

# Moving Beyond Econometrics to Examine the Behavioral Changes behind Impacts

*Anne Dougherty, Opinion Dynamics Corporation*  
*Amanda Dwelley, Opinion Dynamics Corporation*  
*Rachel Henschel, National Grid*  
*Riley Hastings, NSTAR*

## ABSTRACT

Evaluations of information-driven social norm messaging programs have demonstrated that behavioral programs can generate quantifiable energy savings. However, few evaluations have successfully documented the behavioral drivers that lead to increases in energy savings. Past evaluations of behavior-based conservation programs rarely move beyond the “black box” of estimating reductions in kWh to provide insight into exactly how program participants are saving energy. Without this knowledge, implementers are deprived of the insight necessary to create increasingly innovative program interventions.

The Opinion Dynamics Team, with subcontractor Navigant Consulting, conducted an evaluation on behalf of multiple utilities in Massachusetts to assess the impact, value, and scalability of behavioral programs (including OPOWER, Tendril, and Efficiency 2.0) in current and future statewide behavioral program efforts. This paper will detail how our team paired market research techniques with econometrics analysis to examine the behavior changes that drive energy savings for one of these programs, OPOWER. Specifically, we will describe the methods and findings from a statewide evaluation of prominent behavioral programs that draws on multiple market research techniques. The goal of this evaluation was to address the following researchable questions: (1) how are the behavioral program interventions generating changes in energy saving installations and practices among those who are touched by the program?; (2) what are the unique behaviors that contribute to energy savings, including but not limited to measure installation and conservation behaviors?; and (3) how, if at all, are these behaviors persisting over time?

## Introduction

Behavioral programs have become ubiquitous in energy efficiency program portfolios throughout North America. While many program evaluations have documented the energy savings value of these programs, few evaluations to date have sought to determine *how* these programs garner savings.

Opinion Dynamics, with subcontractor Navigant Consulting, conducted a comprehensive process and impact evaluation of National Grid’s electric and gas OPOWER pilot program — called the Home Energy Reports (HER) program — as part of a larger, statewide evaluation of Massachusetts behavioral programs.<sup>1</sup> In addition to verifying the savings gained through the program, the objectives of this evaluation were to determine *how* the Home Energy Reports motivate actions among participants, *what* actions participants are taking as a result of the report (efficiency, conservation, and non-energy actions), and the extent to which these actions may be *attributable to other resource programs*. To answer these larger questions, our evaluation addressed a number of questions to unearth the drivers behind the program’s savings gains.

This study is part of a three-year, multi-program study to determine the effectiveness of behavioral program across multiple programs and utilities. The results herein are the first step in answering these

---

<sup>1</sup> For the purposes of this evaluation report, we refer to the National Grid behavioral program as the “HER program.” We refer to customers receiving Home Energy Reports as “HER participants” and to their counterparts as the “control group.” The National Grid behavioral program evaluated in this report included three waves of program intervention, varying by participant fuel type and the date of the first report. We will refer to the electric-only pilot cohort as the “electric pilot,” the gas-only pilot cohort as the “gas pilot,” and the expansion of the electric cohort to a broader geography at a later date as the “electric expansion.” We will refer to National Grid energy efficiency programs available to HER participant and control households outside of the HER program – e.g., rebate and home assessment programs – as “other National Grid programs.”

questions and will inform our future research studies. Our team is scheduled to confirm findings outlined in this paper drawing on multiple quantitative methods.

For the purposes of this evaluation, our team focused on the OPOWER pilot efforts, implemented from October 2009 to October 2010, as it was the only program that was fully active for the first year of our program evaluation. The pilot program set an annual savings goal of 2.05% kWh savings per participant household for the electric pilot effort, and 1.04% therm savings per participant household for the gas pilot. The HER program was delivered to 24,853 electric pilot participants and 24,994 gas pilot participants during the first year of the pilot program. The HER program also retained 24,752 electric and 24,876 gas customers to serve as a control group for the program.

The program provides normative comparisons coupled with energy savings recommendations to educate and motivate participants to take energy saving actions and behaviors within their homes. The program delivers information on household energy consumption, including neighbor comparisons and historical consumption trends, through monthly Home Energy Reports (direct mail) and an Energy Insider website (promoted in direct mail). Residential single-family homeowners with high energy use are the target customers.

