NAVIGANT

Residential Education and Outreach Program Impact Evaluation Report

Home Energy Reports Program

Energy Efficiency Plan: Gas Plan Year 6 (6/1/2016-12/31/2017)

Presented to
Peoples Gas and North Shore Gas

FINAL

August 14, 2018

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Home Energy Report Impact Evaluation Report

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E. EXECUTIVE SUMMARY

This report summarizes Navigant Consulting, Inc.'s (Navigant's) findings and results from the impact evaluation of the sixth program year (GPY6)[1] of the Peoples Gas (PGL) and North Shore Gas (NSG) Home Energy Reports (HER) programs. Initially launched in 2013, these programs are designed to generate energy savings by providing residential customers with information about their energy use and energy conservation suggestions and tips. Program participants receive information in the form of home energy reports.

In GPY6 the HER programs of both utilities were restructured to adjust the numbers of customers that participated. Both programs began with an initial wave of participants and controls ("Wave 1") in October 2013, the fifth month of GPY3. A second wave was added to the NSG program in September 2015, the fourth month of GPY5 ("Wave 2").[2] In GPY6 these waves were restructured twice – once to reduce the number of participants and again to add participants. Due to the timing of these adjustments, Navigant's GPY6 evaluation of the programs is broken into a twelve-month evaluation of the first set of these restructured waves ("Wave 2016-12mo") and a separate seven-month evaluation of the second set ("Wave 2017-7mo"). For this reason, Navigant urges caution when comparing GPY6 program savings with program savings in prior years: since the numbers of customers participating in the GPY6 waves differ significantly from those in previous waves, the program results in GPY6 are not directly comparable to those achieved in prior years.[3]

An important feature of the PGL and NSG HER programs is that both are designed as randomized controlled trials (RCTs).[4] Customers in the target group of residential customers from each utility are randomly assigned to either the recipient group or the control (non-recipient) group for the purpose of estimating changes in energy use due to the program. Customers may opt *out* of the program at any time but cannot opt *in* due to the RCT design. An implication of the RCT design is that the savings estimates are intrinsically net of free-ridership and most spillover bias. Unless otherwise noted, reported "savings" in this report refer to *net savings*.[5]

E.1 Program Savings

Table E-1 summarizes the GPY6 natural gas savings from the PGL and NSG HER Programs. In its evaluation of GPY6 PGL and NSG HER programs, Navigant verified net savings of 366,991 and 279,414

[1] GPY6 began June 1, 2016 and ended December 31, 2017.

[2] See Navigant, "Residential Education and Outreach Program Evaluation Report: Home Energy Reports Program," Final, Gas Plan Year 5 (March 31, 2017) for more information.

[3] The same comment applies when comparing the results of the GPY6 waves to one another. Additional details on the program restructuring in GPY6 are provided in section 1.1 below.

[4] In selecting each wave, the program implementer, Oracle, randomly allocated targeted PGL and NSG residential customers between participant and control groups. As each wave was added, Navigant confirmed that the usage data was consistent with an RCT design.

[5] In some instances, the word "net" appears in column headings and summary sentences for added clarity.

therms prior to the uplift adjustment[6], resulting in verified gross realization rates for the two programs of 0.92 and 1.16. The verified net therms savings for the PGL and NSG programs after uplift adjustment were 352,754 and 262,337, respectively.

Table E-1. GPY6 Peoples Gas and North Shore Gas HER Program Savings

Utility	*Ex-ante* Savings[7] (Therms)[8]	Verified Savings Prior to Uplift Adjustment (Therms)	Verified Realization Rate[9]	Total Uplift Adjustment* (Therms)	Verified Net Savings After Uplift Adjustment (Therms)
PGL	398,766	366,991	0.92	14,237	352,754
NSG	240,831	279,414	1.16	17,077	262,337

Source: Navigant analysis of PGL and NSG customer billing data.
* The total uplift adjustment includes both the uplift calculated for GPY6 and the legacy uplift from GPY3, GPY4, and GPY5. See Section 6.4 for details.

By way of comparison, Table E-2 summarizes the GPY5 natural gas savings from the PGL and NSG HER Programs. In Navigant's evaluation of GPY5 PGL and NSG HER programs, it verified net savings of 2,520,299 and 1,021,659 therms, respectively, resulting in realization rates of 0.98 and 1.01 percent. Verified net savings after uplift adjustment was 2,447,961 and 992,342, respectively.

Table E-2. GPY5 Peoples Gas and North Shore Gas HER Program Savings

Utility	*Ex-ante* Savings (Therms)	Verified Savings Prior to Uplift Adjustment (Therms)	Verified Realization Rate	Total Uplift Adjustment (Therms)	Verified Net Savings After Uplift Adjustment (Therms)
PGL	2,583,885	2,520,299	0.98	72,338	2,447,961
NSG	1,008,829	1,021,659	1.01	29,317	992,342

Source: Navigant analysis of PGL and NSG customer billing data.

E.2. Program Volumetric Detail

Table E-3 presents participation details for the GPY6 PGL and NSG HER programs. In GPY6, PGL and NSG restructured their HER programs, twice adjusting the size of the programs to more closely align them with their overall savings goals. This resulted in two new waves, which Navigant evaluated separately. The first wave ("2016-12mo"), was a randomly-selected subset of participants from the waves in prior years. The second wave ("2017-7mo") added back some of the dropped customers to the 2016-12mo waves. Since all customers in the 2016-12mo waves are included in the 2017-7mo waves,

[6] Uplift refers to the impact of the HER program on enrollment in *other* PGL and NSG EE programs. To avoid double-counting the savings from this indirect effect, Navigant subtracts the estimated uplift savings from the total HER program savings, including legacy uplift from prior years (cf. Section 6.4 for details). The fact that uplift savings is subtracted from the HER programs' total energy savings does not indicate that the uplift savings was not *caused by* the HER programs, or that the HER programs shouldn't be credited for its occurrence. It is an accounting adjustment to avoid double-counting when aggregating savings over multiple EE programs. Indeed, the existence of uplift is an indicator of successful cross-marketing by the HER programs, and thus should be seen as an added program benefit.

[7] The term *ex-ante* refers to the forecasted savings reported by the Program Administrator that have not been independently verified through evaluation. Savings that have been independently verified by Navigant are referred to as "Verified".

[8] Ex Ante therm savings from email communication from Brittany Gifford, Oracle, June 19, 2018.

