

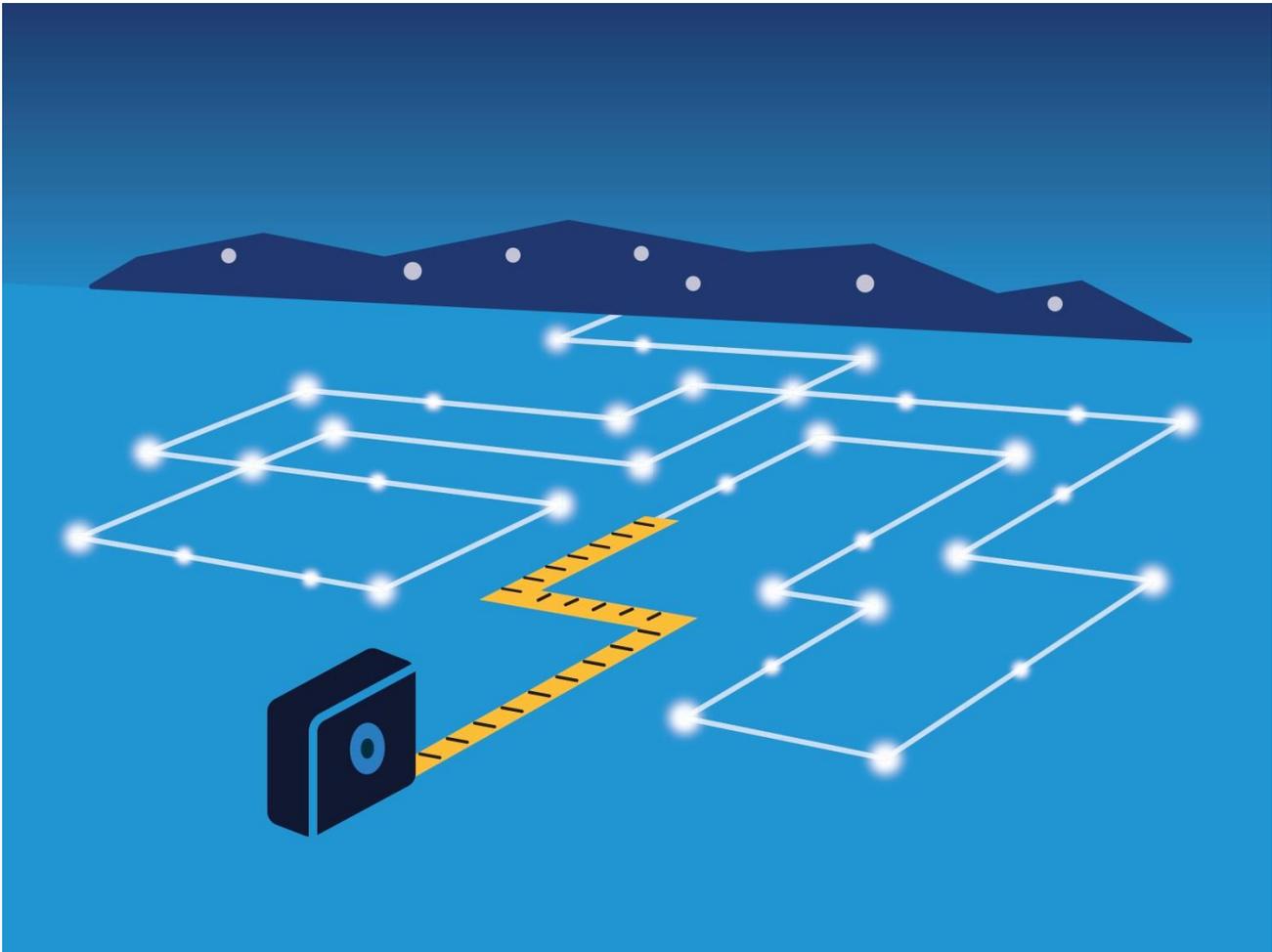


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Impact and Process Evaluation of 2016 (PY9) Ameren Illinois Company Behavioral Modification Program

Final

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1. Executive Summary

This report presents results from the Ameren Illinois Company (AIC) Behavioral Modification Program implemented by Leidos and Oracle from June 2016 to May 2017 (also referred to as Program Year 9 [PY9]). AIC developed the program to reduce its residential customers' energy consumption. Launched in August 2010, the program seeks to:

- Reduce energy consumption by encouraging energy-efficient behaviors,
- Boost customer engagement and education by helping customers understand energy efficiency and how to save energy in their homes, and
- Educate customers about no-cost and low-cost energy-saving measures and behaviors.

The Behavioral Modification Program began in PY3 and, until the end of PY7, AIC oversaw a single dual-fuel program, as well as reviewed and approved any program materials or changes that were made during the program year. Since PY8, AIC has administered the program for gas customers, while the electric portion of the program has been offered through the IPA procurement process. Thus, this report focuses on the PY9 AIC therm savings.

In PY9, the program offered three forms of treatment: (1) a hard-copy printed home energy report (HER) mailed four times a year to the customer's billing address; (2) an electronic HER (eHER) sent once per billing cycle to all customers with email addresses (generally once a month); and (3) an online portal, which customers can log onto to view the same report and access additional information.

The Behavioral Modification Program reached just about a third of AIC's approximately 1 million residential customers in PY9. A total of 308,906 participants received reports in PY9 (including both dual-fuel and gas-only customers). Oracle added a new cohort of just over 46,000 dual-fuel customers in September 2016 (Expansion Cohort 7). As a result, the number of income-qualified customers who received HERs with the Home Energy Program Income-Qualified (HEPIQ) marketing module, increased demonstrating AIC staff commitment to expand services for income qualified customers.

Program Impacts

In PY9, the program achieved adjusted net savings of 1,838,167 therms (see Table 1). Adjusted net savings remove the energy savings that resulted from customer participation in other AIC programs.

Table 1. PY9 Behavioral Modification Program Net Gas Impacts

| Cohort | Number of Customers Treated in PY9 ^a | Unadjusted Net Savings (% per household) | Unadjusted Net Savings (therms per household) | Unadjusted Net Program Savings (therms) ^b | PY9 Savings Uplift (therms) | Legacy Savings Uplift (therms) | Adjusted Net Program Savings (therms) |
|--------------------------|---|--|---|--|-----------------------------|--------------------------------|---------------------------------------|
| Original Cohort | 33,406 | 0.92% | 7.01 | 226,995 | 0 | 6,316 | 220,679 |
| Expansion Cohort 1 | 50,266 | 1.32% | 11.38 | 553,165 | 0 | 13,381 | 539,783 |
| Expansion Cohort 2 | 73,636 | 0.71% | 4.18 | 296,150 | 21,675 | 3,161 | 271,314 |
| Expansion Cohort 3 | 12,015 | 2.16% | 14.93 | 173,368 | 0 | 0 | 173,368 |
| Expansion Cohort 4 | 20,329 | 0.86% | 5.78 | 112,101 | 0 | 11,793 | 100,308 |
| Expansion Cohort 5 | 45,359 | 0.86% | 6.65 | 280,698 | 0 | 242 | 280,456 |
| Expansion Cohort 6 | 27,716 | 0.50% | 2.33 | 59,293 | 0 | 795 | 58,497 |
| Expansion Cohort 7 | 46,179 | 0.84% | 5.94 | 203,528 | 9,767 | 0 | 193,761 |
| Total^c | 308,906 | | 6.17 | 1,905,299 | 31,442 | 35,689 | 1,838,167 |

^a The number of customers in PY9 refers to the number of customers to which AIC/IPA intended to provide HERs and who had an experiment start date

^b Pro-rated for participants whose accounts closed during PY9

^c Totals may not be exact due to rounding

Key Findings and Recommendations

The evaluation team provides the following key findings and recommendations for the program:

- **Key Finding #1: The program reduced energy consumption.** Billing analyses results indicate a net reduction of 1,838,167 therms. Program participants achieved 5.95 therms savings per household per year. We calculated these values by dividing the total adjusted net program therm savings for the evaluated period by the total number of gas program participants.
 - **Recommendation:** Depending on the selected cohorts for future program years, AIC can use the average savings estimates for therms over the evaluated period to inform future participant selection. Theoretically, AIC could multiply these averages by the selected future participant type and produce estimates of the next program year's anticipated electricity and gas savings. These projections of savings provide information about the types of participants to select to include in future program years.
- **Key Finding #2: All cohorts show equivalency in terms of average daily consumption in the pre-participation period.** In addition, we demonstrated equivalency between the treatment and control groups of Expansion Cohort 7 using household, demographic, and psychographic data.
 - **Recommendation:** We recommend that the vendor continue to monitor the equivalency of the treatment and control groups of each cohort to ensure they remain so.
- **Key Finding #3: For the second year in a row, technical issues resulted in reductions to report frequency for many customers.** There were widespread issues with missing monthly billing reads in October 2016 that reduced the frequency of reports for approximately 31,000 customers. Because these billing reads were missing, these customers were mistakenly moved to program opt-out status. In addition, when Oracle converted to its Agile EE platform, the staff discovered 7,600 treatment

customers had not been receiving reports since 2012 or 2013, depending upon the customer. Both issues were addressed and the customers were included back in the program.

- **Recommendation:** Investigate the reoccurring missing reads issue as it affects program delivery and evaluation. The missing billing reads occurred in the fall just as it had in PY8. AIC should perform systematic checks to ensure that the billing data provided to Oracle goes through a thorough quality assurance/quality control (QA/QC) process to prevent this issue from occurring again.

- **Key Finding #4: Oracle's use of exclusion criteria that allow for the inclusion of customers with only 90 days of pre-period billing information may contribute to high program attrition rates, as well as volatility in estimating energy savings associated with the program.** As documented in this report, later cohorts with lower required pre-period billing information have higher attrition rates, and results across statistical models vary and in some cases become negative. Fewer pre-period billing records lead to fewer customers that can be incorporated within a statistical model, leading to more uncertainty in savings estimates. This is particularly notable in modeled gas savings from Expansion Cohort 6, where results from our statistical models are divergent from each other as well as from Oracle's model.

- **Recommendation:** We recommend expanding the number of required pre-participation billing months for any new cohorts to a minimum of nine months.

2. Evaluation Approach

The PY9 evaluation of the Behavioral Modification Program included an impact analysis, as well as a review of program processes and design changes. To evaluate impacts, the evaluation team conducted an equivalency assessment between treatment and control groups, a billing analysis, and a channeling analysis. We reviewed program materials and program-tracking data and conducted interviews with program implementation staff to assess the successes and challenges encountered during the PY9 year and to gain contextual information about the savings generated from the delivery of HERs to targeted customers. We also discussed whether the program implementation differed from previous years.

2.1 Research Objectives

The evaluation team sought to answer the following research questions as part of the PY9 program evaluation.

Impact Questions

- Were the new treatment and control groups equivalent and has equivalency been maintained for previous cohorts?
- What were the estimated therm energy savings from this program for all cohorts in PY9?
- Did the program achieve savings year-over-year for each of the cohorts?
- Did estimated program savings need to be adjusted due to the treated population's participation in other AIC programs? If yes, how much savings should be removed from the program?

Program Process Questions

- How has the program changed since PY8?
- What notable successes occurred and challenges were faced with program implementation?
- Were there any changes in the quantity or frequency of hard copy and/or electronic HERs delivery to customers?

2.2 Evaluation Tasks

Table 2 below summarizes the PY9 evaluation activities conducted for the Behavioral Modification Program and the sections below provide additional details about each of them.

Table 2. Summary of Behavioral Modification Program Evaluation Activities for PY9

| Activity | Impact | Process | Forward Looking | Details |
|--|--------|---------|-----------------|--|
| Program Staff Interviews | ✓ | ✓ | ✓ | Interviewed program managers from AIC and Oracle to discuss changes in program operations since PY8 as well as program successes and challenges faced during PY9. |
| Review of Utility Data and Program Materials | ✓ | ✓ | | Reviewed data to determine if it was adequate to conduct the net impact analysis and reviewed materials to assess program design, implementation, and operations. |
| Equivalency Analysis | ✓ | | ✓ | For Expansion Cohort 7, compared treatment and control groups' energy usage and key demographic, household, and psychographic data to assess whether they are equivalent. For all previous cohorts, we checked treatment and control groups' energy usage to ensure continued equivalency. |
| Billing Analysis | ✓ | | | Conducted billing analysis to quantify the changes in energy use among the treatment and control groups. |
| Channeling Analysis | ✓ | | ✓ | Performed a channeling analysis to ensure we did not double-count savings from participation in other AIC residential programs. |

2.2.1 Program Staff Interviews

We conducted two telephone interviews with key program staff from AIC and Oracle. The interviews provided us with a comprehensive understanding of the program and its implementation, including insights into the daily operation of the program, program changes in PY9, and areas of success and challenges.

