40%	0.000	1,363
	2015	47,570	310,987	336	2,996	0.71%	0.96%	0.26%	0.000	799
	2016	42,699	274,680	230	1,882	0.54%	0.69%	0.15%	0.001	402
Energy Wise	2014	51,341	342,713	531	5,496	1.03%	1.60%	0.57%	0.021	1,951
	2015	47,570	310,987	790	7,458	1.66%	2.40%	0.74%	0.000	2,293
	2016	42,699	274,680	628	6,216	1.47%	2.26%	0.79%	0.000	2,176
ENERGY STAR HVAC	2014	51,341	342,713	138	1,250	0.27%	0.36%	0.10%	0.001	329
	2015	47,570	310,987	187	1,451	0.39%	0.47%	0.07%	0.027	228
	2016	42,699	274,680	185	1,416	0.43%	0.52%	0.08%	0.026	226
ENERGY STAR Lighting*	2014	51,341	342,713	33	324	0.06%	0.09%	0.03%	0.033	104
	2015	47,570	310,987	25	308	0.05%	0.10%	0.05%	0.002	145
	2016	42,699	274,680	1	28	0.00%	0.01%	0.01%	0.114	22

*Includes the mail-in rebate program only and does not include any bulbs purchased through the retail buy-down program. Bulbs purchased through the buy-down program are not tracked by participant.

TABLE D2. NATURAL GAS PARTICIPATION LIFT DETAIL

Program	Treatment Year	Group size (n)		EE Program Participants		Participation Rate		Difference in Participation Rate	p-value of Difference	Incremental Participants
		Control	Treatment	Control	Treatment	Control	Treatment			
Income Eligible Single Family	2014	26,986	165,494	19	51	0.07%	0.03%	-0.04%	0.002	-66
	2015	23,747	147,725	17	49	0.07%	0.03%	-0.04%	0.005	-57
	2016	20,583	129,195	19	54	0.10%	0.04%	-0.05%	0.001	-69
Energy Wise	2014	26,986	165,494	42	131	0.16%	0.08%	-0.08%	0.000	-127
	2015	23,747	147,725	46	143	0.19%	0.10%	-0.10%	0.000	-143
	2016	20,583	129,195	46	148	0.24%	0.12%	-0.12%	0.000	-151
ENERGY STAR HVAC	2014	26,986	165,494	40	96	0.15%	0.06%	-0.09%	0.000	-149
	2015	23,747	147,725	24	85	0.10%	0.06%	-0.04%	0.014	-64
	2016	20,583	129,195	27	84	0.14%	0.07%	-0.07%	0.000	-91

APPENDIX E. DETAILED SAVINGS ADJUSTMENT RESULTS

TABLE E1. DETAILED ELECTRIC SAVINGS ADJUSTMENTS FROM PARTICIPATION IN OTHER PROGRAMS

Metric	Time Period	Dual Fuel – Electric 2013	Electric Only 2013	Electric Only 2014
kWh per HH per day adjustment from measures installed:	March 2013 through May 2014	0.0004	0.0167	
	June 2014 through December 2014	-0.005	0.014	0.009
	January 2015 through December 2015	0.007	-0.006	0.014
	January 2016 through December 2016	-0.0002	0.0174	0.0127
Number of treatment days across all participants	June 2014 through December 2014	19,658,921	20,371,870	9,244,801
	January 2015 through December 2015	33,630,558	33,420,505	15,863,064
	January 2016 through December 2016	31,188,965	31,614,291	14,127,061
June 2014 through December 2014 Savings Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	8	341	-
	Measures installed June 2014 through December 2014	(108)	284	85
	Total Adjustment	(100)	625	85
January 2015 through December 2015 Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	13	559	-
	Measures installed June 2014 through December 2014	(184.4199)	466	147
	Measures installed January 2015 through December 2015	220	(206)	215
	Total Adjustment	49	820	361
January 2016 through December 2016 Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	12	529	0
	Measures installed June 2014 through December 2014	-171	441	131
	Measures installed January 2015 through December 2015	204	-194	191
	Measures installed January 2016 through December 2016	-6	551	180
	Total Adjustment	39	1,326	501

