Opinion Dynamics

MEMORANDUM

To: Nick Warnecke, Ameren Illinois Company (AIC) and Elizabeth Horne, ICC Staff

From: The Opinion Dynamics Evaluation Team

Date: May 07, 2025

Re: Arrearage Reduction Pilot Study Results

INTRODUCTION

AIC operates several energy efficiency (EE) efforts targeting low income customers through its Income Qualified (IQ) Initiative. By increasing EE, these offerings are meant to lower energy usage; and thereby lower bills and reduce difficulty in paying bills for participating customers.

Illinois state law[1] includes a requirement that AIC *"shall… pilot targeting customers with high arrearages, high energy intensity (ratio of energy usage divided by home or unit square footage), or energy assistance programs with energy efficiency offerings, and then track reduction in arrearages as a result of the targeting. This targeting and bundling of low-income energy programs shall be offered to both low-income single-family and multifamily customers (owners and residents)."* In fulfillment of this requirement, Opinion Dynamics assessed the change in customers' bills, arrears, and ability to pay their bills following participation in AIC's IQ offerings.

Our analysis finds that participants experienced an annual reduction of $189 in energy bills associated with AIC-delivered fuels as a result of participation in the IQ Initiative with comprehensive measures. Since bill savings accumulate month-over-month, we investigated the effect that number of months of IQ Initiative participation has on the odds of receiving disconnection notice. Our results indicate statistically insignificant reductions in chances of disconnection following twelve months of IQ Initiative participation. Our analysis also found a statistically insignificant reduction in account balance at the time of disconnection notice.

This memo presents a brief participation summary, the evaluation methodology, evaluation results, and conclusions from the analysis.

INCOME QUALIFIED INITIATIVE CHANNELS & PARTICIPATION SUMMARY

In conversation with AIC, the evaluation team selected four channels of the IQ Initiative[2] as appropriate to include in this study. To avoid COVID-19 related changes in energy consumption, economic conditions, and disconnection moratorium from contaminating the analysis, we selected May 2022 through June 2024 as the period to evaluate. Over that period, 6,607 AIC customers participated in those four channels.[3] Table 1 presents the distribution of participation

[1] 220 ILCS 8/103-B(c).

[2] Channels represent a distinct subset of program delivery within an initiative.

[3] Participation year classifications are made based on the final measure install date for each project and represent the distinct account numbers with projects completed in each year.

across channels and time. The IQ – Single Family, IQ – Multifamily, and IQ - Smart Savers channels accounted for vast majority of participants among this four channels, contributing 89.72%, 5.34%, and 4.48% of participants respectively. Over the same period, roughly 13% of the participants received a disconnection notice.

Table 1. May 2022–June 2024 Income Qualified Initiative Participation Summary

Channel	2022[a]	2023	2024[a]	Total Participants	Share of Total
IQ - Single Family	2,112	2,392	1,424	**5,928**	**89.72%**
IQ - Multifamily	94	148	111	**353**	**5.34%**
IQ - Smart Savers	71	195	30	**296**	**4.48%**
IQ - Community Action Agencies (CAA)	9	11	10	**30**	**0.45%**
Total Count	**2,286**	**2,746**	**1,575**	**6,607**	
Total Percent	**34.60%**	**41.56%**	**23.84%**		**100%**

[a] Partial years: 2022 data starts from May 1, 2022. 2024 data ends on June 30, 2024.

The four channels provide participants with a wide range of measures. Some measures such as low flow faucet aerators are low-cost measures that produce relatively small amounts of energy savings, whereas other measures such as attic insulation are expected to generate larger energy savings. While savings from all measures are likely to be positive, if a participant only receives measures that are unlikely to produce large energy savings, the effects on bills, disconnection probability, or balance at the time of disconnection are unlikely to be statistically detectable. As such, we focus our analysis on participants who received at least one of the comprehensive measures: space heating or cooling measures, weatherization measures, and heat pump water heater measures. Table 2 shows the distribution of participants who received comprehensive measures across the four IQ channels. As with overall participation, the bulk of the population under study is comprised of IQ - Single Family and IQ – Multifamily participants.

Table 2. Channel-wise Distribution of IQ Participants With Comprehensive Measures

Channel	2022	2023	2024a	Total Participants [a]	Share of Total
IQ - Single Family	583	1,183	622	2,388	**85.87%**
IQ - Multifamily	55	136	100	291	**10.46%**
IQ - Smart Savers	19	49	4	72	**2.59%**
IQ - CAA	9	11	10	30	**1.08%**
Total Count	**666**	**1,379**	**736**	**2,781**	
Total Percent	**23.95%**	**49.59%**	**26.47%**		**100%**

[a] Includes participants who received measures through multiple channels.

