DUKE ENERGY OHIO EXHIBIT_____

BEFORE THE

PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Duke Energy Ohio, Inc., for Recovery of Program Costs, Lost Distribution Revenue and Performance Incentives Related to its Energy Efficiency and Demand Response Programs.	))))))	Case No. 20-613-EL-RDR

DIRECT TESTIMONY OF

TRISHA A. HAEMMERLE

ON BEHALF OF

DUKE ENERGY OHIO, INC.

April 14, 2020

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I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Trisha A. Haemmerle. My business address is 139 East Fourth Street, Cincinnati, Ohio 45202.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Duke Energy Business Services, LLC (DEBS), as Senior Manager, Strategy and Collaboration. DEBS provides various administrative and other services to Duke Energy Ohio, Inc., (Duke Energy Ohio or the Company) and other affiliated companies of Duke Energy Corporation (Duke Energy).

Q. PLEASE SUMMARIZE YOUR EDUCATION AND PROFESSIONAL QUALIFICATIONS.

A. I graduated from Ohio University with a Bachelor's Degree in Marketing. I started my career with Cinergy in 1997. I worked for Cinergy and Duke Energy from 1997 to 2010 developing, managing, and analyzing survey activities, as well as market research projects. Starting in 2009, I also managed the coordination of verification for the energy efficiency and demand response programs. I assumed my current position in 2010.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO?

A. Yes, I submitted testimony in support of Duke Energy Ohio's application for recovery of program costs, lost distribution revenue and performance incentives related to its Energy Efficiency (EE) and Demand Response (DR) programs, Case Nos. 14-457-

EL-RDR, 15-534-EL-RDR, 16-0664-EL-RDR, 17-781-EL-RDR, 18-397-EL-RDR and 19-622-EL-RDR.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. The purpose of my testimony in this proceeding is to discuss the history of Rider Energy Efficiency-Peak Demand Response (EE-PDR), Duke Energy Ohio's energy efficiency programs, and the successful achievements Duke Energy Ohio has had with its current portfolio of programs. My testimony will also discuss how the Company determines program cost-effectiveness and explain the Company's evaluation, measurement and verification process (EM&V) used to verify the results of its portfolio of programs. The testimony of Duke Energy Ohio witness James E. Ziolkowski will explain Rider EE-PDR and how it is applied to the programs to determine cost recovery.

II. HISTORY OF RIDER EE-PDR

Q. PLEASE EXPLAIN THE HISTORY OF RIDER EE-PDR.

A. Duke Energy Ohio proposed the Rider EE-PDR energy efficiency and peak demand cost recovery mechanism in its application in Case No. 11-4393-EL-RDR that was filed on July 20, 2011. The Company's application requested approval to implement Rider EE-PDR to replace Rider DR-SAW, which was due to expire on December 31, 2011. The application also proposed a mechanism by which to recover the costs it incurs in achieving the energy efficiency and peak demand reduction targets set by S.B. 221, and to provide the Company with an incentive to exceed the targets. The Public Utilities Commission of Ohio (Commission)

approved a Stipulation and Recommendation resolving intervening parties' concerns and establishing Rider EE-PDR on August 15, 2012. In compliance with the Order, Duke Energy Ohio submitted an updated portfolio filing, Case No. 13-0431-EL-POR, to align the cost recovery mechanism with the portfolio of programs on April 15, 2013. The application was approved on December 4, 2013. The Company also filed and received approval for a new non-residential program, Small Business Energy Saver.[1] The Company filed a new portfolio, Case No. 16-576-EL-POR**,** for years 2017 – 2019 in 2016.

Q. HAS DUKE ENERGY OHIO UPDATED ANY OF ITS PROGRAMS TO BE OFFERED TO CUSTOMERS IN 2017 - 2019?

A. Yes. Duke Energy Ohio filed a new portfolio in 2016 for program years 2017 – 2019. An amended stipulation with the majority of intervening parties was submitted on January 27, 2017. On September 27, 2017 the amended stipulation was approved by the Commission with modifications.[2] Because the Commission's Order was issued in September of 2017, the Commission recognized that the Company's spending for 2017 might exceed the cap imposed. Therefore, the Commission stated that it might permit the Company to exceed the cap but would not permit shared savings for 2017.[3] The Commission also stated that the Company should not exceed the Portfolio Plan budget for programs for calendar year 2017 absent obtaining a waiver from the Commission.[4] On October 12, 2017 Duke

[1] *In the Matter of the Application of Duke Energy Ohio, Inc., for Approval to Add a New Program to its Approved Energy Efficiency Portfolio*, Case No. 14-964-EL-POR, Finding and Order, (September 10, 2014).
[2] *In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of its 2017-2019 Energy Efficiency and Peak Demand Reduction Program Portfolio Plan*, Case No. 16-576-EL-POR, Opinion and Order, p. 1 (September 27, 2017) (2017 Opinion and Order).
[3] *Id.*, pp. 15-16.
[4] *Id.*, p. 16.

Energy Ohio requested a waiver to permit the Company to exceed the Portfolio Plan budget and the waiver was approved on November 21, 2017.[5] Consistent with the amended stipulation that the Commission had approved, until the Company received approval of the 2017 – 2019 portfolio programs, Duke Energy Ohio continued to operate under the 2016 portfolio guidelines. On February 26, 2020, the Commission approved the Company's request to extend its existing portfolio (for 2017 – 2019) through the end of 2020, with an increased budget of $46,895,800.[6] No additional programs were offered in 2019.

Q. PLEASE SUMMARIZE THE COST RECOVERY AND INCENTIVE MECHANISM UNDERLYING RIDER EE-PDR THAT WAS APPROVED IN CASE NO. 16-576-EL-POR.

A. Under Rider EE-PDR, the Company is entitled to recover the costs prudently incurred to deliver energy efficiency and peak demand reduction programs. Additionally, under Rider EE-PDR, the Company is entitled to earn a shared savings incentive in an amount up to $8 million dollars a year on an after-tax basis based upon its ability to *exceed* its annual efficiency savings benchmark targets that are mandated by Ohio law. In Case No. 16-576-EL-POR, the Commission approved recovery of lost distribution margins from all customer classes not included in the Company's pilot distribution decoupling rider (i.e., those customers receiving service under Rates DS, DP, and TS).

[5] *In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of its 2017-2019 Energy Efficiency and Peak Demand Reduction Program Portfolio Plan*, Case No. 16-576-EL-POR, Entry on Rehearing, p. 1 (November 21, 2017).

[6] *In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of its 2017-2019 Energy Efficiency and Peak Demand Reduction Program Portfolio Plan*, Case No. 16-576-EL-POR, Finding and Order, pp. 3, 17 (February 26, 2020) (2020 Finding and Order).

Q. PLEASE DESCRIBE HOW THE COMPANY'S APPROVED SHARED SAVINGS MECHANISM WORKS.

A. The Company's shared savings incentive structure is designed to incentivize the Company for exceeding its energy efficiency benchmark in the most cost-effective manner possible. Under this incentive structure, the level of incentive, or the magnitude of the percentage of the net system benefits (avoided costs less the costs of delivering the efficiency) that the Company may earn, is tiered and can range from 6.0% up to 12.0%, depending on the degree by which the actual efficiency savings exceeds its energy savings benchmark. Please see Table 1 below.

Table 1

Achievement of Annual Target	After-Tax Shared Savings
≤ 100	0.0%
> 100 - 106	6.0%
> 106 - 112	9.0%
> 112	12.0%

This shared savings mechanism allows Duke Energy Ohio an opportunity to recover its costs and earn an incentive for exceeding the mandated benchmarks.

Q. IS THE SHARED SAVINGS INCENTIVE MECHANISM EFFECTIVE IN INCENTIVIZING DUKE ENERGY OHIO TO OVER COMPLY WITH ITS ENERGY EFFICIENCY BENCHMARKS IN 2017 - 2019?

A. Yes. The fact that the shared savings mechanism only allows the Company to earn a shared savings incentive in a year that it meets or exceeds its energy efficiency benchmark will help to ensure that the Company will continue to strive to achieve as much energy efficiency as possible and even more importantly, it motivates the

Company to maximize cost effectiveness. This mechanism incentivizes the Company at 10% allowing customers to receive 90% of the system benefits realized through the Company's portfolio of programs.

Q. DOES THE SHARED SAVINGS CALCULATION INCLUDE COST INCURRED FOR MEASUREMENT AND VERIFICATION?

A. Yes, consistent with the Commission's Order in Case No. 13-753-EL-RDR, the net benefit used in the calculation of shared savings includes cost incurred for EM&V.

Q. IS THE COMPANY'S SHARED SAVINGS MECHANISM APPROVED FOR 2019?

A. Yes, the Company's Shared Savings mechanism was approved along with the Company's last portfolio in Case No.16-576-EL-POR, consistent with the amended stipulation in that case that was approved by the Commission. However, in its order approving the Company's portfolio in Case No. 16-576-EL-POR, the Commission stated that the Company's annual recovery of program costs and shared savings for calendar years 2018 and 2019 could not exceed four percent of the Company's 2015 operating revenues. This decision to effectively impose a $38.7 million cost cap on the Company's portfolio impacted the actual amount of the shared savings incentive earned by the Company.

Q. WHAT IS THE CURRENT STATUS OF THE FOUR PERCENT COST CAP?

A. Duke Energy Ohio timely sought rehearing of the Commission's Opinion and Order in this case and specifically argued that the Commission had no basis – legal or factual

– upon which to impose a cap on cost recovery.[7] The Commission granted rehearing on November 21, 2017, for further consideration.[8] The Company's application for rehearing remains pending. Furthermore, On October 15, 2019, in *In re Application of Ohio Edison Co.*, Slip Opinion No. 2019-Ohio-4196 (*Ohio Edison*),[9] the Ohio Supreme Court reversed an Opinion and Order by the Commission imposing a cost cap on another utility that was virtually identical to that of the Company.

Q. HOW HAS THE OHIO SUPREME COURT'S DECISION IN *OHIO EDISON* AFFECTED THE COMPANY'S APPLICATION(S) FOR COST RECOVERY ASSOCIATED WITH ITS PORTFOLIO APPROVED IN CASE NO. 16-576-EL-POR?

A. The Company's most recent previous application had been filed for recovery of program costs, lost distribution revenues, and a performance incentive for costs incurred in 2018, in Case No. 19-622-EL-RDR. After *Ohio Edison*, the Company filed an amended application in Case No. 19-622-EL-RDR, containing a revised and corrected calculation, excluding and eliminating the improper cost recovery cap, and in a manner that is consistent with the Court's *Ohio Edison* decision. Likewise, in this case, the Company's application for recovery of program costs, lost distribution revenues, and a performance incentive for costs incurred in 2019 requests recovery of the full shared savings incentive earned in addition to full program costs that is beyond the $38.7 million-dollar cost cap.

[7] *In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of its 2017-2019 Energy Efficiency and Peak Demand Reduction Program Portfolio Plan*, Case No.16-576-EL-POR Duke Energy Ohio, Inc.'s Application for Rehearing, (October 27, 2017).

[8] *In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of its 2017-2019 Energy Efficiency and Peak Demand Reduction Program Portfolio Plan*, Case No.16-576-EL-POR, Entry on Rehearing (November 21, 2017).

[9] *In re Application of Ohio Edison Co.*, Slip Opinion No. 2019-Ohio-4196.

Q. PLEASE DESCRIBE THE LOST DISTRIBUTION REVENUE RECOVERY ELEMENT CONTAINED IN THE CALCULATION OF RIDER EE-PDR.

A. The calculation of Rider EE-PDR includes the recovery of lost distribution revenue for customers billed under schedules Rate DP, Rate DS, and Rate TS. Unlike all other customers being billed under Rider EE-PDR, the customers under these three rate schedules were excluded from the distribution revenue decoupling pilot being recovered through Rider DDR. To eliminate the disincentive created by the under-recovery of fixed costs from the customers who are not served under the decoupling pilot, the Commission's order in Case No. 11-5905-EL-RDR authorized the Company to collect thirty-six months of lost distribution margins associated with the impacts of its energy efficiency programs for these customers.

Q. DID THE COMMISSION'S ORDER INCLUDE A PROVISION FOR RECEIVING CARRYING COSTS FOR OVER- OR UNDER-COLLECTION OF LOST MARGINS?

A. No. Any over- or under-collection of lost margins is to be determined without including carrying costs.

III. OVERVIEW OF PORTFOLIO PERFORMANCE

Q. WHAT ENERGY EFFICIENCY AND DEMAND RESPONSE PROGRAMS WERE ULTIMATELY OFFERED TO DUKE ENERGY OHIO CUSTOMERS UNDER RIDER EE-PDR IN 2019?

A. The portfolio of programs approved for inclusion in Rider EE-PDR included the following programs:

- Residential Energy Assessments

- Smart $aver® Residential
- Low Income Services
- Energy Efficiency Education Program for Schools
- Power Manager for Residential Customers
- My Home Energy Report
- Smart $aver® Prescriptive
- Smart $aver® Custom
- PowerShare® for Nonresidential Customers
- Power Manager® for Business
- Low Income Neighborhood Program
- Low Income Pay for Performance
- Small Business Energy Saver

Q. HAS DUKE ENERGY OHIO UPDATED ANY OF ITS PROGRAMS TO BE OFFERED TO CUSTOMERS IN 2019?

A. No. The 2019 portfolio is consistent with the programs offered in 2018.

Q. DID DUKE ENERGY OHIO OFFER ANY OTHER PROGRAMS DURING 2019 THAT WERE NOT INCLUDED IN CASE NO. 16-576-EL-POR?

A. Yes. Consistent with Rule 4901:1-39-05(G) O.A.C.,[10] and the Commission's Opinion and Order in Case No. 10-834-EL-POR, Duke Energy Ohio has offered eligible customers the opportunity to participate in the Ohio Mercantile Self-Direct Rebate Program.

[10] This reference is to Rule 4901:1-39-05(G), as in effect during the entirety of 2019. Chapter 4901:1-39 was recently amended on March 26, 2020.

Q. DID DUKE ENERGY OHIO PARTICIPATE IN THE PJM INTERCONNECTION, INC. BASE RESIDUAL AUCTION?

A. Yes. All eligible[11] and cost effective[12], PJM approved MW resources were bid into the 2021/2022 Base Residual Auction (BRA). This resulted in 42.3 MWs from energy efficiency and 45.9 MWs from DR resulting in 88.2 MWs clearing in the 2021/2022 auction. When the clearing MW revenue is collected, it will be allocated back to programs after all administrative and EM&V costs are covered. Revenue offset is allocated back to the program based on percentage of MWs clearing each auction and customer class and the net offset will be shared with the Company at its approved shared savings percentage as applicable. Due to the FERC ruling delaying the auctions, Duke Energy Ohio has not participated in an auction beyond the 2021/2022 Base Residual Auction.

Duke Energy Ohio kept the Duke Energy Community Partnership (the Collaborative) updated throughout 2019 regarding the auction process.

Q. HAS DUKE ENERGY OHIO BEEN SUCCESSFUL IN MEETING ITS TARGETED MANDATES FOR ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION?

A. Duke Energy Ohio successfully met the 2019 statutory mandates for energy efficiency and peak demand of 1,913,252 MWh and its peak reduction mandate of 371.0 MW.

[11] "Eligible" is defined as existing and planned energy efficiency savings and demand response that comply with PJM Manuals 18 and 18b.

[12] "Cost effective" is defined as the projected auction revenues that are greater than the projected costs for existing and planned energy efficiency and demand response, where the phrase "projected auction revenues" is defined as the estimated kW multiplied by the previous BRA clearing price for the Duke Energy Ohio zone and "projected costs" are defined as the costs necessary to fully qualify and bid the resources into the PJM capacity auctions.

Q. WHAT PROGRAMS WERE THE PRIMARY CONTRIBUTORS TO THE COMPANY'S SUCCESS DURING 2019?

A. While the Company is pleased with the performance of its overall portfolio of programs that were deemed cost effective by the total resource cost test, the Smart Saver® Programs: Smart Saver® for Residential Customers and Smart Saver® Prescriptive and Custom for Nonresidential Customers continue to dominate the portfolio. Together these programs accounted for over 196,000 MWh, 62%, of the total impacts recognized in 2019. These programs continue to flourish in large part due to the attractiveness and expansion of LED lighting options available to both Residential and Non-Residential Customers.

Q. IS DUKE ENERGY OHIO'S ACHIEVEMENT LEVEL VERSUS ITS BENCHMARKS THE SAME ACHIEVEMENT THAT THE COMPANY IS USING TO CALCULATE ITS PERFORMANCE FOR THE PURPOSES OF CALCULATING ITS EARNED INCENTIVE LEVEL FOR 2019?

A. Yes, the Company's achievement level for benchmark achievement is the same as the achievement level to earn incentive.

Q. PLEASE DESCRIBE HOW THE COMPANY'S MERCANTILE SELF-DIRECT REBATE PROGRAM HAS BEEN FACTORED INTO THE CALCULATION OF RIDER EE-PDR.

A. While the impacts and associated net benefits from the Mercantile Self-Direct Rebate Program have been excluded from the calculation of the Company's shared savings incentive, the program costs associated with Mercantile Self-Direct Rebate Program are included for recovery in the calculation of Rider EE-PDR.