TABLE E1. DETAILED GAS SAVINGS ADJUSTMENTS FROM PARTICIPATION IN OTHER PROGRAMS

Metric	Time Period	Dual Fuel – Gas 2013	Gas Only 2013	Gas Only 2015
kWh per HH per day adjustment from measures installed:	March 2013 through May 2014	0.000024	0.000668	
	June 2014 through December 2014	0.000081	0.000383	0.000000
	January 2015 through December 2015	0.000026	-0.000024	0.000840
	January 2016 through December 2016	0.000069	-0.000876	0.000502
Number of treatment days across all participants	June 2014 through December 2014	19,352,871	3,141,607	
	January 2015 through December 2015	33,557,603	5,352,059	714,121
	January 2016 through December 2016	31,157,844	4,767,123	3,756,953
June 2014 through December 2014 Savings Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	467	2,098	-
	Measures installed June 2014 through December 2014	1,568	1,202	-
	Total Adjustment	2,034	3,299	-
January 2015 through December 2015 Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	809	3,574	-
	Measures installed June 2014 through December 2014	2,718	2,047	-
	Measures installed January 2015 through December 2015	862	(131)	600
	Total Adjustment	4,390	5,490	600
January 2016 through December 2016 Adjustment (MWH) (Per day * Treatment days)	Measures installed in March 2013 through May 2014	751	3,183	-
	Measures installed June 2014 through December 2014	2,524	1,823	-
	Measures installed January 2015 through December 2015	801	(116)	3,155
	Measures installed January 2016 through December 2016	2,150	(4,176)	1,884
	Total Adjustment	6,226	714	5,040

APPENDIX F. EHERS DETAILED RESULTS

TABLE F1. ELECTRONIC HOME ENERGY REPORT 2016 ELECTRIC SAVINGS

	Electric Only - 2013	Electric Only-2014
First Report Date	Apr-13	Jan-14
Total Evaluated Participants	87,744	36,625
Control Customers	8,239	6,663
Baseline Usage (average daily kWh)	27.2	18.7
Treatment and eHER Model Coefficients		
Participant	-0.084	-0.279*
ADClag	0.738*	0.691*
ADClag*Participant	-0.008*	0.025*
Email	0.449*	1.589*
eHER (Email * Participant)	-0.103	-1.074*

*Coefficient is significant at the 90% confidence level

TABLE F2. ELECTRONIC HOME ENERGY REPORT GAS SAVINGS - 2016

	Gas Dual Fuel	Gas Only-2015
First Report Date	Apr-13	Oct-15
Total Evaluated Participants	78,945	8,197
Control Customers	8,650	2,052
Baseline Usage (average daily kWh)	2.3	2.1
Treatment and eHER Model Coefficients		
Participant	0.005	-0.009
ADClag	0.858*	0.749*
ADClag*Participant	-0.003*	-0.010*
Email	0.027*	-0.012
eHER (Email * Participant)	-0.032*	0.003

*Coefficient is significant at the 90% confidence level

APPENDIX G. BASELINE SEGMENTATION DETAILED RESULTS

TABLE G1. SEGMENTATION RESULTS – 2013 ELECTRIC ONLY COHORT - 2016

SCENARIO METRICS	BASELINE* (NO CUSTOMERS REMOVED)	PERCENT OF CUSTOMERS REMOVED (BASED ON BASELINE ENERGY USAGE)				
		Lower 15%	Lower 25%	Lower 35%	Lower 45%	Lower 55%
Average Savings per Day per Household (kWh) for Treated Customers	0.32	0.38	0.47	0.49	0.53	0.58
Annualized per Household Savings (kWh) for Treated Customers	118.2	138.1	172.0	177.3	194.5	209.9
Total Evaluated Net Savings (MWh) for Treated Customers	10,211	10,281	11,356	10,206	9,521	8,443
Total Treated Customers	87,744	75,592	67,018	58,402	49,651	40,794
Total Control Customers	8,239	7,018	6,254	5,416	4,591	3,792
Estimated Cost for Treated Customers	$694,932	$598,689	$530,783	$462,544	$393,236	$323,088
Estimated $ spent / MWh saved for treated customers	$68.06	$58.23	$46.74	$45.32	$41.30	$38.27

*Includes only customers with at least 11 months of baseline billing data. This group is slightly different from the group used to calculate PY 2016 savings.

TABLE G2. SEGMENTATION RESULTS – 2013 DUAL FUEL ELECTRIC COHORT – 2016

SCENARIO METRICS	BASELINE* (NO CUSTOMERS REMOVED)	PERCENT OF CUSTOMERS REMOVED (BASED ON BASELINE ENERGY USAGE)				
		Lower 15%	Lower 25%	Lower 35%	Lower 45%	Lower 55%
Average Savings per Day per Household (kWh) for Treated Customers	0.1694	0.1973	0.2424	0.2624	0.3228	0.4223
Annualized per Household Savings (kWh) for Treated Customers	61.84	72.03	88.46	95.76	117.84	154.12
Total Evaluated Net Savings (MWh) for Treated Customers	5013	5157	5698	5437	5742	6225
Total Treated Customers	82,486	72,793	65,452	57,655	49,464	40,981
Total Control Customers	9,022	7,993	7,212	6,379	5,469	4,572
Estimated Cost for Treated Customers	$653,289	$576,521	$518,380	$456,628	$391,755	$324,570
Estimated $ spent / MWh saved for treated customers	$130.32	$111.80	$90.98	$83.99	$68.22	$52.14

*Includes only customers with at least 11 months of baseline billing data. This group is slightly different from the group used to calculate PY 2016 savings.