EVALUATION METHODOLOGY

Research Questions

To assess how AIC's IQ Initiative changes customers' arrears and ability to pay their bills, we estimate the effect of receiving comprehensive measures through IQ Initiatives on:

- Bill amounts,
- The probability of receiving disconnection notices, and

- Account balances at the time of receiving a disconnection notice.

The following subsections summarize key steps in the analysis. Further details are in the appendices.

Data Cleaning and Preparation

The evaluation team received several datasets from AIC in support of this analysis:

- **Customer data,** including service address and account active and inactive dates
- **Initiative participation data**
- **Monthly bills,** including electric usage (kWh), gas usage (therms), and total bill amount ($)
- **Disconnection records** sent due to nonpayment, including the account balance ($) at the time of the notice

The evaluation team requested and received data for IQ Initiative participants between May 2022 and June 2024. Participants after July 2023 were not included in the analysis as one full year of post-participation data were not yet available at the time of the analysis. Instead, these participants were used as a comparison group. See Analysis Approach below. All data were reviewed for completeness, outliers, processed, and cleaned prior to analysis. Only participants with sufficient billing data prior to and following their participation in the IQ Initiative were included in the modeling.[4]

Analysis Approach

The four IQ channels provide participants with a wide range of measures. While savings from all measures are likely to be positive, if a participant only receives measures that are unlikely to produce large energy savings, the effects on bills, and thereby, the effects on disconnection probability or balance at the time of disconnection are unlikely to be statistically detectable. As such, we focus our analysis on participants who received at least one of the comprehensive measures.

Given electricity rate changes that may have occurred during the evaluation period, having a comparison group is preferable to a pre-post analysis for estimation of bill impact and balance at time of disconnection. Moreover, disconnection is ultimately related to difficult to measure and/or unobserved changes in economic and policy conditions. A valid comparison group also controls for these exogenous factors that affects everyone's propensity to be disconnected. The evaluation team attempted to construct a comparison group from participants in the Illinois Low Income Home Energy Assistance Program (LIHEAP) who did not participate in the IQ Initiative given the presumed similarity in economic and energy usage characteristics across these customers. Equivalency analysis revealed differences in the pattern of total bill between the treatment and LIHEAP customers. Due to these differences, we did not use LIHEAP customers as a comparison group.

As an alternative approach, the team split IQ Initiative participants with comprehensive measures into two groups -- those who participated before July 2023, and those after. The former was used as a treatment group and the latter was used as a comparison group. The equivalency analysis revealed that early participants and future participants with comprehensive measures were similar with respect to bill amounts and weather (See Appendix 2: Comparison Group & Equivalency for details). Although there were small but statistically significant differences in some pre-period months, the value of having a comparison group to control for temporal rate changes and overall consumption patterns outweighed the need for a perfectly equivalent comparison group.

[4] Please see Appendix 1: Data Cleaning and Preparation for definitions of sufficiency.

As part of this analysis, the evaluation team estimated the effect of participation in the initiatives on the following metrics:

- **Change in Bill Amount ($):** We conducted a consumption analysis using a linear fixed effects regression (LFER) to estimate changes in bills associated with fuels delivered by AIC. Fixed effects models capture the effect of time-invariant household-specific characteristics and are the industry best practice approach to modeling energy savings. Our model specification included weather—heating degree days (HDD) and cooling degree days (CDD)—and month-year fixed effects to further control for seasonal and temporal differences in energy consumption. The analysis results represent the change in the bill amount following program participation.
- **Likelihood of Disconnection Notice:** Energy efficiency program participation saves energy through installed measures or behavior modification. Both mechanisms can reduce energy usage immediately after program participation. While each month's energy savings may not be a large part of a customer's disposable income, the savings could accumulate to substantially reduce energy cost burdens, thereby lowering chances of disconnection over time, rather than instantaneously. We used logistic regression to estimate the change in odds of receiving a disconnection notice for each additional month after IQ Initiative participation begun.[5] Our final model specification controlled for baseline differences in disconnect notice incidence between early participant and future participants (comparison group), as well as month-year fixed effects to control for temporal differences in disconnections.
- **Change in Account Balance at Time of Disconnection Notice ($):** We conducted this analysis using a LFER model. Our model specification controlled for individual fixed effects and month-year fixed effects to control for temporal differences in account balances at the time of disconnection.

EVALUATION FINDINGS

Table 2 summarizes the first-year change in bill amount, chances of receiving disconnection notice, and account balance at the time of disconnection notice for a typical IQ Initiative participant who received at least one comprehensive measure. As shown, we estimate that participation in the IQ Initiative with comprehensive measures led to an average AIC energy bill reduction of $189 per participant in the first year following participation. Participants had a 0.10 percentage point reduction in the probability of receiving a disconnection notice after a year following their participation, however this reduction was not statistically significant. Similarly, among participants with comprehensive measures who did receive a disconnection notice, the average account balance (i.e., the amount in arrears) at the time of the disconnection notice was lower by $97, but this reduction was statistically insignificant as well. We provide further details on each of these analyses in the sections that follow.