2.2.2 Program Materials Review

The evaluation team reviewed the program-tracking database and other program materials, including Oracle's PY9 implementation plan and web use metrics. This review allowed us to determine if there were any gaps present in the data, particularly around information required for the impact analysis. Table 3 provides a description of the data we reviewed, as well as their sources.

Table 3. PY9 Behavioral Modification Program Evaluation Data Reviewed by Source

| Data Source | Data Details |
|---|---|
| Behavioral Modification Program Information | PY9 program energy savings goals, budget and expenditures, opt-out or move-out dates, treatment and control group information |
| HER Information | Sample reports, tips and recommendations provided in HERs and ActOnEnergy.com/save website, delivery dates for HERs |

| Data Source | Data Details |
|--------------------------------|---|
| Customer Billing Information | For all customer treatment and control groups, electric and gas billing data from July 2009 to May 2017 |
| Customer Information | Customer account information, Experian data (including demographic data, housing characteristics, and psychographic data) |
| AIC Program-Tracking Databases | For all AIC residential programs from June 2009 to May 2017 (PY4–PY9) |
| Weather Data | Heating degree days (HDD) and cooling degree days (CDD) for specific weather stations in AIC service territory |

2.2.3 Impact Analysis

We carried out an equivalency analysis, a billing analysis, and a channeling analysis to arrive at PY9 ex post net energy savings for the Behavioral Modification Program. We present the details of each method below.

Equivalency Analysis

The equivalency analysis includes a comparison of baseline household energy consumption and household characteristics for new cohorts. Through a review of these data, we determine whether there were key differences between the treatment and control groups. Confirming the comparability of the treatment and control groups strengthens the internal validity and defensibility of the research design.

The evaluation team used two methods to identify systematic differences between the treatment and control groups for Expansion Cohort 7. First, we examined average daily fuel consumption in the year before the start of the program by calculating mean household daily consumption and variation in consumption for the 2015 billing period. Second, the evaluation team examined the demographic, housing, and psychographic data purchased from Experian, comparing treatment to control customers. These observable characteristics may reflect other characteristics, such as attitudes and beliefs.

Below, we list variables used in the equivalency check for Expansion Cohort 7:

- Demographic Characteristics
 - Age
 - Dwelling type
 - Education
 - Homeowner/renter distribution
 - Estimated household income
 - Number of adults in household
 - Occupation group

- Number of children in household
- Household Characteristics
 - Building square footage
 - Year built
- Psychographic characteristics
 - Behavior bank (social causes and concerns, e.g., the environment)
 - Behavior bank (e.g., computers—internet/online subscriber or use of internet services)

Equivalency analyses conducted in previous evaluations showed the treatment and control groups were equivalent for the Original Cohort and Expansion Cohorts 1 through 6. Because there has been some attrition, the evaluation team compared energy usage between the treatment and control groups for all cohorts for the 12 months prior to when the first reports were received, but did not include an examination of demographic, housing, and psychographic data from Experian because we conducted this analysis in prior years.

Billing Analysis

We determined program impacts using a billing analysis that leveraged a randomized control trial (RCT) experimental design. The estimated savings from this analysis are net savings, but may still include some savings from other programs, which we later adjusted using channeling analysis. The billing analysis used a regression model on treatment and control group monthly billing data to estimate net savings per household over the program period. Below we outline our approach to the billing analysis.

Data Preparation

The data used in the billing analysis came from three primary sources:

- Monthly billing data from July 2009 to May 2017 from AIC;
- Program launch date specific to each customer (treatment and control) from Oracle; and
- Weather data (HDD and CDD) from National Oceanic and Atmospheric Administration (NOAA). The data came from 46 weather stations across the state and are appended at the zip code level.

To develop the dataset used for the statistical analysis, the evaluation team conducted the following data processing steps:

- Cleaned billing data
 - Removed exact duplicates
 - Dropped billing periods more than 90 days
 - Dropped first and last billing periods with more than 60 days
 - Dropped first and last billing periods with less than 10 days
 - Combined overlapping billing periods

- Combined estimated bills with actual bills to correct for bill estimation
- Removed observations and customers within each cohort based on the following criteria:
 - Moved out before RCT started
 - First report date occurring after inactive date
 - Out-of-range usage data
 - Very low usage data
 - No post-participation period data
 - Insufficient pre-participation period data
- Determined the monthly usage for each customer based on their read cycle (each usage record has a start date and a duration; based on these two variables, the team identified the appropriate month for each read cycle).
- Matched weather data by customer to the geographically closest weather station.

Depending on the cohort, data cleaning removed between <1% to 32% of customers in the electric and gas analyses. The majority of these drops, especially for more recent cohorts, are due to insufficient pre-participation period billing data. We provide the accounting of the number and percentage of accounts removed due to these activities in Appendix B of this report.

Modeling Program Impacts

The impact analysis relied on a statistical analysis of monthly natural gas billing data for all AIC customers who received a HER (the treatment group) and a randomly selected group of customers who did not receive a HER (the control group). The evaluation team used an intent-to-treat (ITT) approach in PY9,¹ and in implementing this approach, we estimated savings using a difference-in-differences (DID) model. The DID refers to the model's implicit comparison of consumption before and after treatment of both treatment and control group customers. The model includes customer-specific intercepts (i.e., fixed effects) to capture unobserved differences between customers that do not change over time and affect customers' energy use.

As part of the impact analysis, we use three different models to aid in comparisons to previous evaluations:

1. An overall model (Equation 1), that incorporates the post-participation period only. This is the lagged dependent variable (LDV) model, which is consistent with program implementer modeling and does a better job of modeling program impacts given Oracle's exclusion criteria of only 90 days pre-period data.
2. An overall model with the addition of weather adjustments (Equation 2), which allows direct year-to-year savings comparison.

¹ ITT estimates the impacts of the program for a group of customers the program intended to treat, (i.e., customers AIC intended to receive HERs or eHERs). In previous years, we used the average treatment effect of the treated (ATT), which estimates the impacts of the program for the group of customers that received HERs and/or eHERs. These approaches differ in the number of customers used in the analysis.

3. A simple overall model (Equation 3), which is consistent with previous years' evaluations.

We provide impact estimates for the program using the first model. We use the second model to assess savings year over year. We use the third model to provide results using the most basic model specification. Our model specifications are as follows:

Model 1: Post-Participation Period Only Model

For reporting purposes, and to enable comparisons to program implementer-supported models (i.e., Oracle, the program implementer's estimates), we estimated a LDV model. A LDV model differs from the linear fixed effects regression (LFER) model in that only usage from the post-participation period is used in estimating the model. Information from the pre-participation period is used only to calculate pre-usage variables that are incorporated into the LDV model, but pre-period usage is not directly modeled. Following last year's evaluation, we used three levels of pre-participation period usage for each customer: overall pre-participation period average daily consumption (ADC), summer pre-participation period ADC, and winter pre-participation period ADC. The LDV model uses the control group in the same way as the LFER model, in that the treatment effect is corrected for control group ADC so that the coefficient of the treatment variable is the average ITT effect. We employed the following estimating equation:

Equation 1. Post-Participation Period Only Model Estimating Equation

$$ADC_{it} = \alpha_i + \beta_1 Treatment_i + \beta_2 PreUsage_i + \beta_3 PreWinter_i + \beta_4 PreSummer_i + \beta_5 MonthYear_t + \beta_6 PreUsage_i \cdot MonthYear_t + \beta_7 PreWinter_i \cdot MonthYear_t + \beta_8 PreSummer_i \cdot MonthYear_t + \varepsilon_{it}$$

Where:

ADC_{it} = Average daily consumption (therms) for household i at time t

α_i = Household-specific intercept

β_1 = Coefficient for the change in consumption for the treatment group

β_2 = Coefficient for the average daily usage across household i available pretreatment meter reads

β_3 = Coefficient for the average daily usage over the months of December through March across household i available pretreatment meter reads

β_4 = Coefficient for the average daily usage over the months of June through September across household i available pretreatment meter reads

β_5 = Vector of coefficients for month-year dummies

β_6 = Vector of coefficients for month-year dummies by average daily pretreatment usage

β_7 = Vector of coefficients for month-year dummies by average daily winter pretreatment usage

β_8 = Vector of coefficients for month-year dummies by average daily summer pretreatment usage

$Treatment$ = Variable to represent treatment and control groups (0 = control group, 1 = treatment group)

$PreUsage$ = Average daily usage for household i over the entire pre-participation period

$PreWinter_i$ = Average daily usage for household i over the pre-participation months of December through March

$PreSummer_i$ = Average daily usage for household i over the pre-participation months of June through September

$MonthYear_t$ = Vector of month-year dummies

ε_{it} = Error

Model 2: Weather-Adjusted Model

To enable better comparisons across program years, we incorporated weather terms. This also improved the precision in the modeled results by accounting for possible differences in weather experienced by the study population. We controlled for weather by accounting for HDD and CDD, using a base of 65 °F for HDD and 75 °F for CDD. This model also helps account for differences between treatment and control group usages that correlate with weather.

Equation 2. Weather-Adjusted Model Estimating Equation

$$ADC_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \beta_3 HDD_{it} + \beta_4 CDD_{it} + \varepsilon_{it}$$

Where:

$ADC_{it}, \alpha_i, Treatment_i$ and ε_{it} are defined as above in Model 1

β_1 = Coefficient for the change in consumption between pre- and post-participation periods

β_2 = Coefficient for the change in consumption for the treatment group in the post-participation period compared to the pre-participation period and to the control group; this is the basis for the net savings estimate

β_3 = Coefficient for HDD

β_4 = Coefficient for CDD

$Post_t$ = Variable to represent the pre- and post-participation periods (0 = pre-participation period, 1 = post participation period²)

HDD_{it} = Sum of HDD (base 65 °F)

CDD_{it} = Sum of CDD (base 75 °F)

² We defined the pre-period as the 12 months before the customer's first report. The month in which a customer receives their first report is neither pre-period nor post-period. The post-period is the time period after the month in which the customer received their first report. For the purposes of this evaluation, we focused specifically on the PY9 post-period and dropped post-period data outside of the program year window (June 2016 through May 2017).

Model 3: Original Model

Equation 3. Original Model Estimating Equation

$$ADC_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \varepsilon_{it}$$

Where:

ADC_{it} , α_i , $Treatment_i$ and ε_{it} are defined as above in Model 1

β_1 , β_2 and $Post_t$ are defined as above in Model 2

Estimating Program Savings

We calculated savings by evaluating these models under two conditions: with treatment and without treatment. We did this using the coefficient in the model that estimates the treatment effect. For Model 1, this is the coefficient of the *Post * Treatment* interaction; for Model 2, this is also the coefficient of the *Post * Treatment* interaction; and for Model 3, this is the coefficient of the *Treatment* variable. The average daily household savings attributable to the program is the value of this coefficient in each of these cases.

We calculated program savings as a percentage reduction by dividing the average daily savings estimate described above by the estimate of ADC under the conditions of non-participation.³ To calculate average household savings attributable to the program for the evaluated period, we multiplied the average, raw, per-household daily savings by the average number of days the treatment group was in the post-participation period during the program year (i.e., the average number of days between the date Expansion Cohort 7 was added to the program [June 8, 2017] and the endpoint of the post-participation billing periods).

Confidence intervals and significance testing are usually provided when evaluating a sample from the participant population. However, this evaluation covers the entire participant population. Consequently, we do not provide confidence intervals, because any savings achieved through the program reflect actual population savings and do not require significance testing.

Participation Lift and Channeling Analysis

The evaluation team conducted the participation lift and channeling analysis (also known as program uplift analysis) to answer the following research questions:

1. Does the program treatment have an effect on participation in other AIC residential energy efficiency programs (also known as “participation lift”)?
2. What portion of savings achieved by customers in the Behavioral Modification treatment group is counted as savings by other AIC residential energy efficiency programs (savings adjustment)?

The evaluation team assumes that customers in the treatment and control groups receive the same treatment from AIC for other energy efficiency programs (i.e., they encounter the same marketing and incentives). Because the Oracle program design for the Behavioral Modification Program randomly assigns customers to the treatment and control groups, any difference between the groups when it comes to participation in other AIC offerings can be attributed to the Program. As such, we conducted a participation lift analysis to calculate

³ This includes usage by the treatment group prior to participation and usage by the control group during the entire period before and after the treatment group’s participation.

increased participation in AIC's other residential energy efficiency programs due to the Behavioral Modification Program.