TABLE G3. SEGMENTATION RESULTS – 2013 GAS DUAL FUEL COHORT - 2016

SAMPLE SEGMENTATION	BASELINE* (NO CUSTOMERS REMOVED)	PERCENT OF CUSTOMERS REMOVED (BASED ON BASELINE ENERGY USAGE)		
		5%	15%	25%
Treatment Effect	0.02	0.02	0.01	0.01
Annualized per Household Savings (kWh)	5.6	5.6	4.5	4.2
Total Evaluated Net Savings (therm)	433,531	427,837	308,127	258,357
Total Treated Customers	78,945	77,747	70,280	62,965
Total Control Customers	8,650	8,531	7,745	6,979
Estimated Cost for Treated Customers	$261,308	$257,343	$232,627	$208,414
Estimated $ spent / therm saved for treated customers	0.60	0.60	0.75	0.80

*Includes only customers with at least 11 months of baseline billing data. This group is slightly different from the group used to calculate PY 2016 savings.

APPENDIX H. SECONDARY LITERATURE REVIEW

TABLE H1. PEAK DEMAND SAVINGS

Utility	Evaluator	Report Name	Report Date
FirstEnergy Ohio Companies	ADM Associates, Inc.	Home Performance Program: Evaluation, Measurement and Verification Report 2013	5/1/2014
PPL Electric	The Cadmus Group, Inc.	Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013, Program Year 4 - Part 1	1/15/2014
Sacramento Municipal Utility District	Integral Analytics	Impact & Persistence Evaluation Report: SMUD Home Energy Report Program	11/2/2012
Southern California Edison	Applied Energy Group	SCE's Home Energy Report Program Savings Assessment: Ex-Post Evaluation Results, Program Year 2013	10/24/2014
Eversource	N/A	Massachusetts 2016-2018 TRM	10/2015
National Grid	N/A	Massachusetts 2016-2018 TRM	10/2015
Midwest Utility 1	Navigant Consulting, Inc.		2016
Midwest Utility 2	Navigant Consulting, Inc.		2016

TABLE H2. UPSTREAM SAVINGS

Utility	Evaluator	Report Name	Report Date
Ameren Illinois	Opinion Dynamics	Impact and Process Evaluation of Ameren Illinois Company's Behavioral Modification Program (PY5)	1/1/2014
Com Ed	Navigant Consulting, Inc.	Home Energy Report Opower Program PY7 Evaluation Report	2/15/2016
Duke Energy	Navigant Consulting, Inc.	EM&V Report for the Residential Energy Efficiency Benchmarking Program	1/27/2014
National Grid New York	DNV KEMA Energy and Sustainability	National Grid Residential Building Practices and Demonstration Program Evaluation Final Results	1/15/2014
Pacific Gas and Electric	Freeman, Sullivan & CO	Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010-2012 Program	4/1/2013
PPL Electric	The Cadmus Group, Inc.	Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013, Program Year 4 - Part 1	1/15/2014
Puget Sound Energy	DNV-GL	Home Energy Report Program: 2013 Impact Evaluation	5/30/2014
Rocky Mountain Power	Navigant Consulting, Inc.	Utah Home Energy Reporting Program 18 Month Evaluation Report (8/1/2012 – 1/31/2014)	6/18/2014
Seattle City Light	DNV-GL	Home Electricity Report Program 2013 Impact Evaluation	7/1/2014
Southern California Edison	The Cadmus Group, Inc.	Evaluation of Southern California Edison 2015 Home Energy Efficiency Survey Program	11/30/2016
Southern California Edison	Applied Energy Group	SCE's Home Energy Report Program Savings Assessment: Ex-Post Evaluation Results, Program Year 2013	10/24/2014
Unnamed Midwest utility	Navigant Consulting, Inc.		2016
Unnamed	Navigant		2016

Midwest utility	Consulting, Inc.		

TABLE H3. DELIVERY CHANNEL EFFECTIVENESS

Utility	Evaluator	Report Name	Report Date
East Bay Municipal District	David L. Mitchell M.Cubed Thomas W. Chesnutt, Ph.D., CAP™ A&N Technical Services, Inc.	Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports	12/1/2013
Sacramento Municipal Utility District	Integral Analytics	Impact & Persistence Evaluation Report: SMUD Home Energy Report Program	11/2/2012
South Carolina Electric & Gas	Angela Wells, Direct Options, Ashlie Ossege, Direct Options	Assessing the Impact of Communication Channel on Behavior Changes in Energy Efficiency	2015

