Home Energy Report Program

2016 Evaluation Report

Prepared for:

AEP Ohio

A unit of American Electric Power

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EXECUTIVE SUMMARY

This document summarizes the 2016 evaluation of AEP Ohio’s Home Energy Report (HER) Program. The program has been operating since August 2010, making 2016 the sixth full year in which the program has been in operation. This sixth annual impact evaluation of the program includes estimates of electric energy and demand savings as well as recommendations based on the impact evaluation conducted.

ES.1 Program Overview

The HER Program helps residential participants reduce electricity usage by encouraging them to alter their habits of electricity use by providing positive reinforcement behavior modification. Through 2016, participants are enrolled on an opt-out basis in the energy efficiency service operated and delivered by the program implementation contractor. Program participants were randomly selected for program enrollment from three AEP Ohio customer groups, including:

- Higher-than-average electricity users (abbreviated as HU for high use customers). HU program participants include the original group of customers enrolled in 2010, as well as additional cohorts enrolled in 2011, 2013, 2014, and 2016.

- Low-income households enrolled in a State of Ohio program called Percentage of Income Payment Plan (PIPP). PIPP program participants include a single group of customers enrolled in 2010.

- Customer residences equipped with Advanced Metering Infrastructure (AMI). AMI program participants include the original group of customers enrolled in 2010, as well as additional cohorts enrolled in 2011, 2013, 2014, 2015, and 2016.

The program provides participants with a mailed or electronic report that is received separately from their normal utility bills. The mailed report (included in Appendix C) consists of a single page (front and back) containing:

- A bar chart comparing last month’s electricity costs for the participant with two groups of similar homes
- A line graph comparing monthly electric use for each of the previous 12 months for the participant, and for two groups of similar homes
- A bar chart showing the participant whether they are using more or less electricity than during the comparable season last year
- Bulleted lists of simple actions the participant can take to reduce electricity usage
- An estimate of savings the customer may see on the electricity bill if a specific action is taken

Access to participant information and more tailored tips is also available through an Internet web portal available to the participant even after opting-out of the mailed reports.¹

¹ https://aepo.opower.com/
ES.2 Evaluation Objectives

This evaluation addresses the following objectives:

- Quantify energy and peak demand savings attributable to the HER Program
- Calculate the energy and peak demand savings attributable to each participant subgroup
- Estimate the increased rate of participation in other AEP Ohio energy efficiency/peak demand reduction (EE/PDR) programs due to participation in the HER Program
- Estimate program cost effectiveness

ES.3 Evaluation Methods

ES.3.1 Impact Evaluation

For the impact evaluation, Navigant used a linear fixed effects regression (LFER) model to estimate program savings. The LFER model combines both cross-sectional and time series data in a panel dataset. The data consists of electric billing data both before program enrollment and for 2016, for both treatment (program) households receiving the Home Energy Reports and control households that do not receive the reports. The program evaluation utilizes a randomized controlled trial (RCT) experimental design, with households randomly allocated to the control and treatment groups. The RCT design eliminates the issue of selection bias that complicates the evaluation of many behavioral programs. The basic LFER model casts the average daily electricity use as a function of a household-specific constant term, a variable indicating whether the observation is in the pre- or post-program period, and a variable indicating whether the household is a treatment (program) household or a control household. Navigant also utilized a Post Program Regression (PPR) model as a robustness check on the savings results.

ES.3.2 Process Evaluation

Due to the relative stability of the HER Program and the lack of significant program changes during the 2016 calendar year, no detailed process evaluation was performed for the HER Program as part of the 2016 evaluation.

Table ES-1 summarizes the data used during the 2016 evaluation of the HER Program.

<table>
<thead>
<tr>
<th>Data Collection Type</th>
<th>Targeted Population</th>
<th>Sample Design</th>
<th>Sample Size</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Tracking Data</td>
<td>Participant and control customers</td>
<td>NA</td>
<td>Attempted program census</td>
<td>Feb 2017 – Mar 2017</td>
</tr>
<tr>
<td>Billing Data</td>
<td>Participant and control customers</td>
<td>NA</td>
<td>Attempted program census</td>
<td>Feb 2017 – Mar 2017</td>
</tr>
<tr>
<td>In-depth Telephone Interviews</td>
<td>Program manager and implementer</td>
<td>NA</td>
<td>2</td>
<td>Feb 2017</td>
</tr>
</tbody>
</table>
ES.4 Key Evaluation Findings and Recommendations

ES.4.1 Evaluation Findings

The Home Energy Report Program reported *ex ante* 67,262 MWh of energy savings and 8,744 kW of demand savings in 2016. The verified (*ex post*) energy and demand savings for 2016 for all HU and PIPP customers combined were 68,807 MWh and 8,971 kW respectively, for a realization rate of 102 percent for energy savings and 103 percent for demand savings. A comparison of *ex ante* and *ex post* HER Program savings are shown in Table ES-2.

Table ES-2. 2016 Overall Evaluation Results

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Program Goals</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Energy Savings (MWh)</td>
</tr>
<tr>
<td>Demand Savings (kW)</td>
</tr>
</tbody>
</table>

Savings from AMI customers are not included in the above *ex ante* and *ex post* calculations because these savings are not counted toward the HER Program savings goals. Navigant estimated AMI customers provided an additional 6,044 MWh of energy savings and 788 kW of peak demand savings. A summary of the savings from each customer group includes:

- All High-use customers accounted for a total of 66,075 MWh of energy savings, corresponding to 8,615 kW of peak demand savings. HU customers represent 88 percent of the total savings.

- Low-income customers accounted for 2,732 MWh of energy savings, corresponding to 356 kW of peak demand savings, and represent approximately 4 percent of total savings.

- AMI customers accounted for 6,044 MWh of energy savings, corresponding to 788 kW of peak demand savings, representing 8 percent of total savings.
Detailed impact results for each customer group participating in the HER Program are provided in Table ES-2 and Table ES-3. In the tables, customers are divided into cohorts based upon when they initially enrolled in the HER Program.

### Table ES-3. Estimated Program Savings by Participant Type

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants (beginning of 2016)</td>
<td>91,147</td>
<td>15,611</td>
<td>85,634</td>
<td>63,577</td>
<td>34,159</td>
<td>62,338</td>
<td>10,322</td>
<td>362,788</td>
</tr>
<tr>
<td>2016 Move-outs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,614</td>
<td>906</td>
</tr>
<tr>
<td>2016 Opt-outs±</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>Number of Participants (end of 2016)</td>
<td>86,533</td>
<td>14,705</td>
<td>78,002</td>
<td>57,163</td>
<td>28,605</td>
<td>54,063</td>
<td>9,155</td>
<td>328,226</td>
</tr>
<tr>
<td>Average Daily Household kWh Used</td>
<td>46.9</td>
<td>61.5</td>
<td>41.9</td>
<td>36.6</td>
<td>36.8</td>
<td>40.8</td>
<td>39.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Daily kWh Savings per participant (standard error)</td>
<td>0.93</td>
<td>1.06</td>
<td>0.74</td>
<td>0.14</td>
<td>0.38</td>
<td>-0.03</td>
<td>0.77</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Annual kWh Savings per participant (standard error)</td>
<td>341</td>
<td>386</td>
<td>271</td>
<td>53</td>
<td>139</td>
<td>-10</td>
<td>280</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Percentage Savings</td>
<td>1.95%</td>
<td>1.69%</td>
<td>1.74%</td>
<td>0.39%</td>
<td>1.03%</td>
<td>0.00%</td>
<td>1.91%</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Total MWh Savings* (a)</td>
<td>30,397</td>
<td>5,875</td>
<td>22,253</td>
<td>3,182</td>
<td>4,368</td>
<td>0</td>
<td>2,732</td>
<td>68,807</td>
</tr>
<tr>
<td>Savings Counted in Other Programs (b)</td>
<td>-52</td>
<td>-60</td>
<td>104</td>
<td>-87</td>
<td>16</td>
<td>-131</td>
<td>47</td>
<td>-163</td>
</tr>
<tr>
<td>Total Savings (MWh) ** = (a)</td>
<td>30,397</td>
<td>5,875</td>
<td>22,253</td>
<td>3,182</td>
<td>4,368</td>
<td>0</td>
<td>2,732</td>
<td>68,807</td>
</tr>
<tr>
<td>Total Savings (kW) †</td>
<td>3,963</td>
<td>766</td>
<td>2,901</td>
<td>415</td>
<td>570</td>
<td>0</td>
<td>356</td>
<td>8,971</td>
</tr>
</tbody>
</table>

