FILED
June 26, 2020
INDIANA UTILITY
REGULATORY COMMISSION

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

PETITION OF DUKE ENERGY INDIANA, INC. FOR APPROVAL OF (1) ITS PROPOSED DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY PROGRAMS FOR 2016-2018, INCLUDING COST RECOVERY, LOST REVENUES AND SHAREHOLDER INCENTIVES IN ACCORDANCE WITH IND. CODE §§ 8-1-8.5-3, 8-1-8.5-10, 8-1-2-42(a) AND PURSUANT TO 170 IAC 4-8-5 AND 170 IAC 4-8-6; (2) AUTHORITY TO DEFER COSTS INCURRED UNTIL SUCH TIME THEY ARE REFLECTED IN RETAIL RATES; (3) RECONCILIATION OF DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY PROGRAM COST RECOVERY THROUGH DUKE ENERGY INDIANA, INC. STANDARD CONTRACT RIDER 66A; AND (4) REVISIONS TO STANDARD CONTRACT RIDER 66A	)	**CAUSE NO. 43955 DSM-3**

ANNUAL COMPLIANCE FILING

Pursuant to the Final Order in Cause No. 43955 DSM-2 ("DSM-2") dated December 30, 2014, the Commission directed Duke Energy Indiana, LLC ("Duke Energy Indiana") to:

> File annually by July 1 under this Cause its independent EM&V report concerning its 2015 EE programs. The EM&V report must include the completed cost/benefit analysis that identifies the total costs, total benefits, and associated benefit cost ratios for the utility cost test, total resource cost test, ratepayer impact measure test, and the participant cost test. It shall also identify the discount rate used in the cost/benefit calculations.

On June 30, 2017, in the DSM-2 proceeding, Duke Energy Indiana filed its Annual Compliance Filing with the Commission and advised at that time, that since the Commission issued its Final Order in Cause No. 43955 DSM-3 ("DSM-3) on March 9, 2016, the June 30, 2017, Annual Compliance Filing would be the final filing in that proceeding and that in 2018, the

Annual Compliance Filings would be filed under DSM-3 and would provide the same information as the prior Annual Compliance Filings.

As such, pursuant to the Commission's DSM-2 and DSM-3 Final Orders, Duke Energy Indiana files the following materials in regard to its Annual Compliance Filing:

Attachment A:	Duke Energy Indiana Residential Energy Assessments Program Evaluation Report - Final - July 31, 2019.
Attachment B:	The current EM&V schedule for Duke Energy Indiana's energy efficiency programs.
Attachment C:	Duke Energy Indiana Program/Portfolio Cost Effectiveness - 2019

Respectfully submitted,

DUKE ENERGY INDIANA, LLC

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Annual Compliance Filing was electronically delivered this 26th day of June 2020, to:

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ATTACHMENT A

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Duke Energy Indiana

Residential Energy Assessments Program Evaluation Report – Final

July 31, 2019

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Table of Contents

Table of Tables

Table of Figures

Table of Equations

1. Evaluation Summary

1.1 Program Summary

Duke Energy Indiana (DEI) Residential Energy Assessments (REA) is a home assessment program that provides customers with a home audit report, including low- and no-cost energy savings recommendations, as well as suggestions for higher cost investments such as a new HVAC system or energy efficient appliances. Customers also receive an energy efficiency starter kit that contains two 9 watt LED light bulbs, a low-flow showerhead, two faucet aerators, a set of six outlet seals, and weather stripping that the auditor installs free of charge. Auditors also encourage behavioral changes and provide customers with a booklet of actionable recommendations to reduce their home energy usage. The program targets owner-occupied, single family residences, and relies largely on email and digital marketing, as well as direct mail. Our evaluation includes 7,307 customers who participated in the program between May 2016 and March 2018.

1.2 Evaluation Objectives

This evaluation includes a billing analysis used to estimate the net savings of the program for the evaluation period. The overall objectives of the DEI Residential Energy Assessments Program evaluation were to:

- Estimate net energy savings, at the household level, using billing analysis;
- Estimate the program net energy savings by multiplying the household net energy savings by the number of DEI customers who participated in the program during the evaluation period;
- Estimate ex post summer and winter peak demand reductions by applying ratios of peak kW to kWh savings – derived in the previous evaluation of the DEI Residential Energy Assessments Program[1] – to the ex post net energy savings estimated based on the billing analysis; and
- Update DSMore tables with energy savings and summer and winter peak demand reductions for energy efficiency kits and additional bulbs distributed through the program.

Because the scope of this evaluation was limited to a billing analysis and application of results from prior evaluations, we did not conduct process, engineering, or net-to-gross (NTG) analyses, and we do not provide any recommendations for program improvement in this report.

1.3 High-Level Findings

Estimated net energy savings for the DEI REA program during the evaluation period (May 1, 2016 to March 31, 2018) are 1,314 kWh per participant, or 9,601 MWh for the program (see Table 1-1). These results include savings from the measures included in the distributed energy efficiency kits, from additional LEDs provided to program participants, from behavioral changes that participants made based on the recommendations received during the assessment, as well as any participant spillover (SO) attributable to the program.

[1] Opinion Dynamics Corporation. July 2017. *Duke Energy Indiana: Residential Energy Assessments Program Evaluation Report - Final.* Dated July 27, 2017.

Table 1-1. Net Impact Results from Billing Analysis

Net Participant Savings			Net Program Savings		
Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
1,314	0.3576	0.2952	9,601	2.6132	2.1568

For planning purposes, Duke Energy requires separate gross and net per-participant savings and demand reduction values for the energy efficiency kit and the additional bulbs distributed to participants. These are provided in Table 1-2.

Table 1-2. DSMore Inputs

DSMore Inputs	kWh	Summer Peak Savings (kW)	Winter Peak Savings (kW)
Net energy efficiency kit savings per participant (excluding additional LEDs)	1,230.17	0.3511	0.2836
Net savings per additional LED bulb	18.63	0.0014	0.0026

2. Program Description

The DEI REA program is a home assessment program that provides customers with a customized energy report that includes recommendations to help lower home energy bills. The program targets residents of owner-occupied, single-family households who have been in their homes for at least four months and uses direct mailing as its main source of marketing and outreach. The program relies on digital marketing and email as additional forms of outreach.

2.1 Program Design

The REA program has two main components. The first is the home energy assessment, branded to customers as the "Home Energy House Call." During the assessment, energy specialists (auditors) enter participants' homes to inspect and assess energy using equipment in the home, including their heating and cooling equipment and the state of duct and home insulation. Auditors also look for places where customers could either make an improvement to equipment (e.g., replacing an outdated heat pump or removing older secondary appliances) or adjust the way that they use current equipment (e.g., adjusting the settings for their furnace fan or using window shades in the summer). These recommendations are meant to steer customers toward home improvements or behaviors that will help them save more energy.

