



# ComEd

## Meter Genius Pilot Program Evaluation Report

**FINAL**  
**Energy Efficiency / Demand Response Plan:**  
**Plan Year 8 (PY8)**  
**(6/1/2015-5/31/2016)**

**Presented to**  
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## E. EXECUTIVE SUMMARY

This report presents a summary of the findings and results from the impact evaluation of the PY8<sup>1</sup> Meter Genius (MG) pilot program. Commonwealth Edison Company (ComEd) designed the pilot with two levels of engagement. The first level involved mailing monthly reports to all participants with information about their energy usage. In the second level, participants had the option to sign up for a web portal/mobile application which showed more detailed information about personal electricity consumption including near real-time data. Through the web portal/mobile application, participants could also participate in weekly competitions against their neighbors to earn prizes and earn rewards points by reducing their electricity consumption and engaging with the platform.

### E.1. Program Savings

Table E-1 summarizes the PY8 electricity savings from the MG pilot program. Navigant’s impact analysis of the MG pilot program yielded estimated savings of 9.9 MWh prior to the uplift adjustment. After adjusting for uplift from other energy efficiency programs (see Section 2.4), estimated savings were 7.5 MWh. However, these results were not statistically significant and therefore cannot be causally attributed to the program. Thus, Navigant’s primary finding is that the MG pilot program achieved no verified energy savings in PY8. As explained in Section 4, a key feature of the randomized controlled trial (RCT) design used for this pilot is that the analysis inherently estimates net savings because there are no participants who otherwise might have received individualized reports in the absence of the program, thus no further net-to-gross (NTG) adjustment is necessary.

**Table E-1. PY8 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)
Implementer Estimated Savings †	-
Net Savings, Prior to Uplift Adjustment	9.9
Net Savings, After Uplift Adjustment	7.5
Final Verified Savings ‡	0
Realization Rate †	-

Source: ComEd data and Navigant analysis.

† Navigant did not receive implementer estimated savings for this program and as such was not able to calculate a realization rate.

‡ The savings are not statistically significant, which means they cannot be causally attributed to the program.

### E.2. Program Savings by Participant Wave

For the purposes of this report, Navigant divided participants in the MG pilot program into three groups based on their level of engagement with the weekly contests. The first group, through the duration of the pilot, participated in no weekly contests (No Contests Wave), the second group participated in one weekly contest (1 Contest Wave), and the third group participated in two or more weekly contests (2+ Contests Wave).

<sup>1</sup> The PY8 program year began June 1, 2015 and ended May 31, 2016. This program’s period of operations was December 1, 2015 to May 31, 2016.

Table E-2 summarizes estimated pilot program savings by weekly contest participation. In this table, the number of PY8 participants, in the first row, represents the number of participants in PY8 in each wave, while the sample sizes in the second and third rows, indicates the number of customers with sufficient data for inclusion in the regression analysis. Across all waves, there were 6,015 participants for whom savings were calculated. Navigant estimated separate savings for each contest wave using regression analysis as described in Section 2.3. The weighted average per customer savings estimate was 0.07 percent (or 1.66 kWh annually).

**Table E-2. PY8 Meter Genius Pilot Program Results by Wave**

Type of Statistic	No Contests Wave	1 Contest Wave	2+ Contests Wave	Total
Number of PY8 Participants	5,791	113	111	6,015
Sample Size - Treatment	5,781	113	110	6,004
Sample Size - Control			2,957	2,957
Percentage Savings	0.02%	-1.22%	3.68%	0.07%
<i>Standard Error</i>	<i>0.70%</i>	<i>2.32%</i>	<i>2.69%</i>	-
Annualized Savings Per Customer, kWh	0.53	-29.10	92.19	1.66
<i>Standard Error</i>	<i>16.97</i>	<i>55.19</i>	<i>67.24</i>	-
Net Savings, Prior to Uplift Adjustment, MWh †	3.04	-3.29	10.12	9.87
<i>Standard Error</i>	<i>97.56</i>	<i>6.24</i>	<i>7.38</i>	-
PY8 Uplift Adjustment, MWh	1.09	0.61	0.7	2.40
Net Savings, MWh ‡	1.95	-3.90	9.42	7.47

*Source: ComEd data and Navigant analysis.*

† Total savings are pro-rated for participants that closed their accounts during PY8.

‡ Net Savings are equal to Net Savings, Prior to Uplift Adjustment less the uplift of savings in other EE programs.