[9] Verified Gross Realization Rate (RR) = Verified Gross Savings/*ex-ante* Gross Savings. Thus, Verified Gross Savings = RR * *ex-ante* Gross Savings

the evaluation periods do not overlap.[10] The two PGL waves achieved average savings rates of 0.70 and 0.38 percent in GPY6, while the NSG waves had average savings rates of 1.03 and 0.61 percent, respectively.

Table E-3. GPY6 Peoples Gas and North Shore Gas HER Program Participation Detail

Utility/Wave	Number of Participants	Number of Controls	Average Participant Savings (therms)	Average Savings Rate	Average Savings Rate Standard Error
NSG 2016-12mo	12,059	18,992	11.58	1.03%	0.25%
NSG 2017-7mo	62,892	17,274	2.22	0.61%	0.27%
PGL 2016-12mo	26,574	19,455	10.09	0.70%	0.21%
PGL 2017-7mo	53,501	17,268	1.85	0.38%	0.24%

Source: Navigant analysis of PGL and NSG customer billing data.

E.3 Findings and Recommendations

For PGL, the total verified energy savings for GPY6 was 366,991 therms prior to the uplift adjustment, and 352,754 therms after the adjustment. For NSG, the corresponding figures were 279,414 therms and 262,337 therms, respectively.

Finding 1. The aggregate therm saving for both programs declined in GPY6 compared to GPY5, primarily because the number of participants was reduced due to the restructuring. Because of this, caution should be exercised when comparing the savings achieved in GPY6 to that achieved in previous years, since the underlying groups on which the estimates were based had changed.

Finding 2. The average savings rates for the 2016-12mo waves are larger than those of the corresponding 2017-7mo waves. This was expected, since the evaluation period for the 2017-7mo waves ran only for seven months (June 2017-December 2017), and thus did not include a full heating season, rather than the twelve months covered by the 2016-12mo waves (June 2016 through May 2017).

[10] The "2016-12mo" waves covered June 2016 through May 2017, and the "2017-7mo" waves covered June 2017-December 2017. Navigant evaluated the waves separately because the treatment and control samples had each changed relative to what had come before, which meant they weren't comparable.

1. INTRODUCTION

1.1 Program Description

This report presents a summary of the findings and results from the impact evaluation of the gas program year 6 (GPY6) Peoples Gas (PGL) and North Shore Gas (NSG) Home Energy Reports (HER) programs. These programs are designed to generate energy savings by providing residential customers with information about their energy use and energy conservation suggestions and tips. Program participants receive information in the form of home energy reports that give customers various types of information, including:

- Assessments of how their recent energy use compares to their own energy use in the past
- Tips on how to reduce energy consumption, some of which are tailored to their own circumstances
- Information on how their energy use compares to that of neighbors with similar homes

Recipient customers received reports by mail and were also invited to log onto a dedicated program website that offers suggestions of additional opportunities to save energy, and allows participants to fine-tune their profiles and report conservation steps that they have taken. Other studies have shown that receiving reports containing this type of information can stimulate customers to reduce their energy use, creating average energy savings in the one percent to three percent range, depending on local energy use patterns.

In GPY6, PGL and NSG restructured their HER programs to bring the size of the programs in line with their overall savings goals. This resulted in two new waves with reduced numbers of participants relative to waves in prior program years. At the beginning of GPY6 the programs kept all of the controls from the set of GPY5 waves but retained only a randomly-selected subset of the participants, resulting in Wave 2016-12mo.[11] In June 2017, the utilities again restructured the program, adding back a random subset of participants from the original GPY5 waves who had not been included in Wave 2016-mo, which resulted in Wave 2017-7mo. Since each restructuring resulted in a changed sample of participants, Navigant evaluated each wave separately.

An important feature of the PGL and NSG HER programs is that both were designed as randomized controlled trials (RCTs). Customers in the target group of residential customers from each utility were randomly assigned to either the recipient group or the control (non-recipient) group for the purpose of estimating changes in energy use due to the program. When the waves were restructured in GPY6, the treatment customers in the newly-formed waves were randomly chosen from the original waves to retain this RCT program design. Having an RCT experimental design makes the process of verifying energy savings much simpler and more robust: among other things, it effectively eliminates free-ridership bias and thus the need for net-to-gross research. Customers may opt *out* of the program at any time, but they cannot opt *in* due to the RCT design. Navigant verified the random allocation of participants and controls for all new waves in GPY6.

In its GPY3 evaluation report, Navigant confirmed the RCT design of both programs by comparing the distributions of monthly energy usage of each treatment group-control group pair and verifying that they

[11] We have labeled the new program waves thusly to make clear that each one existed for a discrete, non-overlapping subset of GPY6: the first June 1, 2016 to May 31, 2017 and the second from June 1 to December 31, 2017.

were consistent with randomized allocation.[12] Navigant performed a similar exercise for each wave in GPY6, which is detailed in the Appendix.

In GPY6 the NSG HER program had 12,059 participants and 18,992 controls in the Wave 2016-12mo, and 62,892 participants and 17,274 controls in Wave 2017-7mo. For the PGL HER program the corresponding figures were 26,574 participants and 19,455 controls in Wave 2016-12mo, and 53,501 participants and 17,268 controls in Wave 2017-7mo (see Table 1-1).

Table 1-1. Synopsis of GPY6 PGL and NSG HER Program Waves

Utility/Wave	Number of Participants	Number of Controls	Participant Average Daily Usage in Post Period (Therms)
NSG 2016-12mo	12,059	18,992	3.13
NSG 2017-7mo	62,892	17,274	1.70
PGL 2016-12mo	26,574	19,455	4.04
PGL 2017-7mo	53,501	17,268	2.28

Source: Navigant analysis of PGL and NSG customer billing data.

Table 1-1 illustrates two key features of the program restructuring that occurred in GPY6: reduced numbers of participants relative to GPY5, and the lower average participant daily usage levels of Wave 2017-7mo compared to Wave 2016-12mo. For comparison, Table 1-2 shows the numbers of participants in the GPY5 programs.

Table 1-2. Synopsis of GPY5 PGL and NSG HER Program Waves

Utility/Wave	Number of Participants	Number of Controls
PGL	151,200	18,766
NSG (Wave 1)	91,349	18,684
NSG (Wave 2)	10,526	2,465

Source: Navigant, "Residential Education and Outreach Program Evaluation Report: Home Energy Reports Program," Final, Gas Plan Year 5 (March 31, 2017).