The second component is a free kit of low-cost, energy-efficient measures. The energy efficiency starter kit consists of two 9W LEDs, two faucet aerators, a low-flow shower head, outlet seals (a package of four outlet and two switch seals), and a 17-foot roll of closed cell foam weather stripping. Customers can also receive up to six additional 9 watt LEDs, regardless of bulbs received from other Duke Energy programs.

In its program-tracking databases, DEI tracks the date that customers sign up for the program, the recommendations made by the auditor during the assessment, and the number of additional light bulbs given to the customer.

2.2 Program Implementation

DEI contracted with Franklin Energy to implement the REA program. The program was implemented using a multichannel marketing approach, including bill inserts and direct mail letters. Customers were very responsive to program marketing leading DEI to scale back its messaging during the evaluation period.

Duke Energy instituted a few changes to the program's implementation during the evaluation period. In the spring of 2017, the program implementer introduced the use of Clipboard, its internally developed application that allows program auditors to generate customizable reports for each program participant. Prior to this, the implementer provided participants with a general list of recommendations to improve energy efficiency. An additional feature adopted by the implementer is the use of infrared cameras during the audit, which provides thermal imaging information and allows auditors to enhance their suggestions to improve home energy efficiency.

2.3 Program Performance

During the evaluation period (May 1, 2016 through March 31, 2018), the program served 7,307 unique participants. The program saved participants, on average, 1,314 kWh per household per year. Peak demand reductions per household were 0.36 kW in summer and 0.30 kW in winter.

3. Key Research Objectives

This evaluation includes a billing analysis used to estimate the net savings of the program for the evaluation period. The overall objectives of the DEI Residential Energy Assessments Program evaluation were to:

- Estimate net energy savings, at the household level, using billing analysis;
- Estimate the program net energy savings by multiplying the household net energy savings by the number of DEI customers who participated in the program during the evaluation period;
- Estimate ex post summer and winter peak demand reductions by applying ratios of peak kW to kWh savings – derived in the previous evaluation of the DEI Residential Energy Assessments Program[2] – to the ex post net energy savings estimated based on the billing analysis; and
- Update DSMore tables with energy savings and summer and winter peak demand reductions for energy efficiency kits and additional bulbs distributed through the program.

Because the scope of this evaluation was limited to a billing analysis and application of results from prior evaluations, we did not conduct process, engineering, or net-to-gross (NTG) analyses, and we do not provide any recommendations for program improvement in this report.

[2] Ibid.

4. Overview of Evaluation Activities

Evaluation activities included an interview with the DEI REA program manager, review of program materials, and a billing analysis. The scope of this evaluation did not include a participant survey, a process evaluation, a deemed savings review, or an engineering analysis or NTG analysis.

4.1 Program Staff Interview

Opinion Dynamics conducted an in-depth interview with the current REA program manager in August 2018. The purpose of the interview was to gauge the current environment of, and expectations for, the REA program, including the program's goals, successes, and challenges over the evaluation period. We also wanted to inquire about programmatic changes that would contextualize the results of the billing analysis. During the interview, we also discussed the marketing of the program, as well as the receptiveness of DEI customers to participating in this offering.

4.2 Program Materials Review

Opinion Dynamics reviewed program materials and the program-tracking database. We found the program materials and the program-tracking database relating to the assessment, recommendations, and marketing to be complete and of high quality.

4.3 Billing Analysis

Opinion Dynamics conducted a billing analysis to determine the net savings attributable to the REA program for the evaluation period. We used a linear fixed effects regression (LFER) model to estimate the overall net ex post program savings. The fixed effect in our model is the customer, which allows us to control for all household factors that do not vary over time. The billing analysis used customers who participated between May 2016 and March 2018 as the treatment group and those who participated between April 2018 and December 2018 as the comparison group. A summary of the billing analysis approach is provided in Section 5; a detailed description of the billing analysis methodology is presented in Appendix A.

5. Impact Evaluation

5.1 Billing Analysis Methodology

Opinion Dynamics conducted a billing analysis to determine the net savings of the REA program. Our billing analysis used participants from May 2016 through March 2018 as the treatment group and participants from April 2018 through December 2018 as the comparison group. This type of comparison group is referred to as a "future participant comparison group," since comparison group participants participated in the future, relative to the evaluation period. A comparison group allows us to establish a counterfactual, i.e., the baseline energy that participants in the treatment group would have used in the absence of the program. In addition, because the comparison group represents energy use in absence of the program, results from the billing analysis are net results, and application of an NTG ratio to billing analysis results is unnecessary.

Our method requires pre- and post-participation electricity usage data for the treatment group. To be included in the treatment group, we need usage data for at least nine months before and after participation. For the comparison group, the model includes only electricity usage data from before their participation.

Table 5-1 summarizes information about the treatment and comparison groups included in the analyses.

Table 5-1. Accounts Included in Final Billing Analysis Model

Metric	Treatment Group	Comparison Group
Months of participation	May 2016–March 2018	April 2018–December 2018
# customers included in the analysis	3,600	1,234
Usage data included	9+ Months of Pre- and Post-Participation Data	9+ Months of Pre-Participation Data

The number of customers included in the billing analysis is approximately 52% of those who participated during the evaluation period, and 64% of those who participated between April and December of 2018. The main reason customers were dropped from the analysis was due to participation in other Duke Energy programs (approximately 33% in the treatment group and 36% in the comparison group). The evaluation team recognizes that this is a large number of customers to exclude from the analysis but took this necessary step to limit the risk of the effects of other programs being confounded with the treatment effect of the REA program. It should be noted that while these customers were not included in the billing analysis model, average modeled savings are still applied to them, i.e., the program receives credit for their savings.

The billing analysis employed a LFER model, which accounts for time-invariant factors, such as square footage, appliance stock, habitual behaviors, household size, and other factors that do not vary over time. The model accounts for differences in weather and pre-program energy use between participants. The model includes interaction terms between weather and the post-participation period for the treatment group, to account for differences in weather patterns across years. A more detailed discussion of the billing analysis methodology, including data-cleaning steps, the comparison group assessment, and the final model, is provided in Appendix A.

5.2 Billing Analysis Results

This section provides billing analysis results and savings estimates for the DEI REA program evaluation period. Table 5-2 shows the results of the billing model for REA program participants. The variable "Post" represents the unadjusted treatment effect, i.e., the change in average daily consumption (ADC) attributable to participation in the REA.

Table 5-2. Results of Billing Analysis Models

Variable	Coefficient
Post (REA program participation)	-0.4185753*
CDD	9.621104*
HDD	0.9932761*
Post-participation period CDD	-1.936585*
Post-participation period HDD	-0.139458*
Constant	31.38086
R-squared	0.58
Additional Terms	**Included**
Monthly effects included	NO
Post-participation period interacted with months included	NO

*Statistically significant at the 90% confidence interval

Due to post-participation period interaction terms in the model, it is necessary to recalculate the coefficient of the treatment effect (Post) by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-participation period, separate of any effect of the included interaction terms. Making these adjustments (detailed in Appendix A), Opinion Dynamics found that each REA program participant included in the model realized 3.6 kWh of daily energy savings, on average.