Q. HAS THE COMPANY INCLUDED ANY COSTS OR IMPACTS FROM TRANSMISSION AND DISTRIBUTION INVESTMENTS THAT REDUCE LINE LOSSES IN THE CALCULATION OF ITS SHARED SAVINGS INCENTIVE IN RIDER EE-PDR?

A. No, the Company has not counted any of the net benefits associated with the impacts from investments in transmission and distribution systems that reduce line losses in the calculation of its shared savings incentive.

Q. HAS THE COMPANY COMPLIED WITH ALL THE DIRECTIVES FROM THE COMMISSION IN ITS 2017 OPINION AND ORDER AND ITS 2020 FINDING AND ORDER IN THE 16-0576-EL-POR CASE?

A. Yes, except insofar as the cost cap directive has been effectively abrogated by the decision of the Ohio Supreme Court in *Ohio Edison*. Otherwise, Duke Energy Ohio has complied with the directives set forth in the 2017 Opinion and Order. For example, the Commission directed the Company to continue to work with its Collaborative and to file specific information in its status reports. The Company has held Collaborative meetings, with significant participation on 03/20/19, 06/13/19, 08/29/19, and 12/04/19.

Additionally, the Company has filed full and complete status reports in Case Nos. 10-0317-EL-EEC, 11-1311-EL-EEC, 12-1477-EL-EEC, 13-1129-EL-EEC and 14-456-EL-EEC, 15-454-EL-EEC, 16-0513-EL-EEC, 17-689-EL-EEC, 18-396-EL-EEC, 19-621-EL-EEC and 20-612-EL-EEC[13]. Finally, the Company is

[13] To be filed by May 15, 2020

filing this true-up in accordance with the 2017 Opinion and Order, the Ohio Supreme Court decision in *Ohio Edison*, and the 2020 Finding and Order.

As additional directives from the 2020 Finding and Order come due, the Company intends to comply and is already making preparations to do so.

IV. OVERVIEW OF EVALUATION, MEASUREMENT, AND VERIFICATION

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY ON EVALUATION, MEASUREMENT AND VERIFICATION (EM&V)?

A. This section of my testimony (1) provides an overview of the programs on which Evaluation, Measurement and Verification (EM&V) activities were performed in 2019, (2) provides the current findings from the Company's EM&V work, and (3) demonstrates how the results from the EM&V process will be used in the true-up.

Q. WHICH PROGRAMS RECEIVED EVALUATION, MEASUREMENT & VERIFICATION IN 2019?

A. The table below provides the detailed, completed EM&V reports for 2019:

Attachment	Program	Evaluation Type	Report Date
1	Power Manager®	Process and Impact	May 2019
2	PowerShare®	Process and Impact	August 2019
3	Multifamily Energy Efficiency Evaluation Report	Process and Impact	December 2019

Additionally, the Company will provide the reports presented here as Appendices C - E as appendices in its annual energy efficiency status report, Case No. 20-612-EL-EEC, to be filed later this year.[14]

Q. HAS THE COMPANY ADOPTED ANY OF THE IMPACT COUNTING PROVISION ESTABLISHED IN S.B. 310?

A. Yes, the Company is operating under the impact counting provisions established by S.B. 310.

Q. HOW WERE THE EVALUATION, MEASUREMENT, AND VERIFICATION RESULTS UTILIZED IN DEVELOPING ESTIMATES OR TRUE-UPS FOR THE EE RIDER?

A. The original projection of program cost-effectiveness utilized projected numbers for participants in the programs and estimates of the load impacts per participant, derived either from initial estimates, previous EM&V results or deemed savings as established by S.B. 310. The Company has measured actual participation and uses this actual participation information as the basis for annual true-ups of estimated incentives for the rider by multiplying the actual participation by the current estimates of load impact per participant.

For those programs on which EM&V has been performed since the filing, the higher of the evaluated estimates of energy efficiency and/or peak demand impacts and net-to-gross ratio or the deemed[15] values are applied prospectively to adjust subsequent impact assumptions until superseded by new EM&V results, if

[14] The EM&V reports were prepared before H.B. 6 took effect and may occasionally refer to Ohio statutory provisions that have since changed. This does not affect the substance of the reports' EM&V analysis.
[15] *See* R.C. 4928.662(B).

any. The evaluated impacts identified in the EM&V report for a program, if found to be higher than the deemed savings, are applied to the rider in the month[16] following the completion of the EM&V report. When applicable, these results will also be used to estimate future target achievement levels for development of estimated incentives and in future cost-effectiveness evaluations[17].

Q. WHAT DATA WERE USED IN THE CALCULATION OF THE REVENUE REQUIREMENT PROVIDED BY DUKE ENERGY OHIO WITNESS JAMES E. ZIOLKOWSKI?

A. The revenue requirement was calculated using both data inputs and outputs from the DSMore™ model, including initial estimates or estimated energy savings, program costs and avoided costs. In addition, the costs of the independent measurement and verification activities, which are not used as an input to the DSMore™ model, are also included in the calculation of revenue requirements.

Q. WERE ATTACHMENTS 1 – 3 PREPARED BY YOU OR AT YOUR DIRECTION?

A. The EM&V reports were prepared by Nexant (Attachment 1) and Navigant (Attachments 2 and 3), all of which are Duke Energy Ohio's independent third-party evaluators.

[16] Impacts for demand response programs are applied at the beginning of the next program cycle.
[17] For demand response programs, the contracted amounts of kW reduction capability from participants are considered to be components of actual participation.

V. CONCLUSION

Q. PLEASE DESCRIBE THE COMPANY'S OVERALL ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PORTFOLIO PERFORMANCE IN 2019.

A. Duke Energy Ohio's portfolio of programs continued to perform exceptionally well in 2019 and delivered cost effective energy savings that exceeded the projected impacts included in Case No. 19-622-EL-RDR by over 12%. That success has allowed customers that participated in its programs to take control of their energy usage and realize significant bill savings, as well as allowing all Duke Energy Ohio customers to realize the benefits of millions of dollars of avoided system costs. In fact, the net present value of the system avoided costs associated with the 2019 energy and capacity achievements from its portfolio of programs is over five times the program cost incurred to achieve the impacts.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

REPORT

Nexant
Reimagine tomorrow.

Duke Ohio 2018 Power Manager Evaluation

May 23, 2019

Eric Bell, Principal
Greg Sidorov, Consultant

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1 Executive Summary

This report presents the results of the 2018 Power Manager impact evaluation for the Duke Energy Ohio territory. Power Manager is a voluntary demand response program that offers incentives to residential customers who allow Duke Energy to reduce the use of their central air conditioner's outdoor compressor and fan during summer days with high energy usage. Through the program, events are called at times when extreme temperatures are expected and household cooling needs are highest. During normal events, a remote signal is sent to participating load control devices that reduce customers' air conditioner use. During emergency operations, all devices are initiated to instantaneously shed loads and deliver larger demand reductions.

1.1 Impact Evaluation Key Findings

The impact evaluation is based on a randomized control trial. All Power Manager program participants who had a load control device installed by the start of the summer were randomly assigned to one of six groups – a primary group made up of 75% of the population, and five research groups, each made up of 5% of the population. During each event, one or more of the smaller research groups (each comprising approximately 2,100 customers) is withheld as a control group in order to provide an estimate of energy load profiles absent a Power Manager event. During the summer of 2018, approximately 43,000 households were actively participating in Power Manager and had load control devices. Of those enrolled in the program, Nexant received useable AMI data for approximately 38,000 customers.

Table 1-1 summarizes the demand reductions attained during each event in 2018 (excluding the PJM test event called on September 6), as estimated using the randomized control trial.[1] Events shown in red and green text indicate emergency shed operations. The events called on August 28 and September 5 included side-by-side tests of emergency and normal operations in order to estimate the incremental demand reductions due to emergency operations. Moreover, both of these events included simultaneous dispatch of two different levels of emergency shed, allowing for a three-way comparison of normal operations, Emergency 1 shed and Emergency 2 shed.

A few key findings are worth highlighting:

- Demand reductions were 0.81 kW per household for the average general population event.
- Emergency shed test events produced load impacts that varied depending on shed percentages and weather factors, ranging from 0.81 kW to 1.21 kW with an average of 0.98 kW.
- In general, the magnitude of demand reductions grows larger when temperatures are higher and resources are needed most.
- The difference in impacts between customers who signed up for the moderate and high load control options was minimal and within the range of uncertainty.

[1] By design, the PJM test event did not involve withholding a control group and therefore, a RCT design could not be applied. Impacts for the PJM test event were estimated using a within-subjects approach and are summarized in Section 5.

- Average customer load shapes during event days indicate that Power Manager events were called prior to the residential system peak.[2]

Table 1-1: Randomized Control Trial Demand Reductions for Individual Events[3]

Event Date	Event Type	Start Time	End Time	Load without DR	Impact	Std. error	90% Confidence Interval		% Impact	90% Confidence interval		Daily Max
							Lower bound	Upper bound		Lower Bound	Upper Bound	
6/18/2018	Emergency 2	4:00 PM	5:00 PM	3.67	-1.21	0.07	-1.32	-1.09	-33.0%	-36.1%	-29.8%	94
6/18/2018	Regular	5:00 PM	6:00 PM	3.81	-0.98	0.07	-1.10	-0.87	-25.9%	-29.0%	-22.8%	94
6/19/2018	Regular	3:00 PM	5:00 PM	3.39	-0.91	0.07	-1.02	-0.80	-26.9%	-30.1%	-23.6%	93
6/29/2018	Regular	3:00 PM	5:00 PM	3.32	-0.75	0.08	-0.87	-0.62	-22.6%	-26.4%	-18.9%	91
7/2/2018	Regular	3:00 PM	5:00 PM	2.82	-0.46	0.07	-0.58	-0.35	-16.5%	-20.5%	-12.5%	92
7/5/2018	Regular	4:00 PM	6:00 PM	3.53	-0.79	0.07	-0.90	-0.68	-22.5%	-25.6%	-19.3%	93
8/28/2018	Emergency 1	4:00 PM	5:00 PM	3.44	-0.95	0.09	-1.10	-0.81	-27.5%	-31.9%	-23.1%	91
8/28/2018	Emergency 2	4:00 PM	5:00 PM	3.44	-1.10	0.08	-1.24	-0.96	-32.1%	-36.3%	-28.0%	91
8/28/2018	Regular	4:00 PM	6:00 PM	3.53	-0.95	0.07	-1.06	-0.84	-27.1%	-30.2%	-24.0%	91
9/5/2018	Emergency 1	5:00 PM	6:00 PM	3.06	-0.83	0.09	-0.97	-0.69	-27.1%	-31.7%	-22.5%	91
9/5/2018	Emergency 2	5:00 PM	6:00 PM	3.06	-0.81	0.09	-0.95	-0.67	-26.4%	-31.1%	-21.8%	91
9/5/2018	Regular	4:00 PM	6:00 PM	3.08	-0.72	0.07	-0.83	-0.61	-23.4%	-27.0%	-19.9%	91
9/20/2018	Regular	4:00 PM	6:00 PM	3.35	-0.88	0.07	-0.99	-0.77	-26.4%	-29.7%	-23.2%	90
Average General Population Event				**3.33**	**-0.81**	**0.07**	**-0.92**	**-0.69**	**-23.9%**	**-27.3%**	**-20.5%**	91.9

1.2 Time-Temperature Matrix and Demand Reduction Capability

A key objective of the 2018 impact evaluation was to quantify the relationship between demand reductions, temperature, hour of day, and cycling strategy. This was accomplished by estimating loads under historical weather conditions and applying observed percent load reductions from the 2018 events. The resulting tool, referred to as the time-temperature matrix, allows users to predict the program's load reduction capability under a wide range of temperature and event conditions.

In an ideal program year, a large number of events would be called under a variety of different weather conditions, dispatch windows and cycling strategies so that demand reduction capability could be estimated for a wide range of operating and planning scenarios. In actuality, opportunities for program events can be sporadic, and based on uncertain weather projections, such that they occur infrequently and under fairly similar conditions. In 2018, a total of eight events were called, all of which occurred between 3:00 p.m. and 6:00 p.m. and covered either a 1-hour or 2-hour period. Moreover, all events occurred under similar weather conditions, with daily maximum temperatures ranging from 90°F to 94°F.

[2] Leveraging data from the 2018 DEO Market Potential Study, Nexant determined that events were, in fact, called during the full DEO system peak (including both residential and commercial classes).

[3] Emergency 1 operations noted with red text; Emergency 2 operations noted with green text.

Figure 1-1: Demand Reduction Capability – Emergency 1 Dispatch with 94°F Maximum Temperature

Inputs	
Dispatch Type	Emergency 1 Dispatch
Option	Overall
Event Start	4 PM
Event Duration (Hours)	1
Daily Max Temp (°F)	94
# Customers	42,872

Event Window Average Impacts		
Load without DR	3.64	kW per customer
Load with DR	2.38	kW per customer
Impact per customer	-1.27	kW per customer
Impact (MW)	-54.38	MW
% Impact	-34.8	%

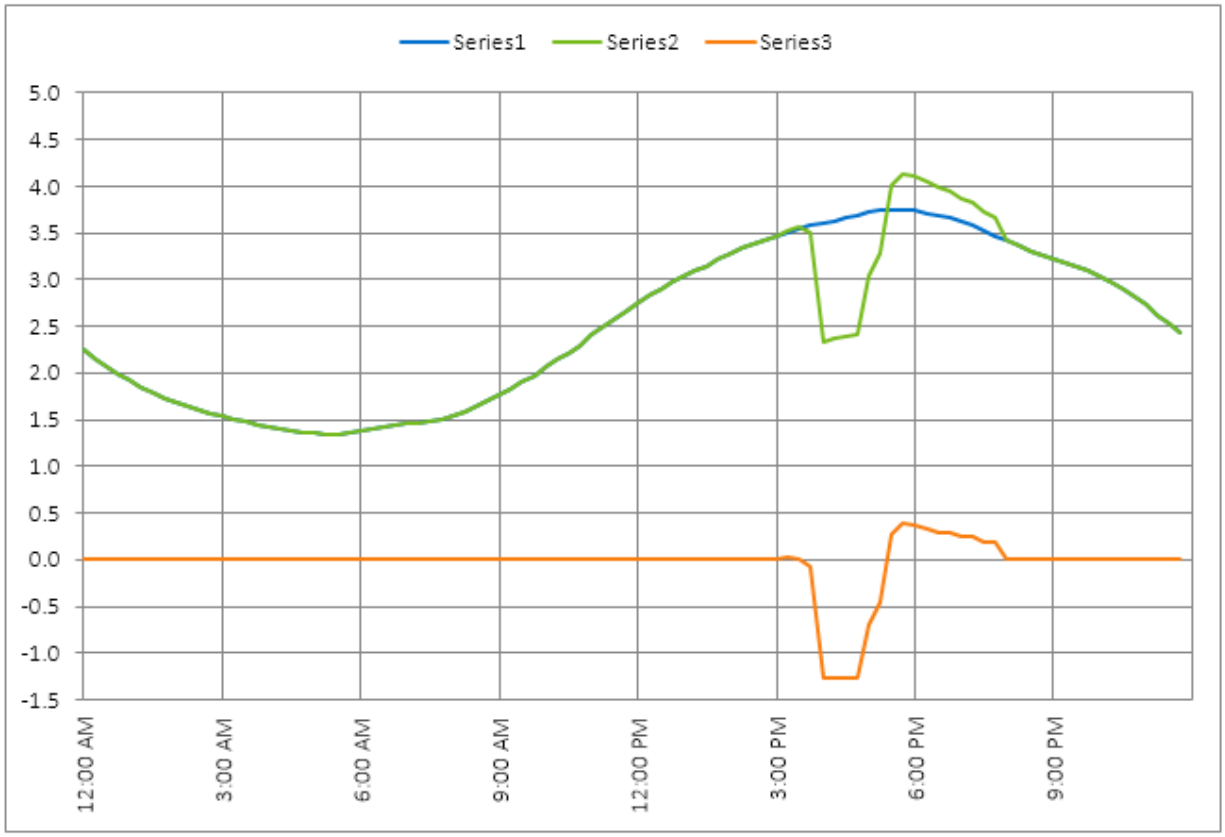


Figure 1-1 shows the demand reduction capability of the program if emergency shed becomes necessary on a day with a maximum temperature of 94°F for a 1-hour event duration. Individual customers are expected to deliver 1.27 kW of demand reduction. Because there are approximately 43,000 devices, the expected aggregate system load reduction is 54.4 MW.

2 Introduction

This report presents the results the 2018 Power Manager impact evaluation for the Duke Energy Ohio (DEO) territory. Power Manager is a voluntary demand response program that provides incentives to residential customers who allow Duke Energy to reduce the use of their central air conditioner's outdoor compressor and fan on summer days with high energy usage.

Because Duke Energy has full deployment of smart meters in DEO territory, and has access to Power Manager customers' interval data, the impact evaluation is based on a randomized control trial that randomly assigned customers to six different groups. During each event, at least one of the groups is withheld to serve as a control group and provide an estimate of customer's energy profiles absent a Power Manager event. The randomized control trial approach was applied during normal Power Manager operations, as well as during specific test events designed to address key research questions.