1.2 Evaluation Objectives

The primary objective of this report is to determine the extent to which the HER program caused PGL and NSG participants to reduce their energy consumption in GPY6, and to assess how program savings changed from the previous program year. A secondary objective is identifying uplift in other PGL and NSG energy efficiency (EE) programs due to the Oracle programs to avoid double-counting energy savings when aggregating across programs. The only process research Navigant pursued for either program in GPY6 consisted of interviewing the program managers, which limits the evaluator's ability to address questions such as why realization and savings rates differed between PGL and NSG programs.

[12] Navigant, 2014. *Home Energy Reports Program GPY3 Evaluation Report Presented to Peoples Gas and North Shore Gas*

2. EVALUATION APPROACH

The evaluation approach used to produce the results presented in this report is consistent with that of the evaluation in the previous program year, and with evaluations of similar programs in other utilities' territories, relying on statistical analysis appropriate for measuring the impacts of RCTs.

2.1 Overview of Data Collection Activities

Navigant received tracking and monthly billing data for all program participants and control customers for the June 2016 to December 2017 period from the program implementer, as shown in Table 2-1.

Table 2-1. Primary Data Collection Activities

Collection Method	Subject Data	Quantity	Net Impact	Process
Customer Billing Data	Program Participants and Controls	All	X	N/A
Program Tracking Data	Program Participants and Controls	All	X	N/A
Tracking Data for Other Programs	Participants in Other Programs	All	X	N/A

Source: Navigant analysis.

For purposes of estimating the GPY6 program impacts, Navigant also used pre-program billing data. For Wave 2016-12mo the pre-period included the twelve-month period from October 2012 through September 2013. For Wave 2017-7mo the pre-period included the seven-month period from October 2012 through December 2012 and June 2013 through September 2013.[13] These correspond to the months before the RCT start date in the original waves created by NSG and PGL. Since all the restructured GPY6 waves comprised customers drawn from prior HER waves, these reflect the appropriate counterfactual for the GPY6 evaluation.

2.2 Sampling Plan

The PGL and NSG HER programs were designed and operated by the program implementer as an RCT, in which individual customers from each utility's target customer group were randomly assigned to either a treatment (participant) or control group for the purpose of measuring program energy savings. When the program was restructured in GPY6, the treatment customers in the newly-formed waves were randomly chosen from the original waves to retain this RCT program design. Data for all participants and controls were included in the impact evaluation.

2.3 Data Used in Impact Analysis

In preparation for the impact evaluation, Navigant combined and cleaned the data provided by the implementer. Navigant performed the following data cleaning steps:

[13] Navigant used non-contiguous months to evaluate Wave 2017-7mo to ensure we compared usage in the same calendar months (i.e., December usage in the program period was compared to December usage in the pre-program period, and so on).

- Exclude post-period data from outside of the period of examination (June 2016 through May 2017 for Wave 2016-12mo, and June 2017 through December 2017 for Wave 2017-7mo)
- Subset to relevant pre-period data for each wave
- Remove exact duplicate observations
- Aggregate bills that end in the same month
- Exclude outlier observations, defined as observations with average daily usage outside plus or minus one order of magnitude from the median usage[14]

Detailed accounts of the customers and observations removed by each cleaning step for wave are included in Section 6.1 of the Appendix.

2.4 Statistical Models Used in the Impact Evaluation

Navigant estimated program impacts using two approaches: a lagged dependent variable regression (LDV) analysis with lagged individual controls and a linear fixed-effects regression (LFER) analysis, both applied to monthly billing data. Both approaches should, in principal, produce unbiased estimates of program savings under a wide range of conditions, but Navigant prefers the LDV results for two reasons. First, savings estimates produced by the LDV model tend to be more accurate and more precisely estimated than those from the LFER model[15] based on past experience analyzing similar HER programs' impacts and recent findings from the academic literature.[16] Second, the implementer uses a similar model for their evaluation, which makes the two sets of results comparable. Although the LDV and LFER models are structurally very different, they should generate similar program savings estimates, assuming the RCT is well balanced with respect to the drivers of energy use. Navigant used the LDV results for reporting total program savings for GPY6, while the LFER provided a robustness check.

The LFER model combines cross-sectional and time-series data in a single panel dataset. The regression essentially compares pre- and post-program billing data for participants and controls to identify the effect of the program on usage. The customer-specific fixed effect is a key feature of the LFER analysis and captures all customer-specific factors affecting natural gas usage that do not change over time, including those that are unobservable. Examples of the latter include the construction and square footage of the premise, the number of occupants, the amount of seasonal sun exposure, and the thermostat settings. The fixed effect represents an attempt to control for any small, systematic differences between the treatment and control customers that might occur due to chance.

Like the LFER model, the LDV model also combines cross-sectional and time-series data in a panel dataset. Unlike the LFER model, however, it uses only the post-program data for estimation and includes the customer's lagged energy usage for the same calendar month of the pre-program period to serve as the control for any small, systematic differences between the treatment and control customers, in that sense serving the same purpose as the customer fixed effect included in the LFER model. Section 6.3 of the Appendix presents the details of the LDV and LFER models used in the analysis.

[14] Navigant removed observations with usage outside the following range: median daily usage plus or minus 10 times median daily usage for each utility wave.

[15] One likely reason for this is that the LDV model embodies more flexibility than the LFER model, in that the former allows the individual customer control variable to vary seasonally while the latter does not – a particularly attractive feature given the highly seasonal nature of natural gas usage. The LFER model treats all unobserved inter-household heterogeneity affecting households' energy usage as time-invariant, while the LDV model uses lagged individual controls that can vary over time. This is discussed in more detail in section 6.2.1 of the Appendix.

[16] Allcott, Hunt and Todd Rogers, 2014. "The Short-Run and Long-Run Effects of Behavioral Intervention: Experimental Evidence from Energy Conservation." *American Economic Review*, 104(10): 3003-37.