### E.3. Findings and Recommendations

The following section includes program findings and recommendations.<sup>2</sup>

**Finding 1.** While participants in the MG pilot overall saved on average 0.07 percent of their electricity usage, customers in the 2+ Contest Wave saved 3.68 percent, although this estimate was not statistically significant. The higher savings for this wave may indicate that additional engagement with the program can lead to higher savings customers. However, it is also possible that the type of customer who joined more than one contest was simply more motivated to participate and would have saved more usage even without the additional engagement had the contests not existed.

**Finding 2.** Though the implementer did not provide an estimate of total program savings, they did estimate that participants who signed up for the web portal (441 participants) had average savings of 1 percent. Navigant estimated savings by contest participation rather than by engagement with the web portal; however, to participate in a contest a customer must first have signed up for the web portal. Therefore, the 224 participants in the 1 Contest and 2+ Contest Waves must have signed up for the web portal. These customers saved 1.21 percent on average. Average savings for these customers were higher than what the implementation

<sup>2</sup> Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the evaluation report for ease of reference between each section.

contractor found likely because participating in a contest was a higher level of participation, leading to increased energy savings compared to participants who only created a web portal account without entering a contest.

**Recommendation 1.** Although the PY8 MG pilot has ended, ComEd should consider similar tactics to encourage engagement and savings in other programs as feasible. Gamification, including online contests such as those featured in the MG pilot, is seen as an effective way to engage customers with online programs. Findings from this pilot suggest that contests appear to motivate participants to save energy and may be applicable to other programs.

**Finding 3.** One factor that contributed to program savings not being statistically significant was the small size of the more engaged program waves. The 2+ Contests Wave included just 111 participants.

**Recommendation 2.** For future pilot programs, the implementation contractor should recruit additional participants to join contests, such as by offering more substantial prizes or through additional marketing. According to a back of the envelope power analysis using results from the 2+ Contests Wave, if the implementation contractor had recruited approximately 375 participants to join to or more contests (and had an equal number of controls), the average savings of 3.68 percent would be statistically significant at the 90 percent confidence level.

## 1. INTRODUCTION

### 1.1 Program Description

This report presents a summary of the findings and results from the impact evaluation of the PY8<sup>3</sup> Meter Genius (MG) pilot program. The MG pilot program started December 1<sup>st</sup>, 2015 and ran through May 31<sup>st</sup>, 2016. Commonwealth Edison Company (ComEd) designed the pilot with two levels of engagement. The first level involved mailing monthly reports to all participants with information about their energy usage. In the second level, participants had the option to sign up for a web portal/mobile application which showed more detailed information about personal electricity consumption including near real-time data. Through the web portal/mobile application participants could also participate in weekly competitions against their neighbors to earn prizes and earn rewards points by reducing their electricity consumption and engaging with the platform.

An important feature of the MG pilot program was that it was a randomized controlled trial (RCT). Customers selected for inclusion in the pilot were randomly assigned to a treatment (participant) group or control (non-participant) group for the purpose of estimating changes in energy use due to the program. There were approximately 6,000 customers in the treatment group and 3,000 in the control group.<sup>4</sup>

For the purposes of this report, Navigant divided participants in the MG pilot program into three groups based on their level of engagement with the weekly contests. The first group participated in no weekly contests (No Contests Wave), the second group participated in one weekly contest (1 Contest Wave), and the third group participated in two or more weekly contests (2+ Contests Wave).<sup>5</sup>

### 1.2 Evaluation Objectives

The objective of this evaluation was to determine the PY8 energy savings generated by the MG pilot program.

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<sup>3</sup> The PY8 program year began June 1, 2015 and ended May 31, 2016. This pilot program's period of operations was December 2015 to May 2016.

<sup>4</sup> Navigant previously reviewed the assignment of customers to the treatment and control groups and verified that it was consistent with random assignment. The results of this verification were provided to ComEd in a memo titled "ComEd PY8 Meter Genius - Validation of Randomization" sent on August 3rd, 2015.

<sup>5</sup> At most, one customer participated in 25 contests.



## 2. EVALUATION APPROACH

The evaluation approach in PY8 relied on statistical analysis appropriate for RCTs and was consistent with the analysis of other ComEd programs which are implemented as RCTs. Navigant estimated program impacts using two approaches applied to monthly billing data: a post-program regression (PPR) analysis with lagged controls and a linear fixed-effects regression (LFER) analysis.

### 2.1 Overview of Data Collection Activities

The core data collection activities included receiving billing and tracking data for the MG pilot program and receiving tracking data for the other programs used in the uplift analysis. The full set of data collection activities is shown in Table 2-1.