Table 5-3 shows the per-home and program-level savings for the program. Overall, customers who participated in the REA program saved 1,314 kWh per year. During the evaluation period, the program realized 9,601 MWh of energy savings. We arrived at program level savings by multiplying the per home daily savings (3.6 kWh) by 365 days by the number of customers who participated in the program during the evaluation period (7,307 participants).

Table 5-3. Annual Savings from Billing Analysis

Annual Savings	
May 2016–March 2018 participants	7,307
Per-home daily savings (kWh)	3.6
Per-home annual savings (kWh)	1,314
Program savings (MWh)	**9,601**

6. Net-to-Gross Analysis

Since the billing analysis produces net savings, development of an NTG ratio is not necessary to determine net program savings. However, a NTG ratio for LEDs is needed to provide the inputs for the DSMore table that Duke Energy requires for program planning.

As noted earlier, this evaluation did not include a NTG analysis. Instead, we leveraged the FR value for LEDs from a recently completed evaluation of the DEI Energy Efficient Appliances and Devices Program indicated below and the SO value from the previous evaluation of the DEI REA program referenced earlier in this report.[3] We used two different sources for these values since the SO value is a program specific value while FR for light bulbs tends to be technology specific and, in both programs, the LEDs are free to participants. This makes the FR value from the DEI Energy Efficient Appliances and Devices Program the most appropriate one to apply for net savings of the REA program (when the DEI REA program was previously evaluated, the energy efficiency kits provided CFLs rather than LEDs).

Table 6-1 shows the FR, SO, and NTG ratio used to develop the DSMore table along with the sources of these values.

Table 6-1. FR, SO, and NTGR

NTG Component	Value	Source
FR	49.2%	Opinion Dynamics Corporation. October 2018. *Duke Energy Indiana: Energy Efficient Appliances and Devices Program Draft Evaluation Report*, submitted to Duke Energy on October 31, 2018.
SO	15.0%	Opinion Dynamics Corporation. July 2017. *Duke Energy Indiana: Residential Energy Assessments Program Evaluation Final Report*, submitted to Duke Energy on July 27, 2017.
NTGR = (100% – FR + SO)	**65.8%**	

[3] Report dated 2017.

7. Key Findings

Estimated net energy savings for the DEI REA program during the evaluation period (May 1, 2016 to March 31, 2018) are 1,314 kWh per participant, or 9,601 MWh for the program (see Table 7-1). These results include savings from the measures included in the distributed energy efficiency kits, from additional LEDs provided to program participants, from behavioral changes that participants made based on the recommendations received during the assessment, as well as any participant spillover (SO) attributable to the program.

Table 7-1. Net Impact Results from Billing Analysis

Net Participant Savings			Net Program Savings		
Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
1,314	0.3576	0.2952	9,601	2.6132	2.1568

For planning purposes, Duke Energy requires separate per-participant savings and demand reduction values for the energy efficiency kit and the additional bulbs distributed to participants. These are provided in Table 7-2. Details about how these values were estimated are presented in Section 8.

Table 7-2. DSMore Inputs

DSMore Inputs	kWh	Summer Peak Savings (kW)	Winter Peak Savings (kW)
Net energy efficiency kit savings per participant (excluding additional LEDs)	1,230.17	0.3511	0.2836
Net savings per additional LED bulb	18.63	0.0014	0.0026

8. DSMore Inputs

For planning purposes, Duke Energy requires separate per-participant savings values for the energy efficiency kit and the additional bulbs distributed to participants. To provide these estimates, we took the following steps:

1. We estimated **net savings per additional LED** by multiplying gross savings per additional LED by the LED NTG ratio of 65.8%. The savings and the FR value are from the following study completed for DEI: "Duke Energy Indiana: Energy Efficient Appliances and Devices Program Draft Evaluation Report" submitted to Duke Energy on October 31, 2018. The SO value is taken from the previous DEI REA Report: "Duke Energy Indiana: Residential Energy Assessments Program Evaluation Final Report" submitted to Duke Energy on July 27, 2017. We used these values because this evaluation did not include an engineering analysis, nor did it include a participant survey to gather information that could be used to estimate the NTG ratio for LEDs.

2. We estimated **net savings of the kit exclusive of additional LEDs** by subtracting net savings for the average number of additional LEDs (4.5 bulbs) from per household savings based on the billing analysis.

Developing these separate inputs ensures that savings from the additional bulbs are not double-counted for planning purposes, as their savings are already included in the billing analysis estimate. Table 8-1 presents the development of the DSMore inputs and the embedded MS Excel file provides the DSMore inputs table.

Table 8-1. Development of DSMore Inputs

Data for Development of DSMore Inputs	Energy Savings (kWh)*	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
Gross savings per additional LED bulb	28.31	0.0022	0.0039
LED NTG ratio = 65.8%			
Net savings per LED additional bulb	18.63	0.0014	0.0026
Program savings per participant: Billing analysis	1,314.00	0.3576	0.2952
Net Savings for additional LED Bulbs (4.5 bulbs)	83.83	0.0065	0.0115
Net kit savings per participant (excluding additional LEDs)	1,230.17	0.3511	0.2836

* The gross savings, the summer and winter coincident demand reductions per additional LED, and the LED FR value used to develop the NTG ratio are taken from "Duke Energy Indiana: Energy Efficient Appliances and Devices Program Draft Evaluation Report" submitted to Duke Energy on October 31, 2018. The SO value used to develop the NTG ratio is from "Duke Energy Indiana: Residential Energy Assessments Program Evaluation Final Report".

DEI Residential Assessments DSMore Inputs Table

(SEE MS EXCEL FILE)

9. Summary Form

Residential Energy Assessments

Completed EM&V Fact Sheet

The REA program provides, free of cost, a home energy assessment, which includes a kit of low-cost energy efficiency measures. A customized report of recommended upgrades and behavioral changes is given to the customer at the end of the assessment.

Date	May 10, 2019
Region(s)	Duke Energy Indiana
Evaluation Period	May 2016–March 2018
Annual kWh Savings	9,601,398 kWh
Annual kWh Savings (per participant)	1,314 kWh
Coincident kW Impact (per participant)	0.3576 kW (Summer) 0.2952 kW (Winter)
Measure Life	Not Evaluated
Net-to-Gross Ratio	Not Evaluated
Process Evaluation	No
Previous Evaluation(s)	July 27, 2017

Evaluation Methodology

The evaluation team conducted a billing analysis to estimate energy savings and used a combination of billing analysis and engineering analysis results from the previously conducted evaluation of this program to estimate coincident demand savings.

Impact Evaluation Details

- Residential customers in DEI service territory who have owned their single-family home for at least four months are eligible for the program. Homes must have an electric water heater, electric heat, or central air conditioning.
- Results from the billing analysis reflect savings associated with measures installed, assessment recommendations, SO, and potential behavioral changes from energy efficiency knowledge gained through participation in the REA program.