Table 3. Participant Bill Payment Outcomes

Metric: Change In ...	Average First Year Impact Per Participant	Percent Change
Bill Amount of Fuels Delivered by AIC ($)	- $189 (± $28)	-7.71%
Probability of Receiving a Disconnection Notice	- 0.10 percentage points [-0.86 percentage points, 1.25 percentage points]	-
Amount Due at Time of Disconnection Notice ($)	- $97 (± $131)	-8.54%

Note: Impacts are presented with a 90% confidence interval.

[5] A logistic regression is appropriate when estimating a binary outcome variable (e.g., receives disconnection notice/does not receive disconnection notice).

Bill Amount of AIC-Delivered Fuels

Participants in the IQ Initiative who received comprehensive measures experienced a reduction in their energy consumption following participation, which decreased their bills. On average, customers paid $201 to AIC in energy charges on each monthly bill before participating in the IQ Initiative. Following participation, this bill decreased by 7.71%, or $16 per month on average (Table 3).

Table 4. Per-Participant First Year Bill Amount Impact

Metric	Value
Monthly Baseline Bill Amount ($)	$201
Average Monthly Bill Change ($)	− $16 (± $2)
Average Annual Bill Change ($)	− $189 (± $28)
Percent Change in Bill	− 7.71% (± 1%)

Note: Bill estimates only include energy (per kWh and per therm) charges and exclude monthly charges, riders, and other flat fees. Impacts are presented with a 90% confidence interval.

Incidence of Disconnection Notices

In the absence of participation in the IQ Initiative, the baseline probability of receiving a disconnection notice is 4.00%. Among IQ Initiative participants who received comprehensive measures, the baseline probability is 1.84%. At the end of twelve months of participation in the IQ Initiative with comprehensive measures, there is an estimated reduction in probability to 1.70% (Table 4).[6] However, the 90% confidence interval around probability of receiving a disconnection notice after 12 months of participation is 0.98% to 3.09%. This reduction translates to a 0.10 percentage points reduction in disconnection notice, with a confidence interval of 0.86 percentage point reduction to 1.25 percentage points increase. As the confidence interval of reduction contains zero, we cannot conclude that there was a statistically significant reduction in chances of receiving a disconnection notice following 12 months of participation in the IQ Initiative with comprehensive measures.

As discussed previously, participation in the IQ Initiative with comprehensive measures leads to approximately $189 in AIC-provided energy bill savings annually. At this level of savings, it is unlikely to lead to a large reduction in the chances of receiving a disconnection notice. Given this, and the low baseline rate of disconnection notices across the participant and comparison group population, any effect on the disconnection rate is expected to be small. With a small, expected impact, a much larger analysis population is likely to be required to detect a statistically significant effect.

Table 5. Per-Participant First Year Disconnect Impact (Comprehensive Measure Recipients)

Metric	Value
Average Baseline Probability of Disconnect	1.84%
Average Probability of Disconnect After 12 Months of Participation	1.75% [0.98%,3.09%]
Change in Disconnect Probability	- 0.10 percentage points [-0.86 percentage points, 1.25 percentage points]

Note: Impacts are presented with a 90% confidence interval.

[6] The coefficient estimate translates to a 0.66% reduction in odds per month, where odds are defined as probability of receiving disconnection notice over probability of not receiving disconnection notice. As explained in "Analysis Approach", the total savings from bill impacts accumulate over time. As such, effect on chances of receiving a disconnection notice over a longer horizon, such as for a full year, is more informative than month-over-month effects.

Account Balance at Time of Disconnection Notice

For IQ Initiative participants with comprehensive measures who received a disconnection notice, their total account balance (i.e., the amount in arrears) at the time of disconnection notice was estimated to be $97 lower following participation compared to before participation. This is equivalent to a 8.54% decrease in the amount due (Table 5). However, this decrease is not statistically significant. To the evaluation team's knowledge, IQ Initiative participation does not lead to a relaxed disconnection threshold. Moreover, given the low rate of disconnection notices across the participant and comparison group population and the estimated bill impacts from IQ Initiative participation, any impact on the account balance at the time of disconnection notice was expected to be small. With a small, expected impact, a much larger participant population would be required to detect a statistically significant effect.

Table 6. Impact on Average Amount Due at the Time of Disconnection Notice

Metric	Value
Baseline Amount Due Before Participation ($)	$1,334
Average Amount Due After Participation ($)	$1037
Average Change in Amount Due ($)	- $97 (± $131)
Percent Change in Amount Due	- 8.54% (± 11.6%)

Note: Impacts are presented with a 90% confidence interval.