2.5 Accounting for Uplift in Other Energy Efficiency Programs

The home energy reports sent to participating households included energy-saving tips, some of which encouraged participants to enroll in other PGL-NSG EE programs. If participation rates in other EE programs were the same for HER participant and control groups, the savings estimates from the regression analysis are already "net" of savings from the other programs, as this indicates the HER Program had no net effect on participation in the other EE programs. However, if the receipt of HERs increased participation rates of recipients relative to controls in other EE programs, then the combined savings across all programs would be lower than indicated by the simple summation of savings in the HER and the other EE programs. For instance, if the HER Program increases participation in another EE program, the resulting increase ("uplift") in savings may be allocated to either the HER Program or the EE program, but cannot be allocated to both programs simultaneously.[17]

As data permitted, Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs. To calculate the DID statistic, Navigant subtracted the change in the participation rate in another EE program between GPY6 and the pre-program period for the control group from the same change for the treatment group. For instance, if the rate of participation in an EE program during GPY6 is five percent for the treatment group and three percent for the control group, and the rate of participation during the year before the start of the HER Program is two percent for the treatment group and one percent for the control group, then the rate of uplift due to the HER Program is one percent, as reflected the following calculation:

(GPY6 treatment group participation – pre-PY treatment group participation) – (GPY6 control group participation – pre-PY control group participation) = DID statistic

(5% – 2%) – (3% – 1%) = 1%

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and control groups, or when they are different due only to differences between the two groups in time-invariant factors, such as the square footage of the residence.

An alternative statistic that generates an unbiased estimate of uplift when the baseline average rate of participation in the EE program is the same for the treatment and control groups is a simple difference in participation rates during GPY6. Navigant uses this alternative statistic –the "post-only difference" (POD) statistic –in cases where the EE program did not exist for the entire pre-program year.

Navigant examined the uplift associated with three other PGL-NSG EE programs: Home Energy Jumpstart, Home Energy Rebate, and Multifamily Energy Savings. For each EE program, uplift savings were calculated separately for each utility. In addition, legacy uplift (uplift from GPY5, GPY4, and GPY3) was also calculated. These calculations are described in greater detail in Section 6.4.

2.6 Process Evaluation

Navigant's GPY6 PGL and NSG HER process evaluations were limited to interviews with the program implementer to update our information about the program, including plans for an additional wave of participants in GPY6. No participant surveys or interviews were pursued.

[17] It is not possible to avoid double-counting of the savings generated by programs for which tracking data are not available, such as upstream lighting programs.

3. GROSS IMPACT EVALUATION

Total program savings are summarized in Table 3-1 below. The reported savings from the implementation contractor was 398,766 therms for PGL and 240,831 therms for NSG. Verified savings, prior to uplift, was 366,991 therms for PGL and 279,414 therms for NSG. PGL caused 14,237 therms of uplift savings in other EE programs while NSG caused 17,077 therms of uplift, resulting in final GPY6 verified savings of 352,754 therms for PGL and 262,337 for NSG. PGL had a gross realization rate of 0.92, and NSG's gross realization rate was 1.16. The uplift adjustment resulted in a 6.1 percent decrease in the net savings for NSG, and a 3.9 percent decrease for PGL which the implementer did not account for in their savings estimate.

Table 3-1. GPY6 PGL and NSG HER Program Gas Savings

Savings Category	PGL Savings (therms)	NSG Savings (therms)
Implementer Estimated Savings*	398,766	240,831
Verified Savings Prior to Uplift Adjustment	366,991	279,414
Verified Net Savings after Uplift Adjustment	352,754	262,337
Verified Gross Realization Rate†	0.92	1.16

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

* This estimate comes from the implementation contractor's ex-post analysis of the program.

† Calculated as the ratio of verified savings prior to uplift adjustment to implementer estimated savings.

3.1 LDV and LFER Model Parameter Estimates

The LDV and LFER models generated very similar results for program savings estimates. Navigant used the LDV results for reporting GPY6 total program savings. Across the two models, the parameter estimates are not statistically different; that is, the estimates for each model are within the 90 percent confidence bounds for the other model. Furthermore, the pattern across the different program waves between the two models is very similar. Section 6 includes detailed estimate information for each wave and model.

3.2 Uplift Analysis Results

The LDV estimates of program savings include savings that resulted from the uplift in participation in other EE programs caused by the HER programs. To avoid double-counting when aggregating savings across programs, program savings resulting from this uplift must be counted towards either the HER Program or the other EE programs, but not both programs. Legacy uplift captures energy savings from previous program years for measures that have multi-year measure lives. GPY6 uplift captures savings from other EE programs that occurred in GPY6, while legacy uplift reflects uplift remaining from prior program years (GPY3, GPY4, and GPY5). For PGL, the GPY6 uplift was 8,013 therms and legacy uplift was 6,224. For NSG, these figures were 2,769 and 14,308 respectively. Table 3-2 shows how the uplift adjustment affects total savings.

Table 3-2. GPY6 PGL and NSG Uplift Results

	PGL Savings (therms)	NSG Savings (therms)
Verified Net Savings, Prior to Uplift Adjustment	366,991	279,414
GPY6 Uplift Adjustment	8,013	2,769
Legacy Uplift Adjustment	6,224	14,308
Final Verified Net Savings	352,754	262,337

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

Section 6.4 in the appendix presents the detailed calculations of GPY6 and legacy uplift for each of the three EE programs considered in the analysis: the HEJ (Home Energy Jumpstart), HEReb (Home Energy Rebate), and MF (Multi-Family) programs.

3.3 Verified Program Impact Results

Table 3-3 summarizes estimated program savings by participant wave, including GPY6 and legacy uplift adjustments. The table also included the number of participants, controls, and average savings rates. Both verified savings prior to uplift and average savings rates include standard error figures. After adjusting for uplift, verified savings were 137,735 therms and 124,601 therms for the first and second NSG waves, respectively, and 261,746 therms and 91,009 therms for the PGL waves.