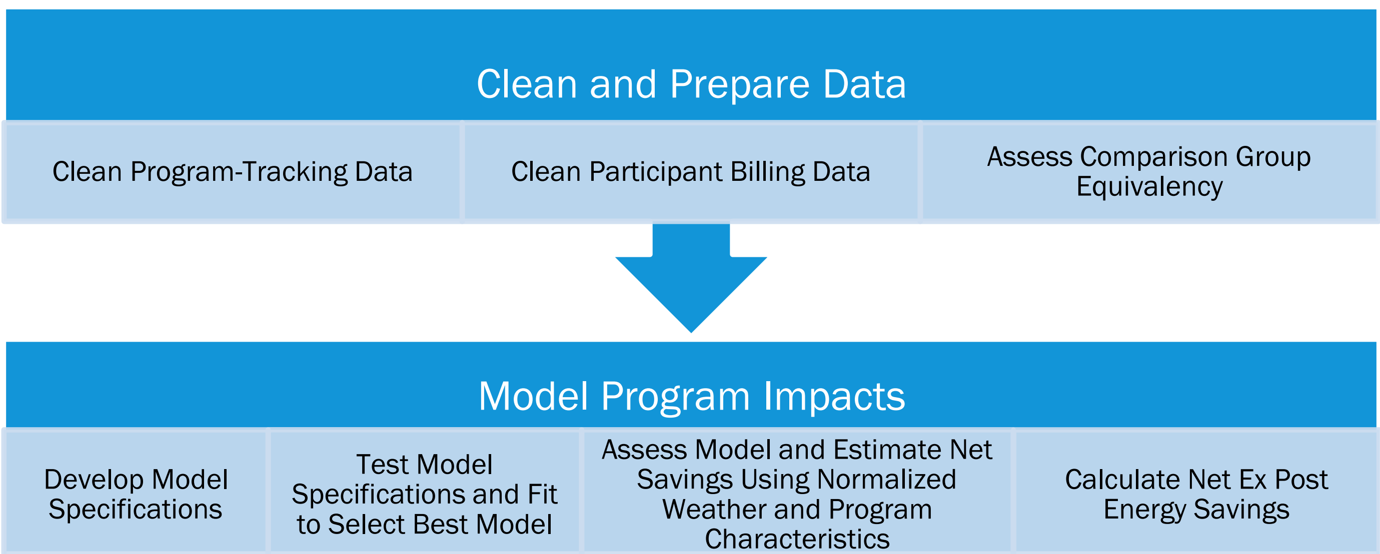
Appendix A. Detailed Billing Analysis Methodology and Results

The evaluation team conducted a billing analysis using an LFER model, with the goal of determining the overall ex post net program savings of the DEI Residential Energy Assessments (REA) program. The fixed effect in the model is at the individual account level, which allows all household factors that do not vary over time to be controlled for by the model.

Data Collection

As part of the billing analysis of REA program participants, the evaluation team followed a standard series of steps for data collection, model specification, and analysis. Section 5 in the body of the report provides a summary of our billing analysis approach, and Figure A-1 outlines the steps.

Figure A-1. Billing Analysis Approach



Comparison Group Selection

A key challenge for estimating energy savings through a billing analysis is the identification of an appropriate comparison group or "counterfactual" to represent a baseline for what participants would have done (and how much energy they would have consumed) in the absence of a program. There are two key considerations in the design of a comparison group. A good comparison group has similar energy usage patterns (compared to participants) before participation (i.e., pre-participation period) and effectively addresses self-selection bias (the correlation between the propensity to participate in a program and energy use). Given this, we aim to use a comparison group that, on average, exhibits very similar usage patterns prior to participation. If there are some differences in energy use patterns between participants and comparison group customers, those differences must be addressed in the model. Achieving this ensures that estimates from our quasi-experiment are representative of the actual effects that the program has on a customer's energy use. For our comparison group, we use customers who participated from April 2018 to December 2018. In the context of the evaluation period, these customers have not yet participated in the program, but will do so in the future. Using future participants as a comparison group is attractive because we know that both groups will eventually participate, allowing us to assume that they are similar in many respects, most notably self-selection.

Billing analyses, when using an appropriate comparison group, incorporate the effects of both FR and participant SO, thus providing program net savings. For example, the energy use patterns of the members of the comparison group, during their pre-participation period, reflect equipment installations and behavioral changes that treatment group participants might have performed in the absence of the program. In addition, any measures installed during the evaluation period beyond program measures (SO) are a factor in an increased coefficient for the participation variables. To investigate how similar the groups are, we first compare the energy usage of the treatment and comparison groups prior to participation.

Weather is also of interest when selecting a comparison group, as stark differences in weather between the treatment and comparison groups can introduce bias. We found that participants from each group experienced nearly identical weather.

Our billing analysis used participants from the evaluation period as the treatment group and future participants as the comparison group. Our method requires post-installation electricity usage data for at least nine months after participation. Pre-participation energy usage of our comparison group was very similar to that of the treatment group (see the section on baseline average daily energy consumption, below).

Data Cleaning and Preparation

This section summarizes how we cleaned and prepared the program participant databases and billing data for the billing analysis.

Program-Tracking Data

As a first step, the evaluation team prepared a master participant dataset that combined the program-tracking data from the evaluation period with dates of participation in other Duke Energy programs. This master dataset was composed of customer information that included:

- **Participation date:** The date of participation in the REA program to ensure that customers participated during the evaluation period.
- **Participation in other programs:** Customers who participated in multiple energy efficiency programs during the time period being analyzed may skew the observed effect of the REA program if they are not accounted for or removed.
- **Location:** We used the address and zip code of each customer to incorporate regional weather data.

Participant Billing Data

The participant monthly billing data from January 2014 to December 2018 was provided directly by Duke Energy. To develop the final dataset used for statistical analysis, we used a multistep approach to combine and clean the data. We describe each billing data-cleaning step below.

- **Cleaned individual billing periods:** Bills marked as charge adjustments that had zero billing days and zero kWh usage were removed. This was 6.3% of the original billing data. Duplicate bills for the same billing month and billing months with multiple bill adjustments were also removed. This was another 4.3% reduction in bill count. Meter read dates and billing days were then examined for overlapping periods and gaps. Another 0.4% of bills were removed because of overlap periods greater than one week. Data gaps were not an issue. Nearly all accounts had typical billing periods of around 30 days. Additionally, we determined average usage for each observation (based on usage and number of billing days in the period).

- **Removed all duplicate billing records:** Duplicate records represented fewer than 0.75% of the records in the data. In cases where the kWh values matched, one copy of the record was retained in the dataset and the duplicate was removed. Duplicate billing records with conflicting kWh values were dropped entirely.