CONCLUSIONS

Based on the results of this evaluation, the evaluation team offers the following conclusions:

- **Conclusion #1:** Participation in the IQ Initiative with comprehensive measures led to a reduction in energy consumption and a corresponding decrease in energy bills. The average participant between May 2022 and June 2023 experienced a 7.71% reduction in their bills following IQ Initiative participation.
- **Conclusion #2:** Participants in the IQ Initiative experienced a modest and statistically insignificant reduction of 0.10 percentage points in the probability of receiving a disconnection notice following twelve months of IQ Initiative participation with comprehensive measures.
- **Conclusion #3:** Participants in the IQ Initiative with comprehensive measures who received a disconnection notice following participation had a statistically insignificant $97 reduction in the amount due (arrearage) at the time of the disconnection notice.

APPENDIX I: DATA CLEANING AND PREPARATION

Participant Data

The evaluation team compiled a participant dataset by combining historical records of participants in AIC's income eligible initiatives. The initiatives included in this analysis were:

- IQ - Single Family
- IQ - Multifamily
- IQ - Smart Savers
- IQ - Community Action Agencies

The team compiled tracking data between May 1, 2022 and June 30, 2024. The dataset contained a variety of fields, including service address, account active and inactive dates, measures received, measure installation dates, and initiative year evaluated. We carefully reviewed the measure installation dates for each participant, which was important to categorize billing periods into pre- and post-installation periods accurately. Additionally, this step ensured that we excluded billing periods from the analysis where some (but not all) initiative measures had already been installed.

The four channels provide participants receive a wide range of measures with differing levels of expected energy savings. Only participants receiving at least one of the comprehensive measures: space heating or cooling measures, weatherization measures, and heat pump water heater measures, are expected to produce large enough energy savings that may have a statistically detectable affect on bills, disconnection probability, or balance at the time of disconnection. As such, we focus our analysis to participants who received comprehensive measures.

Billing Data

We obtained monthly billing data from AIC, including electricity usage (kWh), gas usage (therms), and bill amounts ($). Average Daily Bill (ADB) was calculated as the sum of the electric and gas bills divided by the number of days in the billing period. Data were requested for all low income participants from May 1, 2022, through June 30, 2024, to include one year of pre- and one year of post-installation data for all participants. Upon merging the participant and billing data, we performed the following data cleaning steps:

- **Inadequate number of days:** We identified and dropped bill periods with zero days and bills missing a start or end date.
- **Duplicate and overlapping records:** We explored duplicate records and overlapping bills and made adjustments to arrive at a single bill per period.
- **Negative ADB:** We checked for and dropped bills with negative amounts (less than $0).
- **Negative Average Daily Consumption (ADC):** We checked for and dropped bills with negative usage (less than 0 kWh or 0 therms).
- **Extremely high ADB:** We removed customers with entire pre- or post-installation periods with very high average bills or individual bills that were deemed outliers at the account level.
- **Multiple rate codes:** We removed nine customers with potentially multiple electric or gas rate codes.
- **Missing weather:** We removed bills where weather data was missing for more than 5 days of the billing period.
- **Inadequate billing history before or after initiative participation**: Many energy-saving measures in these initiatives are expected to generate energy savings throughout the year. To assess changes in consumption and bills due to

measures provided through the initiatives before and after installation, we needed to ensure that participants had a billing history covering at least nine months (or the 270-day equivalent) in the pre- and post-installation periods.

- **Insufficient billing history in the cooling season before and after initiative participation:** We required participants to have a billing history covering a minimum of 75% of the cooling season (June through August) in the pre- and post-participation periods.
- **Insufficient billing history in the heating season before and after initiative participation:** Similar to the cooling season, we required participants to have a billing history covering a minimum of 75% of the heating season (December through February) in the pre- and post-participation periods.

Table 6 summarizes the accounts dropped due to each cleaning step. The largest drops were associated with insufficient pre-period and post-period billing data. After the data cleaning, we retained 24% of participants with billing data. Finally, focusing on participants with comprehensive measures led to a further drop in participants under study.