Source: Navigant analysis of customer billing data provided by AEP Ohio.
Note: All savings values are statistically significant at the 95% confidence level.
* Aggregate savings values have been adjusted to account for customer move-outs throughout the program year.
** The analysis of double-counted savings resulted in a negative value (decreased participation in other programs). Since negative double-counted savings would increase the total savings, double-counted savings are assumed to be zero.
† The billing analysis model described in this report cannot be directly utilized for the estimation of demand savings. In order to properly determine demand savings using this method, intraday customer billing data would be needed. In the absence of such data, Navigant applied the ratio of kW to MWh savings from the program plan to the estimate of energy savings produced by the program analysis.
± Opt outs are not removed from the active participant count.
Table ES-4 presents the estimated savings for the AMI cohorts enrolled in the HER Program. Savings for these customers were also adjusted to account for double counted savings and participants that moved out of their households during 2016.

### Table ES-4. Estimated Program Savings by AMI Participant Group Using Equations 1 and 2

<table>
<thead>
<tr>
<th>g</th>
<th>2010/11 AMI</th>
<th>2013 AMI ‡</th>
<th>2014 AMI</th>
<th>2015 AMI</th>
<th>2016 AMI</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants (beginning of 2016)</td>
<td>33,340</td>
<td>4,398</td>
<td>8,142</td>
<td>11,214</td>
<td>9,317</td>
<td>66,411</td>
</tr>
<tr>
<td>2016 Move-outs</td>
<td>2,944</td>
<td>871</td>
<td>1,260</td>
<td>3,383</td>
<td>2,342</td>
<td>10,800</td>
</tr>
<tr>
<td>2016 Opt-outs±</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Number of Participants (end of 2016)</td>
<td>30,396</td>
<td>3,527</td>
<td>6,882</td>
<td>7,831</td>
<td>6,975</td>
<td>55,611</td>
</tr>
<tr>
<td>Average Daily Household kWh Used</td>
<td>29.4</td>
<td>28.9</td>
<td>30.8</td>
<td>24.4</td>
<td>26.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Daily kWh Savings per participant (standard error)</td>
<td>0.38</td>
<td>-0.61</td>
<td>0.34</td>
<td>0.12</td>
<td>0.19</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Annual kWh Savings per participant (standard error)</td>
<td>139</td>
<td>-223</td>
<td>123</td>
<td>42</td>
<td>68</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Percentage Savings</td>
<td>1.28%</td>
<td>0.00%†</td>
<td>1.08%</td>
<td>0.47%</td>
<td>0.70%</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Total MWh Savings* (a)</td>
<td>4,454</td>
<td>0</td>
<td>925</td>
<td>397</td>
<td>268</td>
<td>6,044</td>
</tr>
<tr>
<td>Savings Counted in Other Programs** (b)</td>
<td>7</td>
<td>11</td>
<td>-3</td>
<td>31</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td>Total Savings (MWh)** = (a)</td>
<td>4,454</td>
<td>0</td>
<td>925</td>
<td>397</td>
<td>268</td>
<td>6,044</td>
</tr>
<tr>
<td>Total Savings (kW)†</td>
<td>581</td>
<td>0</td>
<td>121</td>
<td>52</td>
<td>35</td>
<td>788</td>
</tr>
</tbody>
</table>

Source: Navigant Analysis

Note: All values are statistically significant at the 95% confidence level except for the 2013 cohort.

* Aggregate savings values have been adjusted to account for customer move-outs throughout the program year.

** The analysis of double-counted savings resulted in a negative value (decreased participation in other programs). Since negative double-counted savings would increase the total savings, double-counted savings are assumed to be zero.

‡ The analysis of the 2013 AMI cohort of participants produced a negative estimate of savings. Therefore, the total savings from this cohort has been assumed to be zero, since it is unlikely that the program produced an increase in average household energy usage.

† The billing analysis model described in this report cannot be directly utilized for the estimation of demand savings. In order to properly determine demand savings using this method, intraday customer billing data would be needed. In the absence of such data, Navigant applied the ratio of kW to MWh savings from the program plan to the estimate of energy savings produced by the program analysis.

± Opt outs are not removed from the active participant count.

As shown in Table ES-3 and Table ES-4, Navigant found savings varied significantly by customer group. HU participants in the earlier cohorts are estimated to have saved more energy than other customer groups on an absolute basis. This is partly due to their higher average daily energy use compared to other participant cohorts. On a relative basis, the savings from the earlier cohorts enrolled in 2010 through 2013 all exceed one percent of daily energy usage (excluding the 2013 AMI cohort).
A meaningful result from the cohort-level findings is the relatively low rate of savings from the later cohorts compared to the earlier cohorts. The three cohorts enrolled during 2015 and 2016 are estimated to have generated under one percent savings. Prior experience has shown once customers begin receiving Home Energy Reports, it can take up to 18 months for savings to fully materialize after a customer is enrolled in the program. This “ramp-up” phase may be impacting the savings estimate for the 2016 HU and AMI cohorts, but the 2015 AMI cohort was enrolled in the program for over a year prior to the beginning of the 2016 program year. However, this cohort has the lowest average daily usage of any cohort, and low energy users tend to produce lower savings.

This year, overall program savings were not reduced by the savings generated by the increase in participation by HER Program customers in other AEP Ohio EE/PDR programs compared to control customers. Instead, Navigant found a decrease in participation in other programs. Navigant used a Post-Only-Difference (POD) calculation to determine if any program savings should be subtracted to account for the HER Program participant energy savings attributable to other AEP Ohio programs. The approach ensures energy savings from another AEP Ohio EE/PDR program are not double counted in the HER Program. The results of this program uptake analysis are shown in Table ES-5.

<table>
<thead>
<tr>
<th>Table ES-5. Estimate of Energy Savings Attributable to Participation in Other Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliance Recycling</td>
</tr>
<tr>
<td>Average Post-Only-Difference (DID) Statistic</td>
</tr>
<tr>
<td>Change in Program Participation due to HER Program (# of Participants)</td>
</tr>
<tr>
<td>Average Savings per Program Participant (kWh)</td>
</tr>
<tr>
<td>Total Savings (MWh)</td>
</tr>
</tbody>
</table>

Source: Navigant analysis

Due to decreased participation, the analysis determined an estimated -163 MWh of the evaluated savings from the HER Program was double counted in other AEP EE/PDR programs. Negative double counted savings suggest the HER program is depressing participation in other programs. It was determined these reductions were due to random chance, not a direct results of receiving HER reports. Since accounting for these reductions would increase the evaluated savings, Navigant assumed no (zero) double-counted savings for the 2016 program year.

**ES.4.2 Recommendations**

1. Navigant’s analysis shows recent participant cohorts have a lower average daily energy usage and, relatedly, a lower average electricity savings. Evidence from this analysis also suggests some of the more recent cohorts may have a lower relative level of electric savings beyond the initial ramp-up period. Navigant suggests AEP Ohio continue the HER Program as long as regularly reported electric savings remain cost-effective, but also monitor the incremental cost and savings of each new cohort introduced to ensure individual cohorts contribute to the cost-effectiveness of the program as a whole.
2. Further investigation into the construction of the 2013 AMI cohort may be warranted to determine if there are customer characteristics that are adversely impacting participant savings. There may be a household characteristic or personality, either seen or unseen, which is more prevalent in this cohort that negatively impacts program savings. Depending on the outcome of these investigations, it may be possible it is not cost-effective to continue including this cohort in the HER Program.