Table 3-3. PGL and NSG GPY6 HER Program Savings

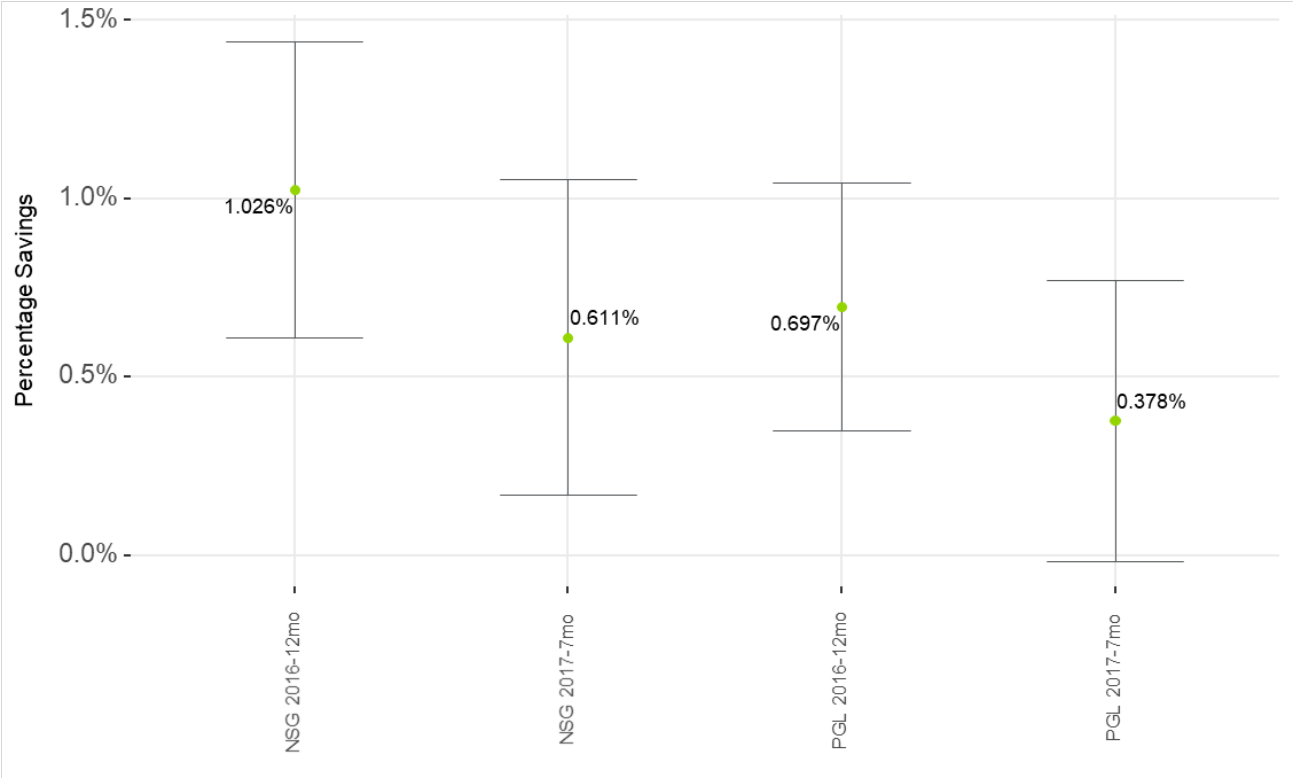
Savings Category	NSG 2016-12mo	NSG 2017-7mo	PGL 2016-12mo	PGL 2017-7mo
Ex Ante Net Savings, therms	107,293	133,538	244,848	153,918
Number of Participants	12,059	62,892	26,574	53,501
Number of Controls	18,992	17,274	19,455	17,268
Verified Savings Prior to Uplift Adjustment, therms	139,598	139,815	268,243	98,749
(Standard Error)	*(34,253)*	*(61,526)*	*(81,284)*	*(62,487)*
Average Savings Rate	1.03%	0.61%	0.70%	0.38%
(Standard Error)	*(0.25%)*	*(0.27%)*	*(0.21%)*	*(0.24%)*
GPY6 Uplift Adjustment, therms	196	2,573	2,706	5,307
Legacy Uplift, therms	1,667	12,641	3,791	2,433
Total Uplift Adjustment, therms	1,863	15,214	6,497	7,740
Verified Net Savings After Uplift Adjustment, therms	137,735	124,601	261,746	91,009

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

Figure 3-1 shows energy savings for each wave with 90 percent confidence intervals. The low savings rates for NSG and PGL Waves 2017-7mo likely result from the evaluation period being seven months

(June 2017 through December 2017) rather than twelve months for the other waves (June 2016 through May 2017).

Figure 3-1. GPY6 Percent Savings and 90 Percent Confidence Interval, by Wave



Source: Navigant analysis of PGL and NSG customer billing data.

4. NET IMPACT EVALUATION

A key feature of the RCT design of the HER program is that the analysis inherently estimates net savings because there are no participants who would have received the individualized reports in the absence of the program. While some customers receiving reports may have taken energy-conserving actions or purchased high-efficiency equipment anyway, the random selection of program participants (as opposed to voluntary participation) implies that the control group of customers not receiving reports would be expected to exhibit the same degree of energy-conserving behavior and purchases. Therefore, this method estimates net savings and no further NTG adjustment is necessary.[18]

[18] Although significant changes were made to the programs' designs in GPY6, they were undertaken in a manner that retained this feature of the RCT experimental design. See sections 1.1 and 6.1 for further discussion.

5. FINDINGS AND RECOMMENDATIONS

For PGL, the total verified energy savings for GPY6 was 366,991 therms prior to the uplift adjustment, and 352,754 after the adjustment. For NSG, the corresponding figures were 279,414 and 262,337, respectively. The aggregate therms saved for both programs declined compared to GPY5, which was primarily due to fewer participants after the GPY6 restructuring.

Finding 1. The aggregate therm savings for both programs declined in GPY6 relative to GPY5 primarily because the number of participants was reduced as a result of the restructuring described in this report. For this reason, the savings rates in GPY6 are not directly comparable to those achieved in GPY5, and caution should be used when making such comparisons.