**Table 2-1. Primary Data Collection Activities**

What	Who	Target Completes	Completes Achieved	When
MG Program Tracking Database	Participants and Controls	-	-	May 2016
MG Program Billing Database	Participants and Controls	-	-	December 2014 – May 2016
Other Program Tracking Database	Participants and Controls	-	-	December 2014 – May 2016

### 2.2 Data Used in Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned the data provided by the implementer. The dataset included 6,015 treatment customers and 2,964 controls. Data during the six month pre-period and during the portion of PY8 for which the pilot program was active (December 2015 to May 2016) was used in the regression analysis for each of the two models described in Section 2.3. Navigant originally received daily data, recorded in half hour intervals, for each customer and this was aggregated to the monthly level for the analysis.

Navigant removed the following customers and data points from the analysis:

- Customers not assigned to the treatment or control group.
- Observations with no usage.
- Observations outside the relevant pre- or post-program periods.
- Observations with fewer than 46 of the 48 half-hourly meter reads.
- Observations with fewer than 16 days when aggregated to the monthly level.
- Observations with negative usage.
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage.<sup>6</sup>

Detailed counts of the customers and observations removed by wave are included in Section 6.1 of the Appendix.

### 2.3 Statistical Models Used in the Impact Evaluation

Navigant estimated program impacts using two approaches applied to monthly billing data: a post-program regression (PPR) analysis with lagged controls and a linear fixed-effects regression (LFER)

<sup>6</sup> Median usage was 10.7 kWh per day.

analysis. Navigant used the PPR results for reporting total program savings for PY8 but ran both models as a robustness check.<sup>7</sup> Although the two models are structurally very different, assuming the RCT is well balanced with respect to the drivers of energy use, in a single sample they generate very similar estimates of program savings.

The PPR model combines both cross-sectional and time-series data in a panel format. It uses post-program data as the dependent variable, with lagged energy use from the same calendar month of the pre-program period serving as a control for any small, systematic differences between the treatment and control customers. The lagged energy use term is similar to the customer fixed effect included in the LFER model explained below.

As with the PPR model, the LFER model combines both cross-sectional and time-series data in a panel format. The regression essentially compares pre- and post-program billing data for participants and controls to identify the program's effect. The customer-specific fixed effect is a key feature of the LFER analysis and captures all customer-specific factors affecting electricity usage that do not change over time, including those that are unobservable. Examples include the square footage of a residence or the home's physical location. The fixed effect represents an attempt to control for small, systematic differences between treatment and control customers that might occur due to chance.

Section 6.2 presents the PPR and LFER models used in the analysis.

## 2.4 Accounting for Uplift in Other Energy Efficiency Programs

### 2.4.1 Accounting for Uplift in PY8

If participation rates in other EE programs are the same for MG treatment and control groups, the savings estimates from the regression analyses are already “net” of savings from other programs, as this indicates the MG pilot program does not increase or decrease participation in other EE programs. However, if the MG pilot program affects participation rates in other EE programs, then savings across all programs are lower than indicated by the simple summation of savings in the MG and EE programs. For instance, if the MG pilot program increases participation in other EE programs, the increase in savings may be allocated to either the MG pilot program or the EE program, but cannot be allocated to both programs simultaneously.<sup>8</sup> Note that when the MG pilot program decreases participation in other programs there is no issue of double-counting and thus no adjustment to the savings total is made.

Data permitting, Navigant uses a difference-in-difference (DID) statistic to estimate uplift in other EE programs. To calculate the DID statistic, the change in the participation rate in another EE program between PY8 and the pre-program year for the control group is subtracted from the same change for the treatment group. For instance, if the rate of participation in an EE program during PY8 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 MG pilot program is two percent for the treatment group and one percent for the control group, then the rate of uplift due to the MG pilot program is one percent, as reflected in Equation 2-1.

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<sup>7</sup> Navigant prefers to report out the PPR model because although both the LFER and PPR models generate unbiased estimates of program savings, as an empirical matter—based on our past analyses and those in the academic literature—estimated savings from the PPR model tend to have lower standard errors than those from the LFER model, though the differences are usually very small.

<sup>8</sup> It is not possible to avoid double counting of savings generated by programs for which tracking data are not available, such as upstream lighting programs.

**Equation 2-1. DID Statistic Calculation**

$$\begin{aligned}
 & (PY8 \text{ treatment group participation} - \text{prePY treatment group participation}) \\
 & - (PY8 \text{ control group participation} - \text{prePY control group participation}) \\
 & = \text{DID statistic} \\
 & \quad (5\% - 2\%) - (3\% - 1\%) = 1\%
 \end{aligned}$$

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 residence’s square footage.

An alternative to the DID statistic is the post-only difference (POD) statistic, which is the simple difference in participation rates between the treatment and control groups during PY8. The POD statistic 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. Navigant uses this alternative statistic in cases where the EE program did not exist for the entire pre-program year.