3. The program evaluation in 2014 included a live audit performed via telephone survey with program participants. This audit asked participants to report on the current state of lighting and thermostats settings in their household. This approach provided quantifiable evidence of specific actions participant households are taking in response to the home energy reports. AEP Ohio should consider using these live audits in the future as a way to either 1) further investigate why some participant cohorts are generating less savings than others, or 2) gather quantifiable data on other actions that participating households may be taking to generate energy and demand savings, beyond the lighting and HVAC actions investigated during the 2014 evaluation.
1. INTRODUCTION

1.1 Program Description

The purpose of the Home Energy Report (HER) Program is to provide feedback to residential participants that will encourage them to change energy use habits to save energy. Customers are encouraged to do this through the use of a personalized report delivered to participating households either bi-monthly or quarterly. The information included in the report shows the energy use pattern of the household relative to peers and offers actions a participant can take to reduce their household’s metered electricity usage. To implement this program, AEP Ohio contracted with an implementation contractor to develop and distribute the reports.

The HER Program provides recipients with the following items:

- A bar chart comparison of last month’s electricity costs for the recipient and for two groups of similar homes.
- A line graph comparing monthly electric use for each of the previous 12 months for the recipient vs. two groups of about 100 similar homes.
- A bar chart showing the recipient whether it is using more or less electricity than during the comparable season last year.
- A short bullet list of simple actions the household could take to reduce electricity usage.
- An estimate of the savings the customer may see on the electricity bill if a specific action is taken.

The goal of the HER Program is to generate electric energy and demand savings by providing customers with information on their energy usage along with methods to manage usage. This is performed through behavioral changes and through influencing household purchasing decisions. Relevant energy habits include turning off appliances and lights when not in use, purchasing and installing low-cost energy efficiency measures, and participating in other AEP Ohio EE/PDR programs.

The program was launched in August 2010 with an initial mailing of the HERs to more than 200,000 residential customers selected as participants. Additional participants (and corresponding control households used for evaluation purposes) were added in 2011, 2013, 2014, 2015, and 2016 to increase the overall program savings, and/or to compensate for original participants that had opted-out of the program or moved out of AEP Ohio’s service territory. The program provides participants with ongoing comparisons, tips, and encouragement that can produce energy savings, lower energy bills, and improve participant satisfaction.

Participants were randomly selected for program enrollment from three AEP Ohio customer groups, including:

- Higher-than-average electricity users (abbreviated as HU for high use customer), living in single-family homes. A total of five cohorts of HU customers have been enrolled in the program. In 2010, OPower randomly selected 125,002 households for enrollment among customers that consume more than 21,000 kWh annually. Approximately 21,750 additional households that met the same criterion were enrolled in 2011. In 2013, the annual usage threshold for consideration as a high use customer was lowered to 16,000 kWh annually. Using this new criterion, 125,968 additional households were enrolled in the HER Program in 2013, 143,430 in two cohorts in 2014, and 62,338 in 2016.
- Lower-income households, enrolled in a State of Ohio program called Percentage of Income Payment Plan (PIPP). To stay enrolled, all households must have a verified annual income at or below 150 percent of the Federal Poverty Level (FPL). The PIPP helps customers arrange affordable long-term payment agreements. The PIPP group enrolled in 2010 was initially 25,000 participants. No additional cohorts of PIPP customers have been added to the HER Program.

- Customers utilizing Advanced Metering Infrastructure (AMI), all of which were located within the footprint of AEP Ohio’s Smart Grid Demonstration Project. The AMI group originally contained 62,027 participants enrolled in 2010. AEP Ohio later added additional treatment households to this group, including 9,980 households in 2011, 12,677 in 2013, 15,000 in 2014, 12,278 in 2015, and 9,317 in 2016.

Additionally, AEP Ohio attempted to expand the program to include an opt-in component. Approximately 250,000 households were provided with marketing material regarding the HER Program and encouraged to opt-in to the program if interested in participating. While this endeavor resulted in 4,088 additional program participants, the result was significantly below the number targeted by AEP Ohio. The majority of the households remaining in the marketing endeavor were subsequently enrolled in the 2013 HU cohort of standard, opt-out participants.

As time passes, the number of active customers in each program cohort declines as a portion of the households opt out of the program, move of the enrolled premise, or otherwise discontinue service at the household enrolled in the HER Program. Table 1-1 shows the number of active treatment and control households in each program subgroup and cohort as of the beginning of the 2016 program year, or at the time of enrollment for the 2016 cohorts.

Table 1-1. Number of Program Participants and Non-Participants

<table>
<thead>
<tr>
<th>Customer Subgroup</th>
<th>Participants</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-use Customers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August 2010 Cohort</td>
<td>91,147</td>
<td>43,891</td>
</tr>
<tr>
<td>November 2011 Cohort</td>
<td>15,611</td>
<td>7,444</td>
</tr>
<tr>
<td>February 2013 Cohort</td>
<td>85,634</td>
<td>34,288</td>
</tr>
<tr>
<td>January 2014 Cohort</td>
<td>63,577</td>
<td>15,084</td>
</tr>
<tr>
<td>August 2014 Cohort</td>
<td>34,159</td>
<td>6,802</td>
</tr>
<tr>
<td>August 2016 Cohort</td>
<td>62,338</td>
<td>19,771</td>
</tr>
<tr>
<td><strong>AMI Customers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August 2010/11 Cohort</td>
<td>33,340</td>
<td>10,052</td>
</tr>
<tr>
<td>February 2013 Cohort</td>
<td>4,398</td>
<td>3,567</td>
</tr>
<tr>
<td>February 2014 Cohort</td>
<td>8,142</td>
<td>6,056</td>
</tr>
<tr>
<td>November 2015 Cohort</td>
<td>11,214</td>
<td>9,189</td>
</tr>
<tr>
<td>July 2016 Cohort</td>
<td>9,317</td>
<td>2,882</td>
</tr>
<tr>
<td><strong>Low-income Customers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10,322</td>
<td>9,393</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>429,199</td>
<td>168,419</td>
</tr>
</tbody>
</table>

Source: Navigant Analysis
1.2 Evaluation Overview

This evaluation report presents the findings from the impact evaluation of the AEP Ohio Home Energy Report Program for 2016. The primary goal of the impact evaluation is to quantify electric energy and demand savings attributable to the HER Program. A secondary goal of the impact analysis is to compare the savings generated among the various participant subgroups and cohorts.
2. EVALUATION METHODOLOGY

The following section provides a detailed description of the evaluation methodologies and data used in the impact and process evaluations of AEP Ohio’s Home Energy Report Program.

2.1 Description of the Data

2.1.1 Data Used in the Impact Evaluation

The impact analysis follows an attempted census approach, using data from all treatment and control households to estimate program savings. Navigant used monthly billing data from AEP Ohio’s customer information system, spanning the period from December 2008 to January 2016. The billing data included a unique customer account ID, the start and end dates of each bill cycle, and the quantity of energy consumed during the bill cycle. Navigant also received participant data from AEP Ohio, including information about when the customer first received an HER, the participant group the customer is in, and a list of customers participating in other AEP Ohio energy efficiency programs to account for double counted savings.