In addition to estimating load impacts during 2018 events, this study enables the estimation of the program's demand reduction capability under a range of weather and dispatch conditions. Average customer load reductions were calculated as a function of event type, control option, event start time, event duration, and maximum daily temperature.

2.1 Key Research Questions

The study data collection and analysis activities were designed to address the following impact evaluation research questions:

- What demand reductions were achieved during each event called in 2018?
- Did impacts vary for customers who enrolled in the moderate vs. high load control options?
- Do impacts vary based on the hour(s) of dispatch and/or weather conditions?
- What is the magnitude of the program's aggregate load reduction capability during extreme conditions?
- In general, were events called during the optimal time-of-day, i.e. during the system's peak demand period?

2.2 Program Description

Power Manager is a voluntary demand response program that provides incentives to residential customers who allow Duke Energy to reduce their central air conditioner's outdoor compressor and fans on summer days with high energy usage. All Power Manager participants have a load cycling switch device installed on at least one outdoor unit of qualifying air conditioners. The device enables the customer's air conditioner to be cycled off and on to reduce load when a Power Manager event is called. Duke Energy initiates events by sending a signal to participating devices through a corporate paging network, which instructs the switch devices to cycle the air conditioning system on and off, reducing the run time of the unit during events.

The program participates in the energy and capacity markets of the PJM market, but Duke Energy generally limits participation in the energy markets to days when the wholesale price exceeds $65/MWh.

Duke Energy regularly bids Power Manager into the capacity market, which means that the program must be available for PJM emergency events. Absent a PJM emergency, Duke Energy's operations team schedules and calls events for local emergency, economic, or testing reasons.

Power Manager events typically occur between May and September in DEO territory, but are not limited to these months. Participants receive financial incentives for their participation based on the amount of load control they experience during an event. Upon program enrollment, Power Manager customers select either moderate or high load control. Approximately 84% of Power Manager devices in DEO are enrolled in the moderate load control option and the remaining 16% are enrolled in the high load control option.[4] The payments received by participants include a one-time installation credit – $25 for moderate load control and $35 for high load control – plus bill credits for cycling events. The minimum bill credit for 2018 participation was $12 for customers enrolled in the moderate option and $18 for customers enrolled in the high option.

In DEO territory, Duke Energy uses a cycling algorithm known as *true cycle*. The algorithm uses learning days to estimate air conditioners' run time (or duty cycle) as a function of hour of day and temperature at each specific site, and aims to curtail load demand by a specified amount. In general, Power Manager events fall into three categories: economic events during which customers are cycled at 60% and 75% for moderate and high control customers, respectively; Emergency 1 events during which both moderate and high customers are cycled at 75%; and Emergency 2 events during which moderate and high customers are cycled at 66% and 75%, respectively. For purposes of program capability reporting, Emergency 1 shed is used. Table 2-1 shows the device cycling levels for each event type and control option.

Table 2-1: DEO Regular and Emergency Level Shed Options

Event Type	Low Option	Moderate Option	High Option
Regular Shed	25%	60%	75%
Emergency 1 Shed	66%	75%	75%
Emergency 2 Shed	66%	66%	75%
PJM Test Event	100%	100%	100%

In 2018, Duke Energy introduced two separate levels of emergency dispatch, each with different load control intensities. Emergency 1 dispatch involves 75% cycling for both high and moderate control customers, while Emergency 2 dispatch involves 75% and 66% cycling for high and moderate customers, respectively.

[4] Customers who ask to be removed from the program are offered a low load control option to minimize attrition. Approximately 0.1% of devices are enrolled in the low load control option.

2.3 Participant Characteristics

Duke Energy serves approximately 660,000 residential customers in DEO service territory, located in the southern portion of Ohio and centered in the Cincinnati area. By the start of summer 2018, over 45,000 devices were part of Power Manager.[5] Of those units, 16% enrolled in the high load control option. On average, participating customers enrolled 1.06 air conditioner units per account.

Table 2-2: Customer Count by Control Option

Control Option	Customer Count	Percent
Low	54	0.1%
Moderate	35,858	83.7%
High	6,952	16.2%
Total	**42,864**	**100%**

To enroll in Power Manager, customers must own a single-family home located in DEO service territory and have a functional central air conditioning unit with an outdoor compressor. According to a residential appliance saturation survey implemented by Duke Energy in 2016, approximately 54.7% of customers meet the eligibility criteria.[6] As of summer 2017, DEO has enrolled approximately 10.9% of eligible customers. Figure 2-1 depicts program enrollment over time.

[5] Slightly more than 43,000 accounts were enrolled in the program, totaling approximately 45,000 air conditioner units.

[6] 77.3% of residential customer in the territory own single family homes and, of those, 82.7% have central air conditioners. The estimate does not include heat pumps.

Figure 2-1: Power Manager Participation Over Time

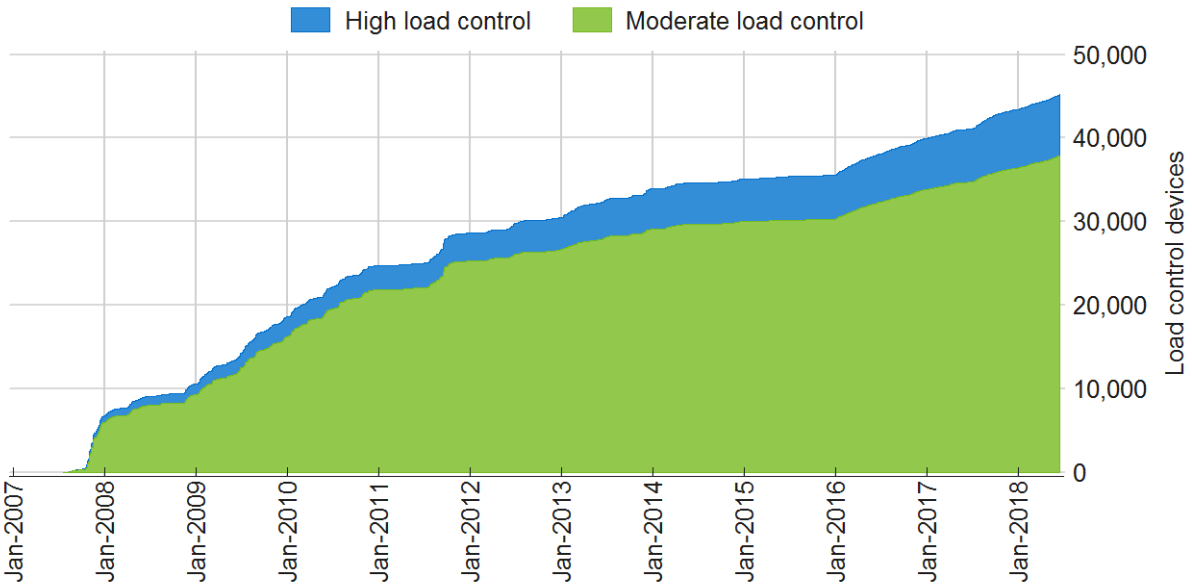


Figure 2-2 shows the distribution of peak household demand during the 4pm to 6pm period on hot, non-event days. Household loads varied substantially, reflecting different occupancy schedules, comfort preferences, and thermostat settings.[7] Roughly 50% of loads exceeded 3.5 kW. As with any program, some enrollees use little or no air conditioning during late afternoon hours on hotter days. These customers are, in essence, free riders. The bulk of the costs for recruitment, equipment, and installation have already been sunk for these customers and, as a result, removing these customers may not improve cost effectiveness substantially. However, given the availability of smart meter data, we recommend assessing nonparticipant afternoon loads on hotter days prior to marketing in order to target customers who are cost effective to enroll.

[7] It is assumed that household-level demand on these days is predominantly due to AC use; however, other factors could contribute to the varying customer loads.

Figure 2-2: Distribution of Peak Period Loads

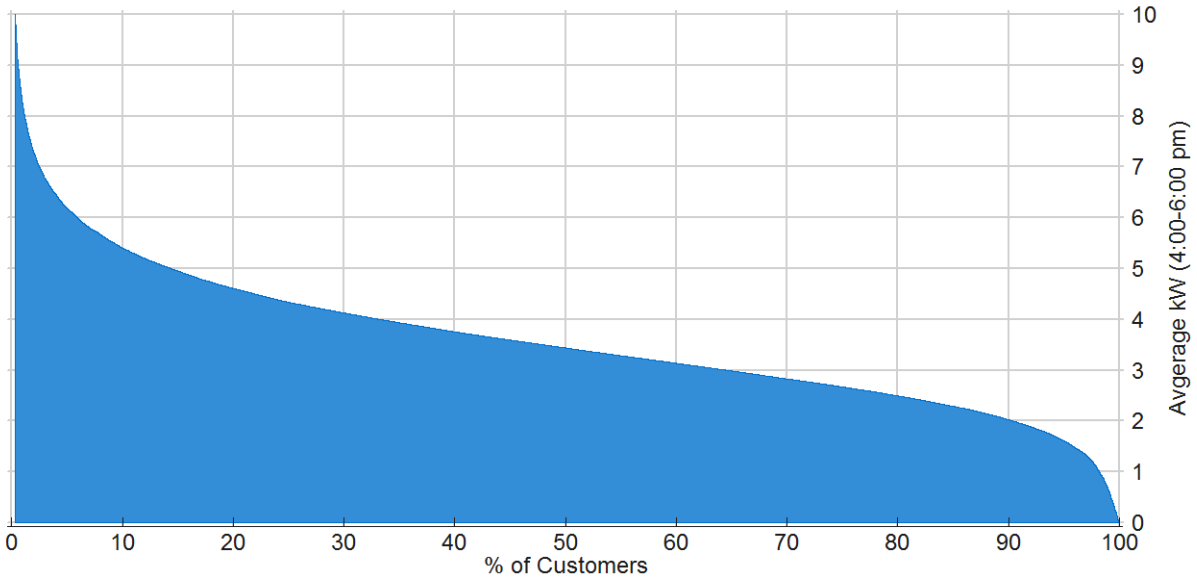
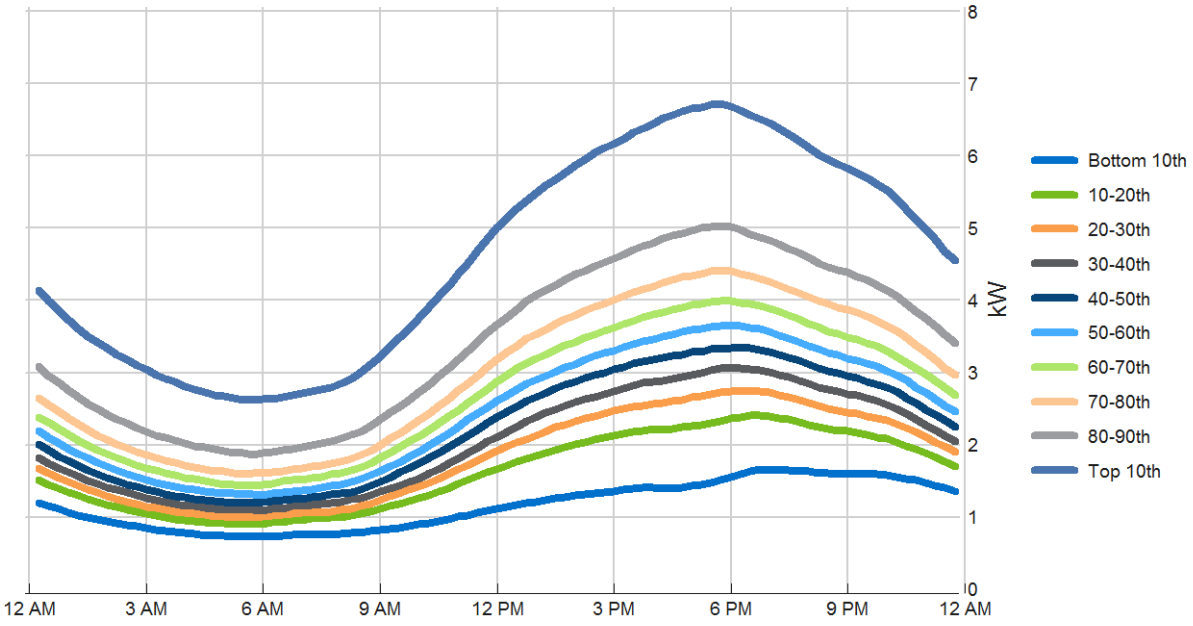


Figure 2-3 provides additional detail and shows the hourly household loads for different customer groups. The customers were classified into ten equally sized groups, known as deciles, based on their household consumption during hot, non-event days. Each line represents the hourly loads for the average customer in each decile.

Figure 2-3: Household Loads by Size Decile



2.4 2018 Event Characteristics

Duke Energy dispatched Power Manager events nine times in 2018. All general population events occurred either between 4:00 and 6:00pm or 3:00 and 5:00pm. Emergency events were dispatched three times, each occurring during a general population event window. This side-by-side dispatch framework allowed for direct comparison of emergency event performance compared to general dispatch. Table 2-3 summarizes 2018 event conditions.

Table 2-3: 2018 Event Operations and Characteristics

Event Date	Start Time	End Time	Type of Event	Customers Dispatched	Control Group	Daily Max Temp	Notes
6/18/2018	4:00 PM	5:00 PM	Research	34,485	1,840	94°F	Group 1 held back
	5:00 PM	6:00 PM	GP Event	34,485	1,840		
6/19/2018	3:00 PM	5:00 PM	GP Event	34,530	1,822	93°F	Group 4 held back
6/29/2018	3:00 PM	5:00 PM	GP Event	34,702	1,837	91°F	Group 2 held back
7/2/2018	3:00 PM	5:00 PM	GP Event	34,797	1,768	92°F	Group 3 held back
7/5/2018	4:00 PM	6:00 PM	GP Event	34,798	1,809	93°F	Group 5 held back
8/28/2018	4:00 PM	6:00 PM	GP Event	32,156	1,874	91°F	Groups 2, 3, and 4 held back
	4:00 PM	5:00 PM	Research	3,728	1,874		Groups 2 and 3 dispatched
9/5/2018	4:00 PM	6:00 PM	GP Event	32,216	1,876	91°F	Groups 1, 4, and 5 held back
	5:00 PM	6:00 PM	Research	3,791	1,876		Groups 1 and 4 dispatched
9/6/2018	4:00 PM	5:00 PM	PJM Test	37,892	-	91°F	No control group
9/20/2018	4:00 PM	6:00 PM	GP Event	36,121	1,917	90°F	Group 1 held back

Duke Energy overlaid three research experiments alongside general population events on June 18, August 28, and September 5. On June 18, Duke Energy implemented a two-stage event, where emergency dispatch was called during the first hour of the event and normal dispatch was called during the second hour of the event. On August 28 and September 5, research groups were dispatched using emergency shed operations side-by-side with a control group and a group that experienced normal operations in order to assess how the magnitude of the emergency shed compares to traditional operations. Both the August 28 and September 5 events included simultaneous Emergency 1 and Emergency 2 level dispatches, in addition to normal dispatch, allowing for a three-way comparison of event strategies.

3 Methodology and Data Sources

This section details the study design, data sources, sample sizes, and analysis protocols for the impact evaluation.

3.1 Randomized Control Trial Design and Analysis

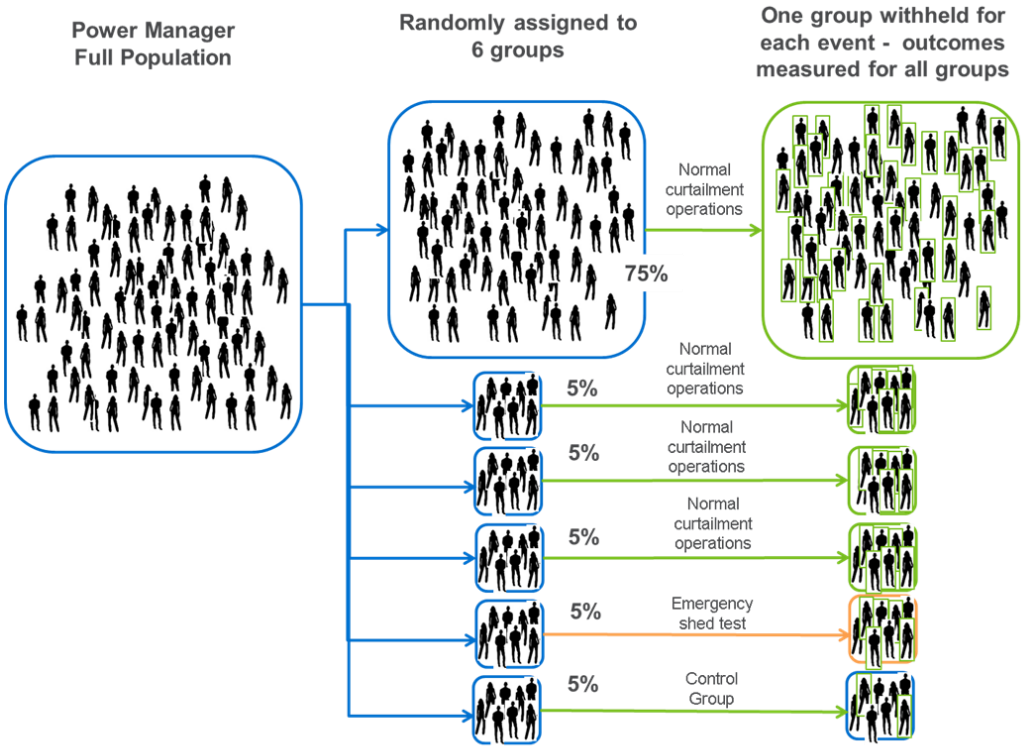
Randomized control trials are well-recognized as the gold standard for obtaining accurate impact estimates and have several advantages over other methods:

- They require fewer assumptions than engineering-based calculations;
- They allow for simpler modeling procedures that are effectively immune to model specification error; and
- They are guaranteed to produce accurate and precise impact estimates, provided proper randomization and large sample sizes.