- **Combined participant data with billing records:** We merged usage data with account-level data, including measure installation dates. We then assigned pre- and post-treatment billing periods based on those dates. We assigned billing periods before the first measure installation date to the pre-participation period, all bills following the last measure installation date as the post-participation period, and any bills occurring between installation dates (or in the month of the audit and measure installations) to a “dead-band” period that was not included in the analysis.

After individual billing records were cleaned and all data were combined, we removed accounts that did not meet certain criteria. We use the following criteria to ensure that all accounts in the final analysis file had sufficient data to allow for robust analysis:

- **Extremely high or low ADC:** We removed customers with very high (>300 kWh/day on average) or very low (<2 kWh/day on average) pre- or post-participation usage. These data points were removed because their atypical usage patterns were likely due to factors that could not easily be controlled for in the model, and thus could have biased results.

- **Inadequate billing history before or after program participation:** The measures included in the kit were expected to generate energy savings throughout the year. To be able to assess changes in consumption due to program measures before and after installation, we included participants with a billing history covering, at a minimum, nine billing records before the first day of program participation, and the same amount of time after participation for our treatment group.

- **Inadequate billing history in the cooling season before and after program participation:** Participants with fewer than two billing records in the summer (cooling season) were excluded because we expected the measures installed to be generally weather sensitive both in terms of temperature and daylight hours. By ensuring that we have enough billing data in the months of June, July, and August, we allow for more rigorous savings estimates.

- **Participated in other Duke Energy programs:** We defined cross-participation as participants who received other program benefits (such as an appliance rebate) from another Duke Energy program. Due to the high rate of overlap in the MyHER program (~91%) and the Smart Saver LED or CFL measures (nearly everyone), those customers who participated only in MyHER program and the lighting measures and no other programs were not counted as cross-participants. Cross-participants were removed from our analysis to limit the risk of the effects of other programs being confounded with the treatment effect of the REA program. A deeper look at the timing of participation in the MyHER program and LED or CFL measures showed it was evenly distributed across the whole evaluation period. Keeping these customers in the analysis should not bias the estimated savings for the REA program.

The following table shows how many accounts were removed from the billing analysis for each reason.

Table A-1. Accounts Removed from Analysis

Reason for Dropping Account	Comparison		Treatment	
	Accounts	Percent of Total	Accounts	Percent of Total
Total Unique Accounts with Billing Data	**1,937**		**6,962**	
High overall average usage (over 300 kWh/day)	-	-	1	0.01%
Low overall average usage (under 2 kWh/day)	1	0.1%	2	0.03%
Too few post-period bills (fewer than nine)	-	-	352	5.1%
Too few pre-period bills (fewer than nine)	-	-	659	9.5%
Too few summer bills (less than two in either period)	-	-	32	0.46%
Cross-participation	702	36.2%	2,316	33.2%
Accounts Remaining for Analysis	**1,234**	**63.7%**	**3,600**	**51.7%**

Comparison Group Equivalency

The comparison group was integral to our billing analysis methods and was used to develop a counterfactual representation of baseline energy used by participants in the absence of the program. Using future participants mitigates self-selection bias that may be present when comparing treatment participants to a general group of non-participating customers. It is important to check that the two groups of participants are equivalent on as many dimensions as possible and to correct for any observed differences in the model. Based on the information at our disposal, we analyzed two main criteria to determine that treatment group participants were equivalent to the comparison group participants and could be used as a valid comparison group. These criteria are:

- **Weather:** Compared average monthly HDD and CDD.[4]
- **Baseline period ADC:** Similarity in ADC before engaging with the program might be a general proxy for behavioral similarities. As such, the evaluation team compared the baseline monthly ADC of participants in each group.

Based on the results of this equivalency check, we determined that the treatment and comparison participant groups used energy in a very similar way and therefore provide a reasonable comparison to analyze program impacts. We discuss each of these criteria in more detail below.

Weather

In order to include weather patterns in our model, we used daily weather data from numerous weather stations across the DEI territory, utilizing the site closest to each account's geographic location. By using multiple sites, we increased the accuracy of the weather data being applied to each account. We obtained these data from the National Climatic Data Center (NCDC).

The daily data were based on hourly average temperature readings from each day. We calculated CDD and HDD for each day (in the analysis and historical periods) based on average daily temperature using the same

[4] A "degree-day" is a unit of measure for recording how hot or how cold it has been over a 24-hour period. The number of degree-days applied to any particular day of the week is determined by calculating the mean temperature for the day and then comparing the mean temperature to a base value of 65 (HDD) and 75 (CDD) degrees F. (The "mean" temperature is calculated by adding together the high for the day and the low for the day, and then dividing the result by 2.) If the mean temperature for the day is 5 degrees higher than 75, then there have been five CDD. On the other hand, if the weather has been cool, and the mean temperature is, say, 55 degrees, then there have been 10 HDD (65 minus 55). http://www.srh.noaa.gov/ffc/?n=degdays.

formula used in weather forecasting. We merged daily weather data into the billing dataset so that each billing period captured the HDD and CDD for each day within that billing period (including start and end dates[5]). For analysis purposes, we then calculated average daily HDD and average daily CDD, based on the number of days within each billing period.

Figure A-2 and Figure A-3 show participants in the treatment and comparison groups experienced virtually the same weather over time.

Figure A-2. Average Heating Degree-Days of Customers Included in Billing Analysis

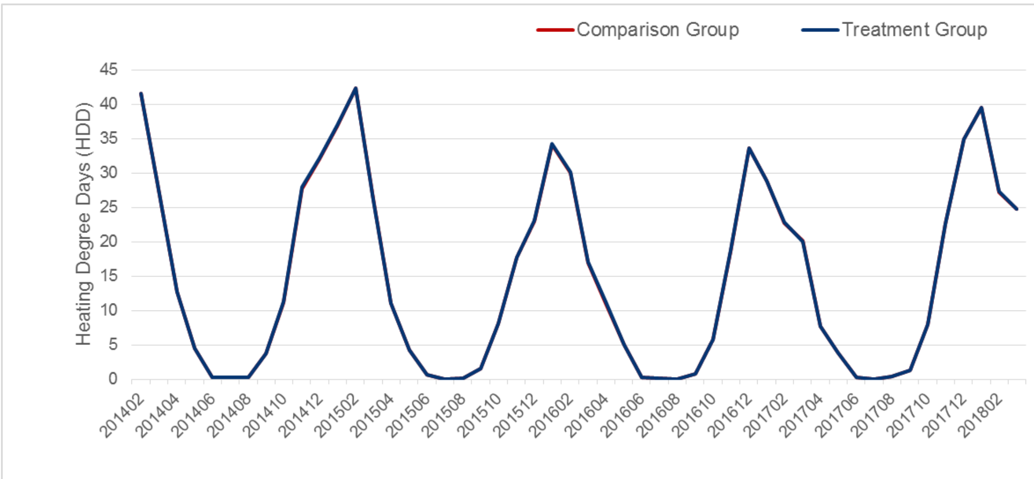
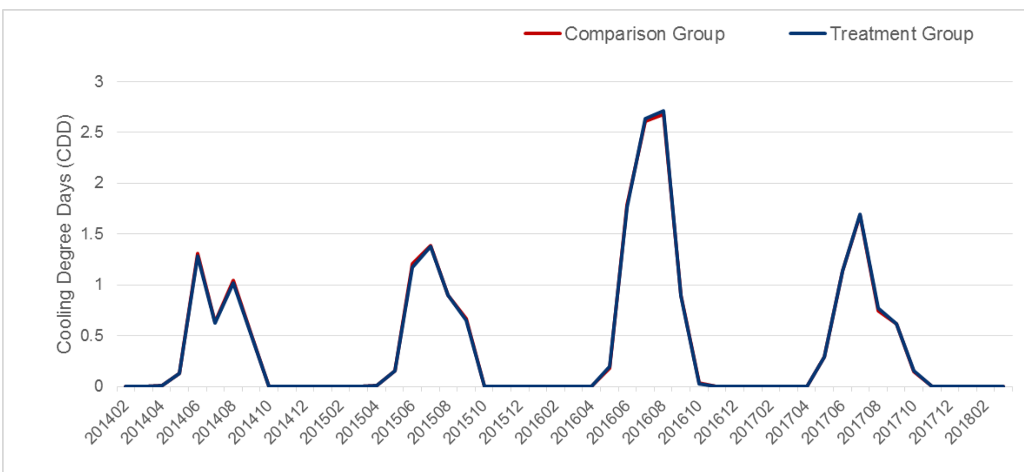