APPENDIX I. DATA CLEANING RESULTS

TABLE I1. ELECTRIC DATA CLEANING RESULTS

Electric Dual Fuel	2014		2015		2016	
	Treatment	Control	Treatment	Control	Treatment	Control
Starting Number of Billing Records	2,367,675	258,990	2,781,815	304,234	2,700,555	295,587
Bill coincidental with report start	114,214	12,457	114,234	12,461	114,234	12,461
	4.8%	4.8%	4.1%	4.1%	4.2%	4.2%
Billing record after move-out date	545	54	706	79	899	100
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bill precedes program start by >1 year	90,835	9,922	87,314	9,528	81,283	8,886
	3.8%	3.8%	3.1%	3.1%	3.0%	3.0%
Less than 15 billing days	51,538	5,650	52,720	5,802	52,215	5,708
	2.2%	2.2%	1.9%	1.9%	1.9%	1.9%
Greater than 31 billing days	52	2	0	0	0	0
	0.00	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	1,743,617	190,563	2,094,667	228,673	1,947,607	213,107
Starting Number of Accounts	118,612	12,997	118,612	12,997	118,612	12,997
Fewer than 11 pre-period months	5,649	609	4,983	561	4,104	457
	4.8%	4.7%	4.2%	4.3%	3.5%	3.5%
Fewer than 2 treatment months	20,082	2,238	24,522	2,711	31,670	3,481
	16.9%	17.2%	20.7%	20.9%	26.7%	26.8%
Extreme Average Usage	439	54	354	40	354	40
	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
Final Number of Accounts	92,434	10,096	88,746	9,686	82,477	9,020

TABLE I2. ELECTRIC DATA CLEANING RESULTS

Electric Only - 2013	2014		2015		2016	
	Treatment	Control	Treatment	Control	Treatment	Control
Starting Number of Billing Records	2,258,506	211,117	2,684,656	251,294	2,621,948	245,545
Bill coincidental with report start	105,135	9,813	105,133	9,813	105,133	9,813
	4.7%	4.6%	3.9%	3.9%	4.0%	4.0%
Billing record after move-out date	473	40	708	62	941	90
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bill precedes program start by >1 year	95,558	8,941	92,633	8,687	87,388	8,216
	4.2%	4.2%	3.5%	3.5%	3.3%	3.4%
Less than 15 billing days	47,868	4,472	48,784	4,545	48,735	4,565
	2.1%	2.1%	1.8%	1.8%	1.9%	1.9%
Greater than 31 billing days	141	11	0	0	0	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	1,813,620	169,489	2,203,605	206,614	2,077,692	195,129
Starting Number of Accounts	106,996	10,000	106,996	10,000	106,996	10,000
Fewer than 11 pre-period months	99	7	90	5	85	4
	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
Fewer than 2 treatment months	10,944	1,028	13,895	1,282	19,166	1,757
	10.2%	10.3%	13.0%	12.8%	17.9%	17.6%
Extreme Average Usage	0	0	2	0	2	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Accounts	95,953	8,965	93,010	8,713	87,744	8,239

TABLE I3. ELECTRIC DATA CLEANING RESULTS

Electric Only – 2014	2014		2015		2016	
	Treatment	Control	Treatment	Control	Treatment	Control
Starting Number of Billing Records	1,011,210	183,684	1,191,626	216,235	1,135,184	206,224
Bill coincidental with report start	54,129	9,875	54,224	9,893	54,224	9,893
	5.4%	5.4%	4.6%	4.6%	4.8%	4.8%
Billing record after move-out date	371	69	518	92	594	96
	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Bill precedes program start by >1 year	3	0	6	0	6	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Less than 15 billing days	26,874	4,816	27,183	4,879	26,534	4,738
	2.7%	2.6%	2.3%	2.3%	2.3%	2.3%
Greater than 31 billing days	66	9	0	0	0	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	804,733	146,010	941,596	170,885	845,576	153,966
Starting Number of Accounts	54,943	10,020	54,941	10,020	54,937	10,020
Fewer than 11 pre-period months	4,930	901	4,031	717	3,052	527
	9.0%	9.0%	7.3%	7.2%	5.6%	5.3%
Fewer than 2 treatment months	6,019	1,117	9,842	1,834	15,065	2,774
	11.0%	11.1%	17.9%	18.3%	27.4%	27.7%
Extreme Average Usage	95	19	0	0	0	0
	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
Final Number of Accounts	43,851	7,955	40,977	7,436	36,689	6,677