The RCT design randomly assigns the Power Manager population into six groups – a primary group consisting of 75% of the population and five research groups, each consisting of 5% of the population. For each event, groups are assigned as either treatment or control according to Duke Energy's operational plan.[8] All devices assigned to the treatment group are controlled during the event window, whereas devices assigned to the control group are withheld and continue to operate normally. As a result of random group assignment, the only systematic difference between the treatment and control groups is that one set of customers is curtailed while the other group was not. Figure 3-1 shows the conceptual framework of the random assignment.

[8] The PJM test event called on September 6 dispatched all program participants and therefore, no control group was withheld.

Figure 3-1: Randomized Control Trial Design



All customers who were enrolled in the program and had addressable load control devices installed by the start of the 2018 summer were randomly assigned into six distinct groups using the last two digits of the device serial number.[9] Table 3-1 summarizes the feeder assignment and number of accounts in each group. By design, the primary general population group includes 75% of participants, approximately 32,000 participants. The remaining five research groups each include 5% of participants, or roughly 2,100 customers each.

Table 3-1: Feeder Group Assignment

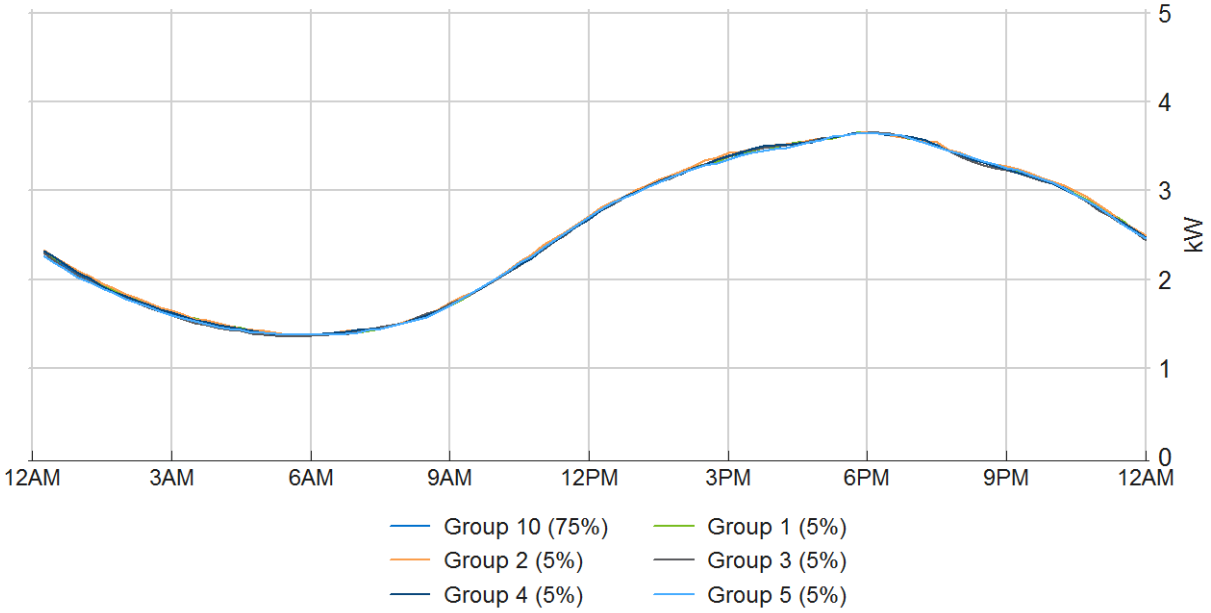
Feeder Group	Last Two Digits of Device Serial Number	Number of Accounts
10	01-75	32,243
1	76-80	2,158
2	81-85	2,144
3	86-90	2,089
4	91-95	2,103
5	96-00	2,135

[9] Some households have multiple load control devices. In these instances the homes were randomly assigned such that all devices in a given home were in the same group.

The purpose of creating six distinctive, randomly assigned groups was twofold. First, it allowed for side-by-side testing of cycling strategies, event start times, or other operational aspects to help optimize the program. Second, it allowed Duke Energy to alternate the group being withheld as control for each event, increasing fairness and helping to avoid exhausting individual customers by dispatching them too often solely for research purposes.

To ensure that random group assignment was properly implemented, average loads for each of the six groups were compared to each other for all non-event days with temperatures reaching 90°F or higher.[10] Figure 3-2 shows average loads for each feeder group on these hottest, non-event days. Feeder loads are nearly identical, which provides strong evidence that the random group assignment effective. It also emphasizes the high degree of precision provided by an effective RCT design for estimating the counterfactual.

Figure 3-2: Average Customer Loads on the Hottest Non-Event Days by Feeder Group



For each event, one of the five smaller research groups was withheld to serve as a control group and establish the electricity load patterns in the absence of curtailment, i.e. the baseline. Within the experimental framework of a RCT, the average usage for control group customers provides an unbiased estimate of what the average usage for treatment customers would have been if an event had not been called. Therefore, estimating event day load impacts requires simply calculating the difference in loads between the treatment and control groups during each interval of the event window, as well as for the hours immediately following the event when snapback can occur. Demand reductions calculated in this way reflect the net impacts and inherently account for offsetting factors, such as device failures, paging

[10] A total of four non-event weekdays reached at least 90°F.

network communication issues, and customers' use of fans to compensate for curtailment of air conditioners.

The standard error, used to calculate the confidence bands, is calculated using the formula shown in Equation 1.

Equation 1: Standard Error Calculation for Randomized Control Trial

$$\boldsymbol{Std.Error\ of\ Difference\ between\ Means_i} = \sqrt{\frac{sd_c^2}{n_c} + \frac{sd_t^2}{n_c}}$$

Where:

- sd = standard deviation
- n = sample size
- t = indicator for treatment group
- c = indicator for control group
- i = individual time intervals

4 Randomized Control Trial Results

One of the primary goals of the impact evaluation is to understand the load impacts associated with the Power Manager program under a variety of temperature and event conditions. General population events were targeted to understand the available load reduction capacity under a variety of temperature conditions during normal operations, while emergency shed events were used to demonstrate the program's capacity for short-duration events under more extreme conditions. In addition, two of the event days were used to dispatch groups of customers under normal operations and emergency shed operations simultaneously, allowing for a side-by-side comparison of impacts under the two scenarios. Section 4.1 presents overall program results for all event days, including general population and emergency shed events. Section 4.2 details the results of the side-by-side comparison of normal operations vs. emergency shed on two event days. Section 4.3 presents impacts by control option (moderate vs. high) for 2018 events.

4.1 Overall Program Results

The load impact estimates resulting from the RCT analysis for the general population events, as well as the research events that occurred side-by-side with normal operation, are presented in Table 4-1. Results for the August 28 and September 5 emergency events are presented separately from the general population events occurring on the same days. Moreover, both of these events included simultaneous dispatch of two different levels of emergency shed, allowing for a three-way comparison of normal operations, Emergency 1 shed and Emergency 2 shed. The load impacts presented for each event, along with their confidence intervals, are the average changes in load during the indicated dispatch windows. Results for the PJM test event, called on September 6, are presented separately in Section 5.

Table 4-1: Randomized Control Trial per Customer Impacts[11]

Event Date	Event Type	Start Time	End Time	Load without DR	Impact	Std. error	90% Confidence Interval		% Impact	90% Confidence interval		Daily Max
							Lower bound	Upper bound		Lower Bound	Upper Bound	
6/18/2018	Emergency 2	4:00 PM	5:00 PM	3.67	-1.21	0.07	-1.32	-1.09	-33.0%	-36.1%	-29.8%	94
6/18/2018	Regular	5:00 PM	6:00 PM	3.81	-0.98	0.07	-1.10	-0.87	-25.9%	-29.0%	-22.8%	94
6/19/2018	Regular	3:00 PM	5:00 PM	3.39	-0.91	0.07	-1.02	-0.80	-26.9%	-30.1%	-23.6%	93
6/29/2018	Regular	3:00 PM	5:00 PM	3.32	-0.75	0.08	-0.87	-0.62	-22.6%	-26.4%	-18.9%	91
7/2/2018	Regular	3:00 PM	5:00 PM	2.82	-0.46	0.07	-0.58	-0.35	-16.5%	-20.5%	-12.5%	92
7/5/2018	Regular	4:00 PM	6:00 PM	3.53	-0.79	0.07	-0.90	-0.68	-22.5%	-25.6%	-19.3%	93
8/28/2018	Emergency 1	4:00 PM	5:00 PM	3.44	-0.95	0.09	-1.10	-0.81	-27.5%	-31.9%	-23.1%	91
8/28/2018	Emergency 2	4:00 PM	5:00 PM	3.44	-1.10	0.08	-1.24	-0.96	-32.1%	-36.3%	-28.0%	91
8/28/2018	Regular	4:00 PM	6:00 PM	3.53	-0.95	0.07	-1.06	-0.84	-27.1%	-30.2%	-24.0%	91
9/5/2018	Emergency 1	5:00 PM	6:00 PM	3.06	-0.83	0.09	-0.97	-0.69	-27.1%	-31.7%	-22.5%	91
9/5/2018	Emergency 2	5:00 PM	6:00 PM	3.06	-0.81	0.09	-0.95	-0.67	-26.4%	-31.1%	-21.8%	91
9/5/2018	Regular	4:00 PM	6:00 PM	3.08	-0.72	0.07	-0.83	-0.61	-23.4%	-27.0%	-19.9%	91
9/20/2018	Regular	4:00 PM	6:00 PM	3.35	-0.88	0.07	-0.99	-0.77	-26.4%	-29.7%	-23.2%	90
Average General Population Event				**3.33**	**-0.81**	**0.07**	**-0.92**	**-0.69**	**-23.9%**	**-27.3%**	**-20.5%**	91.9

[11] Emergency 1 operations noted with red text; Emergency 2 operations noted with green text.

Overall load impacts for the average customer ranged between 0.46 kW and 0.98 kW during normal operations. These impacts are considerably higher than those observed in 2017, which were subject to cooler weather conditions and ranged from 0.24 kW to 0.78 kW. Although the intention was to call events under a range of temperature conditions, the general population event days in 2018 all experienced similar maximum daily temperatures, ranging from 90°F to 94°F.

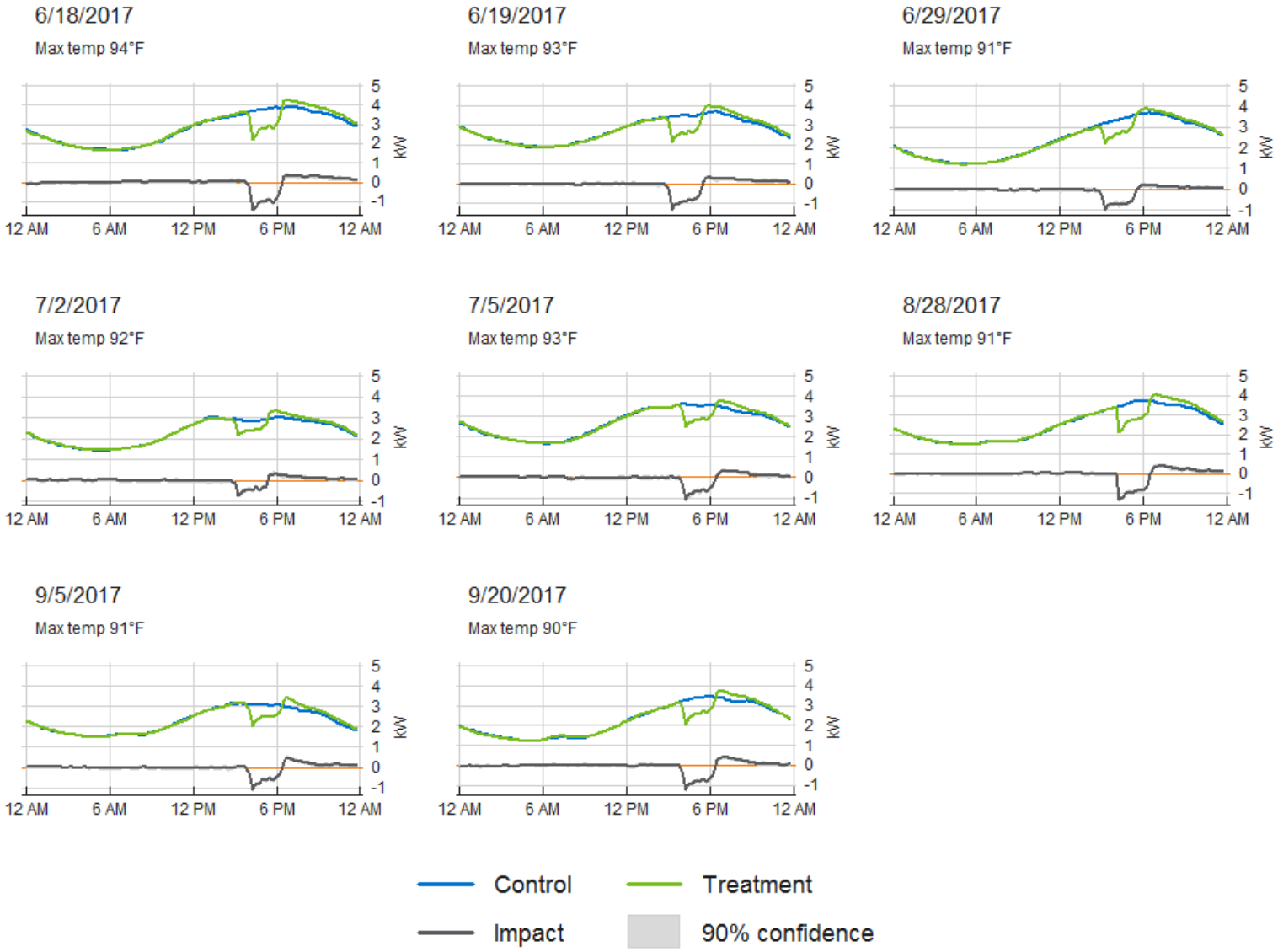
As expected, emergency shed events, on average, produced higher load impacts compared to general population events in 2018. The average load reduction under emergency conditions was 0.98 kW. Emergency 2 impacts were slightly larger than Emergency 1 impacts, on average. The June 18 emergency event – which was called on the hottest event day – produced the highest per customer load impacts of 1.21 kW.

At least 5% of the population was held back as a control group during each event (excluding the PJM test event) in order to establish the baseline. While withholding a control group is an essential component of the RCT research design, it adversely affects the aggregate performance of the program, since customers being withheld do not contribute load reduction to the total impact. Had all program customers been dispatched under normal operation on June 18, the hottest emergency event day, the program would have delivered approximately 38.9 MW. If instead, all customers had been dispatched using emergency operations, reduction would have been 41.5 MW.

The results presented implicitly take device inoperability (and other offsetting factors) into account. Because randomized group assignment was utilized effectively, each of the individual test groups accurately represents the overall percentage of customers with inoperable devices from among the entire population. As such, the estimated load impacts are appropriately de-rated by the non-working devices included in the test groups.

Event impacts are displayed graphically in Figure 4-1, with the average customer load profiles shown for the treatment and control groups. All of the events show a clear drop in treatment group loads during the event dispatch period, as well as a small snapback in energy usage during the hours immediately following the events. Furthermore, most events show an instantaneous and prominent load drop during the first 15-minute interval of the dispatch period, underpinning the immediate, collective response of the load control devices once the event signal is received.