Navigant examined the uplift associated with four EE programs: the Fridge and Freezer Recycling (FFR) program, the Home Energy Assessment (HEA) program, the Home Energy Rebates (Rebate) program, and the Multi-family Energy Savings Program (MESP). The FFR program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners. The HEA program is offered jointly with the local gas utilities and achieves savings by providing direct installation of low-cost efficiency measures for single family homes, such as energy efficient light bulbs and low-flow showerheads. The Rebate program offers weatherization and incentives to residential customers to encourage customer purchases of higher efficiency heating, ventilating, and air-conditioning (HVAC) equipment. The MESP offers direct installation of low-cost efficiency measures, such as water efficiency measures and energy efficient light bulbs at eligible multifamily residences.

For each EE program, double-counted savings were calculated separately for each wave of the MG pilot program.

**2.4.2 Accounting for Legacy Uplift**

There was no need to account for legacy uplift for the MG pilot program because PY8 was the first year this program was implemented.

**2.5 Process Evaluation**

The PY8 MG pilot evaluation did not include a process evaluation.

### 3. GROSS IMPACT EVALUATION

Total program savings are summarized in Table 3-1 below. Navigant’s impact analysis of MG pilot program participant energy savings yielded estimated savings of 9.9 MWh prior to the uplift adjustment. After adjusting for uplift from other energy efficiency programs (see Section 2.4), estimated savings were 7.5 MWh. However, these results were not statistically significant and therefore cannot be causally attributed to the pilot program. Thus, Navigant’s primary finding is that the pilot program achieved no verified energy savings in PY8.

**Table 3-1. PY8 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)
Implementer Estimated Savings †	-
Net Savings, Prior to Uplift Adjustment	9.9
Net Savings, After Uplift Adjustment	7.5
Final Verified Savings ‡	0
Realization Rate †	-

*Source: ComEd data and Navigant analysis.*

† Navigant did not receive implementer estimated savings for this program and as such was not able to calculate a realization rate.

‡ The savings are not statistically significant, which means they cannot be causally attributed to the program.

#### 3.1 PPR and LFER Model Parameter Estimates

The PPR and LFER models generated very similar results for program savings estimates. Navigant used the PPR results for reporting PY8 total pilot program savings.<sup>9</sup> 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 contest participation waves between the two models is very similar. Section 6.3 includes detailed estimate information for each model.

#### 3.2 Uplift of Savings in Other EE Programs

PPR program savings estimates include savings resulting from the uplift in participation in other EE programs caused by the MG pilot program. To avoid double-counting savings, program savings due to this uplift must be counted towards either the MG pilot program or the other EE programs, but not both programs. The uplift of savings in other EE programs was a relatively large proportion of the total savings: 2.4 MWh, or 24.3 percent. Double counting of savings with other ComEd EE programs was a larger percentage of total program savings that is usually estimated for behavioral programs. However, the change in participation in other programs was limited to just 12 additional participants who joined other EE programs because of the MG pilot program. Thus, while the double counted savings was equal to a large percentage of total savings, it was not because the MG pilot program was channeling many customers into other programs, but because the MG pilot savings were very small. Table 3-2 shows how the uplift adjustment affects total savings.

<sup>9</sup> Navigant prefers to report out the PPR model because although both the LFER and PPR models generate unbiased estimates of program savings, as an empirical matter—based on our past analyses and those in the academic literature—estimated savings from the PPR model tend to have lower standard errors than those from the LFER model, though the differences are usually very small.

**Table 3-2. PY8 Uplift Adjustment**

Savings Category	Energy Savings (MWh)
Verified Net Savings, Prior to Uplift Adjustment	9.9
PY8 Uplift Adjustment	2.4
Final Verified Net Savings	7.5

Source: ComEd data and Navigant analysis.

Subtracting the savings uplift from total savings (9.87 MWh) generates a final savings estimate of 7.47 MWh. To put this in perspective, the weighted average percentage savings for PY8 due to the MG pilot was 0.07 percent, and removing the savings uplift in other EE programs reduces this value to 0.05 percent.<sup>10</sup>

Section 6.4 in the Appendix presents the details of the calculation of the PY8 uplift for each of the four ComEd EE programs considered in the analysis. As previously mentioned, the programs included in the uplift analysis in PY8 were the FFR program, the HEA program, the Rebate program and the MESP.<sup>11</sup>

The estimate of double-counted savings is most likely an *overestimate* because it presumes participation in the other EE programs occurs at the very start of PY8. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double-counted savings would be approximately 1.20 MWh, half the estimated value of 2.40 MWh.