Additionally, to ensure that we do not double count savings across programs, the evaluation team calculates a savings adjustment that removes savings captured in the Behavioral Modification consumption analysis that are claimed by other programs. Applying this savings adjustment to the result of the Behavioral Modification consumption analysis produces adjusted net savings.

PY9 Participation Lift Analysis

To determine whether the Behavioral Modification Program treatment generated participation lift in PY9 (e.g., an increase in participation in other energy efficiency programs in PY9 as a result of the Behavioral Modification Program), we calculated whether more treatment than control group members participated in other AIC residential energy efficiency programs after receiving HERs compared to program participation before receiving HERs. We cross-referenced the Behavioral Modification Program database—both treatment and control groups (for all program cohorts)—with the databases of other residential energy efficiency programs in PY9, including:⁴

- Appliance Recycling
- HVAC
- Home Efficiency Income Qualified⁵
- Moderate Income Kits

The participation lift analysis calculates the number of program participants who participated in both the Behavioral Modification Program **and** other energy efficiency programs in PY9. To ensure the participation lift is attributable solely to the Behavioral Modification Program, we calculate participation lift using a difference-in-differences estimator (where possible).⁶ To do so, we identify the total number of treatment and control

⁴ We did not include a number of programs that touched residential customers during PY9 in this analysis for various reasons:

We did not include the Home Efficiency Standard Program for PY9 in the channeling analysis due to the structure of the program-tracking data. Since this data did not have a valid variable for identifying unique customers, our team was not able to link projects to specific residential accounts. A small number of customers participated in this program in PY9 (approximately 70 participants).

The Multifamily Program was not included in the channeling analysis due to the structure of program-tracking data. Since participation is tracked at a multifamily property level, our team was not able to link measures to specific residential accounts.

We did not include the ENERGY STAR® New Homes Program in the channeling analysis because the rebates were given to the builders of new homes. Customers in a new home, if part of the treatment group, received the HER after they occupied their home; thus, their decision to move into an energy-efficient home was not influenced by the Behavioral Modification Program.

We did not include the CFL Distribution Program because it chooses customers randomly, and thus whether or not customers obtain CFLs cannot be influenced by the Behavioral Modification Program.

We excluded the School Kits Program as program data is tracked at a school level and our team was unable to link measures to specific residential accounts.

Finally, we excluded the Rural Kits program; due to its opt-out design, we assume that treatment and control group customers have the same level of participation in this program.

⁵ In prior years, this program was known as the "Moderate Income" offering.

⁶ In many cases, we are unable to calculate a Difference-in-Differences estimator due to lack of pre- period data. In these cases, we calculate a post-only differences estimator, in the following form: $Y_{1t} - Y_{1c}$.

group customers who participated in an AIC energy efficiency program in PY9, as well as the total count of treatment and control group customers who participated in an AIC energy efficiency program prior to receiving HERs. The difference in these calculations is the net participation due to the Behavioral Modification Program (see Table 4). To ensure that our analysis represents only savings that can be definitively attributed to the effects of the Behavioral Modification Program, we test participation lift for statistical significance at a 95% level of confidence, and consider only statistically significant uplift to have been caused by the Program.

Table 4. Difference-in-Differences Estimator

| | Pre-Participation | Post-Participation | Difference |
|-----------------------|-------------------|--------------------|---|
| Treatment (t) | Y_{0t} | Y_{1t} | $Y_{1t} - Y_{0t}$ |
| Control (c) | Y_{0c} | Y_{1c} | $Y_{1c} - Y_{0c}$ |
| T-C Difference | $Y_{0t} - Y_{0c}$ | $Y_{1t} - Y_{1c}$ | $(Y_{1t} - Y_{0t}) - (Y_{1c} - Y_{0c})$ |

Note: Y represents percent participation in other residential AIC programs.

Savings Adjustment

Behavioral Modification Program participants can save energy in three ways: (1) through conservation (e.g., turning off lights when leaving a room or other behavioral practices unrelated to installing equipment), (2) through measures installed outside of an energy efficiency program, and (3) through measures installed as part of other AIC energy efficiency programs. Although savings achieved from measures installed through other energy efficiency programs may not have occurred in the absence of the Behavioral Modification Program (e.g., if the Program induces participation in these programs), these savings would nevertheless be counted by the other programs. The objective of the savings adjustment is to remove savings already captured in other program evaluations and thereby avoid double-counting. This analysis quantifies the energy savings attributable to participation lift to ensure that AIC does not count savings twice (once in the Behavioral Modification Program estimate of savings and again in the savings for other energy efficiency programs).

This analysis requires calculating energy savings associated with measures installed in PY9 (known as “Annual Uplift”), as well savings associated with measures installed in prior program years (known as “Legacy Uplift”).⁷

Annual Uplift Savings Adjustment

To compute this savings adjustment for PY9, we multiply the net PY9 participation uplift due to the Behavioral Modification by the median first year ex post net savings per treatment group customer participating in another AIC residential program in PY9. We considered the same programs in our annual uplift savings adjustment as considered in the PY9 participation lift analysis.

Legacy Uplift Savings Adjustment

The Behavioral Modification Program consumption analysis captures savings within the model for each year of a given measure’s estimated useful life. To ensure that AIC does not inappropriately attribute savings to the Behavioral Modification Program that are associated with other programs and to accurately reflect the evaluation paradigm in Illinois, we also net out the savings from equipment rebated through other energy efficiency programs in past years for each year of the estimated useful life of the measure.

⁷ Legacy Uplift occurs when measures are installed with estimated useful life greater than one year.

We considered the following programs in our legacy uplift savings adjustment:

Table 5. Programs Included in Legacy Uplift Savings Adjustment

| Program | Years Included | | | | |
|--|----------------|-----|-----|-----|-----|
| | PY4 | PY5 | PY6 | PY7 | PY8 |
| Residential Lighting (Online Store Component Only) | ✓ | ✓ | ✓ | ✓ | |
| Appliance Recycling | ✓ | ✓ | ✓ | ✓ | ✓ |
| Home Efficiency Income Qualified | ✓ | ✓ | ✓ | ✓ | ✓ |
| Home Efficiency Standard | ✓ | ✓ | ✓ | ✓ | ✓ |
| HVAC | ✓ | ✓ | ✓ | ✓ | ✓ |
| Moderate Income Kits | | | | | ✓ |
| Residential Efficient Products | ✓ | ✓ | ✓ | | |

We include discontinued programs (e.g., Residential Efficient Products) as energy savings from this program’s past activity still persist in following years.

Savings are calculated in the same manner as the annual adjustment for PY9, with one adjustment. We multiply the net participation uplift due to the Behavioral Modification for each of the past years by the median first year ex post net savings per treatment group customer participating in another AIC residential program in for that year. However, when a measure has reached the end of its effective useful life by PY9, we exclude it from our analysis (e.g., if a measure installed in PY4 has only a three-year effective useful life, it is not considered in the median first year ex post net savings value for PY4 customers).

Note that these adjusted savings could be attributed to the Behavioral Modification Program and to other residential AIC programs, because they would not occur unless both programs were operating, but for accounting purposes, only one program can claim these savings.

2.3 Sources and Mitigation of Error

There are five potential sources of error that affect billing analyses. We document these, and the steps taken to mitigate them, below.

Table 6. Possible Sources of Error

| Research Task | Survey Error | | Non-Survey Error |
|---------------------------|--|---|--|
| | Sampling Error | Non-Sampling Survey Error | |
| Treatment/Control Surveys | <ul style="list-style-type: none"> • Sample frame error • Sampling error | <ul style="list-style-type: none"> • Measurement error • Non-response error | N/A |
| Multilevel Modeling | N/A | N/A | <ul style="list-style-type: none"> • Model specification error • Measurement error |
| Billing Analysis | N/A | N/A | <ul style="list-style-type: none"> • Model specification error • Measurement error • Multi-collinearity • Heteroskedasticity • Serial correlation |

- Non-Survey Errors

- **Model Specification Error:** The most difficult type of modeling error, in terms of bias and the ability to mitigate it, is specification error. In this type of error, variables that predict model outcomes are included when they should not be or left out when they should be included, possibly producing biased estimates. The team addressed this type of error by using a fixed-effects model, which adjusts for constant differences from one household to the next using customer-specific intercepts. Over time, treatment and control groups in a randomized experiment can drift apart due to attrition, causing imbalance between the groups that must be addressed in the model specification. When there is imbalance in consumption, weather, or other factors between treatment and control groups, model specification error can become much more pronounced. For this reason, the team also included models that control for weather conditions to account for differences in temperatures experienced by treatment and control populations.
- **Measurement Errors:** Measurement error can come from variables such as weather data, which are commonly included in the billing analysis models. If an inefficient base temperature is chosen for calculating degree-days or if an incorrect climate zone weather station is chosen, the model results could be subject to measurement error. We addressed this type of error by very carefully choosing the closest weather station for each customer in the model. Specifying an incorrect time period (either pre-treatment or post-treatment) can also lead to measurement error. To the extent that the data received from the program implementer are correct, this should not be a problem; however, little can be done if there is an error in the source data.
- **Multi-collinearity:** This type of modeling error can both bias the model results and produce very large variances in the results. The team dealt with this type of error by using model diagnostics such as variance inflation factor (VIF), though the relatively simple models used in the impact analysis have essentially no chance of problems with multi-collinearity.
- **Heteroskedasticity:** This type of modeling error can result in imprecise model results due to variance changing across customers with different levels of consumption. The team addressed this type of error by using robust standard errors. Most statistical packages offer a robust standard error option and make conservative assumptions in calculating the errors, which has the effect of making significance tests conservative as well.
- **Serial Correlation:** This type of modeling error can result in imprecise model results (due to multiple observations being highly correlated within the customer). The team addressed this type of error by clustering the errors by customer and using robust error estimation.

3. Detailed Evaluation Findings

This section contains detailed findings from the PY9 evaluation of the Behavioral Modification Program.

3.1 Program Design and Implementation

3.1.1 Program Description

The Behavioral Modification Program began in PY3 and, until the end of PY7, AIC oversaw a single dual-fuel program as well as reviewed and approved any program materials or changes that were made during the program year. Since PY8, AIC has administered the program for gas customers, while the electric portion of the program has been adopted through the Illinois Power Agency (IPA) procurement process. Oracle implements both the electric and gas portions of the program while Leidos provides additional oversight for the AIC gas program.

The program's primary tool for encouraging energy-efficient behaviors is the HER. In PY9, the program offered three treatment types: (1) a hard copy printed HER mailed four times a year to the customer's billing address; (2) an eHER sent once per billing cycle to all customers with email addresses (generally once a month); and (3) an online portal, which customers can log onto to view the same report and access additional information. The HERs include the following information:

- A comparison of the customer's current and past energy usage,
- A comparison of the customer's energy usage to that of similar households in the same geographical area, and
- Tips for reducing energy consumption tailored to the customer's home energy profile (e.g., type of home, square footage, and number of occupants).

In terms of report frequency, the Original Cohort and all Expansion Cohorts except for 3 (gas-only) and 7 (the newest expansion cohort of approximately 46,000 customers) received four HERs at evenly spaced intervals through the year.⁸ Expansion Cohort 3, made up of gas-only customers, received four reports at a different cadence, with no reports sent during the summer months.⁹ Expansion Cohort 7 received two back-to-back reports in September and October, a third in January, and a final one for PY9 in May. Overall, dual-fuel cohorts tend to receive HERs on a roughly quarterly basis while the gas-only cohort receives them during the colder months of the year.

3.1.2 Program Changes

Based on interviews with AIC program staff and implementers, there were limited changes made to the program in PY9. Overall, changes in program implementation and processes can be grouped into the following categories: (1) introduction of Oracle's new energy efficiency platform, Agile EE; (2) report frequency; and (3) campaigns.

⁸ The original cohort and all dual-fuel Expansion Cohorts except for 7 were sent reports in July, October, February, and May.

⁹ Gas-only customers received HERs in late September/early October, late October/early November, January, and March.

Agile EE is Oracle's new energy efficiency platform and was used to implement the Behavioral Modification Program in PY9.

- Agile EE includes newly designed HERs and a new suite of self-service online tools available to both AIC customers and program participants.
- In addition to the adoption of Agile EE, AIC program staff made updates to the tip library and images used to promote campaigns in the HERs.