Participants choosing to opt-out of the HER Program during 2016 were included in the analysis, as recipients of HER reports continue to generate savings even after opting out. Figure 2-1 shows the number of program participants that opted-out in each month of the 2016 program year. By the end of December 2016, 124 households had opted-out of the Home Energy Report Program during the program year, including some households that also moved out of AEP Ohio service territory during the year. Opt-outs represents 0.02 percent of 2016 participant households, which is low relative to what behavioral programs usually experience, and what AEP Ohio’s HER Program has experienced in prior program years.
Navigant also included households that moved out of the premise enrolled in the HER program during 2016 as shown in Figure 2-2. These households were included in the analysis up to the date participants’ accounts at the enrolled premise became inactive. In total, these participants represent over 45,000 AEP Ohio customers, or around 7.6% of the number of program participants at the start of 2016.
2.2 Comparability of Treatment and Control Group

When customers are enrolled in the Home Energy Report Program, a randomized control trial (RCT) is utilized to assign perspective participants into treatment and control groups. In principle, this methodology of assignment results in comparable control and treatment groups, where the energy use of the control group can be used as a counterfactual to estimate the program savings of the participant group.

Navigant analyzed characteristics of treatment and control households within each customer group and cohort to determine whether they are balanced in the factors affecting energy use. For this comparison, two primary characteristics were reviewed to ascertain the comparability of the control households:

- The geographic distribution of customers within AEP service territory as indicated by the weather station assigned to each customer.
- Distribution of energy use within each month in the twelve month period prior to the enrollment of the participant households in the HER Program. Monthly levels of energy use were compared using the mean, 5th percentile, 25th percentile, Mean, 75th percentile, and 95th percentile.

Navigant’s position is that a comparison on the last item – the distribution of past energy use – subsumes all other relevant comparisons, because structural differences between a treatment and control group will be revealed by past energy use. Still, comparisons in other dimensions can be a useful check on the balance of the samples. Navigant performed this analysis on all cohorts included in the 2016 evaluation during prior years. Graphs referencing the results of these prior analyses are provided in Appendix A. The analysis of the AMI and HU cohorts enrolled during 2016 is summarized in Section 3.1.3.
2.3 Analytical Methods

This section describes the analytical methods used as part of the impact and process evaluations. In general, the methodologies utilized are in accordance with recommendations from the SEE Action Network Working Group for evaluating behavior-based energy efficiency programs. Two different models are utilized in the impact evaluation to confirm the robustness of the estimated savings impacts.

2.3.1 Impact Evaluation Methods

The main methodological issue for the impact evaluation is to estimate the *counterfactual* energy use by households participating in the HER Program – that is, the energy that households *would have used in the absence of the program*. The program utilized a randomized controlled trial (RCT) experimental design, meaning households were randomly allocated to the control and treatment groups. This eliminates the issue of selection bias that complicates the evaluation of many behavioral programs. The random assignment of households to the treatment and control groups means the control group should serve as a robust baseline against which the energy use of the treatment households can be compared to estimate savings from enrollment in the HER Program.

Navigant estimated the HER program impacts using two approaches applied to monthly billing data: (1) a post-program regression (PPR) analysis with lagged controls, and (2) a linear fixed-effects regression (LFER) analysis. Navigant uses the PPR results for reporting total program savings, but runs both models as a robustness check. Although the two models are structurally very different, assuming the randomized controlled trial (RCT) is well balanced with respect to the drivers of energy use, in a single sample the two approaches generate very similar estimates of program savings.

Navigant prefers to report out the PPR model for two reasons. One, the implementer is also using a post-only model for evaluation. Two, 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.

The PPR model, also known as a lagged dependent variable (LDV) model, combines both cross-sectional and time-series data in a panel format. It 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. The lagged energy use term is similar to the customer fixed effect included in the LFER model explained below. Formally, the model is shown in Equation 1.

---

Equation 1. Post Program Regression Model

\[ ADU_{kt} = \beta_1 \text{Treatment}_k + \sum_j \beta_2 j \text{Month}_{jt} + \sum_j \beta_3 j \text{Month}_{jt} \cdot ADU_{lag_{kt}} + \epsilon_{kt} \]

Where:

- \( ADU_{kt} \) is average daily consumption of kWh by household \( k \) in bill period \( t \)
- \( \text{Treatment}_k \) 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
- \( ADU_{lag_{kt}} \) is household \( k \)'s energy use in the same calendar month of the pre-program year as the calendar month of month \( t \)
- \( \text{Month}_{jt} \) is a binary variable taking a value of 1 when \( j = t \) and 0 otherwise\(^3\)
- \( \epsilon_{kt} \) 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.\(^4\)

The coefficient \( \beta_1 \) is the estimate of average daily kWh energy savings due to the program.

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.

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 \( \text{Treatment}_k \).
2. The binary variable \( \text{Post}_t \), 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, \( \text{Treatment}_k \cdot \text{Post}_t \).

Formally, the LFER model is shown in Equation 2.

Equation 2. Linear Fixed Effects Regression Model

\[ ADU_{kt} = \alpha_0 k + \alpha_1 \text{Post}_t + \alpha_2 \text{Treatment}_k \cdot \text{Post}_t + \epsilon_{kt} \]

---

\(^3\) In other words, if there are \( T \) post-program months, there are \( T \) monthly dummy variables in the model, with the dummy variable \( \text{Month}_t \) the only one to take a value of 1 at time \( t \). These are, in other words, monthly fixed effects.

\(^4\) 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.
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, i.e., the effect directly attributable to the program, is captured by the coefficient $\alpha_2$. 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 treatment group, and so $\alpha_2$ is the estimate of average daily kWh energy savings due to the program.

In prior evaluation years, Navigant found the 2010 AMI treatment group is not statistically comparable to the corresponding control group. Navigant found statistically significant differences in the energy use of control and treatment households in seven out of the 12 months preceding the enrollment of AMI participants. The months where differences were found were all during the heating season, from October 2009 until April of 2010 (as shown in Figure A-4 in Appendix A). After consultation with the program implementer, Navigant determined these deviations are due to different proportions of customers with electric heat in the treatment and control groups. As a result, data regarding the heating type of customers in the AMI treatment and control groups was provided by the program implementer and incorporated into the analysis. After controlling for customers with electric heat, there is no month in the 12 months before the program begins in which the average energy use for the two groups is statistically significant different at the 90 percent confidence level.

The finding of differences in the rate of customers with electric heat in the 2010-11 AMI treatment and control groups requires a modification to the impact evaluation methodology for this cohort. Navigant incorporated two additional terms into the regression equation to account for the differing prevalence of electric heat. Equation 3 formally presents the equation for this model.

**Equation 3. Post Program Regression Model (2010-11 AMI Customer Group)**

$$ADU_{kt} = \beta_1ElectricHeat_k + \beta_2Treatment_k + \beta_3Treatment_k \cdot ElectricHeat_k + \sum_j \beta_4jMonth_{jt} + \sum_j \beta_5jMonth_{jt} \cdot ADU_{lagkt} + \epsilon_{kt}$$

Where,

$ElectricHeat_k =$ A binary variable indicating whether household $k$ utilizes electric heat (taking a value of 1) or non-electric heat (taking a value of 0).

The LFER model is also augmented to account for customer heating type, and presented in Equation 4.

**Equation 4. Linear Fixed Effects Regression Model (2010-11 AMI Customer Group)**

$$ADC_{kt} = \alpha_0k + \alpha_1Post_t + \alpha_2Participant_k \cdot Post_t + \alpha_3ElectricHeat_k \cdot Post_t + \alpha_4Participant_k \cdot ElectricHeat_k \cdot Post_t + \epsilon_{kt}$$

All participants and non-participants that moved out of the program household during 2016 were included in the analysis up to the bill month preceding their departure. Move-out dates were provided to Navigant by AEP Ohio.
One of the ways in which the Home Energy Report Program encourage participants to reduce energy consumption is by channeling them into other energy efficiency programs offered by AEP Ohio, notably the Appliance Recycling, Community Assistance, Efficient Products Rebate, and In-Home Energy Programs. Navigant investigated the effect of the HER Program on increasing participation in these four programs in order to account for the possibility of double counted savings. For each customer group and cohort, Navigant compared the difference in the rate of participation between the treatment group and the control group in the 2016 program year via the Post-Only-Differences (POD) statistic:

\[
POD = \frac{\text{Treatment: # of participants as % of total HER participants}}{\text{Control: # of participants as % of total control households}}
\]

Navigant then multiplied the POD statistic by the number of treatment households to get the change in uptake for each of the three other AEP Ohio programs due to the HER Program. The change in participation in the other programs was then multiplied by the average participant savings for each program to estimate the total savings already accounted for in the savings estimates for the other AEP Ohio programs.