Figure A-3. Average Cooling Degree-Days of Customers Included in Billing Analysis

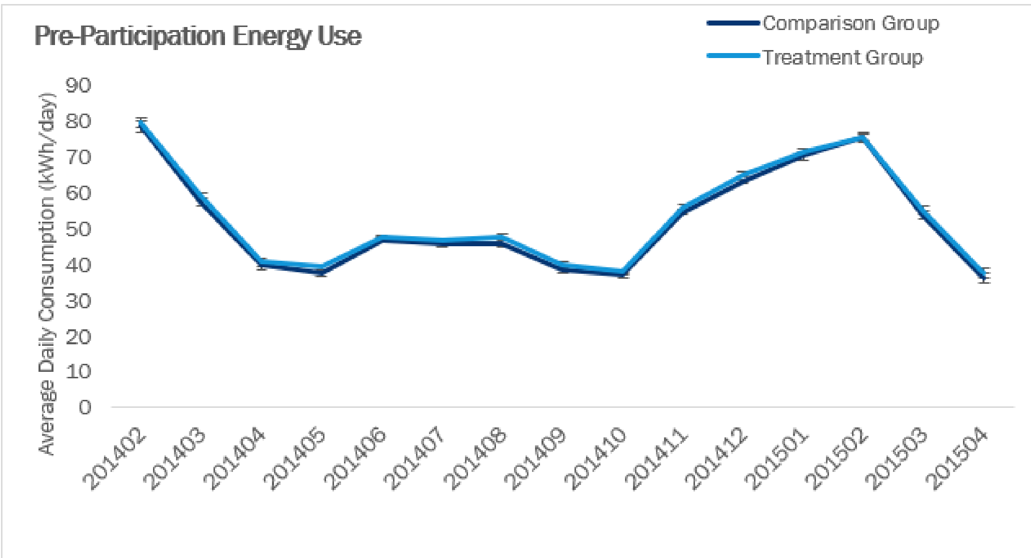


[5] See previous footnote.

Baseline Average Daily Energy Consumption

Opinion Dynamics examined the average daily electricity consumption for several months during each participant's pre-participation period to compare energy consumption patterns. As shown in Figure A-4, participants in the treatment group and comparison group have nearly identical energy usage during the pre-participation period.

Figure A-4. Comparison of Average Baseline Monthly kWh Consumption between Treatment and Comparison Customers



Model Specifications

To estimate savings for the REA program, Opinion Dynamics utilized an LFER model that incorporated weather to account for baseline differences between the treatment and comparison groups. As described in more detail below, we fit a series of models to the data and settled on our final model based on fit statistics and model diagnostics.

Develop and Test Model Specifications

In the development of our final model, we aimed to explain as much variation in the dependent variable as possible. The most direct measure of this is the overall R-squared, which gives an estimate of how much variability in post-participation period usage is explained by the variables included in the model. An R-squared of 1.0 indicates that a model explains 100% of the variance in the dependent variable, and an R-squared of 0.5 would explain 50%.

As previously mentioned, we did not include customers who participated in other programs, except for customers who participated only in the MyHER program and/or LED or CFL measures. We considered not removing these customers and entering indicator variables for each of the other utility programs. Doing this could lead to interference between the influences of each program on energy use, making it difficult to draw valid conclusions about the effects of REA program participation separate of the other programs. As such, we believe it is more appropriate to remove those customers from the analysis.

In the development of our model, we investigated average energy consumption before and after participation, how changes in weather affect the amount of energy used, and differences in energy use in each month. In this investigation, we found a clear relationship between energy use and weather and saw expected fluctuations in energy use through the year.

In our investigation of seasonal changes in energy use, we tested a model that included terms for each month of the year (January–December). This allows a month to be present in both the pre-participation period and the post-participation period, thus capturing the change in usage during said month. Our use of these monthly terms in conjunction with a comparison group can create an improved counterfactual and increase the accuracy of program savings estimates. However, this is only true if weather is relatively consistent from one year to the next. In this study we found that the summer in the post-participation period was much warmer (50% more CDD) and the month variables were not helpful. They were therefore not included in the final model specification.

We added interaction terms of weather and the post-participation period to account for the relationship between weather and consumption following treatment. Failing to account for non-program-related changes that occur during the post-participation period, for example, the warmer summers that were experienced, could undervalue the treatment effect. We tested different combinations of these potential interaction terms to determine the most representative model corrections across participants.

We also tested a model that included a separate savings factor based on the number of additional light bulbs each household received. We found that the estimated savings for additional light bulbs were very small and not statistically significant at any reasonable confidence interval. Further investigation showed that 72% of the treatment customers received six additional bulbs, and 22% of them did not receive any. Since there was so little difference across participants it is not surprising that the model could not detect a separate savings estimate for the additional LEDs distributed through the program.

Final Model for REA Program Participants

Our final model is shown in Equation A-1.