TABLE I4. GAS DATA CLEANING RESULTS

Gas Dual Fuel	2014		2015		2016	
	Treatment	Control	Treatment	Control	Treatment	Control
Starting Number of Billing Records	2,349,111	257,129	2,763,149	302,365	2,684,820	294,033
Bill coincidental with report start	110,525	12,083	110,721	12,089	110,721	12,089
	4.7%	4.7%	4.0%	4.0%	4.1%	4.1%
Billing record after move-out date	571	51	753	87	909	101
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bill precedes program start by >1 year	86,504	9,465	83,313	9,113	77,689	8,512
	3.7%	3.7%	3.0%	3.0%	2.9%	2.9%
Less than 15 billing days	49,738	5,438	51,052	5,596	50,369	5,489
	2.1%	2.1%	1.8%	1.9%	1.9%	1.9%
Greater than 31 billing days	30	4	0	0	0	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	1,661,856	181,891	2,000,451	218,719	1,864,963	204,284
Starting Number of Accounts	118,534	12,981	118,537	12,981	118,522	12,981
Fewer than 11 pre-period months	6,773	725	6,112	668	5,109	557
	5.7%	5.6%	5.2%	5.1%	4.3%	4.3%
Fewer than 2 treatment months	19,647	2,203	24,006	2,646	30,837	3,379
	16.6%	17.0%	20.3%	20.4%	26.0%	26.0%
Extreme Average Usage	3955	409	3612	393	3612	393
	3.3%	3.2%	3.1%	3.0%	3.1%	3.0%
Final Number of Accounts	88,144	9,643	84,792	9,273	78,947	8,650

TABLE I5. GAS DATA CLEANING RESULTS

Gas Only – 2013	2014		2015		2016	
	Treatment	Control	Treatment	Control	Treatment	Control
Starting Number of Billing Records	446,296	193,196	508,013	220,035	489,742	212,611
Bill coincidental with report start	19,584	8,537	19,683	8,569	19,684	8,569
	4.4%	4.4%	3.9%	3.9%	4.0%	4.0%
Billing record after move-out date	163	86	229	117	240	125
	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%
Bill precedes program start by >1 year	13,662	5,978	12,855	5,628	11,506	5,073
	3.1%	3.1%	2.5%	2.6%	2.4%	2.4%
Less than 15 billing days	10,934	4,814	11,239	4,911	10,979	4,790
	2.4%	2.5%	2.2%	2.2%	2.2%	2.3%
Greater than 31 billing days	17	4	0	0	0	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	263,165	115,490	307,938	135,409	276,278	122,332
Starting Number of Accounts	23,015	9,963	23,016	9,966	23,013	9,962
Fewer than 11 pre-period months	1,274	549	1,119	471	887	364
	5.5%	5.5%	4.9%	4.7%	3.9%	3.7%
Fewer than 2 treatment months*	6,415	2,720	7,616	3,240	9,259	3,935
	27.9%	27.3%	33.1%	32.5%	40.2%	39.5%
Extreme Average Usage	1290	538	1094	456	1093	456
	5.6%	5.4%	4.8%	4.6%	4.8%	4.6%
Final Number of Accounts	14,032	6,155	13,182	5,797	11,765	5,204

*The data files included over 6,000 customers who were marked as gas treatment and control customers, but had no billing data in 2014, 2015, 2016. Therefore, the actual number of "active" customers that we removed for having insufficient bills is much lower.

TABLE I6. GAS DATA CLEANING RESULTS

Gas Only – 2015	2015		2016	
	Treatment	Control	Treatment	Control
Starting Number of Billing Records	189,863	47,249	285,987	71,265
Bill coincidental with report start	12,049	2,992	12,049	2,992
	6.3%	6.3%	4.2%	4.2%
Billing record after move-out date	59	10	262	78
	0.0%	0.0%	0.1%	0.1%
Bill precedes program start by >1 year	7,133	1,792	6,944	1,759
	3.8%	3.8%	2.4%	2.5%
Less than 15 billing days	6,639	1,681	7,854	1,984
	3.5%	3.6%	2.7%	2.8%
Greater than 31 billing days	0	0	0	0
	0.0%	0.0%	0.0%	0.0%
Final Number of Billing Records	117,377	29,134	187,039	46,659
Starting Number of Accounts	13,524	3,383	13,532	3,385
Fewer than 11 pre-period months	2,924	758	2,853	733
	21.6%	22.4%	21.1%	21.7%
Fewer than 2 treatment months	2,184	535	2,482	599
	16.1%	15.8%	18.3%	17.7%
Extreme Average Usage	0	0	0	0
	0.0%	0.0%	0.0%	0.0%
Final Number of Accounts	8,416	2,089	8,197	2,052