Technical issues resulted in reductions in report frequency for approximately 40,000 participants. Specifically, missing billing reads¹⁰ and Oracle's transition to Agile EE led to customers being flagged as having opted-out of receiving reports.

- The program experienced issues with missing billing reads, which led to a reduction in the number of reports delivered to customers for a second year in a row. In particular, AIC experienced approximately 88,600 missing customer bill reads in October 2016 and, of these missing bill reads, approximately 31,000 of the affected customers were part of the treatment group (e.g., customers who received reports). Due to the missing bill reads, these customers defaulted to an opt-out status and therefore received no additional HERs or eHERs beyond October 2016. According to the AIC program manager, these customers need to be reinstated into the program for them to receive HERs and eHERs again. As of the end of June 2017, AIC provided Oracle with the missing billing data. Oracle staff investigated which customers did not receive HERs due to the missing billing reads and has incorporated them back into the treatment group so they will receive reports moving forward.
- When Oracle converted over to Agile EE, its staff discovered approximately 7,600 treated customer accounts that had been excluded because they were assigned to two modules¹¹ (thereby making them ineligible to receive reports). According to the AIC program manager, these customers were not marked as opting out of the program, but rather they fell out of circulation. Oracle's records show that these customers have not received a print report since 2012 or 2013. As such, AIC and Oracle have agreed to include a "Welcome Back" module in their first print report that was sent to customers in August 2017.

In addition to reductions in report delivery for several customers, there were changes in terms of the number of participants in the program, as well as changes to specific campaigns.

- The number of income-qualified customers receiving HERs that include the Home Efficiency Income-Qualified Program (HEIQ) marketing module increased when the program added customers through Expansion Cohort 7. AIC initially launched this initiative to expand services for income qualified customers and adding more qualified customers in this latest cohort shows it continues to pursue its efforts. In the previous program year, Leidos used zip codes to identify customers who would likely be eligible for income-qualified programs and these customers received tailored messaging through HERs regarding the program. Since more customers located in these zip codes were added to the program in PY9, additional customers qualified to receive HERs with the HEIQ marketing module.
- The Behavioral Modification Program staff discontinued the "target rank campaign" in PY9, which provided customized short-term goals to high-energy users from Expansion Cohort 1 (approximately

¹⁰ Missing bill reads occur when specific customer meters do not provide bills for a month, leading to gaps in billing history provided to Oracle. As a result, Oracle flagged these customers as having opted-out of the program.

¹¹ Modules refer to different cohort types. In this case, it refers to a dual-fuel and gas-only cohort types.

17,000 customers) to encourage HER recipients to improve their energy efficiency rank. This was done through positive feedback for incremental improvements in reducing energy use and dynamic rank tracking that allowed customers to follow their progress from report to report.

PY9 also saw updates to content and format of HERs regarding campaigns.

- Reports included information promoting rebates for smart thermostats and programmable thermostats available through AIC’s HVAC program. In addition, HERs sent to income-qualified customers included a call to action for customers to sign onto ActOnEnergy.com to familiarize themselves with rebates for energy efficient equipment, as well as tips on saving energy. HERs sent to gas-only customers in September 2016 included an information campaign about how to keep homes warm during the winter and tips on how to reduce water heating bills, as these are the months during which gas-only customers receive most of their print reports.

3.1.3 Program Participation

The Behavioral Modification Program reached just about a third of AIC’s approximately 1 million residential gas customers in PY9. Of these gas customers, 308,906 participants received reports in PY9 (including both dual-fuel and gas-only customers). Note this number excludes customers who opted out of the program, moved out of the AIC service territory, and/or did not receive a report for other reasons in PY9, as described above.

The Original Cohort customers are now in their seventh year with the program and seven additional cohorts were added to the program over the six years that followed the introduction of the program. All cohorts are dual-fuel customers, except for Expansion Cohort 3, which is gas-only.

The program added just over 46,000 dual-fuel customers to the program as Expansion Cohort 7 to address program attrition resulting from opt-outs and move-outs from the overall pool of participants. The program implementer noted that staff used exclusion criteria to identify the set of customers they could include in Expansion Cohort 7. As part of this process, they begin with the customer population and remove customers who do not want to receive reports (opt-outs), customers in prior cohorts, customers without deliverable mailing addresses, and those with medical exclusion codes. As the program includes more customers in additional cohorts and as customers opt-out over time, the set of customers from which new cohorts can be identified shrinks. Table 7 provides a breakdown by cohort of all treatment customers who received reports for at least one month in PY9.

Table 7. Behavioral Modification Program Participation in PY9

| Cohort Name | Fuel Type | Number of Gas Treated Customers in PY9 | Start Date | Program Year |
|--------------------|--------------|--|----------------|-------------------------|
| Original Cohort | Dual-Fuel | 33,406 | August 2010 | 7th year in the program |
| Expansion Cohort 1 | Dual-Fuel | 50,266 | April 2011 | 6th year in the program |
| Expansion Cohort 2 | Dual-Fuel | 73,636 | November 2011 | 6th year in the program |
| Expansion Cohort 3 | Gas-Only | 12,015 | November 2011 | 6th year in the program |
| Expansion Cohort 4 | Dual-Fuel | 20,329 | June 2013 | 4th year in the program |
| Expansion Cohort 5 | Dual-Fuel | 45,359 | September 2014 | 3rd year in the program |
| Expansion Cohort 6 | Dual-Fuel | 27,716 | April 2015 | 3rd year in the program |
| Expansion Cohort 7 | Dual-Fuel | 46,179 | September 2016 | 1st year in the program |
| | Total | 308,906 | | |

As expected, each cohort experienced some attrition as customers opted out of receiving reports, moved and closed their accounts, or never received a report in PY9 because of missing billing reads. We base the attrition rates shown in Table 8 on numbers provided in Oracle’s program tracking database.¹² We also include earlier program year attrition rates to provide context.

Table 8. Behavioral Modification Program Attrition Rates in PY9

| Cohort Name | PY3 | PY4 | PY5 | PY6 | PY7 | PY8 | PY9 |
|--------------------|-------|--------|-------|--------|--------------------------|--------|--------|
| Original Cohort | 6.64% | 7.30% | 7.24% | 6.70% | 6.46% | 6.23% | 5.86% |
| Expansion Cohort 1 | 2.22% | 9.68% | 8.26% | 7.61% | 7.02% | 6.58% | 6.23% |
| Expansion Cohort 2 | | 7.79% | 9.77% | 8.59% | 8.02% | 7.57% | 7.17% |
| Expansion Cohort 3 | | 24.03% | 6.59% | 7.10% | 6.77% | 6.35% | 6.24% |
| Expansion Cohort 4 | | | | 16.72% | 12.29% | 9.46% | 8.31% |
| Expansion Cohort 5 | | | | | 14.03% | 15.74% | 12.63% |
| Expansion Cohort 6 | | | | | 6.69% (April & May only) | 20.96% | 14.77% |
| Expansion Cohort 7 | | | | | | | 20.74% |

Note: The attrition rates do not include those customers who were dropped when moving to the Agile EE platform.

The table shows a higher rate of attrition in the first year of receiving reports. This is partially due to how the evaluation team assigns attrition to program years based on the program data. Customers who never received a report do not have a specified program date on which they left the program. Because of this, we calculate the attrition rates for each cohort by assuming the customers who never received a report left the program in each cohort’s inaugural program year. For example, the customers in the Original Cohort that never received a report are placed in the attrition rate calculation in PY3 (the first year of that cohort). Thus, the attrition rates for the inaugural program year of each cohort are slightly inflated since they include the total number of customers that never received a report for each cohort.

Table 8 also illustrates that later cohorts tend to have higher attrition rates than earlier cohorts. This is primarily driven by higher move-out rates rather than opt-out rates, and one potential explanation is that the type of customer selected for these later cohorts (which billing data cleaning suggests often have less than nine months of pre-period billing history) are more transient than customers who have a longer history of billing records.

Finally, the evaluation team looked at participation in terms of customer engagement with program provided web tools by assessing Oracle web metrics related to customer use of AIC’s web tools that allow access to eHERs online. First time logins represent customers who created an account or first visited the Oracle website. Return logins refer to customers who have visited the site on at least two occasions. Based on this data (Table 9), the number of site visits was at its peak in PY4, remained relatively steady through PY5, and has fallen dramatically since. Based on interviews with Oracle staff, this is likely due to AIC’s use of an additional website provider and associated decline in advertising of the Oracle web tool compared to earlier program years. The number of total logins sums the number of first time and return logins, which are also presented in the table below.

¹² We compared the attrition rates we calculated using AIC’s program tracking database to the attrition rates we calculated using monthly participant data by cohort provided by Oracle. The attrition rates align, only differing on average by 0.1%.

Table 9. Behavioral Modification Program Web Metrics

| Web Metrics | PY4 | PY5 | PY6 | PY7 | PY8 | PY9 |
|---------------|-------|-------|-------|-----|-----|-----|
| First Time | 1,278 | 1,064 | 367 | 107 | 181 | 310 |
| Return Logins | 1,657 | 1,487 | 942 | 439 | 496 | 410 |
| Total Logins | 2,935 | 2,551 | 1,309 | 546 | 677 | 728 |

Note: Oracle provided web metrics beginning with PY4, which is why PY3 information is not included.

3.2 Impact Assessment

The evaluation team undertook a variety of efforts to develop adjusted net impact results for the Behavioral Modification Program. These include a comparison of the equivalency between treatment and control groups, impact modeling, and channeling analysis. We provide detailed results for each effort below.

3.2.1 Equivalency Analysis

The evaluation team performed an equivalency analysis between the Expansion Cohort 7 treatment and control groups to assess how similar they were at the start of the program. As part of this process, we examined both energy usage and key demographic, housing, and psychographic characteristics. In both cases, we found the treatment and comparison households are similar:

- For gas consumption, in the year before the start of the program, ADC was 1.63 therms/day for households in both the control group and treatment group. For electric consumption, ADC in the year before the start of the program was 31.70 kWh/day in the control group and 31.67 kWh/day in the treatment group.
- The team found that the treatment and comparison households are similar across all demographics, housing, and psychographic characteristics studied. In every category, the treatment and control groups differed by less than 1% on the key demographic and psychographic comparisons.

Beyond Expansion Cohort 7, we examined equivalency of treatment and control groups of all previous cohorts based on energy usage and found that these are equivalent as well. Results showing the equivalency of the treatment and control groups for all cohorts are in Appendix A.

3.2.2 Model Results

The evaluation team fit several statistical models to estimate impacts from the program. This section provides findings from each of these models. The first model below presents the unadjusted net savings to which we apply the channeling analysis and derive the final net impact savings above in Table 15. The results using the second model (Equation 2), allows for comparison of results across years, as the results are weather-adjusted. The results from the original model shown in Equation 3 are presented as we use these results to compare the per year savings of the program since the program was launched with the Original Cohort.

Post-Participation Period Only Model Results (Equation 1)

Table 10 presents the PY9 unadjusted net therm savings for the seven dual-fuel cohorts and the gas-only cohort (Expansion Cohort 3). The table shows net savings but does not deduct double-counted savings from participation in other AIC residential programs. These results reflect estimated savings from the post-participation period only model or LDV model. This model is the same used by the implementation contractor,

Oracle, to estimate savings. LDV models use seasonal usage from the pre-participation period, but do not explicitly adjust for weather differences between the pre- and post-treatment periods.

Table 10. PY9 Unadjusted Per-Household Net Therm Savings – Lagged Dependent Model

| Cohort | Number of Customers Treated in PY9 ^a | Unadjusted Net Savings (% per household) | Unadjusted Net Savings (therms per household) | Unadjusted Net Program Savings (therms) ^b |
|--------------------------|---|--|---|--|
| Original Cohort | 33,406 | 0.92% | 7.0 | 226,995 |
| Expansion Cohort 1 | 50,266 | 1.32% | 11.4 | 553,165 |
| Expansion Cohort 2 | 73,636 | 0.71% | 4.2 | 296,150 |
| Expansion Cohort 3 | 12,015 | 2.16% | 14.9 | 173,368 |
| Expansion Cohort 4 | 20,329 | 0.86% | 5.8 | 112,101 |
| Expansion Cohort 5 | 45,359 | 0.86% | 6.6 | 280,698 |
| Expansion Cohort 6 | 27,716 | 0.50% | 2.3 | 59,293 |
| Expansion Cohort 7 | 46,179 | 0.84% | 5.9 | 203,528 |
| Total^c | 308,906 | | 6.2 | 1,905,299 |

^a The number of customers in PY9 refers to the number of customers to which AIC/IPA intended to provide HERs and who had an experiment start date

^b Pro-rated for participants whose accounts closed during PY9

^c Totals may not be exact due to rounding

Overall Program Savings – Weather-Adjusted Model Results (Equation 2)

To enable comparisons across years, we estimated models that incorporated weather terms for each cohort. This also improved the precision in the modeled results by accounting for possible differences in weather experienced by the analyzed population. The evaluation team notes that gas savings for Expansion Cohort 6 are negative, indicating an increase in gas usage caused by the program. This result is not statistically significant however, while the result from the LDV model for Expansion Cohort 6 shows significant savings of 0.5%. Table 11 presents these results.