### 3.3 Verified Program Impact Results

Table 3-3 summarizes estimated program savings by contest participation wave. In this table, the number of PY8 participants, in the first row, represents the number of participants in the pilot program in PY8 in each wave, while the sample sizes, in the second and third rows, indicates the number of customers with sufficient data for inclusion in the regression analysis. The weighted average per customer savings estimate was 0.07 percent (1.66 kWh annually). For the purposes of this report, Navigant divided participants in the MG pilot program into three groups based on their level of engagement with the weekly contests. The first group, through the duration of the pilot, participated in no weekly contests (No Contests Wave), the second group participated in one weekly contest (1 Contest Wave), and the third group participated in two or more weekly contests (2+ Contests Wave).

<sup>10</sup> Multiplying 0.07 percent (the percentage of total energy use saved) by 24.3 percent (the percentage of total savings uplift in other EE programs) generates the value 0.017 percent. Formally, as shown in the following calculation:  $0.0007 \times 0.243 = 0.00017$ . Subtracting this value from 0.0007 gives 0.00053, or 0.053 percent.

<sup>11</sup> ComEd has other residential programs that were not included in the analysis. The Residential Lighting and Elementary Education programs do not track participation at the customer level, and so do not have the data necessary for the uplift analysis. Double counting between the Residential New Construction and MG pilot program is not possible due to the requirement that MG participants have sufficient historical usage data.

**Table 3-3. PY8 Meter Genius Pilot Program Results by Wave**

Type of Statistic	No Contests Wave	1 Contest Wave	2+ Contests Wave	Total
Number of PY8 Participants	5,791	113	111	6,015
Sample Size - Treatment	5,781	113	110	6,004
Sample Size - Control			2,957	2,957
Percentage Savings	0.02%	-1.22%	3.68%	0.07%
<i>Standard Error</i>	<i>0.70%</i>	<i>2.32%</i>	<i>2.69%</i>	-
Annualized Savings Per Customer, kWh	0.53	-29.10	92.19	1.66
<i>Standard Error</i>	<i>16.97</i>	<i>55.19</i>	<i>67.24</i>	-
Net Savings, Prior to Uplift Adjustment, MWh †	3.04	-3.29	10.12	9.87
<i>Standard Error</i>	<i>97.56</i>	<i>6.24</i>	<i>7.38</i>	-
PY8 Uplift Adjustment, MWh	1.09	0.61	0.7	2.40
Net Savings, MWh ‡	1.95	-3.90	9.42	7.47

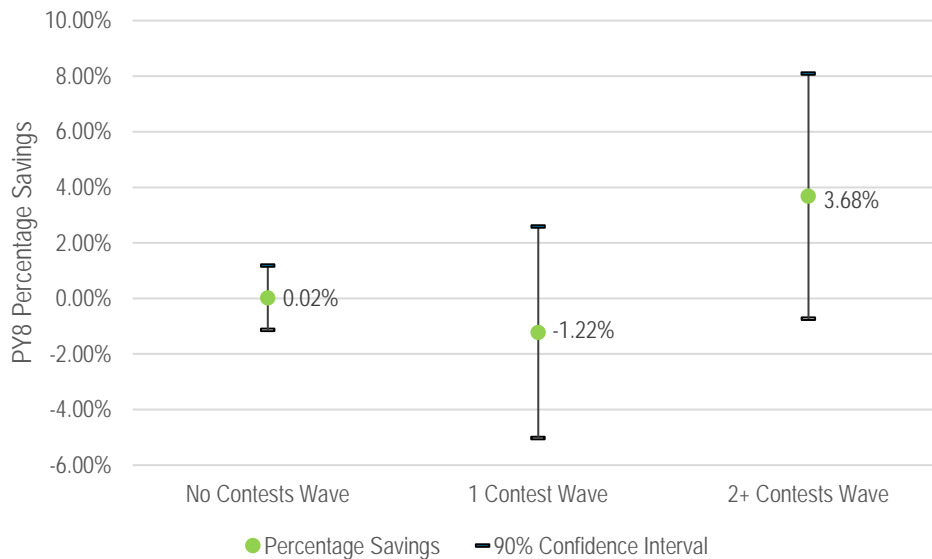
Source: ComEd data and Navigant analysis.

† Total savings are pro-rated for participants that closed their accounts during PY8.

‡ Net Savings are equal to Net Savings, Prior to Uplift Adjustment less the uplift of savings in other EE programs.

Figure 3-1 shows savings for each wave with the 90 percent confidence interval. Waves with larger confidence bounds had smaller sample sizes, which reduces the level of certainty for percent savings estimates. The No Contests Wave had a sample size of 5,781 participants and had a relatively small confidence bound, while the 1 Contest and 2+ Contests Waves had approximately 100 participants each and much larger confidence intervals. The 2+ Contests Wave had considerably higher savings than either of the waves.