APPENDIX J. EQUIVALENCY TEST RESULTS

TABLE J1. EQUIVALENCY TEST RESULTS: DUAL FUEL ELECTRIC

Dual Fuel - Electric	Pre-Cleaning				Post-Cleaning (2016 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	15.3	15.4	0.054	TRUE	15.9	16.0	0.097	TRUE
May 2012	16.2	16.4	0.163	TRUE	17.0	17.1	0.151	TRUE
Jun 2012	21.8	22.0	0.097	TRUE	23.0	23.3	0.083	TRUE
Jul 2012	28.3	28.5	0.240	TRUE	30.0	30.3	0.150	TRUE
Aug 2012	26.7	26.9	0.255	TRUE	28.4	28.7	0.143	TRUE
Sep 2012	19.3	19.5	0.130	TRUE	20.5	20.7	0.102	TRUE
Oct 2012	16.1	16.2	0.155	TRUE	17.1	17.2	0.150	TRUE
Nov 2012	17.3	17.5	0.095	TRUE	18.3	18.5	0.145	TRUE
Dec 2012	19.2	19.4	0.123	TRUE	20.3	20.5	0.222	TRUE
Jan 2013	19.3	19.4	0.217	TRUE	20.3	20.4	0.354	TRUE
Feb 2013	18.5	18.6	0.206	TRUE	19.4	19.5	0.440	TRUE
Mar 2013	17.1	17.2	0.245	TRUE	17.9	18.1	0.359	TRUE

TABLE J2. EQUIVALENCY TEST RESULTS: 2013 ELECTRIC ONLY

Electric Only - 2013	Pre-Cleaning				Post-Cleaning (216 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	22.6	22.6	0.797	TRUE	22.8	22.8	0.986	TRUE
May 2012	23.3	23.3	0.870	TRUE	23.6	23.7	0.666	TRUE
Jun 2012	29.6	29.5	0.753	TRUE	30.2	30.2	0.915	TRUE

Jul 2012	37.1	37.1	0.672	TRUE	37.9	37.8	0.835	TRUE
Aug 2012	35.3	35.1	0.379	TRUE	36.0	35.9	0.468	TRUE
Sep 2012	27.0	26.8	0.433	TRUE	27.5	27.4	0.538	TRUE
Oct 2012	23.8	23.7	0.946	TRUE	24.1	24.1	0.876	TRUE
Nov 2012	26.2	26.2	0.946	TRUE	26.4	26.5	0.846	TRUE
Dec 2012	30.2	30.2	0.892	TRUE	30.5	30.6	0.954	TRUE
Jan 2013	31.2	31.1	0.867	TRUE	31.3	31.3	0.941	TRUE
Feb 2013	29.9	29.9	0.839	TRUE	30.0	30.0	0.777	TRUE
Mar 2013	27.3	27.3	0.993	TRUE	27.5	27.5	0.956	TRUE

TABLE J3. EQUIVALENCY TEST RESULTS: 2014 ELECTRIC ONLY

Electric Only - 2014	Pre-Cleaning				Post-Cleaning (2016 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	20.7	20.9	0.534	TRUE	19.9	20.2	0.251	TRUE
May 2012	20.3	20.4	0.583	TRUE	20.1	20.1	0.984	TRUE
Jun 2012	18.5	18.6	0.633	TRUE	18.3	18.3	0.949	TRUE
Jul 2012	15.8	15.9	0.671	TRUE	15.8	15.8	0.974	TRUE
Aug 2012	15.4	15.5	0.651	TRUE	15.6	15.6	0.959	TRUE
Sep 2012	20.6	20.7	0.587	TRUE	21.0	20.9	0.919	TRUE
Oct 2012	26.6	26.7	0.654	TRUE	27.2	27.2	0.924	TRUE
Nov 2012	21.2	21.2	0.980	TRUE	21.5	21.5	0.787	TRUE
Dec 2012	17.5	17.4	0.712	TRUE	17.7	17.6	0.624	TRUE
Jan 2013	15.9	15.8	0.531	TRUE	15.9	15.9	0.701	TRUE
Feb 2013	18.9	18.9	0.968	TRUE	18.6	18.6	0.991	TRUE
Mar 2013	22.0	22.1	0.742	TRUE	21.5	21.6	0.777	TRUE

TABLE J4. EQUIVALENCY TEST RESULTS: DUAL FUEL GAS

Dual Fuel - Gas	Pre-Cleaning				Post-Cleaning (2016 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	1.7	1.7	0.592	TRUE	1.8	1.8	0.282	TRUE
May 2012	1.0	1.0	0.386	TRUE	1.1	1.1	0.081	TRUE
Jun 2012	0.7	0.7	0.433	TRUE	0.7	0.8	0.165	TRUE
Jul 2012	0.6	0.6	0.376	TRUE	0.6	0.6	0.221	TRUE
Aug 2012	0.6	0.6	0.265	TRUE	0.6	0.6	0.224	TRUE
Sep 2012	0.7	0.7	0.085	TRUE	0.7	0.7	0.086	TRUE
Oct 2012	1.4	1.4	0.314	TRUE	1.4	1.5	0.248	TRUE
Nov 2012	2.6	2.6	0.237	TRUE	2.8	2.8	0.379	TRUE
Dec 2012	3.7	3.7	0.320	TRUE	3.9	4.0	0.419	TRUE
Jan 2013	4.6	4.6	0.435	TRUE	4.9	4.9	0.488	TRUE
Feb 2013	4.6	4.7	0.479	TRUE	4.9	5.0	0.557	TRUE
Mar 2013	3.7	3.7	0.294	TRUE	3.9	3.9	0.528	TRUE