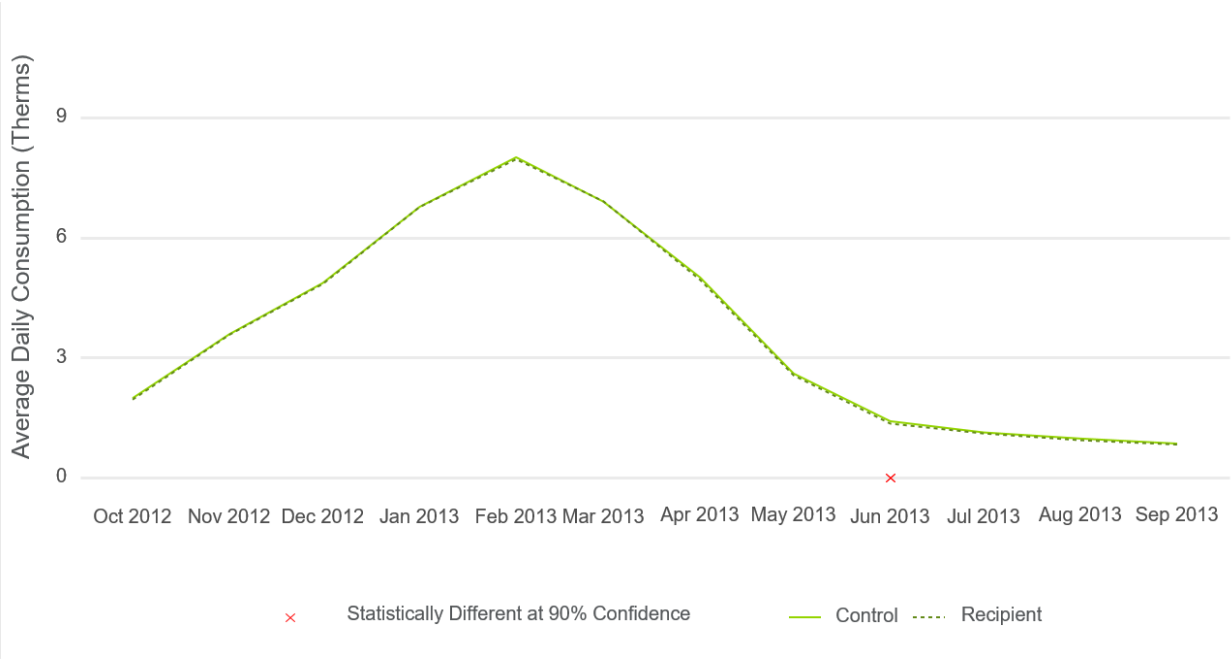
Finding 2. The average savings rates for the 2016-12mo waves are larger than those of the corresponding 2017-7mo waves. This was expected, since to the evaluation period for the 2017-7mo waves ran only for seven months (June 2017-December 2017), and thus not including a full heating season, rather than the twelve months covered by the 2016-12mo waves (June 2016 through May 2017).

6. APPENDIX 1. IMPACT METHODOLOGY DETAIL

6.1 Graphs for RCT Check

Figure 6-1 through Figure 6-4 show participant and control usage for each wave during its pre-period. The similarity in participant and control usage in these illustrates that accounts were randomly assigned to receive treatment according to RCT best practices.

Figure 6-1. RCT Usage Comparison for NSG 2016-12mo

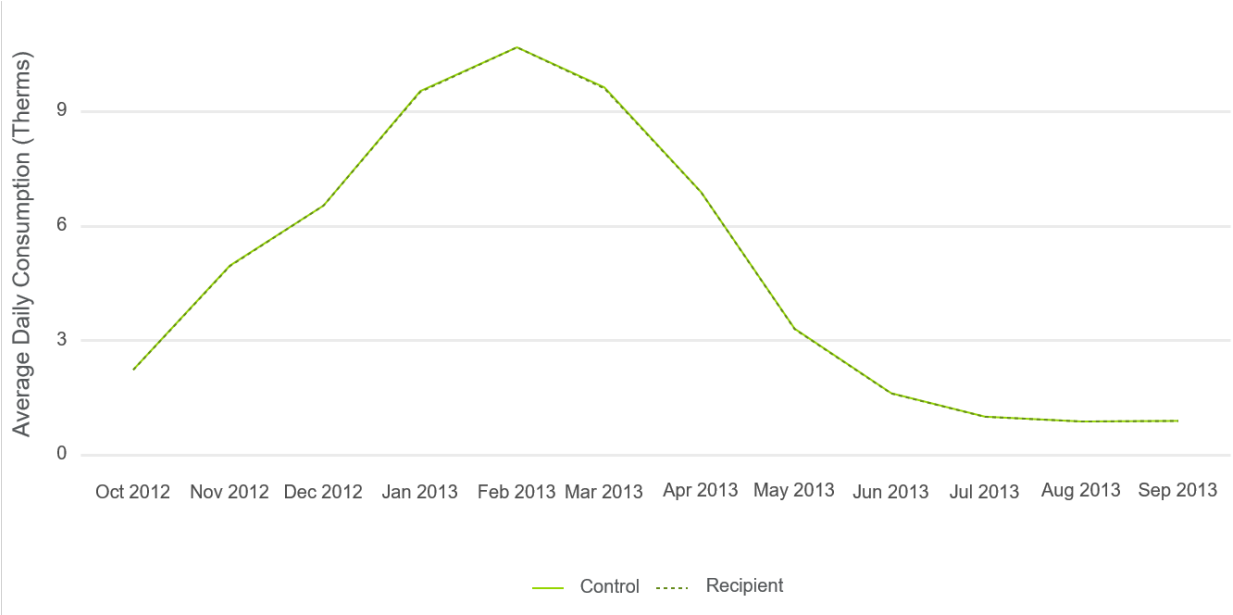


Source: Navigant analysis of PGL and NSG customer billing data.

Figure 6-2. RCT Usage Comparison for NSG 2017-7mo

Source: Navigant analysis of PGL and NSG customer billing data.

Figure 6-3. RCT Usage Comparison for PGL 2016-12mo



Source: Navigant analysis of PGL and NSG customer billing data.

Figure 6-4. RCT Usage Comparison for PGL 2017-7mo

Source: Navigant analysis of PGL and NSG customer billing data.

6.2 Detailed Data Cleaning

Navigant performed the following data cleaning steps:

- Excluded post-period data from outside of the period of examination (June 2016 to May 2017 for Waves 2016-12mo and June 2017 to December 2017 for Waves 2017-7mo)
- Filtered to relevant pre-period data for each wave
- Removed exact duplicate observations
- Aggregated bills that ended in the same month
- Excluded outlier observations, defined as observations with average daily usage outside plus or minus one order of magnitude from the median

Table 6-1 through Table 6-4 give counts of customers and observations removed for the data cleaning steps identified above. Each data cleaning step removed a similar percentage of treatment and control customers for each wave. This suggests that non-random biases were not introduced into the data by the cleaning steps.

Table 6-1. North Shore Gas 2016-12mo GPY6 Data Cleaning Results

Cleaning Step	Customers		Observations	
	Treatment	Control	Treatment	Control
Raw Data	12,059	18,992	767,764	1,209,102
Subset to pre/post periods	12,059	18,992	283,524	446,544
Remove exact duplicate observations	12,059	18,992	283,524	446,544
Bill Flattening	12,059	18,992	275,503	434,118
Exclude outliers	12,059	18,992	274,920	433,178

Source: Navigant analysis of PGL and NSG customer billing data.