### 2.4 In-depth Staff Interviews

Navigant conducted in-depth interviews in February 2017, as summarized in Table 2-1. The purpose of these interviews was to understand changes in program design and implementation, collect feedback on research priorities, and understand stakeholders’ experiences with the program.

<table>
<thead>
<tr>
<th>Data Collection Type</th>
<th>Targeted Population</th>
<th>Sample Frame</th>
<th>Sample Target</th>
<th>Sample Size</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-depth Telephone Interviews</td>
<td>AEP Ohio Program Staff</td>
<td>Contacts from AEP Ohio</td>
<td>HER Program Coordinator</td>
<td>1</td>
<td>February 2017</td>
</tr>
<tr>
<td></td>
<td>Implementation Contractor Program Staff</td>
<td>Contacts from AEP Ohio</td>
<td>AEP Ohio Client Success Manager</td>
<td>1</td>
<td>February 2017</td>
</tr>
</tbody>
</table>
3. DETAILED EVALUATION RESULTS

3.1 Impact Evaluation Results

The Home Energy Report Program reported *ex ante* 74,851 MWh of energy savings and energy 9,759 kW of demand savings in 2016. The verified (*ex post*) energy and demand savings for 2016 for all HU and PIPP customers combined were 68,807 MWh and 8,971 kW respectively. A comparison of *ex ante* and *ex post* HER Program savings are shown in Table 3-1.

|---|

Savings from AMI customers are not included in the above *ex ante* and *ex post* calculations because these savings are not claimed by AEP Ohio as part of meeting annual EE/PDR portfolio goals. Navigant estimated these customer groups provided an additional 6,044 MWh of energy savings and 788 kW of peak demand savings.

The total savings estimate pro-rates savings for customers who moved out or otherwise became inactive during the program year. This adjustment is performed using a participant-day metric that estimates the total numbers of days each household participates in the HER Program in 2016.

### 3.1.1 Results by Participant Type

Table 3-2 presents the estimated program savings using the fixed effects model described in Equation 1 for each of the participant cohorts for which AEP Ohio claimed savings. The number of participants at the beginning of the program year is shown along with the savings estimates and average daily energy use for customers in each wave. Final savings estimates for each wave are adjusted to account for double counted savings and participants that moved out of their households during 2016.
Table 3-2. Estimated Program Savings by HU and PIPP Participant Group Using Equation 1

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants (beginning of 2016)</td>
<td>91,147</td>
<td>15,611</td>
<td>85,634</td>
<td>63,577</td>
<td>34,159</td>
<td>62,338</td>
<td>10,322</td>
<td>362,788</td>
</tr>
<tr>
<td>2016 Move-outs</td>
<td>4,614</td>
<td>906</td>
<td>7,632</td>
<td>6,414</td>
<td>5,554</td>
<td>8,275</td>
<td>1,167</td>
<td>34,562</td>
</tr>
<tr>
<td>2016 Opt-outs±</td>
<td>29</td>
<td>1</td>
<td>32</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>107</td>
</tr>
<tr>
<td>Number of Participants (end of 2016)</td>
<td>86,533</td>
<td>14,705</td>
<td>78,002</td>
<td>57,163</td>
<td>28,605</td>
<td>54,063</td>
<td>9,155</td>
<td>328,226</td>
</tr>
<tr>
<td>Average Daily Household kWh Used</td>
<td>46.9</td>
<td>61.5</td>
<td>41.9</td>
<td>36.6</td>
<td>36.8</td>
<td>40.8</td>
<td>39.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Daily kWh Savings per participant (standard error)</td>
<td>0.93 (0.08)</td>
<td>1.06 (0.24)</td>
<td>0.74 (0.08)</td>
<td>0.14 (0.09)</td>
<td>0.38 (0.15)</td>
<td>-0.03 (0.10)</td>
<td>0.77 (0.21)</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Annual kWh Savings per participant (standard error)</td>
<td>341 (29)</td>
<td>386 (87)</td>
<td>271 (28)</td>
<td>53 (33)</td>
<td>139 (54)</td>
<td>-10 (37)</td>
<td>280 (78)</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Percentage Savings</td>
<td>1.95%</td>
<td>1.69%</td>
<td>1.74%</td>
<td>0.39%</td>
<td>1.03%</td>
<td>0.00%</td>
<td>1.91%</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Total MWh Savings* (a)</td>
<td>30,397</td>
<td>5,875</td>
<td>22,253</td>
<td>3,182</td>
<td>4,368</td>
<td>0</td>
<td>2,732</td>
<td>68,807</td>
</tr>
<tr>
<td>Savings Counted in Other Programs (b)</td>
<td>-52</td>
<td>-60</td>
<td>104</td>
<td>-87</td>
<td>16</td>
<td>-131</td>
<td>47</td>
<td>-163</td>
</tr>
<tr>
<td>Total Savings (MWh) ** = (a)</td>
<td>30,397</td>
<td>5,875</td>
<td>22,253</td>
<td>3,182</td>
<td>4,368</td>
<td>0</td>
<td>2,732</td>
<td>68,807</td>
</tr>
<tr>
<td>Total Savings (kW) †</td>
<td>3,963</td>
<td>766</td>
<td>2,901</td>
<td>415</td>
<td>570</td>
<td>0</td>
<td>356</td>
<td>8,971</td>
</tr>
</tbody>
</table>

Source: Navigant Analysis
* Aggregate savings values have been adjusted to account for customer move-outs throughout the program year.
Note: All values are statistically significant at the 95% confidence level.
† The billing analysis model described in this report cannot be directly utilized for the estimation of demand savings. In order to properly determine demand savings using this method, intraday customer billing data would be needed. In the absence of such data, Navigant applied the ratio of kW to MWh savings from the program plan to the estimate of energy savings produced by the program analysis.
± Opt outs are not removed from the active participant count.
Table 3-3 presents the estimated savings for the AMI cohorts enrolled in the HER Program. Savings for these customers were also adjusted to account for double counted savings and participants moved out of their households during 2016.

### Table 3-3. Estimated Program Savings by AMI Participant Group Using Equations 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>2010/11 AMI</th>
<th>2013 AMI‡</th>
<th>2014 AMI</th>
<th>2015 AMI</th>
<th>2016 AMI</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants (beginning of 2016)</td>
<td>33,340</td>
<td>4,398</td>
<td>8,142</td>
<td>11,214</td>
<td>9,317</td>
<td>66,411</td>
</tr>
<tr>
<td>2016 Move-outs</td>
<td>2,944</td>
<td>871</td>
<td>1,260</td>
<td>3,383</td>
<td>2,342</td>
<td>10,800</td>
</tr>
<tr>
<td>2016 Opt-outs±</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Number of Participants (end of 2016)</td>
<td>30,396</td>
<td>3,527</td>
<td>6,882</td>
<td>7,831</td>
<td>6,975</td>
<td>55,611</td>
</tr>
<tr>
<td>Average Daily Household kWh Used</td>
<td>29.4</td>
<td>28.9</td>
<td>30.8</td>
<td>24.4</td>
<td>26.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Daily kWh Savings per participant (standard error)</td>
<td>0.38 (0.16)</td>
<td>-0.61 (0.21)</td>
<td>0.34 (0.14)</td>
<td>0.12 (0.09)</td>
<td>0.19 (0.18)</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Annual kWh Savings per participant (standard error)</td>
<td>139 (57)</td>
<td>-223 (76)</td>
<td>123 (51)</td>
<td>42 (31)</td>
<td>68 (65)</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Percentage Savings</td>
<td>1.28%</td>
<td>0.00%</td>
<td>1.08%</td>
<td>0.47%</td>
<td>0.70%</td>
<td>N/A</td>
</tr>
<tr>
<td>Estimated Total MWh Savings* (a)</td>
<td>4,454</td>
<td>0</td>
<td>925</td>
<td>397</td>
<td>268</td>
<td>6,044</td>
</tr>
<tr>
<td>Savings Counted in Other Programs** (b)</td>
<td>7</td>
<td>11</td>
<td>-3</td>
<td>31</td>
<td>2</td>
<td>47</td>
</tr>
</tbody>
</table>