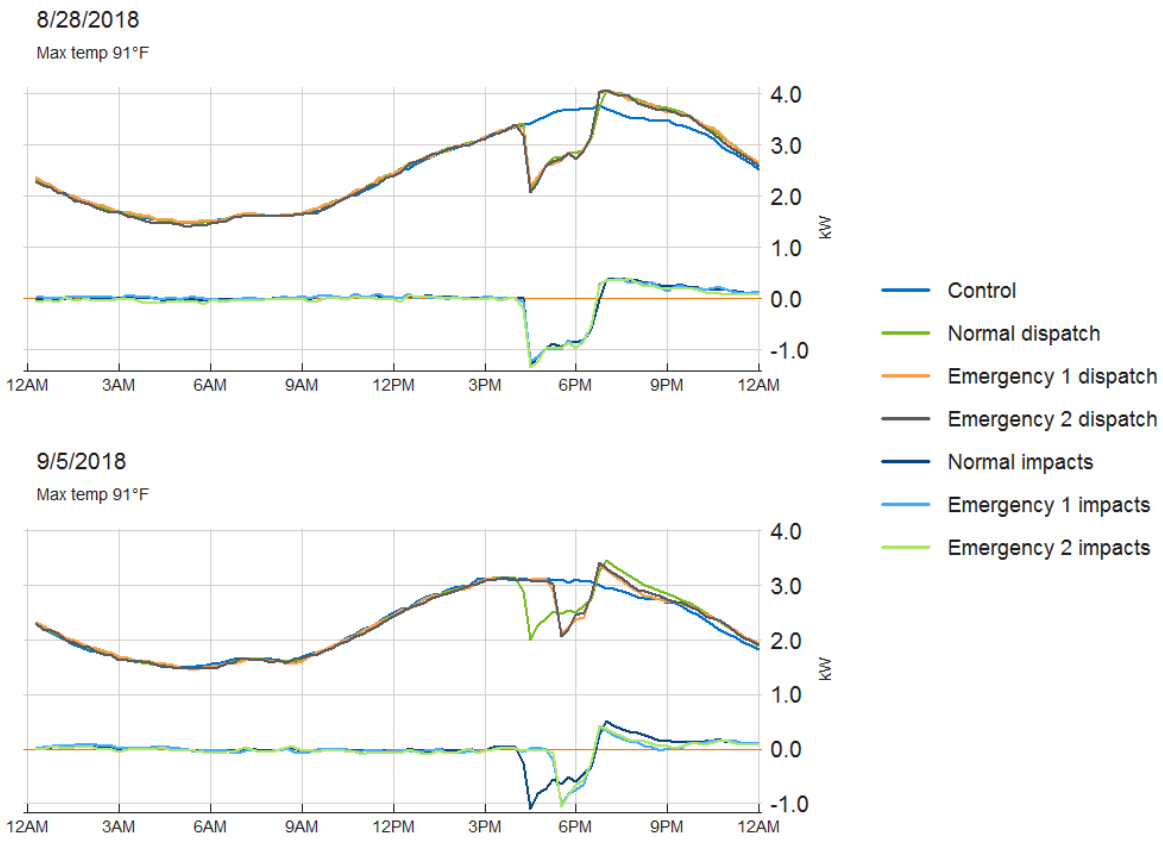
Figure 4-1: Average Customer Loads and Impacts for General Population Event Days



4.2 Side-by-Side Comparison of Normal and Emergency Conditions

Two events called in 2018 allowed for a direct side-by-side comparison of emergency shed to normal event operations. Furthermore, both of these events involved separate dispatches under Emergency 1 and Emergency 2 scenarios, in addition to normal operations, allowing for a three-way comparison of normal operations to both emergency scenarios. Impacts for these events for both normal and emergency operations are presented together in Figure 4-2.

Figure 4-2: Load Profiles for Emergency and Normal Operations on August 28 and September 5



A key takeaway from the side-by-side comparisons is that the customers dispatched under emergency shed options appear to have produced load impacts that are nearly equivalent to the customers dispatched under normal operations on the same day. Nonetheless, emergency operations typically produced slightly larger impacts than normal operations.

On August 28, three distinct groups of customers were dispatched during the same event period (4:00 p.m. to 6:00 p.m.) under different cycling options. Feeder group 2 was released under the Emergency 1 option during the first hour of the event, from 4:00 p.m. to 5:00 p.m., and moved to normal dispatch operations from 5:00 p.m. to 6:00 p.m. Similarly, feeder group 3 was released under Emergency 2 conditions during the first hour, and returned to normal dispatch for the second hour of the event.

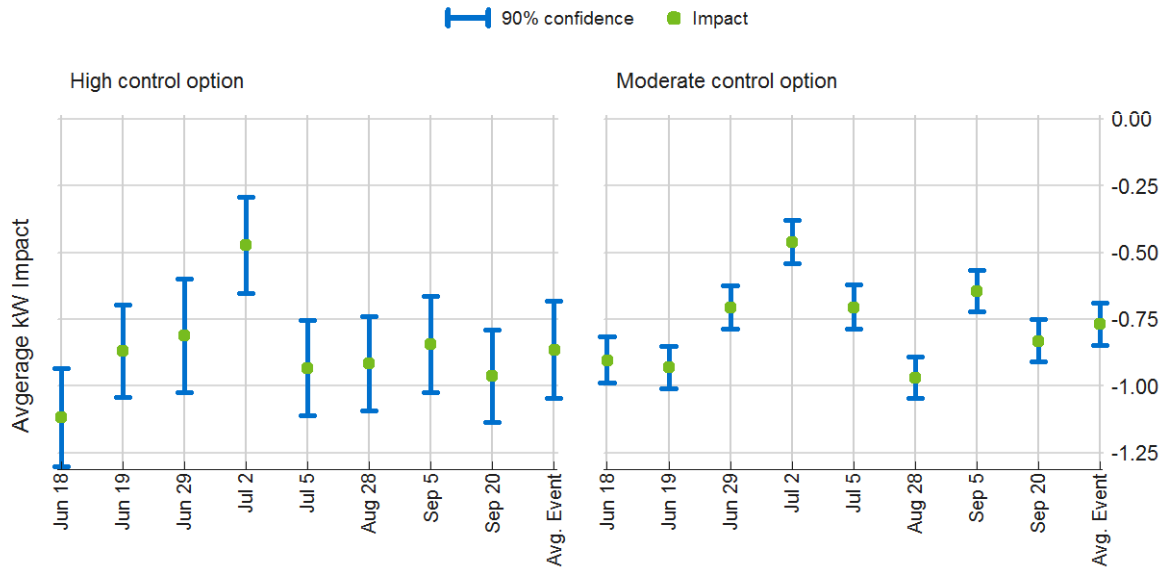
Groups 1, 5 and 10 were all released under normal event conditions for the full two-hour event period, and group 4 was held back as control.

On September 5, feeder groups 3, 4 and 10 were released under normal operations from 4:00 p.m. to 6:00 p.m. Groups 1 and 4 were dispatched separately under Emergency 1 and Emergency 2 conditions, respectively, from 5:00 p.m. to 6:00 p.m. after being withheld during the first hour of the event. Group 5 was held back as the control group for the full event duration.

4.3 Impacts by Load Control Option

Figure 4-33 compares the load impact estimates for customers enrolled in the moderate vs. high load control options, as well as 90% confidence intervals, for each general population event called in 2018. In general, point estimates for load reductions are larger for customers enrolled under the high load control option compared to the moderate control option customers. However, a select few events – specifically June 19 and August 28 – show slightly larger impacts for the moderate option than the high control option. In addition, because there were significantly fewer customers in the high load control option subgroup, the confidence intervals for these point estimates are considerably wider. As a result, any differences in point estimates that do exist are statistically insignificant due to uncertainty. This is also reflected in the average event load impact for each group.

Figure 4-3: Comparison of Load Impact Results by Control Option



4.4 Weather Sensitivity of AC Load and Demand Reductions

Weather sensitivity analysis was not conducted this year due to the uniformity of the temperature conditions seen on event days. The weather sensitivity analysis from the previous evaluation has been placed in Appendix A for reference.

4.5 Key Findings

A few key findings are worth highlighting:

- Demand reductions were 0.81 kW per household for the average general population event.
- Emergency shed events produced load impacts ranging from 0.81 kW to 1.21 kW, with an average of 0.98 kW.
- In general, the magnitude of demand reductions grows larger when temperatures are higher and resources are needed most.
- The difference between impacts between customers enrolled under the moderate and high load control options was minimal and within the range of uncertainty.
- Average customer load profiles during event days indicate that some Power Manager events were called prior to the residential system peak.

5 Within-Subjects Results of PJM Test Event

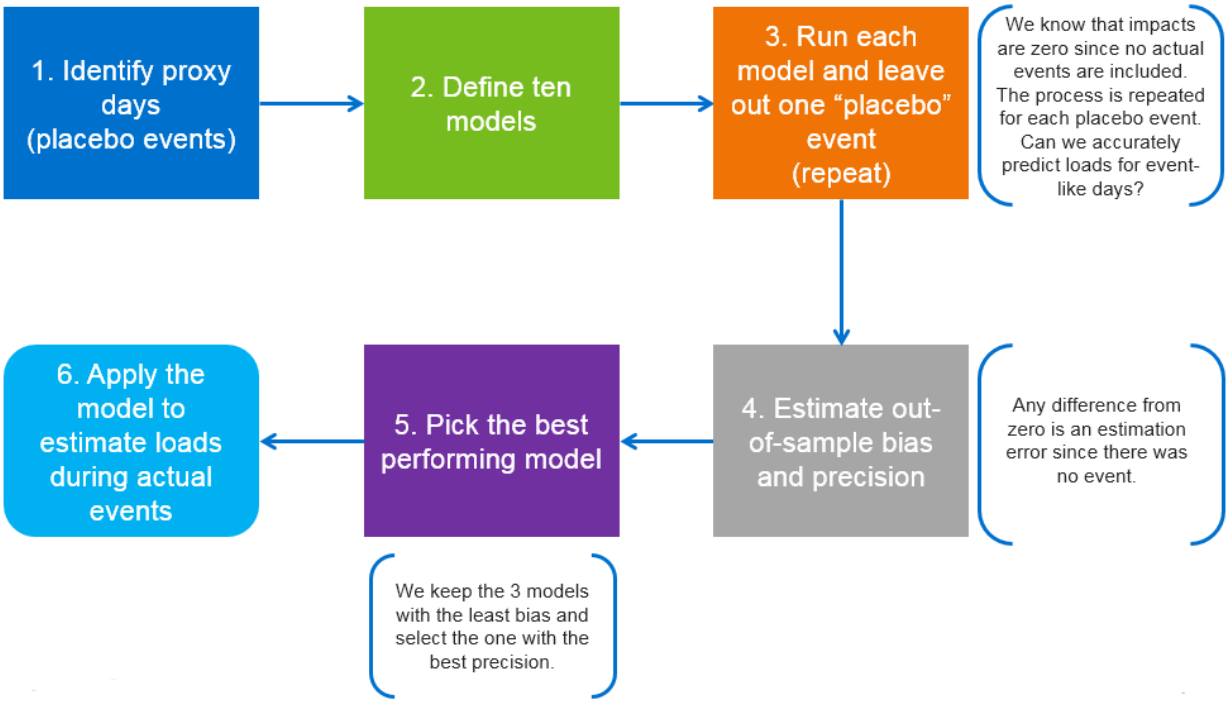
In addition to the regular and emergency shed events described in Section 4, Duke Energy dispatched a PJM test event on September 6. The purpose of the PJM test event was to assess the full extent of program capability for demand reduction under emergency conditions. Under this scenario, the full program population is dispatched for the event and no customers are withheld as a control group. Absent a control group for this event, Nexant employed a within-subjects analysis approach in order to quantify impacts.

5.1 Within-Subjects Analysis Design

In order to quantify impacts of the PJM test event, Nexant modeled the relationship between weather and customer loads on non-event days in order to establish the counterfactual. This approach relies on identifying comparable non-event days and works because the program intervention is introduced on some days, and withheld on other days that could otherwise be considered event-worthy, allowing us to observe load patterns with and without load control.

Using non-event days with similar temperature conditions, regression modeling was applied to estimate the demand reduction as the difference between the predicted baseline loads and the actual event day loads. In order to identify the regression model that best predicts the counterfactual, a rigorous model selection process is applied, whereby ten distinct model specifications were tested and ranked using various accuracy and precision metrics. The best performing model was selected and used to estimate the counterfactual for actual event days. Figure 5-1 summarizes the regression model selection process.

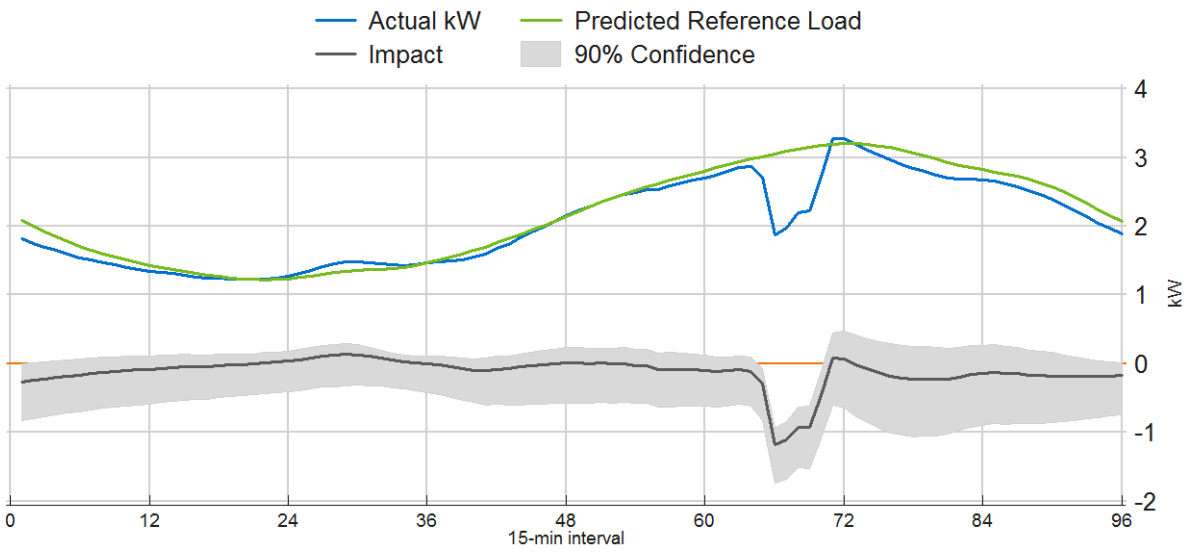
Figure 5-1: Within-Subjects Regression Model Selection



5.2 PJM Test Event Impacts

Load impacts for the September 6 PJM test event are shown in Figure 5-2. The average per household load impact was estimated to be 0.93 kW across the event period. This impact estimate is consistent with the range of impact estimates found for the other emergency shed events via RCT.

Figure 5-2: Load Impacts for PJM Test Event



6 Demand Reduction Capability – Time-Temperature Matrix

A key objective of the 2018 impact evaluation was to quantify the relationship between demand reductions, temperature, hour of day, and cycling strategy. This was accomplished by estimating loads under historical weather conditions and applying observed percent load reductions from the 2018 events. The resulting tool, referred to as the time-temperature matrix, allows users to predict the program's load reduction capability under a wide range of temperature and event conditions. For purposes of reporting program capability, Emergency 1 conditions are used, where both moderate and high customers are cycled at 75% shed.

In an ideal program year, a large number of events would be called under a variety of different weather conditions, dispatch windows and cycling strategies so that demand reduction capability could be estimated for a wide range of operating and planning scenarios. In actuality, opportunities for program events can be sporadic, and based on uncertain weather projections, such that they occur infrequently and under fairly similar conditions. In 2018, events were called under a rather narrow range of temperature conditions, with daily maximum temperatures on event days ranging from 90°F to 94°F. As a result, the ability to predict demand reduction capability across a broader range of conditions was somewhat inhibited.

6.1 Methodology

Figure 6-1 illustrates the weather sensitivity trends of percent load impacts and peak household demand on hot, non-event days. The figure, based on actual 2018 customer load data, shows that Power Manager demand reductions grow on a percentage basis as temperatures increase, and with deeper cycling. At the same time, peak household loads available for curtailment also increase with temperature. The implication is that larger percent reductions are attainable from larger loads, when temperatures are hotter.