Table 7. Summary of Participant Billing Data Cleaning To Obtain Treatment Accounts

Drop Reason	Accounts Remaining	
	N	%
Initial Participant Count	5,727	100%
Only Keep Relevant Initiatives	5,720	100%
Received last measure after June 2023	3,032	53%
Merge Billing Data	3,026	53%
Missing Bill Start or End Date	3,026	53%
Missing Billing Amount	3,026	53%
Negative Billing Amount	3,026	53%
Negative Electric Consumption	3,026	53%
Negative Gas Consumption	3,020	53%
>1 Electric Rate Code	3,018	53%
>1 Gas Rate Code	3,011	53%
Overlapping Bills	3,011	53%
Account-Level ADB Outliers	2,978	52%
Bill ADB Outliers	2,978	52%
Missing <5 Days of Weather	2,978	52%
75% of Overall Pre- and Post-Period	1,889	33%
75% of Heating Season Pre- and Post-Period	1,515	26%
75% of Cooling Season Pre- and Post-Period	1,364	24%
Participants with Comprehensive Measures	528	9%
Final Count	**528**	**9%**

Disconnection Data

AIC provided records of initial disconnection notices sent to low income participants from May 2021 through June 2024 due to nonpayment. The dataset contained account identifiers, the notice date, the reason the notice was sent, and the account balance at the time of the notice. The evaluation team merged the disconnection notice dataset into a monthly time series for each customer so that for every month in the evaluation period, we were able to identify whether the customer received or did not receive a disconnection notice. If the customer received a disconnection notice, we noted

the amount due at the time of the disconnection notice. 571 disconnection notices were sent to the customers with a comprehensive measure.

Weather Data

To include weather patterns in our models, we used daily weather data from numerous weather stations across AIC's territory. We utilized the site closest to each account's geographic location. Using multiple sites increased the accuracy of the weather data associated with each account. We obtained these data from the National Climatic Data Center (NCDC).

The monthly data are based on hourly average temperature readings from each day. We calculated cooling degree-days (CDD) and heating degree-days (HDD) for each day (in the analysis based on average daily temperatures, using the same formula used in weather forecasting). We then merged daily weather data into the consumption dataset so that each billing period captured the HDD and CDD for each day within that billing period. For analysis purposes, we calculated the average daily HDD and average daily CDD for each billing period.

APPENDIX 2: COMPARISON GROUP & EQUIVALENCY

For this analysis, we originally intended to use LIHEAP participants who did not participate in EE initiatives as a comparison group. Due to substantial differences in initial equivalency checks, we determined LIHEAP participants would not be an appropriate comparison group. Instead, we explored withholding more recent participants within the evaluation period (July 2023–June 2024) to use as a comparison group. As part of our assessment of the comparison group equivalency, we explored the following dimensions:

- Pre-period bill amounts
- Weather

Figure 1 compares billing amount patterns (average daily bills and their 95% confidence bounds) between the treatment and comparison groups in the common pre-period: April 2021 through April 2022. As can be seen in the figure, patterns are very similar through the 13-month period, however some small, yet statistically significant differences ($\alpha = 5\%$) are observed in June through September 2021. Ideally the treatment and comparison groups would be perfectly equivalent across all months. However, the value of having a comparison group to control for temporal rate changes and overall consumption patterns outweighed the need for a perfectly equivalent comparison group.