## Methodology

The Opinion Dynamics Evaluation Team used a multi-method approach for this evaluation, including the following techniques: (1) survey research; (2) billing analysis; and (3) channeling analysis. We briefly describe these methods below.

- **Behavior Change Survey:** Opinion Dynamics conducted a telephone survey of 1,002 National Grid electric and gas pilot customers in late November 2010. These customers represent four groups, defined by two dimensions: National Grid behavioral program pilot cohort (electric or gas) and behavioral program treatment (participant or control). Our primary goals for the survey research included the following: (1) to determine what actions participants are taking over and above control groups; (2) to determine the proportion of actions that are equipment efficiency-based versus conservation behavior-based; and (3) to assess specifically which behaviors are contributing to program savings. This survey effort used an aided approach to measuring 42 energy saving actions between the treatment and control groups.
- **Billing Analysis:** Navigant Consulting conducted a billing analysis to assess changes in energy consumption attributable to behavioral programs. We estimated annual electric savings per household for the National Grid electric-only pilot and annual therm savings per household for the National Grid gas-only pilot, using a linear fixed effects regression (LFER) analysis to estimate program effects, and customer billing data.<sup>2</sup> LFER analysis provides a Difference-in-Difference (DID) estimate of program savings. It essentially compares the average change in energy consumption between pre- and post-periods among the participant group to the average change among the control group to assess what participant consumption would have been in the absence of the program, i.e., program savings.
- **Channeling Analysis:** Opinion Dynamics conducted a channeling analysis of the cross-participation in National Grid programs. The HER behavioral program sometimes promotes other National Grid energy efficiency programs — particularly rebate-based programs — in program materials, and directs customers to National Grid resources to sign up for these programs. If HER program materials are effective, we would expect to see a “lift” in participation in other National Grid energy efficiency programs among HER participants — i.e., a higher rate of participation among the treatment group, compared to the control. If incremental participation exists, the savings estimate that

---

<sup>2</sup> Savings estimates for the National Grid Electric Expansion cohort will be provided later in 2011, when a longer billing history (e.g., full heating and cooling season data) is available for program participants.

we observed in billing analysis may be higher than actual program savings, because the program treatment effect (the sum of all coefficients with the program treatment term) may include incremental savings achieved through the joint effect of OPOWER and other National Grid programs (through deemed savings in their tracking databases). Because these incremental savings are already counted by other National Grid programs, we cannot count them as net program savings. The purpose of channeling analysis is therefore to answer the following two questions:

- **What is the participation lift due to the HER?:** To determine whether the behavioral program treatment generates lift in other energy efficiency programs, we compared the numbers of treatment and control groups members who initiated participation in other National Grid energy efficiency programs after the start of the behavioral program. For both treatment and control groups, we cross-referenced the databases of the HER behavioral program with the 2008-2010 databases of other National Grid residential energy efficiency programs available to the customer base targeted by the behavioral program (single-family, standard-income Massachusetts residents).<sup>3</sup> Through this database review, we determined (1) whether each HER program household participated in any program after the start of the HER program, and (2) the date of first participation in each non-behavioral energy efficiency program. The difference in treatment and control participation rates is participation lift. We also looked at participation rates in the year prior to the behavioral program to ensure that there were no pre-existing differences in program participation rates between treatment and control.
- **What savings are potentially double-counted?:** As mentioned above, savings from measures installed in other National Grid programs may be double-counted by the HER program and other National Grid programs *only if* these savings from measure installations are incremental – that is, if savings from measure installations are higher among participants than the control group. If incremental savings from measure installations exist, program savings estimated through billing analysis must be adjusted to reflect only direct program savings – i.e., savings through conservation behaviors or measures installed outside of an energy efficiency program. The objective of the savings adjustment component of channeling analysis is to determine what portion of HER savings detected in billing analysis are also captured in other program databases, and adjust HER savings to reflect only direct savings. To estimate HER Direct Savings, we first estimate total HER program savings from billing analysis, and then estimate HER channeled savings as the difference between savings from other programs achieved by the HER participant group compared with the control group.

## Evaluation Results

The evaluation team found that the HER program has the potential to generate savings through three primary mechanisms: (1) through conservation actions; (2) through direct measure installations outside of rebate programs; and (3) through existing National Grid programs. The first two savings mechanisms are unique to the HER program, while the third mechanism—savings through existing National Grid programs—reflects savings that are already counted by other programs. From this first phase of our study, the evaluation results indicate that the majority of energy savings are direct (outside of other programs) and may also be generated through more equipment installation than originally thought.