**Figure 3-1. PY8 Percent Savings and 90 Percent Confidence Interval, by Wave**



Source: ComEd data and Navigant analysis.

#### 4. NET IMPACT EVALUATION

A key feature of the RCT design of the MG pilot program is that the analysis inherently estimates net savings because there are no participants who otherwise might 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 is 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.

## 5. FINDINGS AND RECOMMENDATIONS

This section includes program findings and recommendations.

**Finding 1.** While participants in the MG pilot overall saved on average 0.07 percent of their electricity usage, customers in the 2+ Contest Wave saved 3.68 percent, although this estimate was not statistically significant. The higher savings for this wave may indicate that additional engagement with the program can lead to higher savings customers. However, it is also possible that the type of customer who joined more than one contest was simply more motivated to participate and would have saved more usage even without the additional engagement had the contests not existed.

**Finding 2.** Though the implementer did not provide an estimate of total program savings, they did estimate that participants who signed up for the web portal (441 participants) had average savings of 1 percent. Navigant estimated savings by contest participation rather than by engagement with the web portal; however, to participate in a contest a customer must first have signed up for the web portal. Therefore, the 224 participants in the 1 Contest and 2+ Contest Waves must have signed up for the web portal. These customers saved 1.21 percent on average. Average savings for these customers were higher than what the implementation contractor found likely because participating in a contest was a higher level of participation, leading to increased energy savings compared to participants who only created a web portal account without entering a contest.

**Recommendation 1.** Although the PY8 MG pilot has ended, ComEd should consider similar tactics to encourage engagement and savings in other programs as feasible. Gamification, including online contests such as those featured in the MG pilot, is seen as an effective way to engage customers with online programs. Findings from this pilot suggest that contests appear to motivate participants to save energy and may be applicable to other programs.

**Finding 3.** One factor that contributed to program savings not being statistically significant was the small size of the more engaged program waves. The 2+ Contests Wave included just 111 participants.

**Recommendation 2.** For future pilot programs, the implementation contractor should recruit additional participants to join contests, such as by offering more substantial prizes or through additional marketing. According to a back of the envelope power analysis using results from the 2+ Contests Wave, if the implementation contractor had recruited approximately 375 participants to join to or more contests (and had an equal number of controls), the average savings of 3.68 percent would be statistically significant at the 90 percent confidence level.



## 6. APPENDIX

### 6.1 Detailed Data Cleaning

Navigant removed the following customers and data points from the analysis:

- Customers not assigned to the treatment or control group.
- Observations with no usage.
- Observations outside the relevant pre- or post-program periods.
- Observations with fewer than 46 of the 48 half-hourly meter reads.
- Observations with fewer than 16 days when aggregated to the monthly level.
- Observations with negative usage.
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage.<sup>12</sup>

Table 6-1 gives counts of customers and observations removed for each step. The table also provides the percentage of customers or observations removed. It is evident from the table that the percentage of customers or observations removed is very similar across the treatment and control groups for each wave. This suggests that non-random biases were not introduced into the data by our cleaning.

**Table 6-1. Customers/Observations Removed by Data Cleaning Step and Wave**

Step	Customers		Observations		Customer % Change		Observation % Change	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Raw Data	6,015	2,963	4,217,184	2,078,432				
Remove Customers not Assigned to a Group (Test or Control)	6,015	2,963	4,217,184	2,078,432	0.00%	0.00%	0.00%	0.00%
Remove Observations with No Usage	6,015	2,963	3,481,784	1,733,128	0.00%	0.00%	17.44%	16.61%
Keep Data in Program Period and Associated Pre Period	6,015	2,963	2,030,183	1,010,966	0.00%	0.00%	41.69%	41.67%
Keep Observations with at least 46 of 48 Usage Reads	6,015	2,963	2,007,415	999,839	0.00%	0.00%	1.12%	1.10%
Remove Duplicate Observations	6,015	2,963	2,007,161	999,295	0.00%	0.00%	0.01%	0.05%
Aggregate Daily Observations to Monthly	6,015	2,963	70,299	34,994	0.00%	0.00%	96.50%	96.50%
Remove Monthly Observations Missing More Than 16 Days	6,014	2,963	68,666	34,199	0.02%	0.00%	2.32%	2.27%
Remove Observations with Negative Usage	6,014	2,963	68,665	34,199	0.00%	0.00%	0.00%	0.00%
Subset to pre/post periods	6,014	2,963	68,665	34,199	0.00%	0.00%	0.00%	0.00%
Exclude outliers	6,014	2,962	68,524	34,110	0.00%	0.03%	0.21%	0.26%
Remove pre-period data for PPR analysis	6,008	2,957	35,767	17,607	0.10%	0.17%	47.80%	48.38%
Remove observations without a monthly pre-use value (for PPR analysis)	6,004	2,957	32,458	16,354	0.07%	0.00%	9.25%	7.12%

Source: ComEd data and Navigant analysis.