Total Savings (MWh)* = (a) | 4,454 | 0 | 925 | 397 | 268 | 6,044 |

Total Savings (kW)† | 581 | 0 | 121 | 52 | 35 | 788 |

Source: Navigant Analysis
Note: All values are statistically significant at the 95% confidence level except for the 2013 cohort.
* Aggregate savings values have been adjusted to account for customer move-outs throughout the program year.
‡ The analysis of the 2013 AMI cohort of participants produced a negative estimate of savings. Therefore, the total savings from this cohort has been assumed to be zero, since it is unlikely that the program produced an increase in average household energy usage.
† The billing analysis model described in this report cannot be directly utilized for the estimation of demand savings. In order to properly determine demand savings using this method, intraday customer billing data would be needed. In the absence of such data, Navigant applied the ratio of kW to MWh savings from the program plan to the estimate of energy savings produced by the program analysis.
± Opt outs are not removed from the active participant count.

As shown in Table 3-2 and Table 3-3, Navigant found savings varied significantly by customer group: HU participants in the earlier cohorts are estimated to have saved more energy than other customer groups on an absolute basis. This is partly due to their higher average daily energy use as compared to other participant cohorts. On a relative basis, the savings from the earlier cohorts enrolled in 2010 through 2013 all exceed one percent of daily energy usage.
A meaningful result from the cohort-level findings is the relatively low rate of savings from the later cohorts compared to the earlier cohorts. The three cohorts enrolled during 2015 and 2016 are estimated to have generated under one percent savings. Prior experience has shown once customers begin receiving Home Energy Reports, it can take up to 18 months for savings to fully materialize after a customer is enrolled in the program. This “ramp-up” phase may be impacting the savings estimate for the 2016 HU and AMI cohorts, but the 2015 AMI cohort was enrolled in the program for over a year prior to the beginning of the 2016 program year. However, this cohort has the lowest average daily usage of any cohort, and low energy users tend to produce lower savings.

Additionally, the 2013 AMI cohort has been in the HER Program for up to 35 months by the beginning of the 2016 program year. This cohorts has demonstrated little to no savings relative to what would normally be expected by this point in time. Further investigation into the construction of the 2013 AMI cohort may be warranted to determine if there are customer characteristics that are adversely impacting participant savings. There may be a household characteristic or personality, either seen or unseen, which is more prevalent in this cohort that negatively impacts program savings. Depending on the outcome of these investigations, it may be possible it is not cost-effective to continue including this cohort in the HER Program.

It is important to note savings differences among the groups are not necessarily due to the identifiers defining group membership. For instance, it cannot be concluded that receipt of an AMI meter causes HER Program savings to be low; factors correlated with group membership, such as levels of pre-enrollment energy use or other household characteristics, might explain the relationship.

3.1.2 Enrollment in Other AEP Ohio Programs

Navigant utilized the Post-Only Difference (POD) statistic to estimate the savings captured in the billing analysis for the HER Program that is already accounted for in the savings estimate for four other AEP Ohio programs: Appliance Recycling, Community Assistance Program, Efficient Products, and In-Home-Audit. In essence, the POD statistic represents the change in participation in other EE programs beyond that which would have occurred in the absence of the HER Program (as measured by control households). This calculation was performed separately for each of these four programs and for each cohort of participant households in the HER Program. The resulting change in program participation due to the HER Program is multiplied by the average claimed savings per HER Household participating in the Appliance Recycling, Community Assistance, Efficient Products, and In-Home Energy Programs to estimate the total amount of savings that is double counted. Table 3-4 shows the results of this calculation across all HER Program cohorts combined for each AEP Ohio EE/PDR program.

Navigant found a decrease in participation in the Appliance Recycling and Community Assistance programs that eclipsed the increased participation in Efficient Products and In-Home Energy. This was primarily due to the higher average savings per participant from Appliance Recycling and the Community Assistance program and resulted in a total of -163 MWh of double counted savings. Subtracting negative double counted savings from the billing analysis results would increase the total verified savings for the HER program, inaccurately attributing decreased participation as savings that would have occurred in absence of the program. Since savings that did not occur cannot be claimed, and these small decreases in participation were not statistically significant, Navigant calculates a total of 0 MWh of claimed savings from the four listed programs is due to channeling from the HER Program and, therefore, is considered double counted savings.
Table 3-4. Estimate of Energy Savings Attributable to Participation in Other Programs

<table>
<thead>
<tr>
<th></th>
<th>Appliance Recycling</th>
<th>Community Assistance Program</th>
<th>Efficient Products Rebates</th>
<th>In-Home</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Difference-in-Differences (DID) Statistic</td>
<td>-0.04%</td>
<td>-0.01%</td>
<td>0.04%</td>
<td>0.04%</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in Program Participation due to HER Program (# of Participants)</td>
<td>-130</td>
<td>-85</td>
<td>129</td>
<td>150</td>
<td>64</td>
</tr>
<tr>
<td>Average Savings per Program Participant (kWh)</td>
<td>1,376</td>
<td>1,385</td>
<td>202</td>
<td>450</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Savings (MWh)</td>
<td>-179</td>
<td>-72</td>
<td>27</td>
<td>61</td>
<td>-163</td>
</tr>
</tbody>
</table>

Source: Navigant Analysis

The amount of savings attributable to increased participation in other AEP Ohio EE/PDR programs due to participation in the HER Program is significantly lower than has been estimated in prior program years. This may be due to increased awareness of energy efficiency programs among the general population, and thus the control households in the HER Program. Additionally, the Appliance Recycling Program was inactive for the first half of 2016. The program lapsed between late 2015 and June 2016 due to the original implementation contractor filing for bankruptcy. This period of inactivity likely contributed to lower participation.

3.1.3 Comparability of Treatment and Control Groups

Navigant compared characteristics of treatment and control households in the AMI and HU cohorts initiated during the 2016 program year to confirm the control households were randomly selected and are suitable for the purposes of the estimating program savings.

The primary comparison Navigant performed to assess the reasonableness of the control groups is to compare the energy used by households in the 12 months preceding enrollment of participating households in the HER Program. Navigant compared the distribution of energy use in each month for treatment and control households. Figure 3-1 shows box-and-whisker graphs comparing the monthly energy use for the July 2016 AMI cohort. Figure 3-2 shows box-and-whisker graphs comparing the monthly energy use for the August 2016 HU cohort. The comparability of the treatment and control customers for this new cohort is analyzed for the first time in this year’s evaluation. (Graphs showing the results of this comparison for 2015 and older cohorts performed in previous evaluation years are presented in Appendix A). In the graphs, the yellow diamonds represent the average monthly electricity use of households in each customer group, the green bars represent the range of energy use between the 25th and 75th percentile of households, and the lines (whiskers) show the range between the 5th and 95th percentile of households.
Figure 3-1. Average Daily Treatment/Control Household Energy Use by Month in July 2016 AMI Cohort

Source: Navigant Analysis
As the preceding graphs and the graphs in Appendix A demonstrate, Navigant found the average energy use and the distribution of energy use by month for control households in the pre-treatment period to be comparable to treatment households for all customer groups and cohorts, except the initial 2010 AMI cohort, as described previously. Navigant also performed t-tests on the difference in mean energy usage between treatment and control households in each month during the year preceding enrollment of participating households for the 2015 AMI cohort. For all 12 t-tests performed on these monthly comparisons, Navigant determined the treatment and control households were not statistically different at the 90 percent confidence level. This further corroborates the conclusion that the control group was constructed appropriately.
3.2 Staff and Contractor Interviews

This section presents findings resulting from in-depth interviews with program staff and installation contractors affiliated with the program. With the help of interview guides, the evaluation team completed conversations with program stakeholders to assess program benefits and barriers, and understand satisfaction with program administration, delivery, and marketing.