Through all three sources, we found that electric pilot household verified savings averaged 184.1 kWh and 1.61% kWh savings per participant among electric pilot participants, for a total of 4,575 MWh across all households, representing 78.5% of the pilot’s first-year percent savings goal. Gas pilot participants

---

<sup>3</sup> Programs under evaluation include MassSave Home Assessment (Electric electric audit and measures; gas audit), ENERGY STAR<sup>®</sup> Appliances (electric), CoolSmart HVAC (electric), Appliance Recycling (electric), MassSave Weatherization (gas), and high-efficiency heating & hot water (gas).

averaged 9.93 therms and 0.77% therms savings per participant for a total of 260,437 therms across all households. These estimates represent 74.3% of the gas pilot's first-year percent savings goal.

### Source of Direct Savings

While overall savings estimates for the pilot program may not have met the program targets, our research suggests that the effective useful life of these savings may be greater than originally estimated and requires additional investigation.<sup>4</sup> Of unique savings gained through the HER program (outside of other programs), we estimate that many of these savings are due to measure installations. Electric pilot participants were more likely than control group members to self-report installing at least one measure in each of the following measure groups: high-efficiency consumer electronics (e.g., ENERGY STAR Televisions), building envelope measures (e.g., insulation), and low-cost measures (e.g., weather stripping). Gas pilot participants were more likely than control group members to self-report installing at least one measure in these measure groups: building envelope measures and light fixtures (indoor and outdoor) (Table 1).

**Table 1. Measure and Behavior Composites of Energy Saving Actions Taken by HER Participant and Control Groups (At least 1 of each group)<sup>a,b</sup>**

Measure Group	National Grid (Electric)		National Grid (Gas)		National Grid (All Fuels)		Lift in Uptake (Treatment % - Control %)
	Treat.	Cntl.	Treat.	Cntl.	Treat.	Cntl.	
High-Efficiency Measures							
Building Envelope (3)	<b>18.0***%</b>	10.7%	<b>13.9***%</b>	7.3%	<b>16.0***%</b>	9.0%	<b>7.0%***%</b>
Consumer Electronics (4)	<b>22.8**</b>	14.0	17.9	13.2	<b>20.4**</b>	13.6	<b>6.8%**</b>
Low-Cost Measures	<b>49.6**</b>	40.6	41.0	37.6	<b>45.3**</b>	39.1	<b>6.2%**</b>
Appliances (3)	28.2	22.8	21.5	16.8	<b>24.8^</b>	19.8	<b>5.0%^</b>
Light Fixtures (2)	9.3	9.2	<b>10.8^</b>	6.5	10.0	7.8	2.2%
Heating / Cooling (5)	11.9	8.6	8.6	8.1	10.2	8.4	1.9%
Behaviors							
Consumer electronics (5)	41.2	37.8	45.4	40.4	43.3	39.1	4.2%
Hot water usage (5)	41.2	35.1	39.8	37.6	40.5	36.3	4.2%
Lighting (4)	34.0	37.5	39.8	34.8	36.9	36.1	0.8%
Space heating and cooling (3)	27.2	28.7	34.7	31.6	30.9	30.1	0.8%
Refrigerator maintenance (3)	20.0	19.1	21.3	23.6	20.7	21.4	-0.7%
HVAC maintenance (5)	22.1	26.3	24.4	29.6	23.2	<b>27.9^</b>	<b>-4.7%^</b>
Home Energy Audit							
Home Energy Audit	3.7	4.9	8.2	7.3	5.9	6.1	-0.2%

<sup>a</sup> Measures metric: Purchased or installed at least one energy efficient item in measure group in past year (as % of eligible base). Note that this metric does not imply positive net savings from these measures, as some could be additional units.