Figure 1. Participant and Comparison Group Usage During Pre-Installation Period

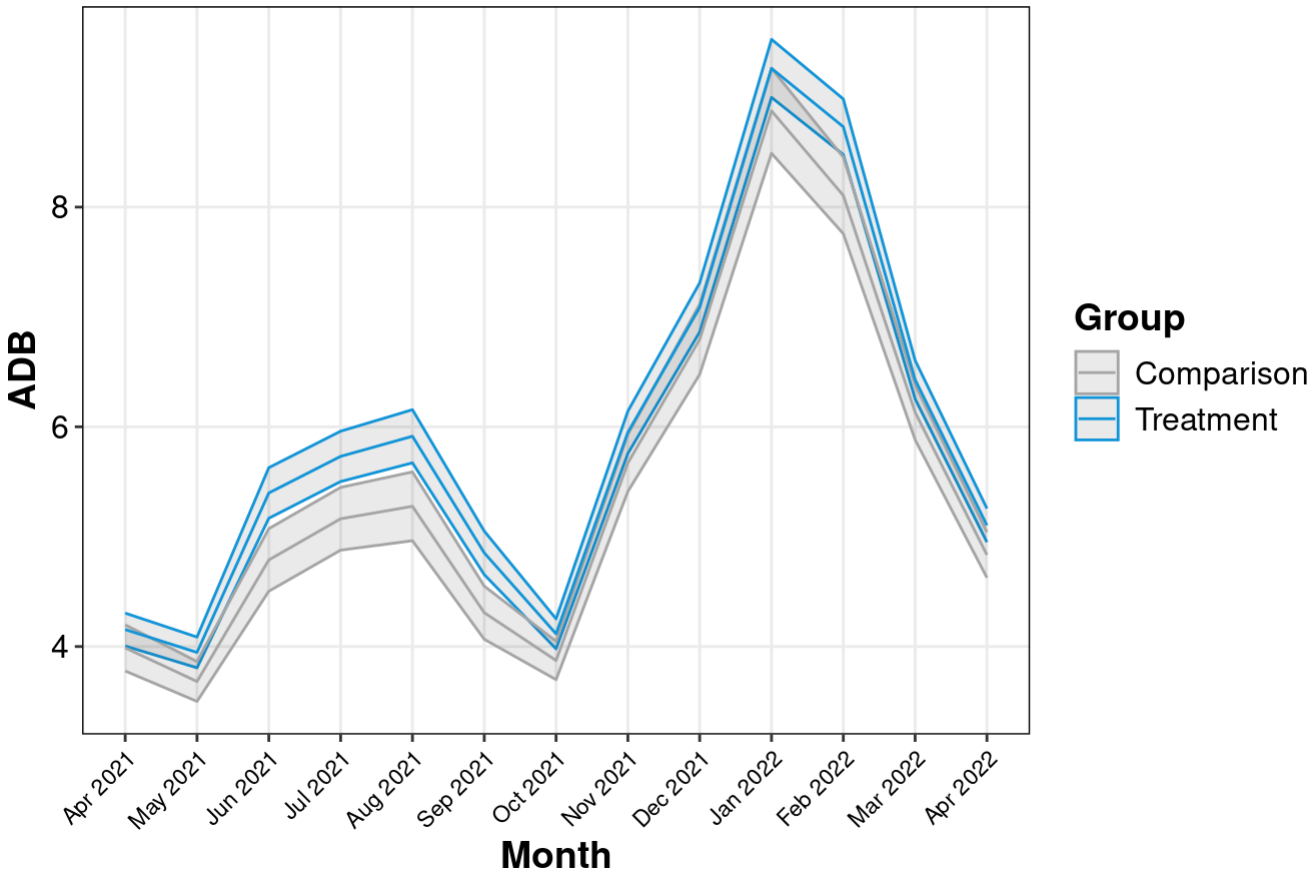


Figure 2 and Figure 3 show a comparison of CDD and HDD patterns between the treatment and comparison groups over time. The weather experienced by the treatment and comparison groups was similar.

Figure 2. Participant and Comparison Group Cooling Degree Days During Pre-Installation Period