Equation A-1. Model Specification

$$ADC_{it} = B_h + B_1 Post_{it} + B_2 HDD_{it} + B_3 CDD_{it} + B_4 Post \cdot HDD_{it} + B_5 Post \cdot CDD_{it} + \varepsilon_{it}$$

Where:

ADC_{it} = Average daily consumption (in kWh) for the billing period
$Post$ = Indicator for treatment group in post-participation period (coded "0" if treatment group in pre-participation period or comparison group in all periods, coded "1" in post-participation period for treatment group)
HDD = Average daily HDD from NCDC
CDD = Average daily CDD from NCDC
B_h = Average household-specific constant
B_1 = Main program effect (change in ADC associated with being a participant in the post-program period)
B_2 = Change in ADC associated with one-unit increase in HDD
B_3 = Change in ADC associated with one-unit increase in CDD
B_4 = Change in ADC associated with each increment increase of HDD for participants in the post-program period (the additional program effect due to HDD)
B_5 = Change in ADC associated with each increment increase of CDD for participants in the post-program period (the additional program effect due to CDD)
ε_{it} = Error term

Estimated Savings and Realization Rate

This section contains the observed net savings from our billing analysis. The results account for FR and reflect savings associated with installed measures, participant SO, and behavioral changes from energy efficiency knowledge gained during the assessment.

Estimated Savings

The regression model results presented in Table A-2 shows a reduction in electricity use after customers participate in the REA program, controlling for weather, time, and the household characteristics (reflected in the constant term).

Table A-2. Final Model

Variable	Coefficient
Post (REA program participation)	-0.4185753*
CDD	9.621104*
HDD	0.9932761*
Post-participation period CDD	-1.936585*
Post-participation period HDD	-0.139458*
Constant	31.38086
R-squared	0.58
Additional Terms	**Included**
Monthly effects included	NO
Post-participation period interacted with months included	NO

*Statistically significant at the 90% confidence interval.

Due to the weather and weather interaction terms in the model, it was necessary to recalculate the coefficient of the treatment effect (Post) by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-treatment period, including any reduction caused by warmer temperatures. Utilizing a simple linear equation, shown in Equation A-2, which combines the coefficients of those interaction terms with the average post-participation period values for each, we estimated the overall savings associated with the program.

Equation A-2. Model Specification for Change in ADC

$$\Delta ADC = B_1 Post + \cdot\, (B_4 Post \cdot AvgHDD) + \ (B_5 Post \cdot AvgCDD)$$

Where:

ΔADC	= Change in ADC
$AvgHDD$	= Average number of HDD per day during the post-participation period
$AvgCDD$	= Average number of CDD per day during the post-participation period

Table A-3. Adjusted Estimate of Daily Program Savings

REA Program Estimate	Standard Error	t	p<|t|	90% Confidence Interval	
				Lower	Upper
−3.6	0.17	-21.01	p<.001	-3.8	-3.3

The value of the new REA program estimate seen in Table A-3 represents a 3.6 kWh reduction in ADC associated with moving from pre-treatment to post-treatment. There is a 90% probability that overall program savings range between 3.3 kWh and 3.8 kWh per day for REA program participants. We extrapolated these estimates to calculate the overall net program savings for DEI REA program participants. To facilitate a clear comparison of program performance across Duke Energy territories, we provided savings as a percentage of the baseline usage (Table A-4), because customers may differ in their energy use across territories. We calculated baseline usage as the average kWh/day in the pre-participation period for all treatment customers in the final analysis dataset. Doing this shows the energy that customers would have used on average if they did not participate, i.e., the counterfactual. To estimate the percent savings from participants' baseline energy consumption, we divide the coefficient for the REA program, representing the change in daily usage, by the mean baseline ADC to arrive at the percentage of savings.

Table A-4. Estimated Savings from Billing Analysis Compared to Baseline Usage

	Baseline Usage (kWh)	Standard Error	90% Confidence Interval of Baseline kWh		Savings (kWh)	Percent Savings
Overall daily savings*	50.6	0.169	50.4	50.9	3.6	7.1%

* Daily savings estimate is the inverse of the coefficient for the REA program shown in Table A-3.

Based on our analyses, we found an average savings of 1,314 kWh annually for REA program participants. With 7,307 participants in the evaluation period (May 2016–March 2018), the program saved 9,601.4 MWh in one year, as shown in Table A-5.

Table A-5. Annual Energy Savings for REA Program

Participants	Annual Baseline Usage (kWh)	Percent Savings	Annual Energy Savings (kWh)	
			Per-Home Savings	Program Savings
7,307	50.6	7.1%	1,314	9,601,398

In the table below, we present the coefficient estimates, standard errors, t-statistics, and p-values for the final model specification used to estimate the ex post net energy savings for the program.

Table A-6. Full Model Results

Term	Estimate	Standard Error	t-statistic	p-value
Post	-0.41858	0.22313	-1.88	0.0607
CDD	9.6211	0.0805	119.52	<.0001
HDD	0.99328	0.00464	213.85	<.0001
Post:CDD	-1.93659	0.13821	-14.01	<.0001
Post:HDD	-0.13946	0.00962	-14.5	<.0001

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Planned[1] Evaluation, Measurement and Verification (EMV) Activities

Residential Program	Program/Measure	Previous Evaluation Report(s)	Q1 2020	Q2 2020	Q3 2020	Q4 2020	Q1 2021	Q2 2021	Q3 2021	Q4 2021	Q1 2022	Q2 2022	Q3 2022	Q4 2022
Energy Efficiency Education Program for Schools	K12 Curriculum	7/28/17	M&V	M&V	Report				M&V	M&V	M&V	Report		
Neighborhood Energy Saver		5/11/17	M&V	Report							M&V	M&V	M&V	Report
Low Income Weatherization[1]							M&V	M&V	M&V	Report				
Multi-Family EE Products & Services		4/28/14, 12/11/17				M&V	M&V	Report						M&V
My Home Energy Report	MyHER	11/21/13, 8/12/16, 8/10/18	M&V	M&V	Report						M&V	M&V	M&V	Report
Residential Energy Assessments	HEHC	CORE, 7/27/17, 7/31/19					M&V	M&V	M&V	Report				
Residential Smart Saver®	Retail Lighting		M&V	Report						M&V	M&V	Report		
	Online Store & LED	10/31/2018					M&V	M&V	M&V	Report				
	HVAC & Building Shell, Pool Pumps, Water Heating	11/4/15, 5/3/18									M&V	M&V	M&V	Report
	Water	5/3/2018	M&V	Report						M&V	M&V	Report		
Power Manager® Demand Response	Power Manager® AC	5/24/14, 6/1/15, 4/7/17, 6/21/17, 10/31/18	M&V	M&V	Report				M&V	M&V	Report			
	Power Manager® AC & WH, PM Apts (WH & AC)[1]													

Non-Residential Program	Program/Measure	Previous Evaluation Report(s)	Q1 2020	Q2 2020	Q3 2020	Q4 2020	Q1 2021	Q2 2021	Q3 2021	Q4 2021	Q1 2022	Q2 2022	Q3 2022	Q4 2022
Power Manager® for Business	Demand Response		M&V	M&V	Report						M&V	M&V	Report	
Small Business Energy Saver		8/10/2018			M&V	M&V	Report							M&V
Smart $aver Non-Res	Custom 2	8/12/2016, 8/10/18	M&V	M&V	M&V	M&V	Report				M&V	M&V	M&V	Report
	Prescriptive 2	11/6/14, 6/1/15, 7/31/17, 3/6/19			M&V	M&V	M&V	Report						M&V

New Programs	Program/Measure	Previous Evaluation Report(s)	Q1 2020	Q2 2020	Q3 2020	Q4 2020	Q1 2021	Q2 2021	Q3 2021	Q4 2021	Q1 2022	Q2 2022	Q3 2022	Q4 2022
Energy Efficient Appliances	EEAPPL													
Manufactured Home Retrofit														
Multifamily Retrofit														
Multifamily My Home Energy Report			M&V	M&V	Report									
Residential New Construction	NEWCON													
Bring Your Own Thermostat[1]	BYOT													

1 - Future Process and Impact Evaluation Report dates are projections only. Actual report dates will vary depending on program participation to provide a significant sample and the time needed to collect adequate data.