<sup>b</sup> Behaviors metric: Started or increased at least one of items in behavior group in past year (as % of eligible base)

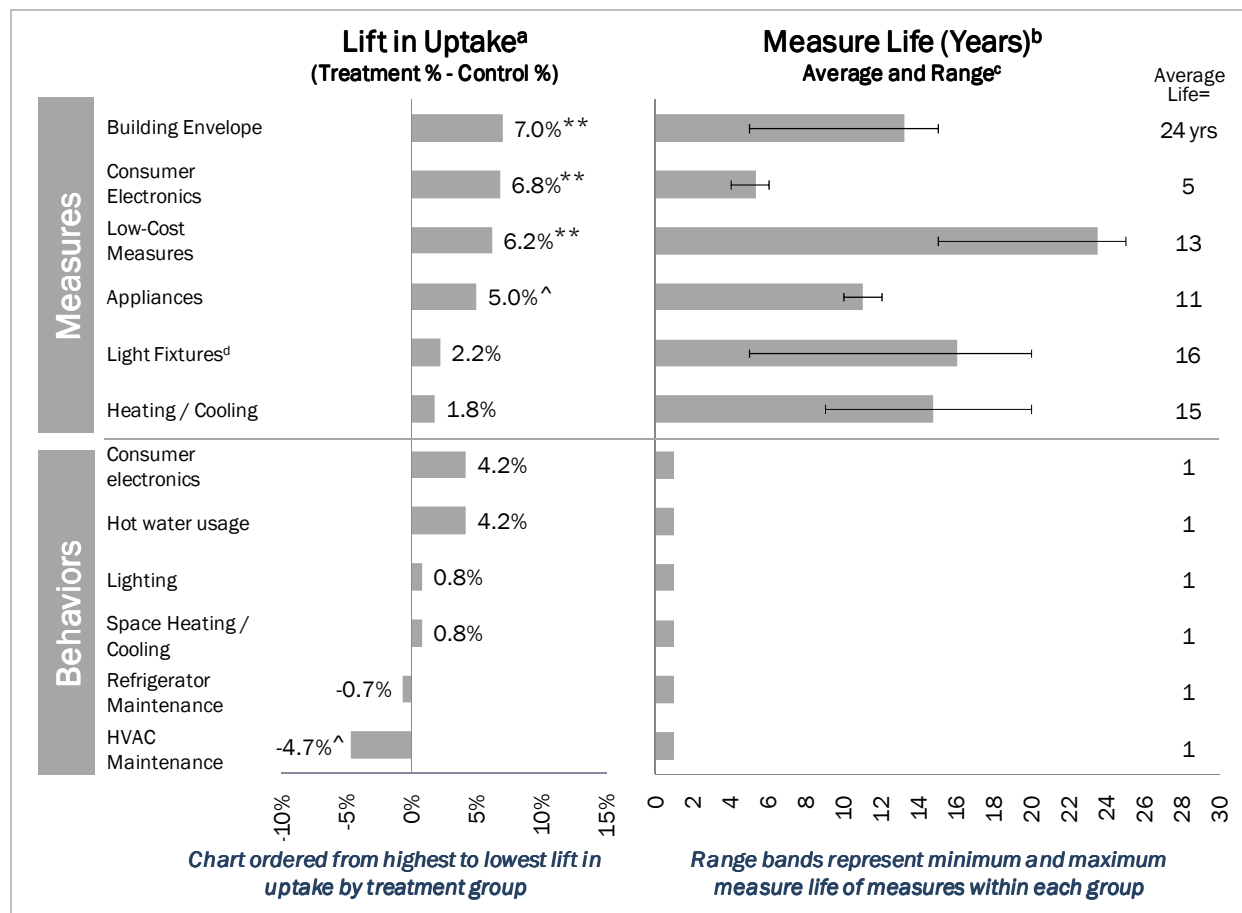
\*\* Difference between treatment and control statistically significantly greater than zero at 95% confidence level

^ Difference between treatment and control statistically significantly greater than zero at 90% confidence level

<sup>4</sup> We will further investigate these findings in our 2011 program evaluation, which will explicitly explore the persistence of the HER program.

Notably, HER participants did not report an overall change in conservation behaviors that surpassed the control group in our survey research. National Grid HER participants were no more likely to self-report taking new actions or increasing existing energy-saving behaviors over the control group. When we examine differences by unique behaviors (as opposed to composites), we see a few differences between the participant and control groups, but these differences do not show a clear trend in favor of the program — i.e., the control group was slightly more likely to change some conservation behaviors than the treatment group.

**Figure 1. Illustration of Potential Measure Life Range of HER Installation and Behavioral Savings**



<sup>a</sup> Source: Measure and behavior composites of energy saving actions taken by HER participant and control groups. Note this figure represents overall lift, not net positive changes (e.g. installations minus additions of additional or more energy intensive equipment)

<sup>b</sup> Source: Massachusetts Technical Reference Manual for Residential Electric Efficiency Measures (Effective Date 1/1/2011) – Estimate of average, minimum and maximum for each measure group based on measures within measure group. Note that measure life calculations weight by relative uptake of measures by control group, and do not attempt to account for savings.