<sup>12</sup> Median usage was 10.7 kWh per day.

## 6.2 Detailed Impact Methodology

Navigant used two regression models to estimate impacts, a PPR model and an LFER model. The following sections present each model.

### 6.2.1 Post Program Regression Model

The PPR model controls for non-treatment differences in energy use between treatment and control customers using lagged energy use 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. Post Program Regression Model**

$$ADU_{kt} = \beta_1 Treatment\_0_k + \beta_2 Treatment\_1_k + \beta_3 Treatment\_2up_k + \sum_j \beta_{4j} Month_{jt} + \sum_j \beta_{5j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

Where

$ADU_{kt}$	is average daily consumption of kWh by household $k$ in bill period $t$
$Treatment\_0_k$	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 and participated in 0 contests
$Treatment\_1_k$	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 and participated in 0 contests
$Treatment\_2up_k$	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 and participated in 0 contests
$ADUlag_{kt}$	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 <sup>13</sup>
$\varepsilon_{kt}$	is the cluster-robust error term for household $k$ during billing cycle $t$ ; cluster-robust errors account for heteroskedasticity and autocorrelation at the household level. <sup>14</sup>

<sup>13</sup> In other words, if there are  $T$  post-program months, there are  $T$  monthly dummy variables in the model, with the dummy variable  $Month_{jt}$  the only one to take a value of 1 at time  $t$ . These are, in other words, monthly fixed effects.

<sup>14</sup> Ordinary Least Squares (OLS) regression models assume that the data are homoskedastic 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.

The coefficient  $b_1$  is the estimate of average daily kWh energy savings due to the program in PY8.

### 6.2.2 Linear Fixed Effects Regression Model

The simplest version of an LFER model convenient for exposition 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  $Treatment_k$  for each wave
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,  $Treatment_k \cdot Post_t$

For this program we have broken the interaction between post and treatment into three parts, one for each level of contest participation. Formally, the LFER model is showing in as shown in Equation 6-2.

#### Equation 6-2. Linear Fixed Effects Regression Model

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_{0k} \cdot Post_t + \alpha_3 Treatment_{1k} \cdot Post_t + \alpha_4 Treatment_{2upk} \cdot Post_t + \varepsilon_{kt}$$

Three observations about this specification deserve comment. First, the coefficient  $\alpha_{0k}$  captures all household-specific effects on energy use that do not change over time, including those that are unobservable. Second,  $\alpha_1$  captures the average effect *across all households* of being in the post-treatment period. Third, the effect of being both in the treatment group and in the post period—the effect directly attributable to the program—is captured by the coefficient  $\alpha_2$ ,  $\alpha_3$ , or  $\alpha_4$  depending on the group. In other words, whereas the coefficient  $\alpha_1$  captures the change in average daily kWh use across the pre- and post-treatment for the *control* group, the sum  $\alpha_1 + \alpha_2$  captures this change for the zero contest treatment group, and so  $\alpha_2$  is the estimate of average daily kWh energy savings due to the program in PY8 for the No Contest Wave. Similarly,  $\alpha_3$  is the estimate for 1 Contest Wave and  $\alpha_4$  is the estimate for the 2+ Contest Wave.

### 6.3 Detailed Impact Results: Parameter Estimates

Table 6-2 and Table 6-3 show the results of the PPR and LFER models for each wave. 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.

**Table 6-2. PPR Model Estimates**

	Estimate	Std. Error	t value	Pr(> t )
Treatment0	0.00	0.09	-0.03	0.98
Treatment1	0.16	0.30	0.53	0.60
Treatment2	-0.50	0.37	-1.37	0.17
yrm0201512	3.23	0.25	12.75	0.00
yrm0201601	2.98	0.23	12.80	0.00
yrm0201602	3.30	0.22	14.98	0.00
yrm0201603	2.58	0.19	13.41	0.00
yrm0201604	1.71	0.15	11.76	0.00
yrm0201605	1.95	0.13	14.84	0.00
yrm0201512:pre_use	0.92	0.02	39.93	0.00
yrm0201601:pre_use	0.80	0.02	48.87	0.00
yrm0201602:pre_use	0.68	0.02	44.70	0.00
yrm0201603:pre_use	0.73	0.02	45.57	0.00
yrm0201604:pre_use	0.88	0.01	63.01	0.00
yrm0201605:pre_use	0.92	0.01	75.69	0.00
Residual standard error: 5.047 on 48,797 degrees of freedom				
Multiple R-squared: 0.90, Adjusted R-squared: 0.90				
F-statistic: 29,520 on 15 and 48,797 DF, p-value: 0.00				

Source: ComEd data and Navigant analysis.