Table 6-2. North Shore Gas 2017-7mo GPY6 Data Cleaning Results

Cleaning Step	Customers		Observations	
	Treatment	Control	Treatment	Control
Raw Data	62,892	17,274	3,754,356	1,030,423
Subset to pre/post periods	62,892	17,274	852,111	233,905
Remove exact duplicate observations	62,892	17,274	852,111	233,905
Bill Flattening	62,892	17,274	837,382	229,847
Exclude outliers	62,882	17,272	828,345	227,101

Source: Navigant analysis of PGL and NSG customer billing data.

Table 6-3. Peoples Gas 2016-12mo GPY6 Data Cleaning Results

Cleaning Step	Customers		Observations	
	Treatment	Control	Treatment	Control
Raw Data	26,574	19,455	1,663,773	1,219,290
Subset to pre/post periods	26,574	19,455	616,929	452,015
Remove exact duplicate observations	26,574	19,455	616,929	452,015
Bill Flattening	26,574	19,455	601,920	440,891
Exclude outliers	26,574	19,455	601,853	440,857

Source: Navigant analysis of PGL and NSG customer billing data.

Table 6-4. Peoples Gas 2017-7mo GPY6 Data Cleaning Results

Cleaning Step	Customers		Observations	
	Treatment	Control	Treatment	Control
Raw Data	53,501	17,268	3,158,477	1,019,345
Subset to pre/post periods	53,501	17,268	721,873	233,066
Remove exact duplicate observations	53,501	17,268	721,873	233,066
Bill Flattening	53,501	17,268	708,037	228,421
Exclude outliers	53,501	17,268	705,766	227,685

Source: Navigant analysis of PGL and NSG customer billing data.

6.3 Detailed Impact Methodology

Navigant used two regression models to estimate impacts: an LDV model and an LFER model. The following sections present each model.

6.3.1 LDV Model

The LDV model controls for non-program differences in energy use between the treatment and control groups using each customer's lagged energy usage as an explanatory variable. In particular, the model frames energy use in calendar month *t* of the post-program period as a function of both the treatment variable and energy use in the same calendar month of the pre-program period. The underlying logic is that systematic differences between control and treatment customers will be reflected in differences in their past energy use, which is highly correlated with their current energy use. Formally, the model is shown in Equation 6-1.

Equation 6-1. Lagged Dependent Variable Regression Model

$$ADU_{kt} = \beta_1 Treatment_k + \sum_J \beta_{2j} Month_{jt} + \sum_J \beta_{3j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

where:

ADU_{kt} is average daily consumption of kWh by household k in bill period t

$Treatment_k$ is a binary variable taking a value of 0 if household k is assigned to the control group, and 1 if assigned to the treatment group

$ADUlag_{kt}$	is household k's energy use in the same calendar month of the pre-program year as the calendar month of month t
$Month_{jt}$	is a binary variable taking a value of 1 when $j = t$ and 0 otherwise[19]
ε_{kt}	is the cluster-robust error term for household k during billing cycle t; cluster-robust errors account for heteroscedasticity and autocorrelation at the household level.[20]

The coefficient β_1 is the estimate of the average daily kWh energy savings due to the program.

6.3.2 LFER Model

The LFER model used by Navigant is one in which average daily consumption of kWh by household k in bill period t, denoted by ADU_{kt}, is a function of the following three terms:

1. The binary variable $Treatment_k$
2. The binary variable $Post_t$, taking a value of 0 if month t is in the pre-treatment period, and 1 if in the post-treatment period.
3. The interaction between these variables, $Treatment_k \cdot Post_t$

Formally, the LFER model is shown in Equation 6-2.

Equation 6-2. Linear Fixed Effects Regression Model

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t + \varepsilon_{kt}$$

In this model, the coefficient α_{0k} captures all household-specific effects on energy use that do not change over time, including those that are unobservable, the coefficient α_2 captures the average effect *across all households* of being in the post-treatment period, and the effect of being both in the treatment group and in the post period (i.e., the effect directly attributable to the program) is captured by the coefficient α_2. In other words, while the coefficient α_1 captures the change in average daily kWh use across the pre- and post-treatment for the *control* group, the sum α_1 + α_2 captures this change for the treatment group, and so α_2 is the estimate of average daily kWh energy savings due to the program.

[19] 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.

[20] 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 heteroskedastic 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.

6.4 Detailed Uplift Analysis Results

6.4.1 GPY6 Uplift

Table 6-5 through Table 6-8 present program savings due to participation in other EE programs in GPY6. Each table provides the uplift for a single program group in each of four EE Programs for which estimates for deemed savings are available: Home Energy Jumpstart (HEJ), Home Energy Rebates (HEReb), and Multi-Family (MF). While these tables show estimates of both positive and negative uplift, only positive values were used to adjust program savings for double-counting. For all cases where the EE program did not exist in the pre-program year, the estimate is based on a post-only difference (POD) statistic; otherwise it is based on a difference-in-difference (DID) statistic.[21]

The tables also include the percentage change in EE program participation rate for HER participants. This differs from the change in EE program participation rate for the entire EE program, which is not reported here. These rates should be interpreted with caution because they likely have very wide error bounds, many of which likely include zero. The calculation of standard errors on these rates is not straightforward and therefore Navigant does not report them here.

Table 6-5. GPY6 PGL 2016-12mo HER Uplift Adjustment Details

	HEJ	HEReb	MF
Median program savings (annual therms per participant)*	59.22	213.39	82.85
Number of treatment customers	26,575	26,575	26,575
Treatment rate of participation, GPY6 (%)	1.11%	0.51%	0.03%
Change in rate of treatment participation from pre-program year (%)	-0.05%	-0.40%	0.03%
Number of control customer	19,456	19,456	19,456
Control rate of participation, GPY6 (%)	0.96%	0.60%	0.01%
Change in rate of control participation from pre-program year (%)	-0.17%	-0.35%	-0.01%
DID or POD statistic	0.12%	-0.05%	0.04%
Participant uplift	32	-14	10
Statistically significant at the 90% confidence level?	Yes	No	Yes
Savings attributable to other programs (therms)	1,899	-3,013	806
Percentage change in EE program participation rate for HER participants	-99%	-99%	-100%

Source: Navigant analysis of PGL program tracking and customer billing data.
* Median program savings are the median therms impacts of HER recipients in each program.