<sup>c</sup> Range bands represent minimum and maximum measure life of measures within each group

<sup>d</sup> Note that “Light Fixtures” group excludes CFLs, which are in Low-Cost Measures group

\*\* Significantly higher than other treatment group at 95% confidence level

^ Significantly higher than other treatment group at 90% confidence level

### Savings Through Participation in Other Programs

Our channeling analysis results further support these findings. While the evaluation team found that the HER program is facilitating program participation in other National Grid programs, most of the of

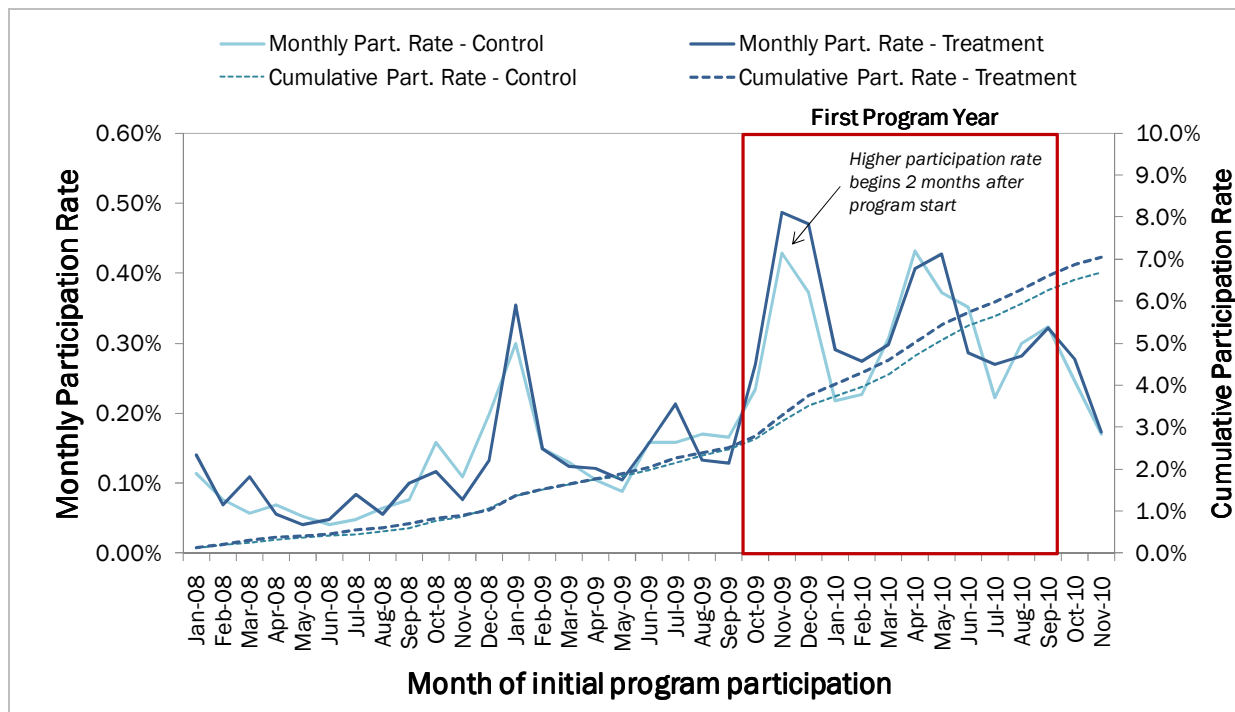
participation lift appears to occur between two and five months after the reports were delivered to participants and was relatively small (see

Figure 2 and Figure 3).

The HER program has channeled 88 incremental electric pilot participants into existing National Grid programs. However, the differences in participation did not result in incrementally higher deemed savings from program measures installed by program participants compared to those of the control groups (based on the statistical significance of difference between treatment and control savings from other National Grid programs).<sup>5</sup> Estimates of incremental savings gained through gas programs were greater: We estimate that 4.7% of per household gas savings detected in billing analysis were gained through program channeling (i.e., the joint effect of the HER and other programs).

While we did not find evidence of incremental channeled savings among electric pilot households, there appears to be variation in program participation by treatment group (a higher participation rate overall and a higher participation rate in the Home Assessment program), indicating there is no universal relationship in the HER's channeled savings. Notably, our initial review of the expansion electric cohort found that participation in other programs is greater than the pilot estimates, indicating a potential trend towards greater incremental program participation in 2010 for electric customers.