2 - Evaluation work for the following programs will be done in batches, with some data collected each year to contribute to the final analysis: Non-Res Smart $aver Custom and Prescriptive.

* At this time, no further evaluations are planned for Agency Assistance Portal and Free LED Lighting

LEGEND	
M&V	Data collection (surveys, interviews, onsite visits, billing data) and analysis
Report	Evaluation Report

Program/Portfolio Cost Effectiveness - 2019*, **

Program	UCT	TRC	RIM	PCT***	NPV Cumulative Avoided T&D Electric (net)	NPD Avoided Ancillary (net)	NPV Cumulative Cost-Based Avoided Elec Production (net)	NPV Cumulative Cost-Based Avoided Elec Capacity (net)	NPV Cost-Based Avoided Gas Production (net)	NPV Cumulative Elec Lost Rev Net of Fuel NF (net)	NPV Total Program Costs (Including Incentives Excluding EMV)	NPV Incentives	NPV Participant Costs(net)	NPV Participant Costs(gross)	Participant Elec Bill Savings (gross)	NPV EMV Costs
					A	B	C	D	E	F	G	H	I	J	L	M
Residential Programs																
Agency Assistance Portal	2.68	2.68	0.81	>1.00	$ 65,394	$ -	$ 272,545	$ 45,929	$ -	$ 331,388	$ 143,287	$ -	$ -	$ -	$ 518,822	$ -
Energy Education Program for Schools	3.67	3.67	1.34	>1.00	$ 580,104	$ -	$ 1,047,705	$ 605,592	$ -	$ 1,060,781	$ 608,101	$ -	$ -	$ -	$ 1,574,431	$ -
Low Income Neighborhood	1.27	1.27	0.68	>1.00	$ 104,231	$ -	$ 399,267	$ 108,708	$ -	$ 415,014	$ 444,214	$ -	$ -	$ -	$ 652,250	$ 37,500
Low Income Weatherization	1.12	1.12	0.65	>1.00	$ 29,246	$ -	$ 124,089	$ 30,730	$ -	$ 116,736	$ 164,596	$ -	$ -	$ -	$ 182,904	$ -
Multi-Family EE Products & Services	3.70	3.70	0.93	>1.00	$ 65,285	$ -	$ 530,326	$ 68,387	$ -	$ 532,218	$ 179,631	$ -	$ -	$ -	$ 899,999	$ -
My Home Energy Report	1.19	1.19	0.57	>1.00	$ 914,699	$ -	$ 2,264,243	$ 361,203	$ -	$ 3,241,304	$ 2,963,700	$ -	$ -	$ -	$ 5,132,135	$ -
Residential Energy Assessments	3.90	3.90	1.25	>1.00	$ 1,080,341	$ -	$ 2,084,046	$ 482,486	$ -	$ 1,990,516	$ 880,069	$ -	$ -	$ -	$ 3,244,629	$ 54,000
Smart $aver® Residential	3.46	2.72	0.92	7.54	$ 4,147,434	$ -	$ 25,638,352	$ 2,797,037	$ -	$ 26,110,161	$ 9,309,564	$ 3,631,320	$ 6,176,348	$ 8,538,784	$ 60,753,684	$ 114,243
Power Manager®	4.32	5.88	4.32	>1.00	$ 4,646,598	$ -	$ -	$ 4,818,538	$ -	$ -	$ 2,172,364	$ 581,708	$ -	$ -	$ -	$ 19,890
Duke Portfolio - Residential Total	**3.12**	**2.80**	**1.05**	**9.04**	$ 11,633,332	$ -	$ 32,360,574	$ 9,318,610	$ -	$ 33,798,118	$ 16,865,525	$ 4,213,027	$ 6,176,348	$ 8,538,784	$ 72,958,854	$ 225,634
Non-Residential Programs																
Power Manager® for Business	1.50	1.77	1.05	>1.00	$ 650,997	$ -	$ 466,078	$ 676,274	$ -	$ 513,133	$ 1,143,309	$ 185,630	$ -	$ -	$ 785,893	$ 53,000
Small Business Energy Saver	3.47	2.04	1.00	3.05	$ 1,669,020	$ -	$ 7,393,560	$ 1,745,698	$ -	$ 7,706,270	$ 3,113,164	$ 2,433,626	$ 4,619,699	$ 4,277,525	$ 10,618,987	$ -
Smart $aver® Non-Residential	5.36	2.57	1.10	3.60	$ 8,615,148	$ -	$ 35,638,046	$ 8,524,822	$ -	$ 37,954,479	$ 9,806,545	$ 6,824,486	$ 17,484,085	$ 21,012,847	$ 68,914,090	$ 37,645
Duke Portfolio - Non-Residential Total	**4.62**	**2.44**	**1.08**	**3.55**	$ 10,935,165	$ -	$ 43,497,684	$ 10,946,794	$ -	$ 46,173,882	$ 14,063,018	$ 9,443,742	$ 22,103,784	$ 25,290,373	$ 80,318,970	$ 90,645
Overall Portfolio Total	**3.80**	**2.59**	**1.07**	**4.93**	$ 22,568,497	$ -	$ 75,858,257	$ 20,265,403	$ -	$ 79,972,000	$ 30,928,544	$ 13,656,769	$ 28,280,132	$ 33,829,157	$ 153,277,824	$ 316,278

*Discount rate is 6.92%

**Please note that this annual filing incorporates the results for all of 2019.

***The PCT score cannot be calculated when there are no participant costs. In these instances, the program passes the PCT as indicated by the ">1.00" in the table above.

Note - The cost effectiveness results above are intended to show the relationship between the net present value of avoided costs, program costs, and any out of pocket participant costs associated with each program for calendar year 2019. Since costs and participation of a program may vary year to year over a program's life, these test results may or may not be indicative of the cost effectiveness over the full life of the program.

UCT Calculation = (A+B+C+D+E)(Total Benefits)/(G+M)(Total Costs)
TRC Calculation = (A+B+C+D+E)(Total Benefits)/(G-H+I+M)(Total Costs)
RIM Calculation = (A+B+C+D+E)(Total Benefits)/(F+G+M)(Total Costs)
PCT Calculation = (H+L)(Total Benefits)/(J)(Total Costs)