Table 11. PY9 Unadjusted Per-Household Net Therm Savings – Weather-Adjusted Model

| Cohort | Unadjusted Net Savings (% per household) | Unadjusted Net Savings (therms per household) |
|--------------------|--|---|
| Original Cohort | 1.03% | 7.8 |
| Expansion Cohort 1 | 1.36% | 11.6 |
| Expansion Cohort 2 | 0.70% | 4.1 |
| Expansion Cohort 3 | 2.01% | 13.8 |
| Expansion Cohort 4 | 0.83% | 5.5 |
| Expansion Cohort 5 | 0.89% | 6.7 |
| Expansion Cohort 6 | -0.05% | -0.2 |
| Expansion Cohort 7 | 1.04% | 6.3 |

Original Model (Equation 3)

Table 12 summarizes results from the original model. Similar to the weather adjusted model, gas savings for Expansion Cohort 6 are negative, indicating an increase in gas usage caused by the program. This result is not statistically significant; however, the result from the LDV model for Expansion Cohort 6 shows significant savings of 0.5%.

Table 12. PY9 Unadjusted Per-Household Net Therm Savings – Original Model

| Cohort | Unadjusted Net Savings (% per household) | Unadjusted Net Savings (therms per household) |
|--------------------|--|---|
| Original Cohort | 0.98% | 7.5 |
| Expansion Cohort 1 | 1.30% | 11.1 |
| Expansion Cohort 2 | 0.71% | 4.2 |
| Expansion Cohort 3 | 2.01% | 13.7 |
| Expansion Cohort 4 | 0.71% | 4.8 |
| Expansion Cohort 5 | 0.82% | 6.2 |
| Expansion Cohort 6 | -0.23% | -1.1 |
| Expansion Cohort 7 | 0.85% | 6.2 |

Per-Year Savings

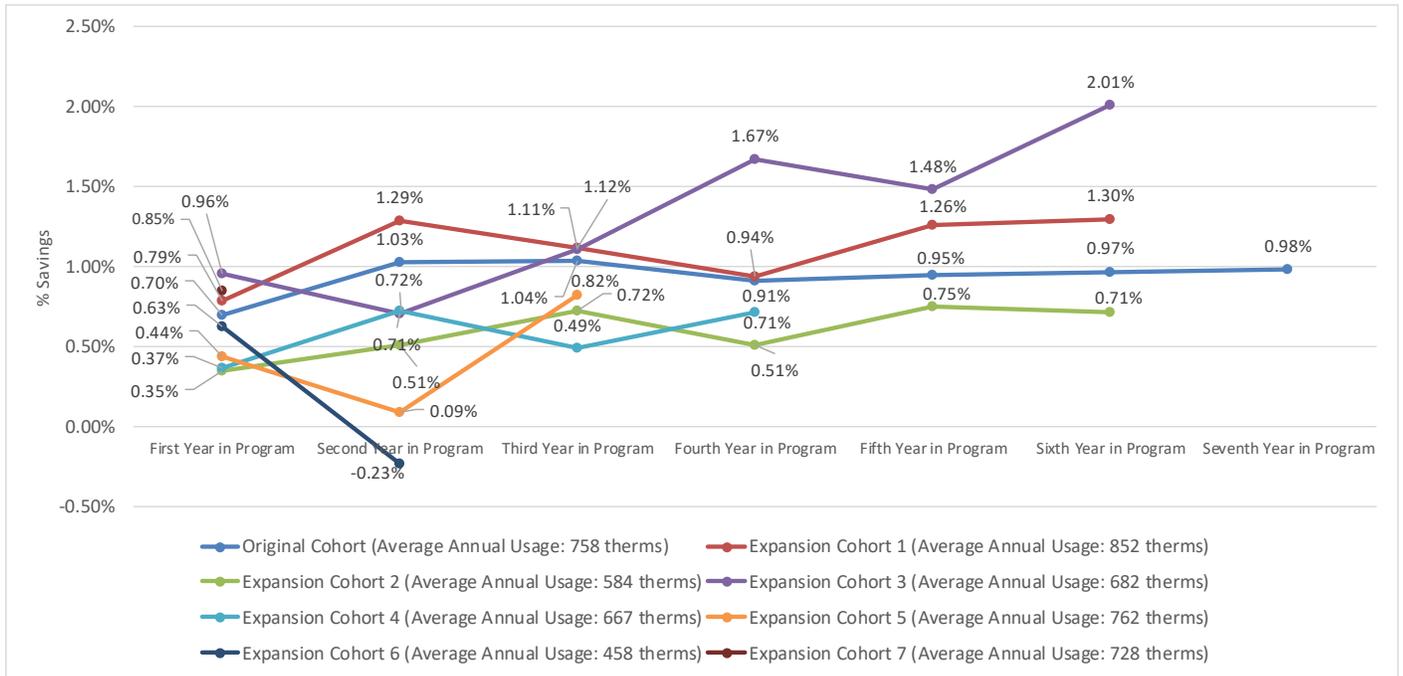
In Figure 1 below, we present the billing analysis results across program years based on the original model (Equation 3).¹³ These provide the gas percent household savings by cohort and by year. These include the two key factors that correlate with program energy impacts: pre-participation period usage and number of years a participant has been in the program.

Notably, because these results do not adjust for variations in weather year over year, they cannot be directly compared. However, we do provide weather-adjusted results in the accompanying evaluation binder of results. As with earlier evaluations, we find that pre-participation period consumption correlates with increased energy savings by cohort.

For gas cohorts, we see a varied picture across pre-participation period consumption, as well as savings year over year. Several cohorts (Original, Expansion Cohort 1, Expansion Cohort 2, and Expansion Cohort 4) plateaued or showed slight increases in usage relative to previous years, while Expansion Cohorts 3 and 5 showed the largest increase. Expansion Cohort 6 savings decreased in the second year.

¹³ We use the original model results for PY9 to make comparisons across years because we have estimated savings for each evaluation year using this model and do not necessarily have LDV modeling results for each year.

Figure 1. Year-Over-Year Savings – Gas (Original Model)



Since PY7, the evaluation team has estimated impacts using a weather adjusted model as it allows us to assess the changes in energy savings year over year that are not due to extreme changes in weather. As a result, Table 13 provides the percent household savings for the last three years for each cohort. As can be seen, the gas-only cohort yields the highest percent savings year over year. In addition, with the exception of Expansion Cohort 6, all cohorts have increased savings annually.

Table 13. Weather Adjusted Percent Gas Savings – PY7-PY9

| Gas Cohorts | PY7 | PY8 | PY9 |
|---|-------|-------|--------|
| Original Cohort (Average Annual Usage: 758 therms) | 0.90% | 0.65% | 1.03% |
| Expansion Cohort 1 (Average Annual Usage: 852 therms) | 0.93% | 1.03% | 1.36% |
| Expansion Cohort 2 (Average Annual Usage: 584 therms) | 0.60% | 0.60% | 0.70% |
| Expansion Cohort 3 (Average Annual Usage: 682 therms) | 1.61% | 1.54% | 2.01% |
| Expansion Cohort 4 (Average Annual Usage: 667 therms) | 0.80% | 0.61% | 0.83% |
| Expansion Cohort 5 (Average Annual Usage: 762 therms) | 0.36% | 0.34% | 0.89% |
| Expansion Cohort 6 (Average Annual Usage: 458 therms) | | 0.79% | -0.05% |
| Expansion Cohort 7 (Average Annual Usage: 728 therms) | | | 1.04% |

3.2.3 Channeling Analysis

The savings analysis for the Behavioral Modification Program considers energy savings that resulted from energy-efficient actions taken through other AIC residential energy efficiency programs. While a base rate of participation in these programs would be expected in both the treatment and control groups, it is possible that

the Behavioral Modification Program resulted in an increase, or “uplift,” in participation in other AIC residential energy efficiency programs among the members of the treatment group by channeling treated customers to those programs.

To ensure that we do not double count savings across programs, we calculate a savings adjustment that removes savings that result from this uplift. To calculate this adjustment, we first calculate the participation uplift resulting from the Behavioral Modification Program, and then apply a median savings value per uplifted participant to this uplift to calculate savings uplift. We then deduct these savings from our original estimate of program savings. We also include “legacy uplift,” deducting savings from measures installed in prior program years.

Table 14 presents the results from our uplift analysis. Detailed cohort-level participation lift calculations are provided in Appendix D. We deduct approximately 3.5% of unadjusted program savings due to this analysis, of which roughly half (1.9%) are due to legacy measures installed in prior program years.

Table 14. PY9 Behavioral Modification Program Impacts – Gas

| Cohort | Unadjusted Program Savings (therms) | PY9 Savings Uplift | | Legacy Savings Uplift | | Total Savings Uplift | |
|--------------------|-------------------------------------|--------------------|-------------|-----------------------|-------------|----------------------|-------------|
| | | Therms | % | Therms | % | Therms | % |
| Original Cohort | 226,995 | 0 | 0.0% | 6,316 | 2.8% | 6,316 | 2.8% |
| Expansion Cohort 1 | 553,165 | 0 | 0.0% | 13,381 | 2.4% | 13,381 | 2.4% |
| Expansion Cohort 2 | 296,150 | 21,675 | 7.3% | 3,161 | 1.1% | 24,836 | 8.4% |
| Expansion Cohort 3 | 173,368 | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Expansion Cohort 4 | 112,101 | 0 | 0.0% | 11,793 | 10.5% | 11,793 | 10.5% |
| Expansion Cohort 5 | 280,698 | 0 | 0.0% | 242 | >0.1% | 242 | >0.1% |
| Expansion Cohort 6 | 59,293 | 0 | 0.0% | 795 | 1.3% | 795 | 1.3% |
| Expansion Cohort 7 | 203,528 | 9,767 | 4.8% | N/A | N/A | 9,767 | 4.8% |
| | 1,905,299 | 31,442 | 1.7% | 35,689 | 1.9% | 67,132 | 3.5% |

3.2.4 Net Impacts

This section presents adjusted net savings for the PY9 Behavioral Modification Program. The program achieved 1,838,167 therms in adjusted net savings (Table 15). Adjusted net savings refer to modeled impacts using Equation 1, less savings accounted for from participation in other AIC residential programs (as discussed in Section 3.2.3). These findings confirm that the Behavioral Modification Program reduces energy consumption.

Table 15. PY9 Behavioral Modification Program Total Gas Savings

| Cohort Name | Unadjusted Program Savings (therms) | PY9 Savings Uplift (therms) | Legacy Savings Uplift (therms) | Final Adjusted Net Program Savings (therms) |
|--------------------|-------------------------------------|-----------------------------|--------------------------------|---|
| Original Cohort | 226,995 | 0 | 6,316 | 220,679 |
| Expansion Cohort 1 | 553,165 | 0 | 13,381 | 539,783 |
| Expansion Cohort 2 | 296,150 | 21,675 | 3,161 | 271,314 |
| Expansion Cohort 3 | 173,368 | 0 | 0 | 173,368 |
| Expansion Cohort 4 | 112,101 | 0 | 11,793 | 100,308 |
| Expansion Cohort 5 | 280,698 | 0 | 242 | 280,456 |
| Expansion Cohort 6 | 59,293 | 0 | 795 | 58,497 |
| Expansion Cohort 7 | 203,528 | 9,767 | 0 | 193,761 |
| Total | 1,905,299 | 31,442 | 35,689 | 1,838,167 |

4. Key Findings and Recommendations

The Behavioral Modification Program achieved its stated goals to reduce energy consumption and educate customers about energy savings measures and behaviors. PY9 implemented no major implementation changes. Program staff added a new cohort of approximately 46,000 dual-fuel customers in September 2016 and continued to offer its income-qualified customer module initiative to support the Home Efficiency Income Qualified Program.