Figure 6-1: Weather Sensitivity of Percent Load Impacts and Household Loads

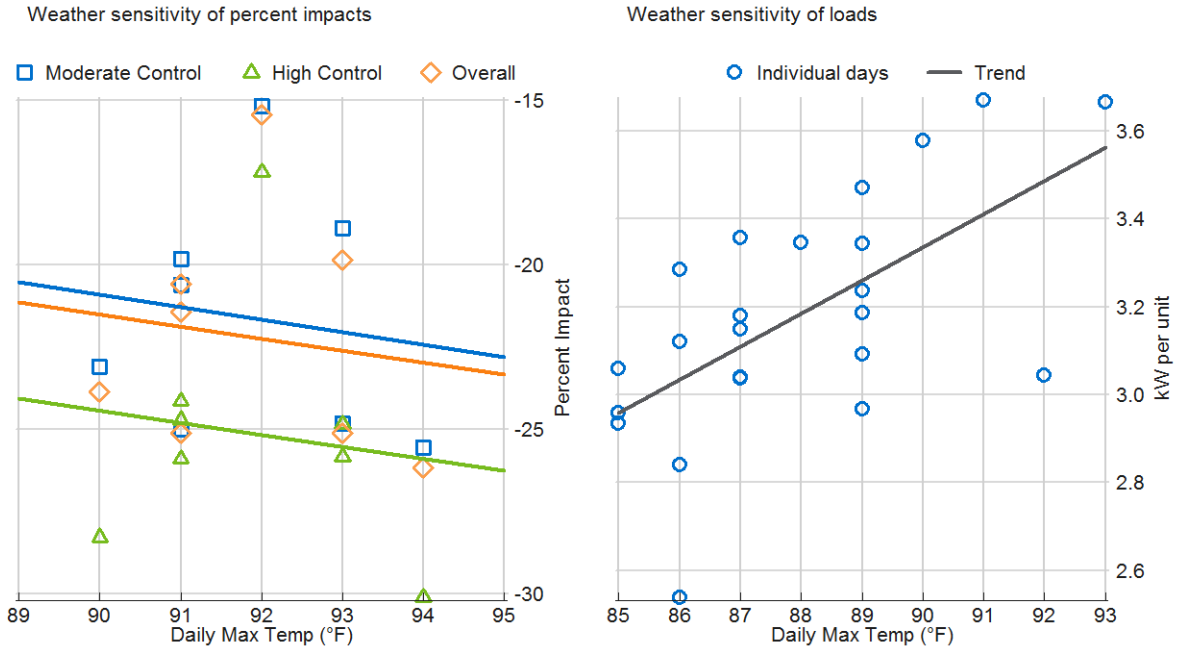
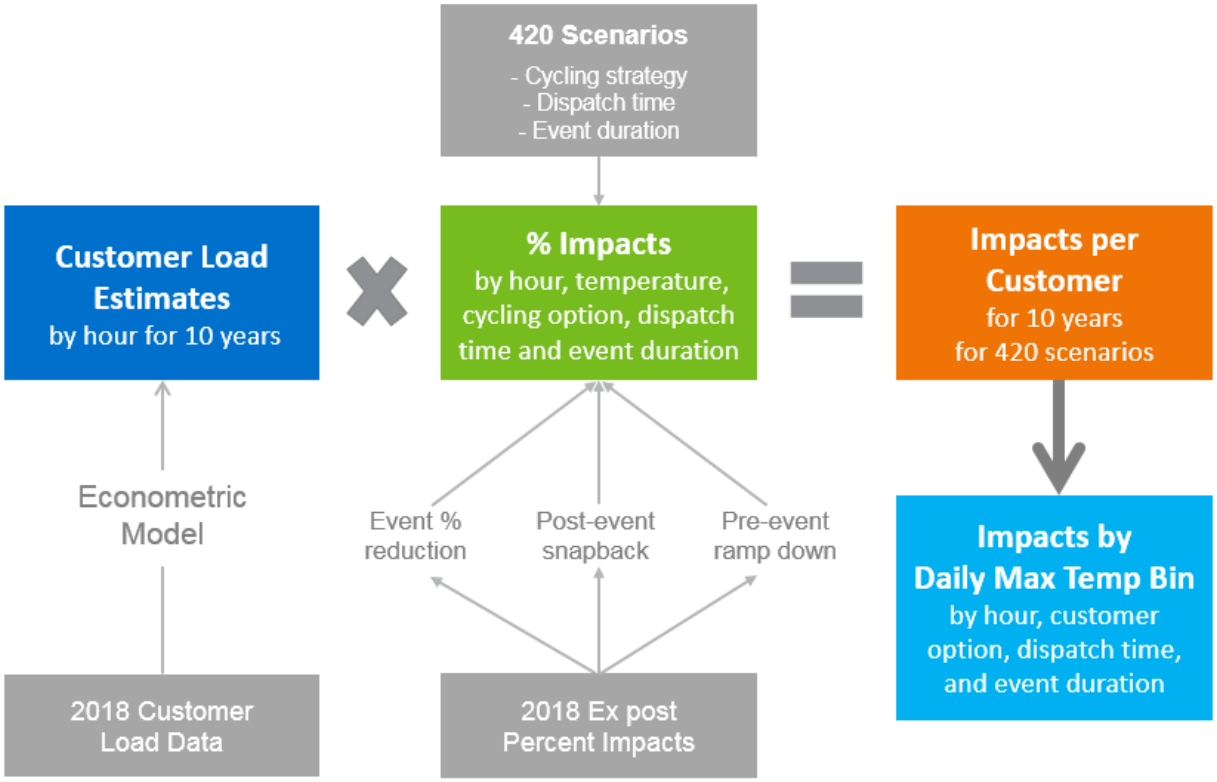


Figure 6-2 summarizes the process used to develop the 2018 time-temperature matrix for estimating demand reduction capability under various scenarios.

Figure 6-2: Time Temperature Matrix Development Process



The process used to produce the time-temperature matrix involved the following primary components:

- Estimates of customer loads were developed by applying 2018 AMI data to the same regression models used to estimate impacts. All weekdays with daily average temperatures above 70˚F were included in the models. The 2018 usage patterns were applied to actual weather patterns experienced over the past ten years rather than hypothetical weather patterns.
- Estimates of the percent reductions were based on three distinct econometric models: load control phase-in, percent reductions during the event, and post-event snapback. The models were based on the percent impacts and temperatures experienced during 2018 events.
- A total of 420 scenarios were developed to reflect various cycling/control strategies, event dispatch times, and event lengths.
- Estimated impacts per customer were produced by combining the estimated household loads, estimated percent reductions, and dispatch scenarios. The process produced estimated hourly impacts for each hot weekday during 2009-2018 under 280 scenarios.
- Multiple days were placed into 2-degree temperature bins and were averaged to produce an expected load reduction profile for each temperature bin.

6.2 Demand Reduction Capability for Emergency Conditions

While Power Manager is typically dispatched for economic or research reasons, its primary function is to deliver demand relief during extreme conditions, when demand is high and capacity is constrained. Extreme temperature conditions can trigger emergency operations, which are designated to deliver larger demand reductions than normal event cycling. During emergency conditions, all program devices are instructed to instantaneously shed loads. While emergency operations are rare and ideally avoided, they represent the full demand reduction capability of Power Manager.

Figure 6-3: Demand Reduction Capability – Emergency 1 Dispatch with 94°F Maximum Temperature

Inputs	
Dispatch Type	Emergency 1 Dispatch
Option	Overall
Event Start	4 PM
Event Duration (Hours)	1
Daily Max Temp (°F)	94
# Customers	42,872

Event Window Average Impacts		
Load without DR	3.64	kW per customer
Load with DR	2.38	kW per customer
Impact per customer	-1.27	kW per customer
Impact (MW)	-54.38	MW
% Impact	-34.8	%

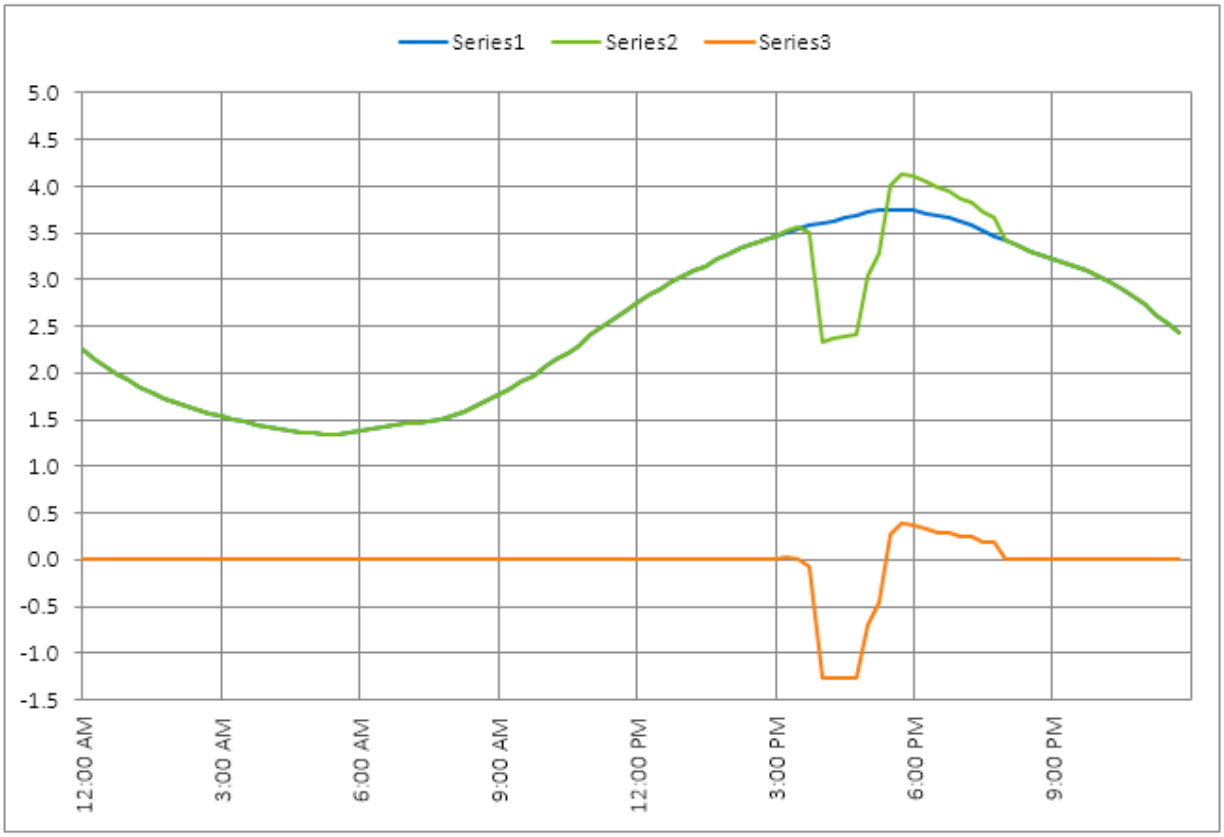


Figure 6-3 shows the demand reduction capability of the program if emergency shed becomes necessary on a day with 94˚F maximum temperature. Individual customers are expected to deliver 1.27 kW of demand reduction over a one-hour event window. Because there are approximately 43,000 customers enrolled in Power Manager, the expected aggregate reduction is 54.4 MW.

6.3 State Bill 310 Compliance

In the state of Ohio, electric distribution utilities (EDUs), including Duke Energy, are required to achieve a cumulative annual energy savings of more than 22% by 2027, in addition to achieving 0.75% peak demand reductions (PDR) in 2017-2020, per Ohio Senate Bill (SB) 310. Under current law, EDUs must implement PDR programs designed to achieve a 1% PDR and an additional 0.75% PDR each year through 2018. SB 310 also introduced new mechanisms that adjust how EDUs may estimate their energy savings

or PDR achieved through demand side management (DSM) programs. Specifically, SB 310 requires the Ohio Public Utilities Commission (PUC) to permit EDUs to account for energy-efficiency or PDR savings estimated on whichever value is higher between an "as-found" or a deemed basis. In the case of the 2018 Power Manager evaluation, the "deemed" savings approach will be applied using results from the 2016 impact evaluation. The relevant language for SB310 is provided in Appendix B.

Table 6-1 compares the deemed peak demand reductions from 2016-2017 to the as-found demand reductions from the 2018 impact evaluation. Note that the impacts reported in Table 6-1 have been converted to reflect per device impacts rather than per customer impacts. Per SB310, Duke Energy will claim the deemed values from 2016-2017 for Power Manager.

Table 6-1: SB 310 Compliance Peak Demand Reductions

Event Conditions	Number of Customers	Average Impact per Device	Aggregate Impact	Source
Emergency Shed	45,000	1.41 kW	67.0 MW	Time-Temperature Matrix based on 2016 and 2017 impacts
Emergency Shed	42,872	1.20 kW	54.4 MW	Time-Temperature Matrix based on 2018 impacts

6.4 Key Findings

Key findings from the development of the time temperature matrix include:

- While emergency operations are rare and ideally avoided, they represent the full demand reduction capability of Power Manager.
- Power Manager demand reductions grow on a percentage basis as temperatures increase, and with deeper cycling. At the same time, peak household loads available for curtailment also increase with temperature.
- If emergency shed becomes necessary on a 94˚F maximum temperature day, Power Manager can deliver 1.27 kW of demand reductions per household during a 1-hour event.
- Because there are approximately 43,000 Power Manager customers, the expected aggregate reductions total 54.4 MW.
- The event start time also influences the magnitude of reductions which, generally, are larger during hours when customer loads are highest.

Appendix A Weather Sensitivity of AC Load and Demand Reductions

Replicated from the 2016 evaluation - the load reduction capacity of Power Manager is dependent on weather conditions, as shown in Figure A-1. The plot shows the estimated average customer impact for each event as a function of daily maximum temperature. There is a clear correlation between higher temperatures and greater load reduction capacity, with the greatest load reductions occurring on the hottest day. Both emergency and normal operation impacts are displayed on this plot for that day, with the greater magnitude impacts attributable to the emergency operations customers.

While the weather correlation is clear, the question remains: How much of the bigger reduction capacity is due to larger air conditioners loads versus larger demand reductions? Both percent reduction and air conditioner loads grow with hotter temperatures. The whole house reductions were 18.9% on the coolest event day (87°F) and 26.1% on the hottest day (93°F). Figure A-2 shows the weather sensitivity of whole house load for the average customer in Power Manager. All nonevent weekdays with a daily high above 70°F were classified into two degree temperature bins. The plot shows how the loads vary by hour as temperatures grow hotter.

The key finding is simple. Demand reductions grow larger in magnitude when temperatures are hotter and resources are needed most. Because peak loads are driven by central air conditioner use, the magnitude of air conditioner loads available for curtailment grows in parallel with the need for resources. Not only are air conditioner loads higher, but the program performs at its best when it is hotter.

Figure A-1: Weather Sensitivity of Load Reduction based on Randomized Control Trial Analysis

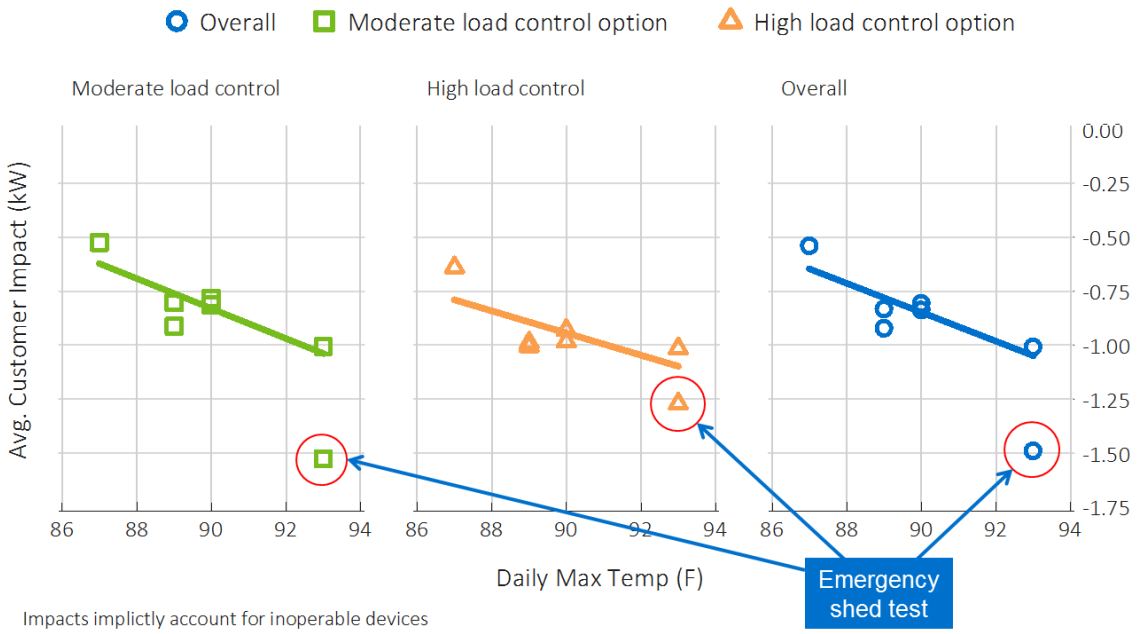
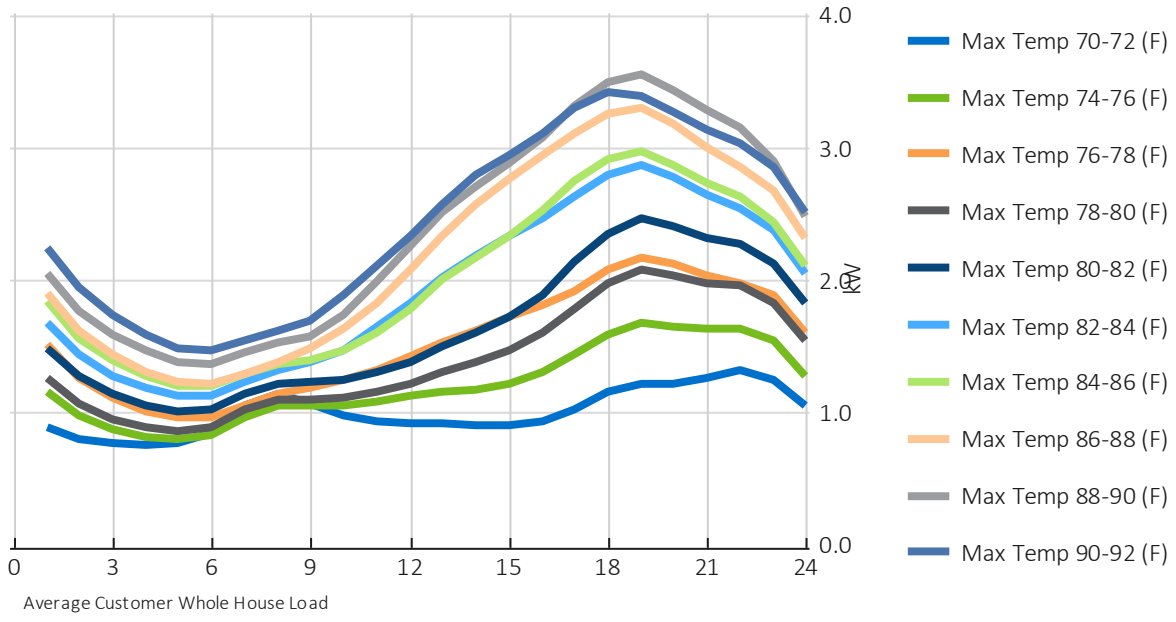


Figure A-2: Weather Sensitivity of Average Customer Loads



Appendix B Senate Bill 310 Legislation on Energy Efficiency Accounting

130th General Assembly Senate Bill Number 310

Sec. 4928.662. For the purpose of measuring and determining compliance with the energy efficiency and peak demand reduction requirements under section 4928.66 of the Revised Code, the public utilities commission shall count and recognize compliance as follows:

(A) Energy efficiency savings and peak demand reduction achieved through actions taken by customers or through electric distribution utility programs that comply with federal standards for either or both energy efficiency and peak demand reduction requirements, including resources associated with such savings or reduction that are recognized as capacity resources by the regional transmission organization operating in Ohio in compliance with section 4928.12 of the Revised Code, shall count toward compliance with the energy efficiency and peak demand reduction requirements.