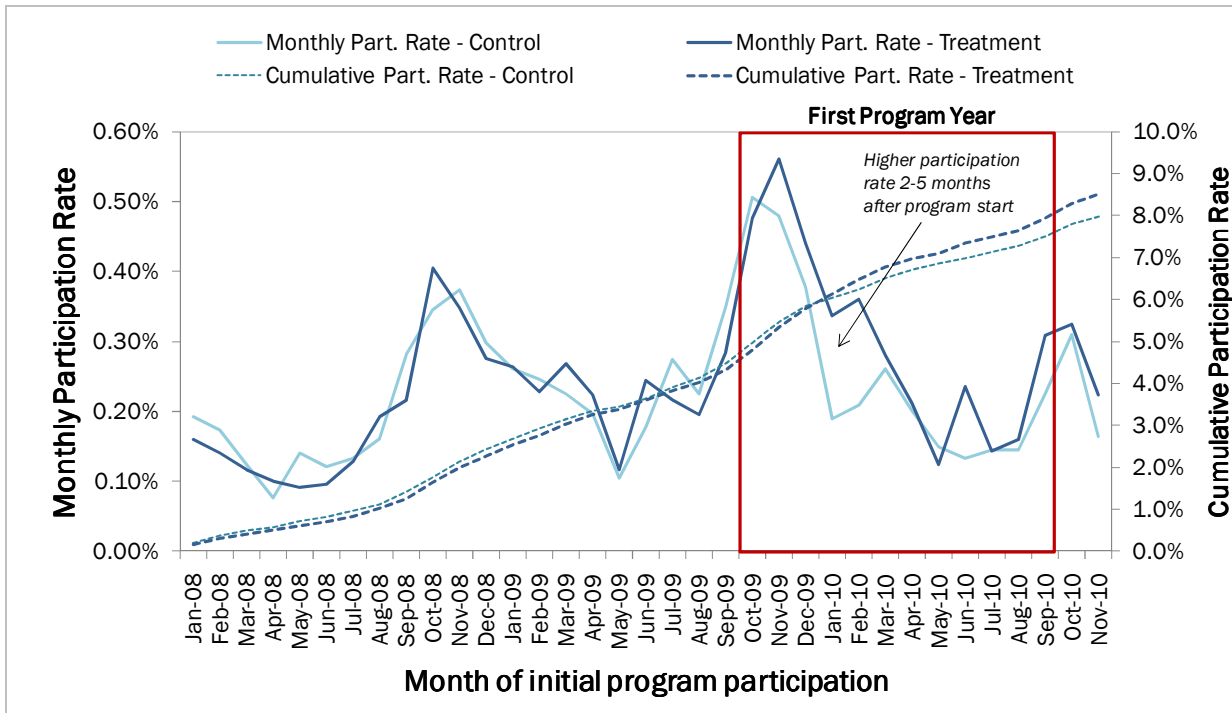
**Figure 2. Trended Electric Program Participation Rate for Electric Pilot Cohort<sup>a</sup>**



<sup>a</sup> Monthly participation rate captures the number of households that *first* initiated participation in a National Grid energy efficiency program in that month. A participating household is only counted once, in the month that it initiated participation in any of the programs under evaluation. The cumulative participation rate captures the proportion of households that had initiated participation in any program on or before that month.

<sup>5</sup> Our data found that the program may have gained an additional 1.07 kWh savings per household through other electric programs — the difference between average savings from other programs achieved among participant households compared with control group households — but these incremental savings were not statistically significant (p-value of 0.7184 in a two-tailed test).

**Figure 3. Trended Gas Program Participation Rate for Gas Pilot Cohort**



**Table 2. National Grid Program Participation among HER Participants and Control Group**

Cohort	Electric Pilot		Gas Pilot	
	Control	Treatment	Control	Treatment
Group size (n)	24,752	24,853	24,876	24,994
<b>Before Behavioral Program</b>				
Participants in other EE programs <sup>a</sup>	467	457	796	766
Participation Rate	1.89%	1.84%	3.20%	3.06%
Difference in Participation Rate	-0.05%		-0.14%	
p-value of difference	0.693		0.386	
Incremental Participants	n/a		n/a	
<b>After Behavioral Program (PY1)</b>				
Participants in other EE programs	956	1,048	798	962
Participation Rate	3.86%	<b>4.22%**</b>	3.21%	<b>3.85%**</b>
Difference in Participation Rate	<b>0.35%**</b>		<b>0.64%**</b>	
p-value of difference	0.045		0.0001	
Incremental Participants	88		160	

<sup>a</sup> Participation in other EE programs specific to fuel type—i.e., for the electric pilot, this is the number that initiated participation in any electric EE program during the analysis period.