The evaluation team provides the following key findings and recommendations for the program:

- **Key Finding #1: The program reduced energy consumption.** Billing analyses results indicate a reduction of 1,838,167 therms. Program participants achieved 5.95 therms savings per household per year. We calculated these values by dividing the total adjusted net program savings for the evaluated period by the total number of program participants for electricity and gas, respectively.
 - **Recommendation:** Depending on the selected cohorts for future program years, AIC can use the average savings estimates for therms over the evaluated period to inform future participant selection. Theoretically, AIC could multiply these averages by the selected future participant type and produce estimates of the next program year's anticipated electricity and gas savings. These projections of savings provide information about the types of participants to select to include in future program years.
- **Key Finding #2: Our evaluation showed equivalency in terms of average daily consumption in the pre-participation period for all cohorts.** In addition, we demonstrated equivalency between the treatment and control groups of Expansion Cohort 7 using household, demographic, and psychographic data.
 - **Recommendation:** We recommend that the vendor continue to monitor the equivalency of the treatment and control groups of each cohort to ensure they remain so.
- **Key Finding #3: For the second year in a row, technical issues resulted in reductions to report frequency for many customers.** There were widespread issues with missing monthly billing reads in October 2016 that reduced the frequency of reports for approximately 31,000 customers. Because these billing reads were missing, these customers were mistakenly moved to program opt-out status. In addition, when Oracle converted to its Agile EE platform, the staff discovered 7,600 treatment customers had not been receiving reports since 2012 or 2013, depending upon the customer. Both issues were addressed and the customers were included back in the program.
 - **Recommendation:** Investigate the reoccurring missing reads issue as it affects program delivery and evaluation. The missing billing reads occurred in the fall just as it had in PY8. AIC should perform systematic checks to ensure that the billing data provided to Oracle goes through a thorough quality assurance/quality control (QA/QC) process to prevent this issue from occurring again.
- **Key Finding #4: The exclusion criteria of including customers with 90 days of pre-period billing information may contribute to high attrition rates, as well as volatility in estimating energy savings associated with the program.** As documented in this report, later cohorts with lower required pre-period billing information have higher attrition rates, and results across statistical models vary and in some cases become negative. Fewer pre-period billing records lead to fewer customers that can be incorporated within a statistical model, leading to more uncertainty in savings estimates. This is

particularly notable in modeled gas savings from Expansion Cohort 6, where results from our statistical models are divergent from each other as well as from Oracle's model.

- **Recommendation:** We recommend expanding the number of required pre-participation billing months for any new cohorts to a minimum of nine months.

Appendix A. Equivalency Analysis Results

We examined the average daily fuel consumption for the 12 pre-participation period months for treatment and control group customers used for modeling to ensure that attrition from the program did not bias findings in PY9. Table 16 shows that all cohorts were generally equivalent based on ADC in the pre-participation period.

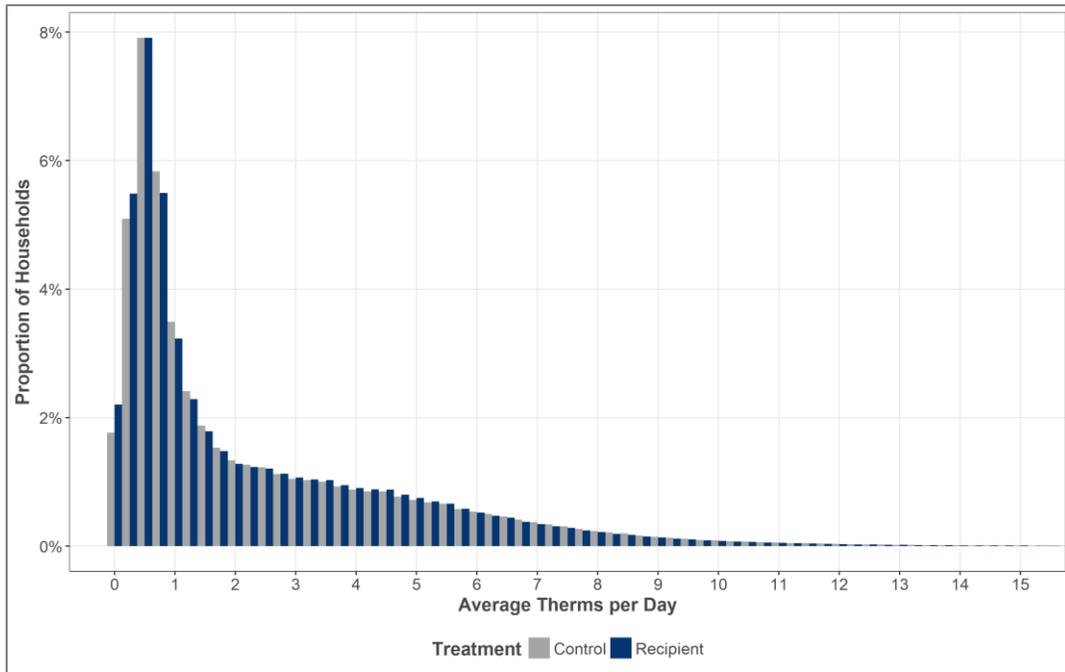
Table 16. Pre-Participation Therm Average Daily Consumption

| Cohort | Treatment (Pre-Participation) Consumption in Therms | Control (Pre-Participation) Consumption in Therms |
|--------------------|---|---|
| Original Cohort | 2.50 | 2.49 |
| Expansion Cohort 1 | 2.91 | 2.91 |
| Expansion Cohort 2 | 1.90 | 1.90 |
| Expansion Cohort 3 | 2.23 | 2.24 |
| Expansion Cohort 4 | 2.09 | 2.09 |
| Expansion Cohort 5 | 2.77 | 2.78 |
| Expansion Cohort 6 | 1.94 | 1.96 |
| Expansion Cohort 7 | 1.64 | 1.64 |

We found Expansion Cohort 7 to be equivalent in terms of gas usage. In the year before the start of the program, ADC was 1.64 therms/day for households in both the control group and treatment group.

Figure 2 presents the pre-participation period gas consumption for both treatment and control groups for all cohorts and exhibits equivalency.

Figure 2. Pre-Participation Period Gas Consumption, Treatment vs Control, All Waves



The evaluation team obtained secondary data for demographic, housing, and psychographic characteristics for the Expansion Cohort 7 treatment and control groups. Table 17 summarizes key characteristics of the treatment and control group members.

Table 17. Expansion Cohort 7: Key Demographic, Housing, and Psychographic Comparisons

| Category | | Treatment (n=46,133) | Control (n=18,540) |
|-------------------------|------------------------------------|-------------------------|-----------------------|
| Demographics | | | |
| Age | Under 35 | 30.0% | 30.2% |
| | 35-54 | 30.1% | 29.5% |
| | 55+ | 23.4% | 22.6% |
| | N/A | 17.5% | 17.7% |
| Household size | Avg. number of Adults ^b | 1.95 | 1.96 |
| Children in household | At least 1 child <18 years. | 21.9% | 22.2% |
| Education of respondent | Less than High School Diploma | 10.6% | 10.5% |
| | High School Diploma | 32.9% | 32.9% |
| | Some College | 35.4% | 35.2% |
| | Bachelor Degree | 12.7% | 12.9% |
| | Graduate Degree | 7.5% | 7.6% |
| | N/A | 1% | 0.9% |
| Household Income | Under \$50K | 53.4% | 52.8% |

| Category | | Treatment (n=46,133) | Control (n=18,540) |
|----------------------|------------------------------------|-------------------------|-----------------------|
| | \$50-\$100K | 30.0% | 29.4% |
| | \$100-\$200K | 14.0% | 14.8% |
| | \$200K or higher | 2.7% | 2.7% |
| | N/A | 0.3% | 0.3% |
| Occupation | Sales/Service | 12.6% | 12.5% |
| | Professional/Technical | 23.2% | 23.4% |
| | Blue Collar | 25.8% | 25.7% |
| | Retired | 9.2% | 8.5% |
| | Other | 28.1% | 28.8% |
| | N/A | 0.1% | 0.9% |
| Gender | Female | 48.5% | 48.6% |
| Housing | | | |
| Homeownership | Own | 54.9% | 54.9% |
| Home Size | Home square footage of 100-5,999 | 83.1% | 82.7% |
| | Home square footage of 6,000-9,999 | 0.4% | 0.5% |
| | Home square footage of over 10,000 | 0.03% | 0.04% |
| | N/A | 16.5% | 16.8% |
| Age of House | Before 1960 | 63.0% | 62.3% |
| | 1960-1989 | 11.6% | 11.2% |
| | 1990 or later | 8.7% | 9.4% |
| | N/A | 16.8% | 17.1% |
| Length of Residence | 0-9 Years | 69.9% | 71.1% |
| | 10-20 Years | 18.5% | 17.7% |
| | 21 Years or Higher | 11.6% | 11.2% |
| Psychographic | | | |
| | Health | 8.3% | 8.0% |
| | Religious | 6.0% | 6.2% |
| | Veterans | 5.3% | 5.1% |
| | Animal Welfare | 4.8% | 4.7% |
| | Political - Conservative | 1.5% | 1.4% |
| | Political - Liberal | 0.79% | 0.73% |
| | Children | 7.5% | 7.1% |
| | Other Social Cause | 10.8% | 10.7% |

Appendix B. Billing Analysis Data Cleaning Results

This appendix shows the results of the data cleaning effort for the billing analysis. Results include all customers who were assigned to a treatment or control group with available billing data. We include both electric and gas data cleaning results to contextualize our results. The primary driver leading to removal of customers for the analysis is insufficient pre-period billing data.

Table 18. Cohort Level Data Cleaning Results for Treatment and Control Groups, Gas

| Cohort | Metric | Unique Customers | | Observations | |
|--------------------|-------------|------------------|---------|--------------|-----------|
| | | Treatment | Control | Treatment | Control |
| Original Cohort | Initial # | 49,694 | 49,688 | 3,974,091 | 3,983,586 |
| | Final # | 49,283 | 49,266 | 3,968,334 | 3,977,673 |
| | % Remaining | 99.17% | 99.15% | 99.86% | 99.85% |
| Expansion Cohort 1 | Initial # | 75,688 | 25,202 | 5,328,093 | 1,782,381 |
| | Final # | 73,854 | 24,581 | 5,303,390 | 1,773,783 |
| | % Remaining | 97.58% | 97.54% | 99.54% | 99.52% |
| Expansion Cohort 2 | Initial # | 112,668 | 19,583 | 7,297,752 | 1,267,389 |
| | Final # | 106,601 | 18,454 | 7,142,958 | 1,238,076 |
| | % Remaining | 94.62% | 94.23% | 97.88% | 97.69% |
| Expansion Cohort 3 | Initial # | 20,632 | 10,108 | 1,193,270 | 579,465 |
| | Final # | 16,713 | 8,082 | 1,138,712 | 551,244 |
| | % Remaining | 81.01% | 79.96% | 95.43% | 95.13% |
| Expansion Cohort 4 | Initial # | 31,484 | 10,494 | 1,529,574 | 510,410 |
| | Final # | 26,151 | 8,786 | 1,378,318 | 462,539 |
| | % Remaining | 83.06% | 83.72% | 90.11% | 90.62% |
| Expansion Cohort 5 | Initial # | 62,988 | 12,597 | 2,465,275 | 491,657 |
| | Final # | 54,765 | 10,961 | 2,252,026 | 449,186 |
| | % Remaining | 86.95% | 87.01% | 91.35% | 91.36% |
| Expansion Cohort 6 | Initial # | 37,796 | 16,500 | 1,196,099 | 522,019 |
| | Final # | 25,703 | 11,169 | 925,073 | 401,924 |
| | % Remaining | 68.00% | 67.69% | 77.34% | 76.99% |
| Expansion Cohort 7 | Initial # | 46,183 | 18,490 | 930,777 | 372,515 |
| | Final # | 30,029 | 12,039 | 706,741 | 283,131 |
| | % Remaining | 65.02% | 65.11% | 75.93% | 76.01% |

Table 19. Cohort Level Data Cleaning Results for Treatment and Control Groups, Electric

| Cohort | Metric | Unique Customers | | Observations | |
|--------------------|-------------|------------------|---------|--------------|-----------|
| | | Treatment | Control | Treatment | Control |
| Original Cohort | Initial # | 49,694 | 49,688 | 3,976,624 | 3,985,749 |
| | Final # | 49,279 | 49,265 | 3,970,754 | 3,979,900 |
| | % Remaining | 99.16% | 99.15% | 99.85% | 99.85% |
| Expansion Cohort 1 | Initial # | 75,688 | 25,202 | 5,333,469 | 1,783,833 |
| | Final # | 73,854 | 24,589 | 5,309,395 | 1,775,784 |
| | % Remaining | 97.58% | 97.57% | 99.55% | 99.55% |
| Expansion Cohort 2 | Initial # | 112,668 | 19,583 | 7,304,591 | 1,268,110 |
| | Final # | 106,744 | 18,476 | 7,156,798 | 1,240,151 |
| | % Remaining | 94.74% | 94.35% | 97.98% | 97.80% |
| Expansion Cohort 4 | Initial # | 31,485 | 10,497 | 1,534,186 | 512,007 |
| | Final # | 26,959 | 9,024 | 1,421,658 | 475,775 |
| | % Remaining | 85.62% | 85.97% | 92.67% | 92.92% |
| Expansion Cohort 5 | Initial # | 62,988 | 12,597 | 2,467,487 | 492,054 |
| | Final # | 54,959 | 10,997 | 2,261,506 | 450,839 |
| | % Remaining | 87.25% | 87.30% | 91.65% | 91.62% |
| Expansion Cohort 6 | Initial # | 37,795 | 16,500 | 1,198,779 | 523,248 |
| | Final # | 26,164 | 11,394 | 941,459 | 410,141 |
| | % Remaining | 69.23% | 69.05% | 78.53% | 78.38% |
| Expansion Cohort 7 | Initial # | 46,183 | 18,490 | 932,393 | 373,143 |
| | Final # | 30,371 | 12,176 | 715,118 | 286,408 |
| | % Remaining | 65.76% | 65.85% | 76.70% | 76.76% |

Appendix C. Billing Analysis Model Coefficients

Below we provide the billing analysis model coefficients and per-year savings results using Equation 1. We include both electric and gas model coefficients to contextualize our results.