(B) Energy efficiency savings and peak demand reduction achieved on and after the effective date of S.B. 310 of the 130th general assembly shall be measured on the higher of an as found or deemed basis, except that, solely at the option of the electric distribution utility, such savings and reduction achieved since 2006 may also be measured using this method. For new construction, the energy efficiency savings and peak demand reduction shall be counted based on 2008 federal standards, provided that when new construction replaces an existing facility, the difference in energy consumed, energy intensity, and peak demand between the new and replaced facility shall be counted toward meeting the energy efficiency and peak demand reduction requirements.

(C) The commission shall count both the energy efficiency savings and peak demand reduction on an annualized basis.

(D) The commission shall count both the energy efficiency savings and peak demand reduction on a gross savings basis.

(E) The commission shall count energy efficiency savings and peak demand reductions associated with transmission and distribution infrastructure improvements that reduce line losses. No energy efficiency or peak demand reduction achieved under division (E) of this section shall qualify for shared savings.

(F) Energy efficiency savings and peak demand reduction amounts approved by the commission shall continue to be counted toward achieving the energy efficiency and peak demand reduction requirements as long as the requirements remain in effect.

(G) Any energy efficiency savings or peak demand reduction amount achieved in excess of the requirements may, at the discretion of the electric distribution utility, be banked and applied toward achieving the energy efficiency or peak demand reduction requirements in future years.

Duke Energy PowerShare Program

2018 Evaluation Report for Duke Energy Ohio

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1. DUKE ENERGY POWERSHARE PROGRAM DESIGN

This document presents Navigant's evaluation of the Duke Energy Ohio (DEO) PowerShare® program for program year (PY) 2018. The PowerShare Program is a demand response (DR) program offered to commercial and industrial (C&I) customers that is part of Duke Energy's portfolio of demand-side management (DSM) programs. PowerShare offers participating C&I customers a financial incentive to reduce their electricity consumption when called upon by Duke Energy.

In 2018, the DEO PowerShare program had 39 participating customer accounts with a contracted option load of 44 MW. The DEO program offers customers two participation options to choose from:

- **CallOption:** The CallOption program requires participating customers to reduce and maintain a predetermined load during Emergency Curtailment Periods. Participants receive a monthly credit on their energy bill, and additional Load Reduction Credits are paid for load curtailed during events.

- **QuoteOption:** By enrolling in the QuoteOption program, participants can take part in voluntary Curtailment Periods on a per-event basis. If a participant elects to participate in an event, they should reduce and maintain load to a level they specify prior to the event. A QuoteOption event is initiated at Duke Energy's discretion and participants are typically provided with event notification on the morning of the event.

Participants enrolled in CallOption must further select one of three seasonal participation periods[1]:

1. **Limited Summer** – A maximum of 10 emergency events may occur from June 1 to September 30. Events may only be called on non-holiday weekdays from 12 noon to 8 pm and events may be a maximum of 6 hours in length.
2. **Summer Only** – No limit is placed on the number of emergency events that may occur from June 1 to September 30. Events may be called on any day during those months between 10 a.m. and 10 p.m., and an event may last no more than 10 hours.
3. **Annual** – No limit is placed on the number of events, and events may occur any day through the year (June 1, 2018 to May 31, 2019). Events may last up to 12 hours between June and October, as well as May. Events may last up to 15 hours between November and April.

CallOption participants may choose between one of two compliance options: that of having curtailment evaluated based on a "Firm" demand level ("down to") or a "Fixed" demand reduction ("down by"). CallOption participants must further choose between one of two energy options: "Capacity Only" where they may also participate in PJM energy markets and "Emergency Full" where Duke Energy acts as the participant's sole curtailment service provider.

There are many factors that affect the curtailment potential. For example, as customers install large-scale energy efficiency projects, such as a LED lighting retrofits, their demand is lowered, reducing the potential of curtailable load. The persistence of the contracted curtailable load also fluctuates as DEO participants may leave the program due to business closure. The curtailment potential is also affected by other factors, such as jurisdictional tariffs and federal US Environmental Protection Agency (EPA) emissions guidelines for onsite backup generators.

[1] Participation periods shown are specific to a given calendar period, as specified in the program literature.

2. PROGRAM EVALUATION METHODS

This report summarizes the findings from Navigant's process evaluation of the PowerShare program for PY2018, as well as a brief summary of Navigant's review of program impacts as determined by Duke Energy's Energy Profiler Online (EPO) software developed by Schneider Electric. Navigant used the following questions to guide the evaluation.

- What is the status of the program?
- What are the strengths of the program, and what are areas for improvement?
- What are the barriers to program participation? How can these barriers be addressed?
- In what ways can the program potentially increase kilowatt (kW) impacts?
- What actions can be taken, if any, to increase the efficiency of program implementation?
- Are there opportunities for implementation of the program?
- Why do customers desire to continue with or leave the program?

The research methods used in this evaluation include program materials review, program staff interviews, an implementer interview, surveys and interviews with Duke Energy Account Executives who implement the program, and a survey of participating customers. The evaluation team synthesized the results of the materials review, interviews, and surveys to identify trends, findings, and recommendations. All findings were mapped to the research questions outlined in the evaluation plan.

2.1 Program Impact Evaluation

Process evaluation activities were the primary focus of this evaluation cycle. The impact evaluation for the 2018 program year included a review and summary of the EPO event settlement data provided by Duke Energy. In the period of this evaluation, DEO PowerShare participants were subject to only test events. Navigant reviewed the settlement results to check for relative consistency with previous program years, and this report includes a summary of those results.

2.2 Program Staff Interviews

Navigant conducted a telephone interview with the DEO program manager on May 10, 2018. The interview identified strengths and opportunities to improve Duke Energy's PowerShare Program. Interview findings are incorporated into this report to support the evaluation.

2.3 PowerShare Implementer Interview

Navigant interviewed implementation contractor personnel from Schneider Electric over the phone on June 27, 2018. The interview identified strengths and opportunities to improve Duke Energy's PowerShare Program. As with the program manager interview, interview findings are incorporated into this report to support the evaluation.

2.4 Duke Energy Account Executive Interviews and Surveys

Navigant surveyed five DEO Account Executives over the phone from May 29 through June 28, 2018. These interviews identified how Duke Energy's PowerShare Program is currently operating, how the

process has changed over the past few years, and the effect of those changes on the program and participants to identify improvements to the program.

2.5 PowerShare Participant Surveys

Navigant established a target of 10-20 online participant surveys for the DEO jurisdiction. Survey invitations were sent to all DEO participants in October-November 2018, and 10 usable and completed surveys were received.

2.6 Process Evaluation Analysis Methods

The evaluation team used multiple analysis methods for the various modes of research, which included program materials review, interviews, email surveys with Account Executives, and online participant surveys. The transcription notes from the program manager and implementation contractor interviews and the email survey results were reviewed for consistency of issues and concerns. For the participant surveys, an SPSS analysis of the surveys categorized and summarized the responses. In some cases, the participant contact list contained multiple contacts at a given participant site. When more than one member of a participant's staff responded, those responses were weighted to prevent skewing of the results.

3. POWERSHARE PROGRAM EVALUATION FINDINGS

The following section presents the program evaluation findings, split into several categories:

- Program impacts
- Program strengths
- Areas for improvement
- Barriers to participation
- Opportunities to increase enrolled capacity
- Opportunities to improve program implementation

3.1 Program Impacts

In 2018, the program had a total of 39 participating customers, all of which were enrolled in the CallOption program. Table 1 shows the number of participants and contracted load for each program option.

Table 1. Number of Participants and Contracted Option Load

Program Option	Number of Participants	Total Contracted Option Load (MW)
CallOption Annual	**2**	**13.9**
CallOption Limited Summer	**16**	**15.6**
CallOption Summer Only	**21**	**14.5**
Total	**39**	**44.0**

Source: Navigant summary of Duke Energy Option Load Data, totals subject to rounding

Duke Energy scheduled one test event on September 6, 2018 for all participants. Additional retest events were held on September 18th, 25th and 27th during which some participants retested to improve performance. All events were one hour in length, and held from 4 p.m. to 5 p.m.[2] Table 2 shows the curtailed demand for the program-wide test event on September 6th, as well as the subsequent retests which only included a small number of participants.

[2] A single participant performed a retest from 4:30 to 5:30 p.m. on September 18th.

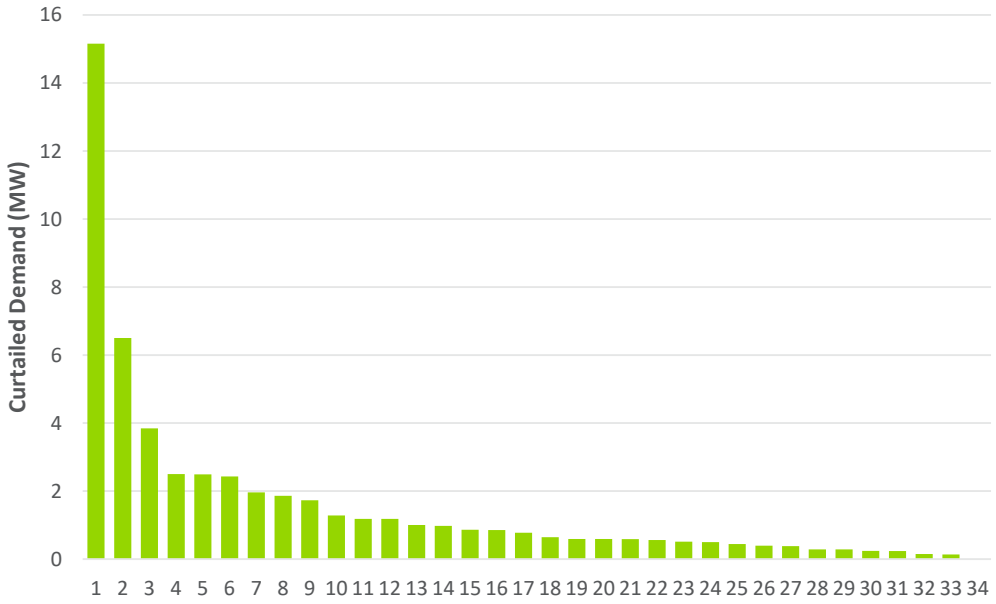
Table 2. Summary of 2018 Curtailed Demand

Curtailed Demand	September 6 Test Event (34 participants)	September 18 Retest (3 participants)	September 25 Retest (1 participant)	September 27 Retest (1 participant)
Firm Contract (MW)	**40.07**	**0.55**	**0.71**	**1.13**
Fixed Contract (MW)	**13.07**	**0.00**	**0.00**	**0.00**
Total (MW)	**53.14**	**0.55**	**0.71**	**1.13**

Source: Navigant summary of Duke Energy EPO Event Settlement Data, results subject to rounding

Figure 1 shows the curtailed demand for each participant for the September 6th test event. A total of 34 unique customer accounts participated in the event. The largest participant curtailed just over 15 MW during the event.

Figure 1. Curtailed Demand by Participant During September 6th Test Event (34 unique accounts)

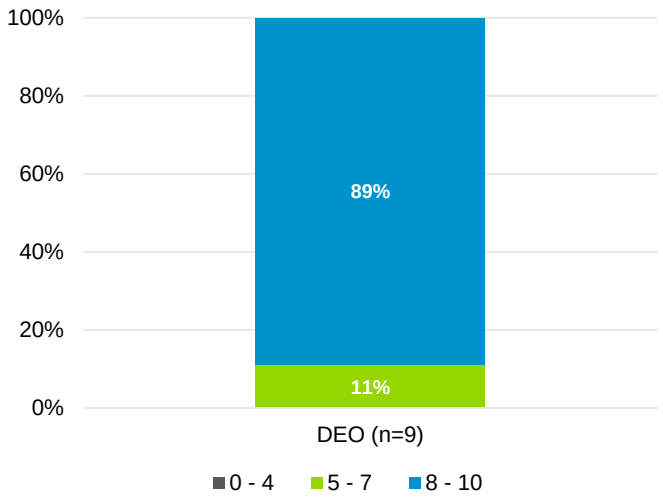


3.2 Program Strengths

Through the participant surveys, many respondents provided positive feedback about the program. Customers reported overall satisfaction with the program, finding the incentives, the notification time before events, and the frequency and duration of events to be acceptable.

Most DEO customers were satisfied with the program, with 89% of survey respondents ranking their satisfaction an 8-10, as shown in Figure 2.

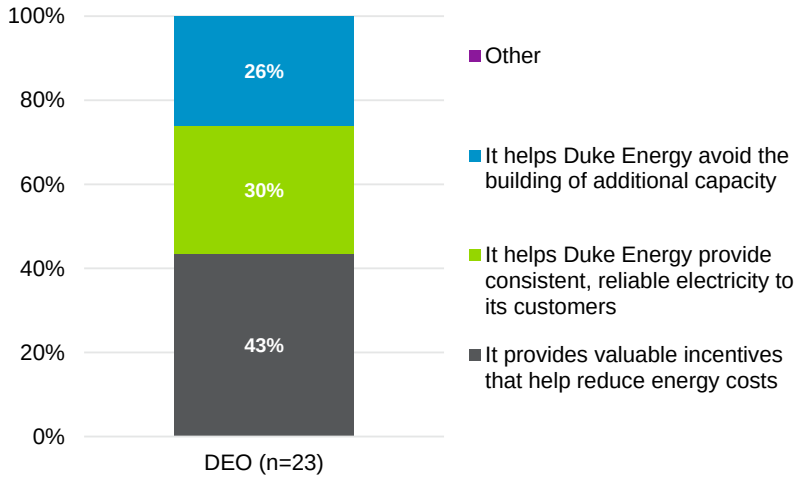
Figure 2. PowerShare Program Satisfaction Scores (0-10 Scale)



Source: Navigant analysis

As shown in Figure 3, 43% of DEO respondents indicated that a primary strength of the program is that it provides valuable incentives that help reduce energy costs. Respondents also felt that their participation allowed Duke Energy to provide consistent, reliable energy to its customers while avoiding building additional capacity.

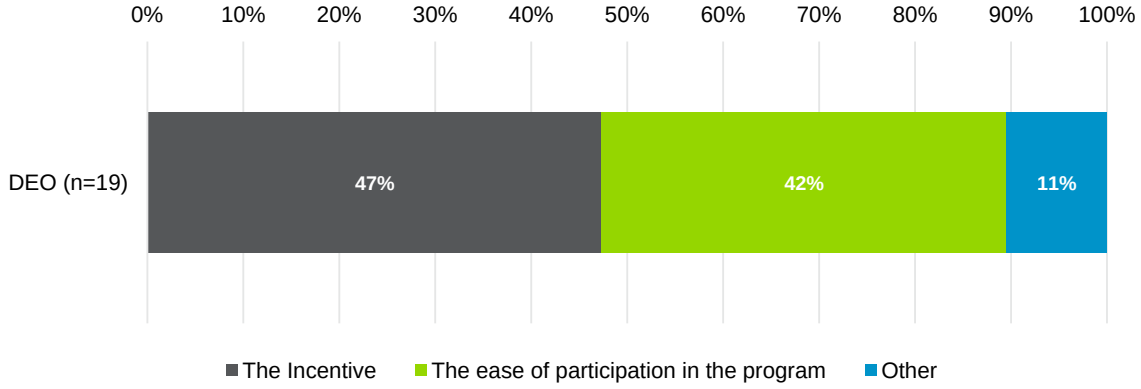
Figure 3. What do you think are the program strengths? (multiple response)



Source: Navigant analysis

The incentive was the main reason 47% of DEO respondents choose to continue in the program, as seen in Figure 4, and 42% of respondents indicated the ease of participating in the program was a key reason for choosing to continue.