3.2.1 Program Coordinator Interview

The AEP Ohio Program Coordinator manages the HER program for AEP Ohio side and is responsible for maintaining effective communication between AEP Ohio and the implementation contractor. In-person meetings with the implementation contractor occur on a quarterly basis. The Program Coordinator also regularly reviews savings reports, decides the cadence of reports, aids in the design of promotional modules, and facilitates customer opt-outs.

Since the program inception in 2010, the program has shifted towards email reports due to their lower per-participant cost. Email click-through metrics are provided on a monthly basis by the implementation contractor. The Program Coordinator noted one customer segment still receives four mailed reports a year, and customers without a verified email received two mailed reports a year.

3.2.2 Implementation Contractor Interview

The HER implementation contractor client success manager (CSM) was interviewed in February 2017. The current CSM took over the AEP Ohio HER account in early 2016. The CSM’s responsibilities include ensuring smooth implementation of the program, creating promotional modules, designing refills and expansions. Goals include achieving reliable and cost effective savings, increasing digital engagement and program promotion, and increasing customer satisfaction.

In 2016, the AEP Ohio HER reports included 12 promotional modules. The CSM considered this to be a high number of promotional modules and commended AEP Ohio’s efforts to keep their report experiences fresh and engaging. The CSM believes these efforts contribute to the high savings AEP Ohio achieves relative to its goals.

The implementation contractor conducted an independent customer engagement survey in 2016 via telephone and interviewed both treatment and control HER customers. They found high report readership rates and high satisfaction among treatment customers. Compared to control customers, they found an increase in EE program awareness and stated participation, as well as an increase in the belief AEP Ohio wants to save its customers money. Overall, the CSM saw the AEP Ohio HER program as successful.

3.3 Cost Effectiveness Review

This section addresses the cost effectiveness of the 2016 Home Energy Report Program. Cost effectiveness is assessed through the use of the Total Resource Cost (TRC) test. The cost-effectiveness analysis does not include the impacts of the AMI participants. The AMI component is administered and charged to another internal organization. Table 3-5 summarizes the unique inputs used in the TRC test.
Table 3-5. Inputs to Cost-Effectiveness Model for AEP HER Program

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure Life</td>
<td>1</td>
</tr>
<tr>
<td>Participants</td>
<td>362,788</td>
</tr>
<tr>
<td>Annual Energy Savings (kWh)</td>
<td>68,807,281</td>
</tr>
<tr>
<td>Coincident Peak Savings (kW)</td>
<td>8,971</td>
</tr>
<tr>
<td>Third Party Implementation Costs</td>
<td>$686,000</td>
</tr>
<tr>
<td>Utility Administration Costs</td>
<td>$130,157</td>
</tr>
<tr>
<td>Utility Incentive Costs</td>
<td>$0</td>
</tr>
<tr>
<td>Participant Contribution to Incremental Measure Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Based on these inputs, the TRC ratio for the AEP Ohio HER Program is 3.0, and the program is cost-effective. Table 3-6 summarizes the results of the cost-effectiveness tests. Results are presented for the Participant test, the TRC test, the Ratepayer Impact Measure test, and the Utility Cost test.

Table 3-6. Cost-Effectiveness Results for the HER Program

<table>
<thead>
<tr>
<th>Cost-Benefit Test</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Resource Cost</td>
<td>5.4</td>
</tr>
<tr>
<td>Participant Cost Test</td>
<td>N/A</td>
</tr>
<tr>
<td>Ratepayer Impact Measure</td>
<td>0.5</td>
</tr>
<tr>
<td>Utility Cost Test</td>
<td>5.4</td>
</tr>
</tbody>
</table>

At this time, additional benefits related to reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC. These additional benefits would increase the given TRC benefit/cost ratio.
4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Impact Evaluation

Navigant utilized methodologies in accordance with recommendations from the SEE Action Network Working Group for evaluating behavior-based energy efficiency programs in order to estimate HER Program savings. Two different models were utilized in the impact evaluation to confirm the robustness of the estimated savings impacts.

4.1.1 Key Impact Evaluation Findings

The Home Energy Report Program reported _ex ante_ 67,262 MWh of energy savings and 8,744 kW of demand savings in 2016. The verified _ex post_ energy and demand savings for 2016 for all HU and PIPP customers combined were 68,807 MWh and 8,971 kW respectively, for a realization rate of 102 percent on energy savings and 103 percent on peak demand savings. Savings from AMI customers are not included in the above _ex ante_ and _ex post_ calculations because these savings are not counted toward the HER Program savings goals. Navigant estimated these customer groups provided an additional 6,044 MWh of energy savings and 788 kW of peak demand savings. Across all customer groups, Navigant estimates the HER Program saved 74,851 MWh and 9,759 kW during the 2016 program year.

Navigant found savings varied significantly by customer group. HU participants in the earlier cohorts are estimated to have saved more energy than other customer groups on an absolute basis. This is partly due to their higher average daily energy use as compared to other participant cohorts. On a relative basis, the savings from the earlier cohorts enrolled in 2010 through 2013 all exceed one percent of daily energy usage.

A meaningful result from the cohort-level findings is the relatively low rate of savings from the later cohorts compared to the earlier cohorts. The three cohorts enrolled during 2015 and 2016 are estimated to have generated under one percent savings. Prior experience has shown once customers begin receiving Home Energy Reports, it can take up to 18 months for savings to fully materialize after a customer is enrolled in the program. This “ramp-up” phase may be impacting the savings estimate for the 2016 HU and AMI cohorts, but the 2015 AMI cohort was enrolled in the program for over a year prior to the beginning of the 2016 program year. However, this cohort has the lowest average daily usage of any cohort, and low energy users tend to produce lower savings.

Navigant’s estimates of overall program savings were not reduced by double counted savings, as Navigant found no increase in participation among HER Program customers in other AEP Ohio EE/PDR programs as compared to control customers. Navigant used a Post-Only-Difference (POD) analysis to determine no (zero) estimated savings are likely already counted in other AEP Ohio programs. The total savings estimate pro-rated savings for customers that moved-out during the program year.

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4.1.2 Recommendations

1. Navigant’s analysis shows recent participant cohorts have a lower average daily energy usage and, relatedly, a lower average electricity savings. Evidence from this analysis also suggests some of the more recent cohorts may have a lower relative level of electric savings beyond the initial ramp-up period. Navigant suggests AEP Ohio continue the HER Program as long as regularly reported electric savings remain cost-effective, but also monitor the incremental cost and savings of each new cohort introduced to ensure individual cohorts contribute to the cost-effectiveness of the program as a whole.

2. Further investigation into the construction of the 2013 AMI cohort may be warranted to determine if there are customer characteristics that are adversely impacting participant savings. There may be a household characteristic or personality, either seen or unseen, which is more prevalent in this cohort that negatively impacts program savings. Depending on the outcome of these investigations, it may be possible it is not cost-effective to continue including this cohort in the HER Program.