TABLE J5. EQUIVALENCY TEST RESULTS: 2013 GAS ONLY

Gas Only - 2013	Pre-Cleaning				Post-Cleaning (2016 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	1.0	0.9	0.900	TRUE	1.0	1.0	0.855	TRUE
May 2012	0.7	0.7	0.782	TRUE	0.7	0.7	0.835	TRUE
Jun 2012	0.6	0.6	0.759	TRUE	0.6	0.6	0.600	TRUE
Jul 2012	0.6	0.6	0.709	TRUE	0.6	0.6	0.511	TRUE

Aug 2012	0.7	0.7	0.667	TRUE	0.7	0.7	0.610	TRUE
Sep 2012	1.2	1.2	0.290	TRUE	1.3	1.3	0.440	TRUE
Oct 2012	2.4	2.4	0.508	TRUE	2.7	2.7	0.417	TRUE
Nov 2012	3.3	3.4	0.270	TRUE	3.7	3.8	0.395	TRUE
Dec 2012	4.1	4.2	0.153	TRUE	4.6	4.7	0.299	TRUE
Jan 2013	4.2	4.2	0.193	TRUE	4.7	4.8	0.308	TRUE
Feb 2013	3.3	3.4	0.143	TRUE	3.7	3.7	0.319	TRUE
Mar 2013	2.0	2.0	0.230	TRUE	2.2	2.2	0.294	TRUE

TABLE J6. EQUIVALENCY TEST RESULTS: 2015 GAS ONLY

Gas Only - 2015	Pre-Cleaning				Post-Cleaning (2016 Program Year)			
Month and year	Treatment ADC	Control ADC	P-value	Equivalent*	Treatment ADC	Control ADC	P-value	Equivalent*
Apr 2012	1.2	1.2	0.453	TRUE	1.2	1.2	0.357	TRUE
May 2012	2.7	2.7	0.990	TRUE	2.8	2.8	0.721	TRUE
Jun 2012	3.8	3.7	0.644	TRUE	3.8	3.8	0.746	TRUE
Jul 2012	5.1	5.0	0.544	TRUE	5.2	5.2	0.583	TRUE
Aug 2012	5.6	5.5	0.446	TRUE	5.8	5.8	0.621	TRUE
Sep 2012	4.1	4.1	0.816	TRUE	4.3	4.2	0.795	TRUE
Oct 2012	2.1	2.1	0.875	TRUE	2.2	2.2	0.935	TRUE
Nov 2012	0.9	0.9	0.372	TRUE	1.0	0.9	0.496	TRUE
Dec 2012	0.6	0.6	0.512	TRUE	0.7	0.7	0.467	TRUE
Jan 2013	0.5	0.5	0.842	TRUE	0.6	0.6	0.929	TRUE
Feb 2013	0.5	0.5	0.794	TRUE	0.5	0.5	0.876	TRUE
Mar 2013	0.6	0.6	0.953	TRUE	0.6	0.6	0.806	TRUE

TABLE J7. EQUIVALENCY TEST RESULTS: 2013 ELECTRIC DUAL FUEL

Electric Dual Fuel	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	-0.212	0.128	-1.656	0.098
Post Cleaning	-0.217	0.134	-1.613	0.107

TABLE J8. EQUIVALENCY TEST RESULTS: 2013 ELECTRIC ONLY

Electric Only - 2013	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	-0.212	0.128	-1.656	0.098
Post Cleaning	-0.217	0.134	-1.613	0.107

TABLE J9. EQUIVALENCY TEST RESULTS: 2014 ELECTRIC ONLY

Electric Only - 2014	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	-0.006	0.159	-0.039	0.969
Post Cleaning	-0.060	0.159	-0.378	0.706

TABLE J10. EQUIVALENCY TEST RESULTS: 2013 GAS DUAL FUEL

Gas Dual Fuel	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	-0.015	0.015	-1.011	0.312
Post Cleaning	-0.014	0.014	-1.011	0.312

TABLE J11. EQUIVALENCY TEST RESULTS: 2013 GAS ONLY

Gas Only - 2013	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	-0.026	0.024	-1.108	0.268
Post Cleaning	-0.023	0.024	-0.973	0.331

TABLE J12. EQUIVALENCY TEST RESULTS: 2015 GAS ONLY

Gas Only - 2015	Pre-Program Year Treatment Effect	Standard Error	T Statistic	P-Value
Original Treatment and Control Groups	0.021	0.028	0.751	0.453
Post Cleaning	0.016	0.034	0.480	0.631

APPENDIX K. LFER MODEL SPECIFICATION

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

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 treatment 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.