Lagged Dependent Variable Model Coefficients

Table 20 and Table 21 show the Equation 3 LDV billing analysis model coefficients for the gas and electric cohorts.

Table 20. LDV Model Billing Analysis Model Coefficients – Gas

| Cohort | Coefficient | Robust Standard Error |
|---------------------------|--------------|-----------------------|
| Original Cohort | | |
| treat | -0.019206038 | 0.001860718 |
| pre_adc | 0.131377159 | 0.017638497 |
| pre_adc_summ | 0.332502618 | 0.013385702 |
| pre_adc_win | -0.001100411 | 0.00634472 |
| Expansion Cohort 1 | | |
| treat | -0.031165389 | 0.002502067 |
| pre_adc | 0.224178283 | 0.015448784 |
| pre_adc_summ | 0.414580288 | 0.012735767 |
| pre_adc_win | -0.040214949 | 0.005668049 |
| Expansion Cohort 2 | | |
| treat | -0.011448311 | 0.001749051 |
| pre_adc | 0.238573432 | 0.014670407 |
| pre_adc_summ | 0.422964157 | 0.013261578 |
| pre_adc_win | -0.041299843 | 0.005303148 |
| Expansion Cohort 3 | | |
| treat | -0.040890457 | 0.003658752 |
| pre_adc | 0.371706808 | 0.033226031 |
| pre_adc_summ | 0.286123947 | 0.023961396 |
| pre_adc_win | -0.089496681 | 0.01202031 |
| Expansion Cohort 4 | | |
| treat | -0.01583242 | 0.003859176 |
| pre_adc | 0.38510153 | 0.024644579 |
| pre_adc_summ | 0.421537405 | 0.017299336 |
| pre_adc_win | -0.119723655 | 0.010619617 |
| Expansion Cohort 5 | | |
| treat | -0.01821726 | 0.003020121 |
| pre_adc | 0.118945358 | 0.011865671 |
| pre_adc_summ | 0.606249855 | 0.013288526 |
| pre_adc_win | -0.009879831 | 0.004465524 |
| Expansion Cohort 6 | | |

| Cohort | Coefficient | Robust Standard Error |
|---------------------------|--------------|-----------------------|
| treat | -0.006387339 | 0.002088178 |
| pre_adc | 0.065028127 | 0.020369706 |
| pre_adc_summ | 0.709642683 | 0.016997906 |
| pre_adc_win | 0.00183656 | 0.009713517 |
| Expansion Cohort 7 | | |
| treat | -0.016276022 | 0.002810625 |
| pre_adc | 0.087488588 | 0.015148087 |
| pre_adc_summ | 0.716350317 | 0.01454354 |
| pre_adc_win | 0.00760925 | 0.006139766 |

Table 21. LDV Model Billing Analysis Model Coefficients – Electric

| Cohort | Coefficient | Robust Standard Error |
|---------------------------|--------------|-----------------------|
| Original Cohort | | |
| treat | -0.49007334 | 0.030025204 |
| pre_adc | 1.621325721 | 0.023990833 |
| pre_adc_summ | -0.318031614 | 0.01210016 |
| pre_adc_win | -0.507523293 | 0.009851715 |
| Expansion Cohort 1 | | |
| treat | -0.608456366 | 0.038299038 |
| pre_adc | 1.600988776 | 0.017664941 |
| pre_adc_summ | -0.247597208 | 0.007837118 |
| pre_adc_win | -0.503266066 | 0.007939905 |
| Expansion Cohort 2 | | |
| treat | -0.254552033 | 0.028599225 |
| pre_adc | 1.583041785 | 0.01732745 |
| pre_adc_summ | -0.223997465 | 0.0077552 |
| pre_adc_win | -0.510347709 | 0.007884863 |
| Expansion Cohort 3 | | |
| N/A | | |
| Expansion Cohort 4 | | |
| treat | -0.503602725 | 0.072203283 |
| pre_adc | 1.584894035 | 0.029193341 |
| pre_adc_summ | -0.150657258 | 0.012183101 |
| pre_adc_win | -0.599409409 | 0.013210999 |
| Expansion Cohort 5 | | |
| treat | -0.298853467 | 0.043454342 |
| pre_adc | 1.2322131 | 0.024453378 |
| pre_adc_summ | -0.055501262 | 0.013017294 |
| pre_adc_win | -0.38548325 | 0.009780871 |
| Expansion Cohort 6 | | |
| treat | -0.255661283 | 0.038145192 |

| Cohort | Coefficient | Robust Standard Error |
|---------------------------|--------------|-----------------------|
| pre_adc | 1.298792789 | 0.029194675 |
| pre_adc_summ | 0.014143684 | 0.012445514 |
| pre_adc_win | -0.548506342 | 0.014624842 |
| Expansion Cohort 7 | | |
| treat | -0.175199982 | 0.035208584 |
| pre_adc | 1.111977303 | 0.016850389 |
| pre_adc_summ | 0.073849622 | 0.008104437 |
| pre_adc_win | -0.30808343 | 0.007551481 |

Appendix D. Participation Lift and Channeling Analysis

PY9 Annual Uplift

To determine whether the Behavioral Modification Program treatment generated participation lift in PY9 (e.g., an increase in participation in other energy efficiency programs in PY9 as a result of the Behavioral Modification Program), we calculated whether more treatment than control group members participated in other AIC residential energy efficiency programs after receiving HERs compared to program participation before receiving HERs. We cross-referenced the Behavioral Modification Program database—both treatment and control groups (for all program cohorts)—with the databases of other residential energy efficiency programs in PY9, including:

- Appliance Recycling (ARP)
- HVAC
- Home Efficiency Income Qualified (HEIQ)
- Moderate Income Kits (MICK)

The participation lift analysis calculates the number of program participants who participated in both the Behavioral Modification Program **and** other energy efficiency programs in PY9. To ensure the participation lift is attributable solely to the Behavioral Modification Program, we calculate participation lift using a Difference-in-Differences estimator (where possible). To do so, we identify the total number of treatment and control group customers who participated in an AIC energy efficiency program in PY9, as well as the total count of treatment and control group customers who participated in an AIC energy efficiency program prior to receiving HERs. The difference in these calculations is the net participation due to the Behavioral Modification Program.

Table 22 presents the result of our participation lift analysis for PY9. Generally, we see that the treatment group had a higher rate of overall program participation than the control group, although on a program-by-program basis the effects are less consistent. However, most of these effects appear to be statistically insignificant. Given that many of these customers are dual-fuel customers, each customer was counted only once as having participated in the program (i.e., the lift analysis was conducted by cohort, not by cohort and fuel type).

Table 22. PY9 Participation Lift Rate by Cohort and Program

| Program Name | Original Cohort | Expansion Cohort 1 | Expansion Cohort 2 | Expansion Cohort 3 - Gas | Expansion Cohort 4 | Expansion Cohort 5 | Expansion Cohort 6 | Expansion Cohort 7 |
|--------------|-----------------|--------------------|--------------------|--------------------------|--------------------|--------------------|--------------------|--------------------|
| ARP | 0.00% | 0.01% | 0.02% | 0.02% | -0.07% | -0.06% | 0.05% | 0.08% |
| HEIQ | -0.03% | -0.04% | 0.10%* | 0.00% | 0.09% | -0.03% | 0.08% | 0.06%* |
| HVAC | 0.05% | 0.07% | 0.13% | -0.02% | 0.41% | 0.02% | -0.22% | 0.14%* |
| MICK | -0.24% | -0.03% | -0.09% | -0.01% | -0.20% | -0.38% | 0.16% | -0.07% |

* Positive, statistically significant difference

While the percentage increase seems small, the overall effect is substantial given the size of the cohorts. The Behavioral Modification Program channeled about 168 customers into other AIC residential programs in PY9.¹⁴

Table 23 through Table 30 present estimated program savings due to participation uplift in other EE programs during PY9. We include estimates of annual savings uplift for the following programs:

- HEIQ
- HVAC
- MICK

Note that while the Behavioral Modification Program channels customers into the Appliance Recycling Program, the Appliance Recycling Program has no gas impacts, and therefore produces no gas savings uplift. Therefore, it is not included in the tables below.

We present all estimates of both positive and negative uplift for context, but only statistically significant estimates of positive uplift are used to adjust program savings (Table 31 presents the results used to adjust program savings). To compute these estimates, we multiply the net PY9 participation uplift due to the Behavioral Modification Program by the median first year ex post net savings per treatment group customer participating in another AIC residential program in PY9.

We typically use a difference-in-differences estimator to assess uplift. In a number of cases (notably the first four program waves, as well as the Moderate Income Kits Program in all waves except Expansion Cohort 7), pre-period data is not available for participation. In these cases, we use a post-only difference (POD) estimator to determine uplift, marked prominently in the tables below.

Table 23. PY9 Annual Uplift Adjustment for Original Cohort

| PY9, Original Cohort | Program | | |
|---|-----------------|--------|--------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 251.7 | -11.3 | 7.3 |
| Treatment group customers | 33,406 | | |
| Treatment group rate of PY9 participation | 0.21% | 0.71% | 1.82% |
| Change in rate of treatment group participation from pre-program year | <i>POD used</i> | | |
| Control group customers | 33,619 | | |
| Control group rate of PY9 participation | 0.24% | 0.66% | 2.05% |
| Change in rate of control group participation from pre-program year | <i>POD used</i> | | |
| Post-only difference statistic | -0.03% | 0.05% | -0.24% |
| Positive and statistically significant? | No | No | No |
| Participant uplift | -9 | 17 | -79 |
| Total savings attributable to other programs (therms) | -2,389.5 | -196.7 | -570.8 |

¹⁴ Please note that this number is additive across programs. E.g., a customer channeled into both ARP and HVAC is counted twice.