3. The program evaluation in 2014 included a live audit performed via telephone survey with program participants. This audit asked participants to report on the current state of lighting and thermostats settings in their household. This approach provided quantifiable evidence of specific actions participant households are taking in response to the home energy reports. AEP Ohio should consider using these live audits in the future as a way to either 1) further investigate why some participant cohorts are generating less savings than others, or 2) gather quantifiable data on other actions that participating households may be taking to generate energy and demand savings, beyond the lighting and HVAC actions investigated during the 2014 evaluation.
APPENDIX A. VERIFICATION OF CONTROL GROUPS

The following graphs present the distribution of energy use in the pre-program period for treatment and control households in each customer group and cohort. In the graphs, the blue diamonds represent the average monthly electricity use of households in each customer group, the red bars represent the range of energy use between the 25th and 75th percentile of households, and the lines (whiskers) show the range between the 5th and 95th percentile of households.

Figure A-1. Average Daily Treatment/Control Household Energy Use by Month in 2010 HU Cohort

Source: Navigant Analysis
Figure A-2. Average Daily Treatment/Control Household Energy Use by Month in 2011 HU Cohort

Average Electricity Usage by Month (kWh)

Source: Navigant Analysis

Figure A-3. Average Daily Treatment/Control Household Energy Use by Month in 2013 HU Cohort

Average Electricity Usage by Month (kWh)

Source: Navigant Analysis
Figure A-4. Average Daily Treatment/Control Household Energy Use by Month in January 2014 HU Cohort

Source: Navigant Analysis
Figure A-5. Average Daily Treatment/Control Household Energy Use by Month in August 2014 HU Cohort

Source: Navigant Analysis

Figure A-6. Average Daily Treatment/Control Household Energy Use by Month in 2010 PIPP Cohort

Source: Navigant Analysis
Figure A-7. Average Daily Treatment/Control Household Energy Use by Month in 2010 AMI Cohort

Source: Navigant Analysis

Figure A-8. Average Daily Treatment/Control Household Energy Use by Month in 2014 AMI Cohort

Source: Navigant Analysis
Figure A-9. Average Daily Treatment/Control Household Energy Use by Month in 2015 AMI Cohort

Source: Navigant Analysis
APPENDIX B. PER PARTICIPANT REGRESSION RESULTS

Table B-1 presents the key outputs of the post-program regression and fixed-effects analyses. These values are per participant daily savings estimates in terms of kWh.

Table B-1. Per Participant Coefficients and Standard Errors by Program Cohort

<table>
<thead>
<tr>
<th>Program Cohort</th>
<th>PPR Coefficient</th>
<th>PPR Clustered Standard Error</th>
<th>FE Coefficient</th>
<th>FE Clustered Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 HU</td>
<td>-0.9340</td>
<td>0.0799</td>
<td>-0.9183</td>
<td>0.0840</td>
</tr>
<tr>
<td>2011 HU</td>
<td>-1.0584</td>
<td>0.2381</td>
<td>-1.0086</td>
<td>0.2521</td>
</tr>
<tr>
<td>2013 HU</td>
<td>-0.7437</td>
<td>0.0760</td>
<td>-0.5051</td>
<td>0.0761</td>
</tr>
<tr>
<td>Jan 2014 HU</td>
<td>-0.1440</td>
<td>0.0898</td>
<td>-0.1838</td>
<td>0.0929</td>
</tr>
<tr>
<td>Aug 2014 HU</td>
<td>-0.3815</td>
<td>0.1487</td>
<td>-0.4039</td>
<td>0.1604</td>
</tr>
<tr>
<td>2016 HU</td>
<td>0.0267</td>
<td>0.1005</td>
<td>-0.0672</td>
<td>0.0834</td>
</tr>
<tr>
<td>PIPP</td>
<td>-0.7660</td>
<td>0.2140</td>
<td>-0.5835</td>
<td>0.2184</td>
</tr>
<tr>
<td>2010/11 AMI</td>
<td>-0.3822</td>
<td>0.1551</td>
<td>-0.4107</td>
<td>0.1659</td>
</tr>
<tr>
<td>2013 AMI</td>
<td>0.6119</td>
<td>0.2093</td>
<td>0.6778</td>
<td>0.2075</td>
</tr>
<tr>
<td>2014 AMI</td>
<td>-0.3376</td>
<td>0.1384</td>
<td>-0.4157</td>
<td>0.1427</td>
</tr>
<tr>
<td>2015 AMI</td>
<td>-0.1158</td>
<td>0.0852</td>
<td>-0.1201</td>
<td>0.0923</td>
</tr>
<tr>
<td>2016 AMI</td>
<td>-0.1856</td>
<td>0.1783</td>
<td>-0.1691</td>
<td>0.1653</td>
</tr>
</tbody>
</table>

Source: Navigant Analysis
APPENDIX C. SAMPLE HOME ENERGY REPORT

Home Energy Report
Account number: 
Report period: 04/01/11 - 05/31/11

We are pleased to provide you periodic, personalized Home Energy Reports as part of an AEP Ohio gridSMART® initiative. These reports are designed to provide you more information to make informed energy choices to help you save energy and money.

If you have any questions about these reports or would like to no longer receive them, you can contact us at (800) 277-2177 or gridSMARTOhioReports@aep.com.

Update your home information at: gridSMARTOhio.com/go/reports

Last 2 Months Household Comparison

- You used 30% LESS electricity than efficient similar homes.

<table>
<thead>
<tr>
<th>YOUR HOME</th>
<th>Efficient Similar Homes</th>
<th>Similar Homes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>055 kWh*</td>
<td>026</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.364</td>
</tr>
</tbody>
</table>

* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

How you’re doing:

- GREAT 🐻 🐻 🐻
- Good 🐻 🐻 🐻
- More than average 🐻 🐻 🐻

Is your home compared correctly?
Tell us more about your home:
gridSMARTOhio.com/go/reports

Last 12 Months Household Comparison

- You used 50% LESS electricity than similar homes.
- This saves you about $591 per year.

Key: Your Home • Similar Homes • Efficient Similar Homes

Turn over for savings ——>
Home Energy Report Program
2016 Evaluation Report

An Average Day Last Month

On average, you used the most from 10 pm – 12 am.
Think about what uses electricity during this time.

Do you use more on weekdays or weekends? Visit gridSMARTOhio.com/go/reports to find out.

Action Steps | Personalized tips chosen for you based on your energy use and housing profile

Quick Fix
Something you can do right now

☐ Raise your thermostat setting
By setting your thermostat appropriately in the summer, you can stay cool and save energy. You can save 3-5% on cooling costs for each degree you increase the temperature.

Set the thermostat to 78°F or higher when you are awake and home, and use fans to stay comfortable.
When you leave home, change the thermostat to an energy saving level — a 10°F adjustment is a good rule of thumb.

SAVE UP TO $120 PER YEAR

Great Investment
A big idea for big savings

☐ Choose an efficient room air conditioner
In the summer, air conditioning can account for a significant portion of your home’s energy bill.
When you decide to replace your old room air conditioner, invest in an efficient ENERGY STAR® qualified unit to lower your cooling costs.
We’re offering a $25 mail-in rebate when you recycle your old, working room air conditioner and purchase an ENERGY STAR qualified model May 1, 2011 through August 31, 2011.

SAVE UP TO $20 PER YEAR

Quick Fix
Something you can do right now

☐ Keep out the sun’s heat
Sunlight passing through windows can heat up your home and make your air conditioner work extra hard.
Keep blinds or draperies closed on sunny days to block this heat. You can also purchase and install shade screens, which are an affordable and effective way to keep out the sun’s heat.
Blocking sunlight from entering your home will help you stay comfortable and save on cooling costs.

SAVE UP TO $10 PER YEAR

Questions? Want to opt-out of reports? | (800) 277-2177 | gridSMARTOhio.com/go/reports@ep.com

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