β_2 is the estimate of the treatment effects: the average daily energy savings per household due to behavioral program treatment. β_{0k} is the customer-specific fixed effect. β_1 is the effect of being in the post-period on energy use to account for non-program effects that impact both the treatment and control groups.

APPENDIX L. COMPARISON OF LFER AND PPR TREATMENT EFFECTS

TABLE L1. ELECTRIC TREATMENT EFFECTS: ELECTRIC DUAL FUEL 2013

Electric Dual Fuel 2013						
Year	2014		2015		2016	
Model Type	PPR	LFER	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.31	-0.28	-0.27	-0.24	-0.17	-0.13
Confidence Interval – Lower Bound	-0.19	-0.16	-0.13	-0.10	-0.03	0.01
Confidence Interval – Upper Bound	-0.43	-0.40	-0.40	-0.38	-0.31	-0.27

TABLE L2. ELECTRIC TREATMENT EFFECTS: ELECTRIC ONLY 2013

Electric Only 2013						
Year	2014		2015		2016	
Model Type	PPR	LFER	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.50	-0.50	-0.33	-0.33	-0.32	-0.33
Confidence Interval – Lower Bound	-0.35	-0.34	-0.17	-0.17	-0.15	-0.15
Confidence Interval – Upper Bound	-0.65	-0.65	-0.49	-0.50	-0.50	-0.50

TABLE L3. ELECTRIC TREATMENT EFFECTS: ELECTRIC ONLY 2014

Electric Only 2014						
Year	2014		2015		2016	
Model Type	PPR	LFER	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.26	-0.27	-0.29	-0.30	-0.20	-0.21
Confidence Interval – Lower Bound	-0.15	-0.14	-0.13	-0.15	-0.02	-0.03
Confidence Interval – Upper Bound	-0.38	-0.40	-0.44	-0.45	-0.38	-0.39

TABLE L4. GAS TREATMENT EFFECTS: GAS DUAL FUEL 2013

Gas Dual Fuel 2013						
Year	2014		2015		2016	
Model Type	PPR	LFER	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01
Confidence Interval – Lower Bound	-0.01	0.00	-0.01	-0.01	-0.01	0.00
Confidence Interval – Upper Bound	-0.02	-0.02	-0.03	-0.03	-0.03	-0.02

TABLE L5. GAS TREATMENT EFFECTS: GAS ONLY 2013

Gas Only 2013						
Year	2014		2015		2016	
Model Type	PPR	LFER	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.01	0.00	-0.02	-0.02	-0.01	-0.01
Confidence Interval – Lower Bound	0.00	0.02	0.00	0.00	0.01	0.01
Confidence Interval – Upper Bound	-0.02	-0.01	-0.04	-0.04	-0.03	-0.02

TABLE L6. GAS TREATMENT EFFECTS: GAS ONLY 2015

Gas Only 2015				
Year	2015		2016	
Model Type	PPR	LFER	PPR	LFER
Treatment Effect (kWh saved per household per day)	-0.03	-0.03	-0.03	-0.05
Confidence Interval – Lower Bound	0.00	0.01	-0.01	-0.03
Confidence Interval – Upper Bound	-0.06	-0.06	-0.05	-0.07

APPENDIX M. GLOSSARY

Below are definitions and examples of common terms and acronyms which are used in this report. All definitions refer to usage within this report.

Baseline: This refers to the amount of average amount of energy used by a customer prior to participation in the program.

Cohort: This refers to the different groups, or waves, of customers who are selected and sent reports.

Control group: This refers to customers who did not receive home energy reports, but are used as a comparison group. These customers were assigned randomly.

eHER: "Electronic Home Energy Report" This refers to the subset of National Grid customers who receive emailed reports in addition to a mailed paper version. Customers are not assigned this delivery method randomly, but rather receive emailed reports if they have an email on file within their National Grid account.

HER: "Home Energy Report" This refers to the overall behavioral opt-out report program implemented by Opower for National Grid.

Net Savings: The savings calculated in this report are "net" savings (as opposed to "gross" savings) as the program design and analyses account for the influence of the program, and the counterfactual, by utilizing a control group against which to compare treatment customers

Opower: The implementer of the Home Energy Report program for National Grid Rhode Island. Opower manages the program design and delivery, including delivering reports to customers.

RCT: "Randomized Control Trial" This refers to the experimental design of the Home Energy Report program, which utilizes groups of treatment customers, who receive reports, and control customers, who do not. As customers are randomly assigned to either group, they are presumed to be equivalent in aggregate, which allows comparability and measurement of energy savings of the treatment group.

Treatment group: This refers to customers who received home energy reports as part of the program's experimental design. These customers were assigned randomly.