Table 24. PY9 Annual Uplift Adjustment for Expansion Cohort 1

| PY9, Expansion Cohort 1 | Program | | |
|---|----------|--------|--------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 313.7 | -11.3 | 7.3 |
| Treatment group customers | 50,266 | | |
| Treatment group rate of PY9 participation | 0.12% | 0.63% | 1.23% |
| Change in rate of treatment group participation from pre-program year | POD used | | |
| Control group customers | 16,853 | | |
| Control group rate of PY9 participation | 0.17% | 0.56% | 1.26% |
| Change in rate of control group participation from pre-program year | POD used | | |
| Post-only difference statistic | -0.04% | 0.07% | -0.03% |
| Positive and statistically significant? | No | No | No |
| Participant uplift | -22 | 35 | -15 |
| Total savings attributable to other programs (therms) | -6,747.7 | -391.2 | -111.2 |

Table 25. PY9 Annual Uplift Adjustment for Expansion Cohort 2

| PY9, Expansion Cohort 2 | Program | | |
|---|----------|----------|--------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 290.8 | -11.3 | 7.3 |
| Treatment group customers | 73,636 | | |
| Treatment group rate of PY9 participation | 0.22% | 0.51% | 1.79% |
| Change in rate of treatment group participation from pre-program year | POD used | | |
| Control group customers | 12,773 | | |
| Control group rate of PY9 participation | 0.12% | 0.38% | 1.87% |
| Change in rate of control group participation from pre-program year | POD used | | |
| Post-only difference statistic | 0.10% | 0.13% | -0.09% |
| Positive and statistically significant? | Yes | No | No |
| Participant uplift | 75 | 94 | -63 |
| Total savings attributable to other programs (therms) | 21,675.4 | -1,056.2 | -456.1 |

Table 26. PY9 Annual Uplift Adjustment for Expansion Cohort 3 (Gas Only)

| PY9, Expansion Cohort 3 (Gas Only) | Program | | |
|---|----------|--------|--------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 245.5 | 57.3 | 7.3 |
| Treatment group customers | 12,015 | | |
| Treatment group rate of PY9 participation | 0.02% | 0.18% | 0.12% |
| Change in rate of treatment group participation from pre-program year | POD used | | |
| Control group customers | 5,818 | | |
| Control group rate of PY9 participation | 0.02% | 0.21% | 0.14% |
| Change in rate of control group participation from pre-program year | POD used | | |
| Post-only difference statistic | 0.00% | -0.02% | -0.01% |

| | | | |
|---|-------|--------|-------|
| Positive and statistically significant? | No | No | No |
| Participant uplift | 0 | -3 | -2 |
| Total savings attributable to other programs (therms) | -16.0 | -159.5 | -11.0 |

Table 27. PY9 Annual Uplift Adjustment for Expansion Cohort 4

| PY9, Expansion Cohort 4 | Program | | |
|---|---------|--------|----------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 182.6 | -11.2 | 7.3 |
| Treatment group customers | 20,329 | | |
| Treatment group rate of PY9 participation | 0.24% | 0.69% | 1.33% |
| Change in rate of treatment group participation from pre-program year | 0.19% | -0.46% | POD used |
| Control group customers | 6,783 | | |
| Control group rate of PY9 participation | 0.19% | 0.50% | 1.53% |
| Change in rate of control group participation from pre-program year | 0.10% | -0.87% | POD used |
| Difference-in-difference/post-only difference statistic | 0.09% | 0.41% | -0.20% |
| Positive and statistically significant? | No | No | No |
| Participant uplift | 18 | 83 | -41 |
| Total savings attributable to other programs (therms) | 3,289.8 | -928.2 | -295.4 |

Table 28. PY9 Annual Uplift Adjustment for Expansion Cohort 5

| PY9, Expansion Cohort 5 | Program | | |
|---|----------|--------|----------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 182.6 | -11.2 | 7.3 |
| Treatment group customers | 45,359 | | |
| Treatment group rate of PY9 participation | 0.25% | 0.54% | 1.09% |
| Change in rate of treatment group participation from pre-program year | 0.20% | -0.74% | POD used |
| Control group customers | 8,976 | | |
| Control group rate of PY9 participation | 0.30% | 0.42% | 1.47% |
| Change in rate of control group participation from pre-program year | 0.23% | -0.76% | POD used |
| Difference-in-difference/post-only difference statistic | -0.03% | 0.02% | -0.38% |
| Positive and statistically significant? | No | No | No |
| Participant uplift | -15 | 10 | -171 |
| Total savings attributable to other programs (therms) | -2,760.4 | -107.9 | -1,241.6 |

Table 29. PY9 Annual Uplift Adjustment for Expansion Cohort 6

| PY9, Expansion Cohort 6 | Program | | |
|---|---------|--------|----------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 323.9 | -11.2 | 7.3 |
| Treatment group customers | 27,716 | | |
| Treatment group rate of PY9 participation | 0.25% | 0.44% | 1.23% |
| Change in rate of treatment group participation from pre-program year | 0.22% | -0.32% | POD used |

| | | | |
|---|---------|--------|----------|
| Control group customers | 12,056 | | |
| Control group rate of PY9 participation | 0.15% | 0.55% | 1.07% |
| Change in rate of control group participation from pre-program year | 0.14% | -0.11% | POD used |
| Difference-in-difference/post-only difference statistic | 0.08% | -0.22% | 0.16% |
| Positive and statistically significant? | No | No | No |
| Participant uplift | 23 | -60 | 44 |
| Total savings attributable to other programs (therms) | 7,422.7 | 676.1 | 322.6 |

Table 30. PY9 Annual Uplift Adjustment for Expansion Cohort 7

| PY9, Expansion Cohort 7 | Program | | |
|---|---------|---------|--------|
| | HEIQ | HVAC | MICK |
| Median therm savings per participant | 255.6 | 33.0 | 7.3 |
| Treatment group customers | 46,179 | | |
| Treatment group rate of PY9 participation | 0.21% | 0.50% | 0.46% |
| Change in rate of treatment group participation from pre-program year | 0.10% | 0.22% | -0.15% |
| Control group customers | 18,490 | | |
| Control group rate of PY9 participation | 0.16% | 0.42% | 0.49% |
| Change in rate of control group participation from pre-program year | 0.03% | 0.08% | -0.09% |
| Difference-in-difference statistic | 0.06% | 0.14% | -0.07% |
| Positive and statistically significant? | Yes | Yes | No |
| Participant uplift | 30 | 64 | -31 |
| Total savings attributable to other programs (therms) | 7,672.0 | 2,095.0 | -225.3 |

Table 31 summarizes the total PY9 annual uplift savings by cohort.

Table 31. Total PY9 Annual Uplift Adjustment

| Cohort | Savings Attributable to Other PY9 Programs (therms) | | | Total Savings Attributable to PY9 Programs (therms) |
|--------------------|---|--------------|----------|---|
| | HEIQ | HVAC | MICK | |
| Original Cohort | — | — | — | 0 |
| Expansion Cohort 1 | — | — | — | 0 |
| Expansion Cohort 2 | 21,675 | — | — | 21,675 |
| Expansion Cohort 3 | — | — | — | 0 |
| Expansion Cohort 4 | — | — | — | 0 |
| Expansion Cohort 5 | — | — | — | 0 |
| Expansion Cohort 6 | — | — | — | 0 |
| Expansion Cohort 7 | 7,672 | 2,095 | — | 9,767 |
| Total | 29,347 | 2,095 | 0 | 31,442 |

Legacy Uplift

The Behavioral Modification Program consumption analysis captures savings within the model for each year of a given measure’s estimated useful life. To ensure that AIC does not inappropriately attribute savings to the Behavioral Modification Program that are associated with other programs and to accurately reflect the

evaluation paradigm in Illinois, we also net out the savings from equipment rebated through other energy efficiency programs in past years for each year of the estimated useful life of the measure.

Savings are calculated in the same manner as the annual adjustment for PY9, with one adjustment. We multiply the net participation uplift due to the Behavioral Modification Program for each of the past years analyzed by the median first year ex post net savings per treatment group customer participating in another AIC residential program in for that year. However, when a measure has reached the end of its effective useful life by PY9, we exclude it from our analysis (e.g., if a measure installed in PY4 has only a three-year effective useful life, it is not considered in the median first year ex post net savings value for PY4 customers).

Table 32 presents the programs considered in our legacy uplift savings adjustment. We include discontinued programs (e.g. Residential Efficient Products) as energy savings from this program’s past activity still persist in following years.

Table 32. Programs Included in Legacy Uplift Savings Adjustment

| Program | Years Included | | | | |
|--|----------------|-----|-----|-----|-----|
| | PY4 | PY5 | PY6 | PY7 | PY8 |
| Residential Lighting (Online Store Component Only) (OLS) | ✓ | ✓ | ✓ | ✓ | |
| ARP | ✓ | ✓ | ✓ | ✓ | ✓ |
| HEIQ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Home Efficiency Standard (HES) | ✓ | ✓ | ✓ | ✓ | ✓ |
| HVAC | ✓ | ✓ | ✓ | ✓ | ✓ |
| MICK | | | | | ✓ |
| Residential Efficient Products (REEP) | ✓ | ✓ | ✓ | | |

Table 33 through Table 37 present legacy uplift savings from PY4 through PY8 that we deduct from PY9 Behavioral Modification Program savings. Note that while the Behavioral Modification Program channels customers into the Appliance Recycling Program, the Appliance Recycling Program has no gas impacts, and therefore produces no gas savings uplift. Therefore, it is not included in the tables below.

Table 33. PY4 Legacy Uplift Therm Savings

| Cohort | Savings Attributable to PY4 Programs (therms) | | | | | | Total Savings Attributable to PY4 Programs (therms) |
|--------------------|---|--------------|----------|----------|----------|----------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 1 | — | 5,759 | — | N/A | — | — | 5,759 |
| Expansion Cohort 2 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 3 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 5,759 | 0 | 0 | 0 | 0 | 5,759 |

Table 34. PY5 Legacy Uplift Therm Savings

| Cohort | Savings Attributable to PY5 Programs (therms) | | | | | | Total Savings Attributable to PY5 Programs (therms) |
|--------------------|---|--------------|----------|----------|----------|----------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | 1,766 | — | N/A | — | — | 1,766 |
| Expansion Cohort 1 | — | 7,622 | — | N/A | — | — | 7,622 |
| Expansion Cohort 2 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 3 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 9,388 | 0 | 0 | 0 | 0 | 9,388 |

Table 35. PY6 Legacy Uplift Therm Savings

| Cohort | Savings Attributable to PY6 Programs (therms) | | | | | | Total Savings Attributable to PY6 Programs (therms) |
|--------------------|---|-----------|---------------|----------|----------|--------------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 1 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 2 | — | — | — | N/A | — | 3,161 | 3,161 |
| Expansion Cohort 3 | — | — | — | N/A | — | — | 0 |
| Expansion Cohort 4 | — | 49 | 11,580 | N/A | — | — | 11,628 |
| Expansion Cohort 5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 49 | 11,580 | 0 | 0 | 3,161 | 14,789 |

Table 36. PY7 Legacy Uplift Therm Savings

| Cohort | Savings Attributable to PY7 Programs (therms) | | | | | | Total Savings Attributable to PY7 Programs (therms) |
|--------------------|---|--------------|----------|----------|----------|----------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | 3,963 | — | N/A | — | N/A | 3,963 |
| Expansion Cohort 1 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 2 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 3 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 4 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 5 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 6 | — | — | — | N/A | — | N/A | 0 |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 3,963 | 0 | 0 | 0 | 0 | 3,963 |

Table 37. PY8 Legacy Uplift Therm Savings

| Cohort | Savings Attributable to PY8 Programs (therms) | | | | | | Total Savings Attributable to PY8 Programs (therms) |
|--------------------|---|--------------|----------|----------|----------|----------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | 587 | — | — | N/A | N/A | 587 |
| Expansion Cohort 1 | — | — | — | — | N/A | N/A | 0 |
| Expansion Cohort 2 | — | — | — | — | N/A | N/A | 0 |
| Expansion Cohort 3 | — | — | — | — | N/A | N/A | 0 |
| Expansion Cohort 4 | — | 165 | — | — | N/A | N/A | 165 |
| Expansion Cohort 5 | — | 242 | — | — | N/A | N/A | 242 |
| Expansion Cohort 6 | — | 795 | — | — | N/A | N/A | 795 |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 1,790 | 0 | 0 | 0 | 0 | 1,790 |

Table 38 summarizes total legacy uplift savings from PY4 through PY8 by cohort.

Table 38. Total Legacy Uplift Therm Savings (PY4-PY8)

| Cohort | Savings Attributable to PY4-PY8 Programs (therms) | | | | | | Total Savings Attributable to PY4-PY8 Programs (therms) |
|--------------------|---|---------------|---------------|----------|----------|--------------|---|
| | HEIQ | HES | HVAC | MICK | OLS | REEP | |
| Original Cohort | — | 6,316 | — | — | — | — | 6,316 |
| Expansion Cohort 1 | — | 13,381 | — | — | — | — | 13,381 |
| Expansion Cohort 2 | — | — | — | — | — | 3,161 | 3,161 |
| Expansion Cohort 3 | — | — | — | — | — | — | 11,775 |
| Expansion Cohort 4 | — | 214 | 11,580 | — | — | — | 11,793 |
| Expansion Cohort 5 | — | 242 | — | — | — | — | 242 |
| Expansion Cohort 6 | — | 795 | — | — | — | — | 795 |
| Expansion Cohort 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Total | 0 | 20,949 | 11,580 | 0 | 0 | 3,161 | 35,689 |

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