**Table 6-3. LFER Model Estimates**

	Estimate	Std. Error	t value	Pr(> t )
post	0.13	0.08	1.68	0.09
post.trt0	0.10	0.10	1.03	0.30
post.trt1	0.12	0.29	0.41	0.68
post.trt2	-0.64	0.41	-1.57	0.12
R-Squared: 0.000555; Adj. R-Squared : 0.000506				
F-statistic: 13 on 4 and 93,654 DF, p-value: 0.00				

Source: ComEd data and Navigant analysis.

## 6.4 Savings Due to Participation Uplift in Other EE Programs

Table 6-4 through Table 6-6 present program savings for each wave due to participation uplift in other EE programs. Each table provides the uplift for a single program group in each of four EE programs for which estimates of deemed savings are available: the FFR program, the HEA program, the Rebate program, and MESP.

In all tables, a dash (-) in a row concerning the change in rate of participation from the pre-program year indicates the EE program did not exist for the entire pre-program year. For all cases where the EE program did not exist in the pre-program year, the estimate is based on a POD statistic, otherwise it is based on a DID statistic.

The tables also include the percentage change in EE program participation rate for MG 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 6-4. Estimates of Double-Counted Savings: No Contests Wave**

	Program			
	FFR	HEA	MESP	Rebate
Median program savings (annual kWh per participant)	592	146	288	188
Number of treatment customers	5,781	5,781	5,781	5,781
Program participation, PY8	0.00%	0.28%	0.00%	0.42%
Change in participation from pre-program year	-0.50%	0.16%	-0.02%	0.40%
Number of matched control customers	2,957	2,957	2,957	2,957
Matched control participation, PY8	0.00%	0.37%	0.00%	0.68%
Change in participation from pre-program	-0.54%	0.37%	-0.07%	0.64%
DID or POD statistic	0.04%	-0.22%	0.05%	-0.24%
Participation uplift	2	-13	3	-14
Statistically significant at the 90% confidence level?	No	Yes	No	No
Savings attributable to other programs (kWh)	675.00	-915.40	419.05	-1,329.50
Percentage change in EE program participation rate for MG participants	-100.00%	-43.87%	-100.00%	-37.08%

Source: ComEd data and Navigant analysis.

**Table 6-5. Estimates of Double-Counted Savings: 1 Contest Wave**

	Program			
	FFR	HEA	MESP	Rebate
Median program savings (annual kWh per participant)	592	525	288	164
Number of treatment customers	113	113	113	113
Program participation, PY8	0.00%	0.89%	0.00%	3.54%
Change in participation from pre-program year	0.00%	0.89%	0.00%	3.54%
Number of matched control customers	2,957	2,957	2,957	2,957
Matched control participation, PY8	0.00%	0.37%	0.00%	0.68%
Change in participation from pre-program	-0.54%	0.37%	-0.07%	0.64%
DID or POD statistic	0.54%	0.51%	0.07%	2.90%
Participation uplift	1	1	0	3
Statistically significant at the 90% confidence level?	No	No	No	Yes
Savings attributable to other programs (kWh)	180.98	152.30	11.01	267.60
Percentage change in EE program participation rate for MG participants	-100.00%	137.89%	-100.00%	450.91%

Source: ComEd data and Navigant analysis.

**Table 6-6. Estimates of Double-Counted Savings: 2+ Contests Wave**

	Program			
	FFR	HEA	MESP	Rebate
Median program savings (annual kWh per participant)	592	573	288	2,326
Number of treatment customers	110	110	110	110
Program participation, PY8	0.00%	0.91%	0.00%	0.91%
Change in participation from pre-program year	0.00%	0.91%	0.00%	0.91%
Number of matched control customers	2,957	2,957	2,957	2,957
Matched control participation, PY8	0.00%	0.37%	0.00%	0.68%
Change in participation from pre-program	-0.54%	0.37%	-0.07%	0.64%
DID or POD statistic	0.54%	0.54%	0.07%	0.27%
Participation uplift	1	1	0	0
Statistically significant at the 90% confidence level?	No	No	No	No
Savings attributable to other programs (kWh)	176.18	169.40	10.71	341.00
Percentage change in EE program participation rate for MG participants	-100.00%	144.38%	-100.00%	41.48%

Source: ComEd data and Navigant analysis.