\*\* Significantly higher than other treatment group at 95% confidence level

^ Significantly higher than other treatment group at 90% confidence level

**Table 3. Home Energy Report Net Savings and Performance against Goals, PY1**

	Electric Pilot Participants			Gas Pilot Participants		
	Average % Reduction in kWh	Average kWh Savings per Household	Total MWh Savings <sup>a</sup>	Average % Reduction in Therm	Average Therm Savings per Household	Total Therm Savings <sup>a</sup>
<b>Program Goal<sup>b</sup></b>	<b>2.05%</b>	<b>228.78</b>	<b>5,825</b>	<b>1.04%</b>	<b>13.10</b>	<b>334,280</b>
Net Program Savings, from Billing Analysis	1.61%	184.07	4,575	0.81%	10.42	260,437
Incremental savings from other programs	--	--	--	0.04%	0.49	12,180
<b>Net Program Savings, Final</b>	<b>1.61%</b>	<b>184.07</b>	<b>4,575</b>	<b>0.77%</b>	<b>9.93</b>	<b>248,257</b>

Of those who were aware of the HER program, our survey research found that participants are self-reporting installing more measures that are eligible for rebates when compared with the control group. As indicated in the table below, our survey found that while HER participants are taking more rebate-eligible actions as a result of the HER program (top row), they are only seeking out rebates for about one-third of these energy efficiency purchases (middle row). These findings further suggest that the program savings obtained through rebate programs are primarily direct. Based on self-report, at least two-thirds of the savings from incremental rebate-eligible items are likely not counted by rebate programs, and there may be incremental savings from incremental measures that participants are installing that are not rebate-eligible (e.g., lift in low-cost measure installation rate shown in Figure 1).

**Table 4. Rebates for Energy Efficient Measures**

	National Grid (Electric)		National Grid (Gas)		National Grid (All Fuel)	
	Part.	Cntl.	Part.	Cntl.	Part.	Cntl.
Purchased any rebate-eligible item (as % of total n)	<b>45.4%**</b>	34.4%	<b>36.8%**</b>	27.9%	<b>41.1%**</b>	31.1%
Used rebate (as % of people with at least one eligible purchase)	29.8%	33.7%	34.8%	28.6%	32.0%	31.4%
Used rebate (as % of total n)	13.5%	11.6%	<b>12.8%^</b>	8.0%	<b>13.2%^</b>	9.8%
Total n	250	251	251	250	501	501

Note: Please refer to questions PE9a-PE9t in the Topline Results document for the rebate-eligible items.

\*\* Significantly higher than other treatment group at 95% confidence level.

^ Significantly higher than other treatment group at 90% confidence level.

### Participant Characteristics as Potential Predictors of Action

In addition, our data suggest that a number of factors, including but not limited to baseline energy consumption, may correlate with greater energy savings. In addition to baseline consumption (widely understood to predict savings potential), we found that household composition, and demographic and ideological differences play a role in the likelihood to take actions across National Grid pilot customers (including the control group), indicating potential predispositions to take different types of energy saving actions.<sup>6</sup>

<sup>6</sup> We classified survey respondents as falling above vs. below the median (within their cohort) in terms of (1) measure uptake: the number of high-efficiency measures purchased or installed in the past year (adjusted for household equipment / capacity to install measures); and (2) behavior change: the number of net positive behavior changes made in the past year (adjusted for household equipment/capacity to make changes).



Specifically, National Grid pilot customers with high measure uptake (relative to other customers) were significantly more likely to be white, live in a single-family detached home, and describe themselves as liberal or moderate compared with customers with low measure uptake. There is also a slight difference in the income distribution, with slightly more customers with high measure uptake having annual household income over \$100,000. These differences may be related to ability to purchase high-efficiency equipment for the home. Notably, there were not differences in household composition (such as number of occupants and children) for this group, with the exception of higher prevalence of living in single-family homes.