[21] See section 2.5 for more information on POD and DID statistics.

Table 6-6. GPY6 PGL 2017-7mo HER Uplift Adjustment Details

	HEJ	HEReb	MF
Median program savings (annual therms per participant)*	51.06	276.00	28.59
Number of treatment customers	53,501	53,501	53,501
Treatment rate of participation, GPY6 (%)	0.53%	0.07%	0.01%
Change in rate of treatment participation from pre-program year (%)	-0.73%	-0.97%	-0.01%
Number of control customer	17,268	17,268	17,268
Control rate of participation, GPY6 (%)	0.56%	0.05%	0.00%
Change in rate of control participation from pre-program year (%)	-0.72%	-1.00%	-0.01%
DID or POD statistic	-0.01%	0.04%	0.00%
Participant uplift	-7	19	2
Statistically significant at the 90% confidence level?	No	No	No
Savings attributable to other programs (therms)	-347.94	5,244.40	62.80
Percentage change in EE program participation rate for HER participants	-99%	-100%	-100%

Source: Navigant analysis of PGL program tracking and customer billing data.
* Median program savings are the median therms impacts of HER recipients in each program.

Table 6-7. GPY6 NSG 2016-12mo HER Uplift Adjustment Details

	HEJ	HEReb	MF
Median program savings (annual therms per participant)*	58.41	165.69	28.59
Number of treatment customers	12,060	12,060	12,060
Treatment rate of participation, GPY6 (%)	0.61%	1.84%	0.00%
Change in rate of treatment participation from pre-program year (%)	0.35%	0.46%	-0.07%
Number of control customer	18,995	18,995	18,995
Control rate of participation, GPY6 (%)	0.58%	1.79%	0.00%
Change in rate of control participation from pre-program year (%)	0.34%	0.58%	-0.10%
DID or POD statistic	0.01%	-0.12%	0.03%
Participant uplift	1	-15	4
Statistically significant at the 90% confidence level?	No	No	No
Savings attributable to other programs (therms)	79.80	2,458.75	116.17
Percentage change in EE program participation rate for HER participants	-99%	-98%	-100%

Source: Navigant analysis of NSG program tracking and customer billing data.
* Median program savings are the median therms impacts of HER recipients in each program.

Table 6-8. GPY6 NSG 2017-7mo HER Uplift Adjustment Details

	HEJ	HEReb	MF
Median program savings (annual therms per participant)*	57.94	272.00	30.19
Number of treatment customers	62,892	62,892	62,892
Treatment rate of participation, GPY6 (%)	0.52%	0.23%	0.00%
Change in rate of treatment participation from pre-program year (%)	0.27%	-1.28%	-0.08%
Number of control customer	17,274	17,274	17,274
Control rate of participation, GPY6 (%)	0.47%	0.21%	0.00%
Change in rate of control participation from pre-program year (%)	0.21%	-1.11%	-0.10%
DID or POD statistic	0.06%	-0.17%	0.03%
Participant uplift	35.29	-106.96	17.54
Statistically significant at the 90% confidence level?	No	Yes	No
Savings attributable to other programs (therms)	2,044.69	-29,092.38	529.30
Percentage change in EE program participation rate for HER participants	-99%	-100%	-100%

Source: Navigant analysis of NSG program tracking and customer billing data.
* Median program savings are the median therms impacts of HER recipients in each program.

6.4.2 Legacy Uplift

To calculate legacy uplift from GPY3, GPY4, and GPY5, Navigant considered double-counted savings for the following programs: HEJ, HEReb, and MF. The measure lives for the GPY3, GPY4, and GPY5 programs were taken from the total resource cost report.[22] The measure lives for these programs are the simple average of the measures included in that program. Table 6-9, Table 6-10, and Table 6-11 show double counted savings (kWh) from each program for GPY3, GPY4, and GPY5, respectively. These tables show estimates of both positive and negative uplift; however, only positive uplift was used to adjust program savings for double-counting.

Table 6-9. Doubled Counted Savings (Therms) from GPY3

	HEJ	HEReb	MF
Measure Life	10	15	12
PGL 2016-12mo	1,058	760	122
PGL 2017-7mo	601	-4,783	3
NSG 2016-12mo	713	-3,566	116
NSG 2017-7mo	1,828	9,743	292

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

[22] Navigant Consulting, 2016. *Plan Year 1 through 3 Total Resource Cost Test Results and Impact Summary Evaluation Report.* Presented to Peoples Gas

Table 6-10. Doubled Counted Savings (Therms) from GPY4

	HEJ	HEReb	MF
Measure Life	10	15	12
PGL 2016-12mo	197	1530	124
PGL 2017-7mo	1,602	-3,790	227
NSG 2016-12mo	776	-5,328	62
NSG 2017-7mo	232	-52,082	547

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

Table 6-11. Doubled Counted Savings (Therms) from GPY5

	HEJ	HEReb	MF
Measure Life	10	15	12
PGL 2016-12mo	-1,411	3,046	46
PGL 2017-7mo	-1,406	4,155	34
NSG 2016-12mo	1,053	-5,721	142
NSG 2017-7mo	2,998	-17,651	529

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.

7. APPENDIX 2. TOTAL RESOURCE COST DETAIL

Table 7-1 the Total Resource Cost (TRC) variable tables for PGL and NSG only includes cost-effectiveness analysis inputs available at the time of finalizing the GPY6 Home Energy Reports impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to evaluation later. Detail in this table (e.g., EULs), other than final GPY6 savings and program data, are subject to change and are not final.

Table 7-1. Total Resource Cost Savings Summary for PGL and NSG

Savings Category	NSG 2016-12mo	NSG 2017-7mo	PGL 2016-12mo	PGL 2017-7mo
Number of Participants	12,059	62,892	26,574	53,501
Effective Useful Life (Years)	1	0.58	1	0.58
Ex Ante Net Savings, therms	107,293	133,538	244,848	153,918
Verified Gross Savings After Uplift Adjust., therms	137,735	124,601	261,746	91,009
Verified Net Savings After Uplift Adjust., therms	137,735	124,601	261,746	91,009

Source: Navigant analysis of PGL and NSG program tracking and customer billing data.