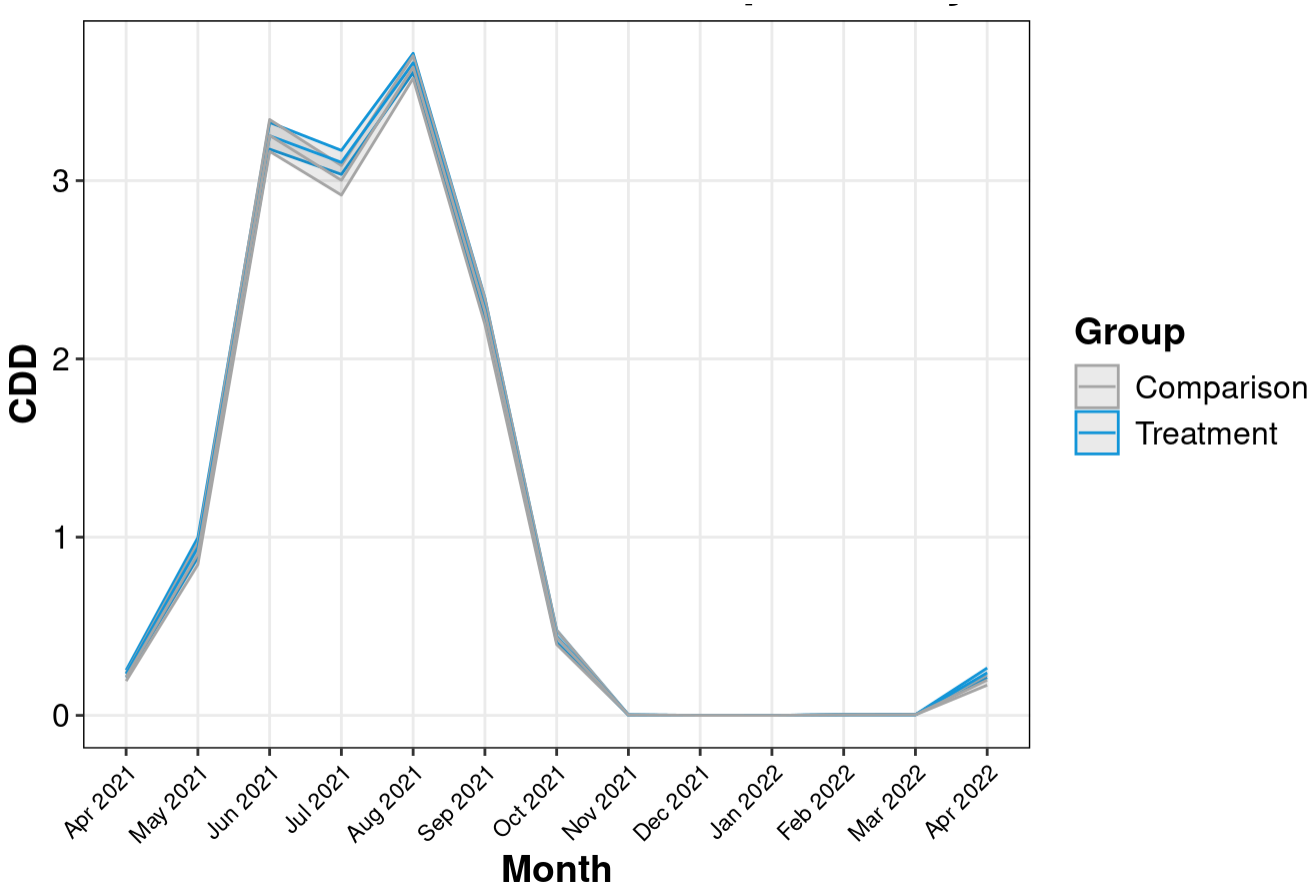
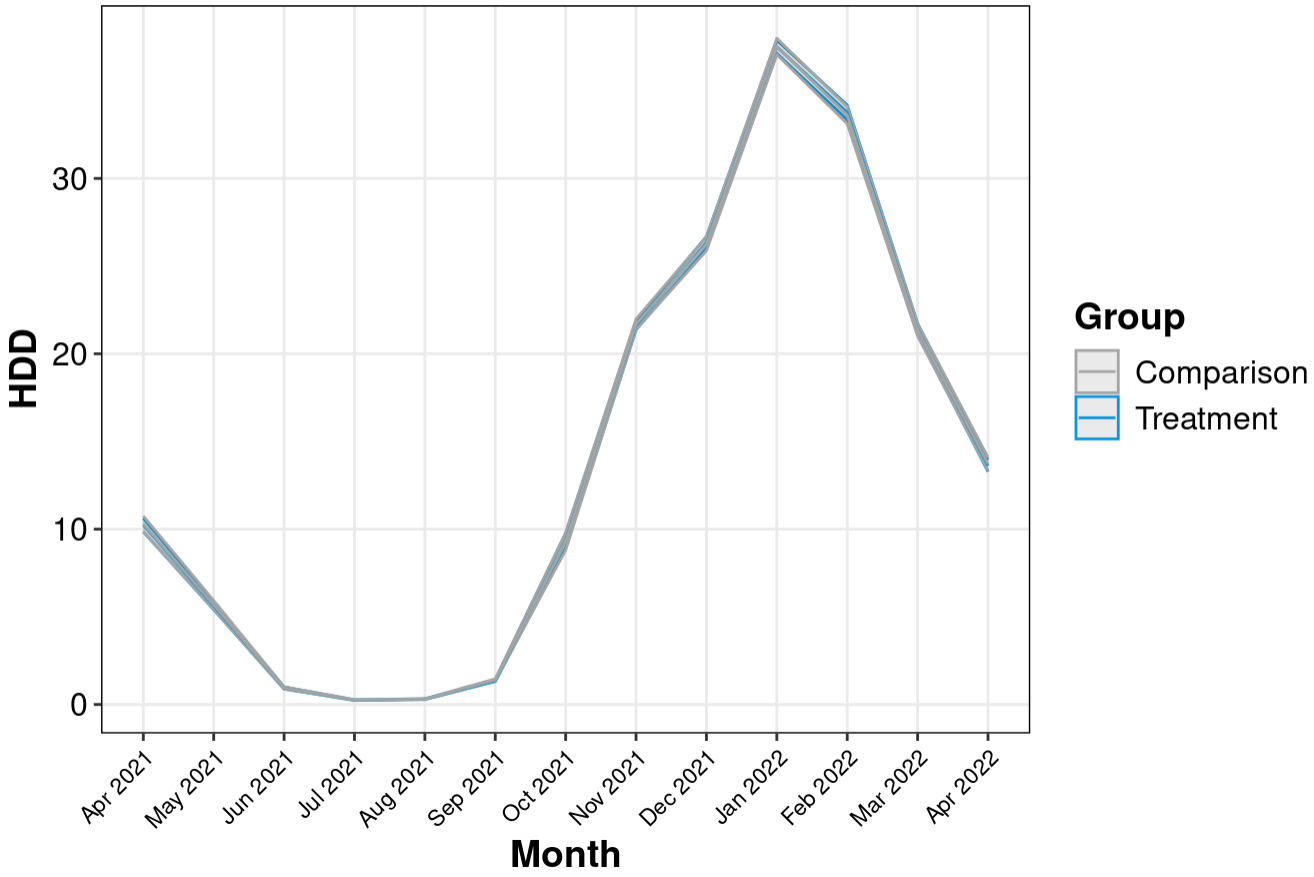


Figure 3. Participant and Comparison Group Heating Degree Days During Pre-Installation Period



APPENDIX 3: MODELING

We specified models for three dependent variables as part of this effort: billing amount, disconnection notice, and account balance at the time of disconnection notice. The three models are described in detail below.