The story is slightly different for behaviors — pilot customers who made a relatively high number of behavior changes have more people in the household (3.1) compared with households who made a low number of behavior changes (2.9 people in the home). They are also relatively more likely to have children in the household (47% have children under 18 in the household), be younger (54% are between the ages of 35-54), be female, and be non-white. These factors suggest that household composition may play a stronger role in adoption of behavior changes compared with higher-cost measure installation.

**Table 5. Demographic and Housing Characteristics of Respondents with Low and High Measure Uptake and Low and High Behavior Change**

		Low Measure Uptake	High Measure Uptake	Low Behavior Uptake	High Behavior Uptake	
<b>Demographics</b>						
Age	under 35	3.0	3.5	1.6	4.9	
	35-54	45.3	48.2	40.0	<b>53.5**</b>	
	55+	51.7	48.2	58.4	<b>41.7**</b>	
Household size	Avg. number of people	2.9	3.1	2.9	<b>3.1**</b>	
Children in household	At least 1 child <18 yrs	39.5	44.3	36.8	<b>46.9**</b>	
Education of respondent	Bachelor's or higher	62.1	65.2	65.6	61.6	
Household Income	under 50K	21.0	16.8	<i>^ difference in overall income distribution</i>	19.2	18.6
	50-100K	40.7	36.6		41.4	36.1
	100-200K	31.2	36.6		31.0	36.5
	200K or higher	7.1	10.1		8.4	8.8
Gender	Female	56.8	52.1	51.4	57.6 <sup>^</sup>	
Race	White	90.5	<b>95.0**</b>	<b>94.2<sup>^</sup></b>	91.2	
<b>Housing</b>						
Homeownership	Own	97.1	98.4	98.4	97.0	
Housing type	Single-family detached	92.1	<b>95.5**</b>	94.4	93.2	
Home size	Avg. square feet	3,339	3,355	3,310	3,384	
Age of house	Before 1960	55.5	51.9	55.3	52.1	
	1960-1990	31.5	34.8	33.0	33.2	
	1990 or later	13.1	13.4	11.7	14.7	
<b>Changes in past year</b>						
Household occupancy	Increase in occupancy	7.7	8.3	6.6	9.4	
	Decrease in occupancy	14.9	11.4	13.2	13.2	
	No change	77.4	80.3	80.2	77.5	
Employment status of people in household	Increase in employment	4.7	5.1	4.4	5.4	
	Decrease in	17.7	19.6	16.8	20.4	

	employment				
	No change	77.6	75.4	78.8	74.2
<b>Other</b>					
Politics	Liberal or moderate	64.1	<b>69.6<sup>^</sup></b>	65.4	68.2
	Conservative	<b>35.9<sup>^</sup></b>	30.4	34.6	31.8
Total n		509	493	500	502

\*\* Statistically significant increase over other group at 95% confidence level

<sup>^</sup> Statistically significant increase over other group at 90% confidence level

Note: All figures are percentages, unless denoted as “Avg.” (average). Significance testing based on chi-squared test (if more than two categories) or z-test (if two categories; only one shown).

There is a relationship between high and low measure uptake and the overall income distribution at a 90% confidence level based on a chi-squared test for joint significance.

## Conclusions

Our findings indicate that National Grid’s HER program is generating savings. Our survey data indicate that, when asked, participants and control group members perform similarly on conservation actions both in terms of new behavioral adoption and in terms of intensity of actions taken. This finding is meaningful in that it calls into question exactly what types of behaviors are generating program savings. Further, our survey research and channeling analysis both indicate that HER participants are installing more energy efficient measures compared to our control group, and that these installations were taken, in large part, outside of existing National Grid programs. Thus, a greater proportion of HER participant savings were gained through direct measure installations (compared to changes in conservation behaviors) than previously thought. While these results are preliminary and will be verified through future evaluations, the findings indicate that it may be necessary to revisit the effective useful life assumptions of the HER program.

As part of the 2011 evaluation efforts, our team will be integrating these survey results with billing data to estimate the weighted average of savings by measure. This analysis will provide greater insight into the source of the savings and will allow us to determine if increases in the estimate of the potential effective useful life of the HER program are warranted due to the magnitude and persistence of savings due to measure installations.

In addition, our data also suggests that the type of participants who take conservation compared to efficiency actions may be different. This finding suggests that program targeting and planning may be further refined to maximize savings by targeting household demographic characteristics rather than relying on housing stock and baseline energy use alone.