Bill Amount Analysis

Using monthly billing data, we specified a linear fixed effect regression (LFER) model in a differences-in-differences design that incorporates weather and interaction terms to show the effect of weather in the post-installation period for participants that received comprehensive measures. The fixed effect for the model is set at the account level, which controls for all household factors that do not vary over time. Monthly fixed effects control for temporal trends in billing amounts across both participants and comparison group customers.

Equation 1 represents the final model specification.

Equation 1. Final Model Specification - Bill Savings

$$ADB_{it} = \alpha_i + B_{1-29}MonthYear_t + B_{30}Post_{it} + B_{31}CDD_{it} + B_{32}HDD_{it} + B_{33}Post_{it} \cdot CDD_{it} + B_{34}Post_{it} \cdot HDD_{it} + \varepsilon_{it}$$

Where:

ADB_{it} = Average daily bill (in dollars) for a participant *i* in billing month *t*

$MonthYear_t$ = Indicator for a given calendar month and year in billing month *t*

$Post_{it}$ = Indicator for a participant in the post-installation period (coded "0" in the pre-participation period, coded "1" in the post-installation period)

CDD_{it} = Cooling degree days for participant *i* in billing month *t*

HDD_{it} = Heating degree days for participant *i* in billing month *t*

α_i = Household-specific constant

B_{1-29} = Increments in ADB associated with each calendar month and year

B_{30} = Main effects (change in ADB associated with being a participant in the post-installation initiative period)

B_{31} = Increment in ADB associated with one-unit increase in CDD

B_{32} = Increment in ADB associated with one-unit increase in HDD

B_{33} = Increment in ADB associated with one-unit increase in CDD in the post-installation period

B_{34} =Increment in ADB associated with one-unit increase in HDD in the post-installation period

ε_{it} = Error term

Likelihood of Receiving Disconnection Notice

Using the disconnection notice dataset described above, we specified a logistic regression model to estimate the change in odds of receiving a disconnection notice in the post-installation period for participants that received comprehensive measures. The model accounts for seasonal differences or trends in the likelihood of receiving a notice through monthly fixed effects.

Equation 2 represents the final model specification.

Equation 2. Final Model Specification - Disconnection Notice Likelihood

$$NoticeReceived_{it} = B_{1-29}MonthYear_t + B_{30}Participant_i + B_{31}Total\ Post_{it} + \varepsilon_{it}$$

Where:

$NoticeReceived_{it}$ = Indicator for customer *i* in month *t* who received a disconnect notice (coded "0" for no disconnect notice received and "1" for disconnect notice received)

$MonthYear_t$ = Indicator for a given calendar month and year

$Participant_i$ = Indicator if customer *i* was a initiative participant (coded "0" for customers in the comparison group and "1" for participating customers, regardless of whether they were pre-participation or post-participation)

$Total\ Post_{it}$ = Number of months following participation

B_{1-29} = The log-odds ratio of receiving a disconnect notice associated with each calendar month and year with respect to the reference month

B_{30} = The baseline log-odds ratio of receiving a disconnect notice for participants with respect to the comparison group

B_{31} = The log-odds ratio of receiving a disconnect notice in the post-period with respect to the pre-period

ε_{it} = Error term

Amount Due at Time of Disconnection Notice

We specified a LFER model in a differences-in-differences design using the disconnection notice dataset. The fixed effect for the model is set at the account level, which controls for all household factors that do not vary over time. Monthly fixed effects control for temporal trends in account balances across both participants and comparison group customers.

Equation 3 represents the final model specification.

Equation 3. Final Model Specification - Disconnection Balance Amount

$$NoticeBalance_{it} = \alpha_i + B_{1-29}MonthYear_t + B_{30}Post_{it} + \varepsilon_{it}$$

Where:

$NoticeBalance_{it}$ = The notice balance for customer *i* in month *t* when they received a disconnect notice

$MonthYear_t$ = Indicator for a given calendar month and year

$Post_{it}$ = Indicator for a participant in the post-installation period (coded "0" in the pre-participation period, coded "1" in the post-installation period)

α_i = Household-specific constant

B_{1-29} = The baseline disconnection notice balance associated with each calendar month and year

B_{30} = Main effect (change in disconnect notice balance associated with being a participant who received a disconnect notice in the post-installation period)

ε_{it} = Error term