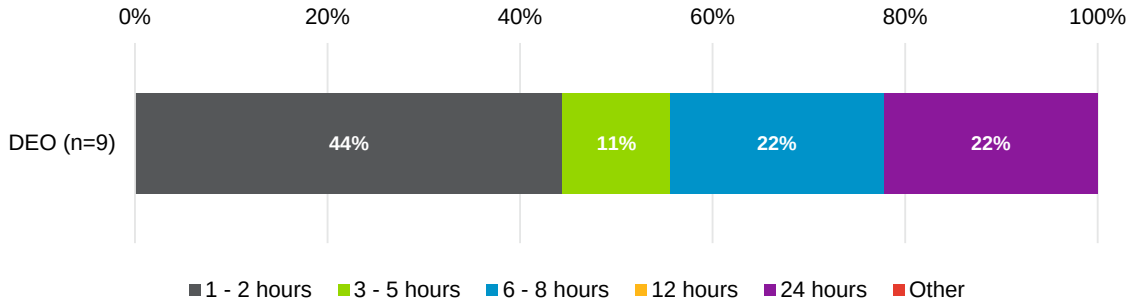
Figure 4. What aspects of the program encourage a customer to continue in the program? (multiple response)



Source: Navigant analysis

Figure 5 shows that 44% of the DEO survey respondents thought a 1-2 hour notification prior to a DR event was reasonable, while 22% said they preferred a 24-hour notification prior to an event.

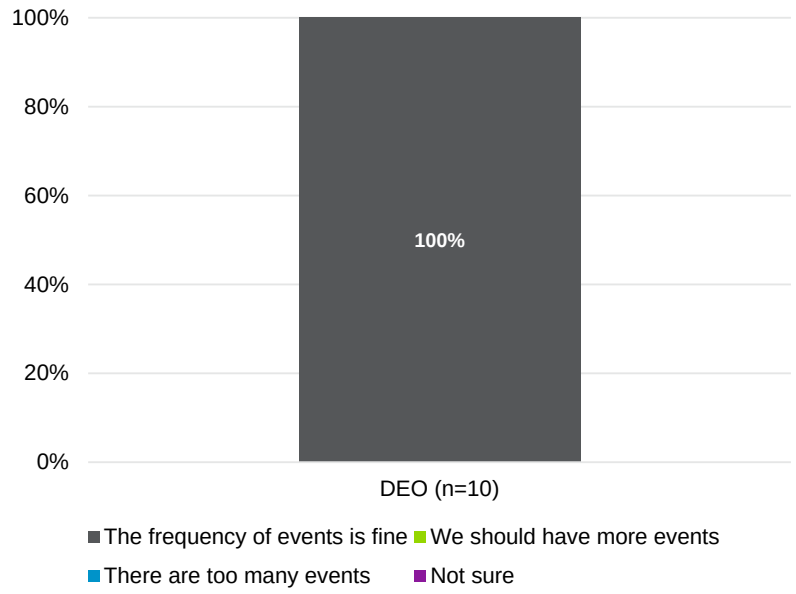
Figure 5. What is the minimum amount of time you would like to be notified ahead of a curtailment event?



Source: Navigant analysis

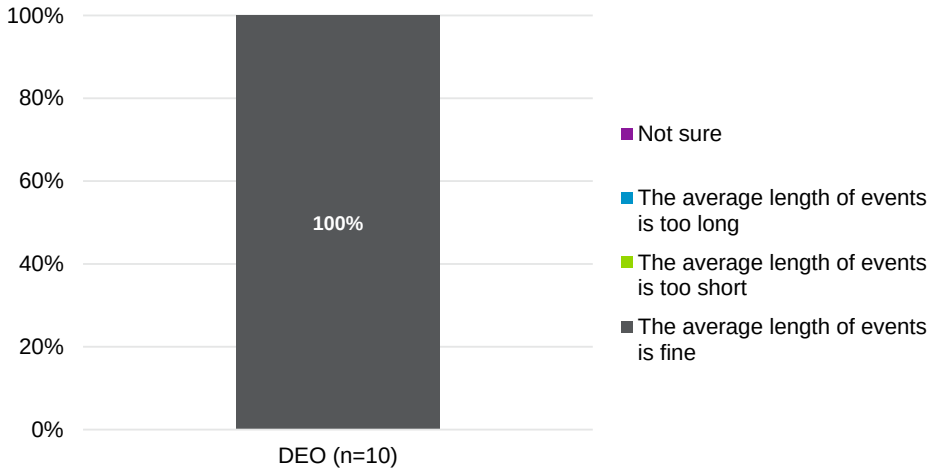
As seen in Figure 6 and Figure 7, 100% of DEO survey respondents thought the frequency of events was reasonable, and 100% felt the length of the events was acceptable as well.

Figure 6. What are your thoughts on the frequency of events?



Source: Navigant analysis

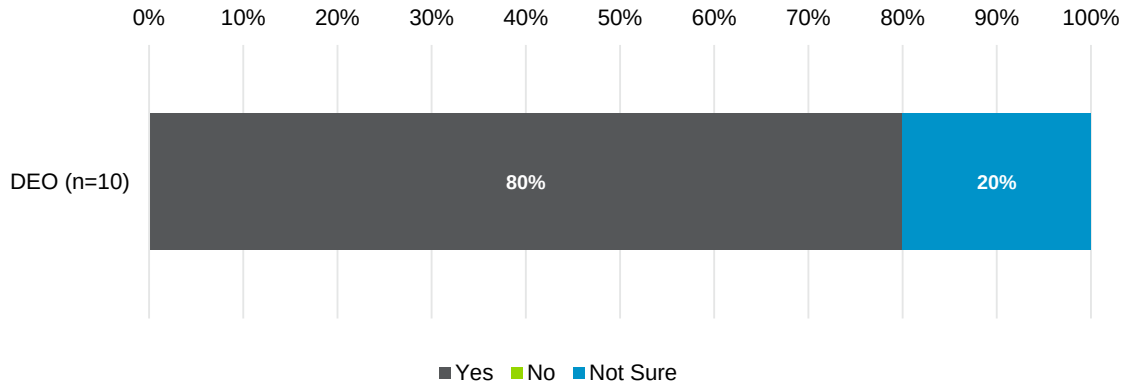
Figure 7. What are your thoughts on the duration of events?



Source: Navigant analysis

Most DEO survey respondents (80%) could meet their curtailment load during an event, as shown in Figure 8. The remaining 20% of respondents were not sure.

Figure 8. Are you able to meet curtailment?



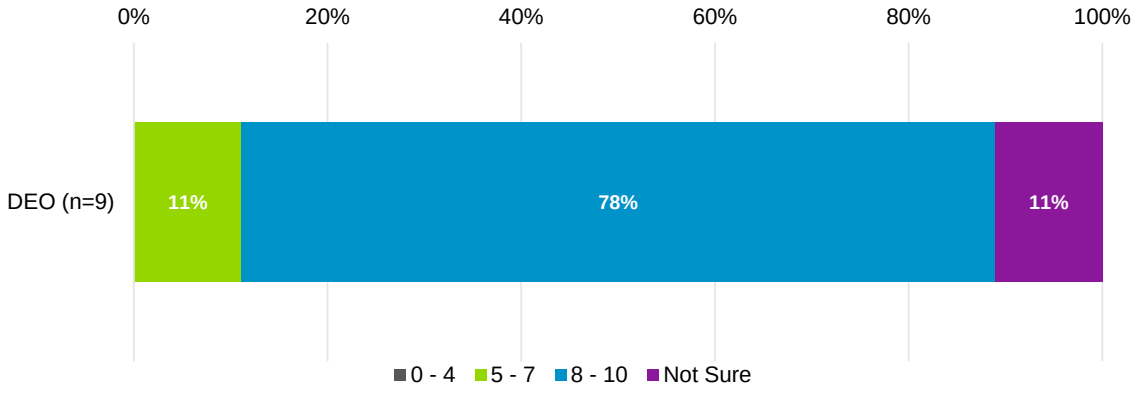
Source: Navigant analysis

3.3 Areas for Improvement

While the PowerShare program is well-liked by participants, there are some opportunities for improvement.

Even though the incentive is the main reason for participation, 22% of DEO respondents do not have a strong understanding of how the incentive is calculated, as shown in Figure 9 as the sum of responses of 7 or less and those who reported "not sure".[3]

Figure 9. How well do you understand the incentive you receive for the load curtailed?

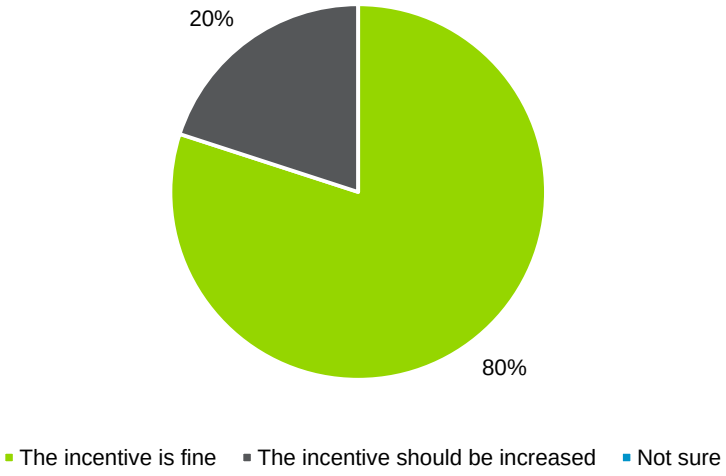


Source: Navigant analysis

[3] Respondents were asked to rate their understanding of the incentive received for the load curtailed on a scale of 0-10, with 0 being "do not understand at all", 5 being "neutral" and 10 being "understand completely".

As seen in Figure 10, the majority (80%) of DEO PowerShare respondents thought the incentive level was reasonable, whereas the remaining 20% thought the incentive should be increased.

Figure 10. What are your thoughts on the PowerShare incentives? (n=10)



Source: Navigant analysis

The program staff and Account Executive interviews also found that PowerShare participants do not receive communication at the end of the season thanking them for participating and ensuring they understand the results of the program. While most Account Executives do conduct an annual DR review with their customers, Duke Energy could increase its efforts to acknowledge/thank participants for contributing to load management and ensuring that participants fully understand their performance and credits. This acknowledgement might go a long way toward participants feeling appreciated and a part of a larger initiative to manage peak demand.

3.4 Barriers to Program Participation

As mentioned previously, the monthly incentive is one of the main motivators for respondent participation in the program. However, the financial benefit of participating is offset by the following costs to the participant:

- Loss of production
- Not meeting manufacturing deadlines
- Impact to employee wages

Duke Energy should consider periodically reviewing the benefit of the incentive levels to ensure they help offset these costs while remaining a cost-effective prog
ram.

The evaluation team also identified the following other barriers to participation:

- If the cost of electricity is a small percentage of overall business costs, a customer will likely not participate.

- While the concept of how to participate in the PowerShare program is easy to understand, understanding the specifics of the performance report can be confusing.

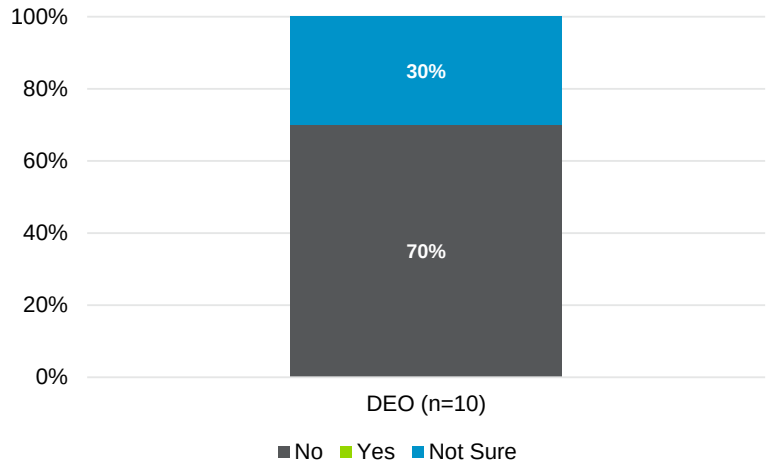
3.5 Opportunities to Increase Enrolled Capacity

None of the DEO respondents were planning on increasing their curtailable load, as shown in Figure 11.

There is also potential to increase the curtailment load by customers in certain segments:

- Customers with EPA-compliant onsite backup generators such as hospitals
- Customers who have a tight profit margin and may benefit from the monthly incentives

Figure 11. Do you have plans to increase the kW enrolled for curtailment?



Source: Navigant analysis

3.6 Opportunities to Improve Program Implementation

Both Duke Energy Account Executives and the survey respondents reported that participants would benefit from near real-time usage data on their load reductions. The ability to monitor the status of their actual curtailment compared to their contracted curtailment at the time of the event will provide participants the information needed to know if additional equipment should be shut down. If Duke Energy could create a web portal, app, or other means of accessing performance data quicker than waiting for their next bill or reviewing EPO the day following an event, participants would be more highly satisfied and could potentially also improve their overall curtailment capabilities. Providing near real-time usage data to the customer may help Duke Energy increase its curtailed load if the participant is able to identify other lines or processes that could be shut down during the event. Having real-time usage information will also provide needed information for the customer when deciding whether to buy-though an event. [4]

As mentioned in Section 3.4, respondents weighed the benefits of participating in a curtailment event against negative impacts to their business such as lost production, lost wages, and missing deadlines. Having the most current information on curtailment schedule changes helps the participant determine if

[4] Participants have the opportunity to "buy-through", rather than curtail during an economic event by paying a charge for their non-curtailed energy that is based on the day-ahead market price for each hour of the event.

they need to notify their employees of schedule or production changes. It should be noted that Duke Energy does provide participants with the ability to view curtailment schedules for each event through EPO, but some survey respondents indicated a need for additional notification of events. Official event notification occurs via the participant's preferred communication channel (e.g. email, text, phone). But Duke Energy may be able to improve participant understanding by providing further communication with participants to ensure they know where to look for event schedules and/or to provide additional notifications via the preferred notification channels.

Supporting the PowerShare program is one of the many responsibilities of an Account Executive. Helping to minimize their workload will improve the efficiency and implementation of the program. The following program delivery considerations can help the Account Executives sell and administer the PowerShare program more efficiently:

- Reduce the paperwork involved in re-signing to the program each year
    - Account Executives re-sign customers to the program every year and while repeat participants need to be made aware of changes to the program rules year to year, there are likely opportunities to reduce the paperwork involved in re-signing.
    - Changing PowerShare enrollment status to opt-out rather than opt-in would reduce the time needed to establish a new contract for both the customer and the Account Executives.
- During curtailment season, provide a daily status update email to all Account Executives that can be edited and sent to their specific customers.
- Similar to other energy efficiency programs, have a team to support the Account Executives in enrolling customers in the program and writing the curtailment agreements.

4. POWERSHARE PROGRAM EVALUATION RECOMMENDATIONS

The following tables present a summary of the findings from the PY2018 program evaluation and associated recommendations. The findings and recommendations are categorized into process improvements, curtailment improvements, and opportunities to increase the enrolled load. Navigant developed these findings and recommendations by synthesizing the information collected during the interviews and surveys performed during this evaluation cycle. This process generated the following list of potential program improvements. Navigant does not suggest that all should be pursued or that any one recommendation is needed to maintain an effective program with high customer satisfaction; however, they are listed here for Duke Energy to consider.

4.1 Process Improvements

Table 3. Recommendations for potential process improvements

#	Finding	Recommendation	Status of Recommendation
1	Participants are not acknowledged/thanked for their contribution.	Consider sending an end of season thank you as a nice goodwill gesture. Include total program impact.	Under consideration by Duke Energy
3	Participants seem to understand the program in face-to-face interactions, but they report the performance report is confusing and may be a deterrent to participation.	Consider ways to simplify the performance report.	Under consideration by Duke Energy
4	Some participants do not understand how their incentives are calculated.	Consider providing training along with the simple breakdown of the incentive structure and how the pro forma is calculated to allow Account Executives and participants to find and use existing information. Consider ways to ensure that participants know where to find this information.	Under consideration by Duke Energy
5	Account Executives must re-sign each customer every year, even if they have participated many years in a row.	Streamline the renewal option, even if customers have to accept minor program changes year to year.	Under consideration by Duke Energy

4.2 Curtailment Improvements

Table 4. Recommendations for potential curtailment improvements

#	Finding	Recommendation	Status of Recommendation
1	Participants lack access to near real-time usage data and need faster performance feedback.	Consider providing access to near real-time usage data through a web portal or other platform.	Under consideration by Duke Energy
2	Some participants would like more notification time.	When possible, offer earlier notification.	Under consideration by Duke Energy
3	Due to the difficulty of shutting down, the length of the curtailment period needs to be worth it.	Consider continuing to ensure all curtailments re 4 hours or longer.	Under consideration by Duke Energy

4.3 Opportunities to Increase Enrolled Load

Table 5. Potential opportunities for increasing enrolled load

#	Finding	Recommendation	Status of Recommendation
1	Certain customer segments may have higher potential for enrolled load.	Periodically revisit program participation opportunities with customers that have EPA-compliant onsite generators (such as hospitals) and those with tight profit margins (such as quarries and textiles). Existing participants may find opportunity to increase enrolled load, and there may be opportunity to recruit additional participants.	Under consideration by Duke Energy

EM&V Report for the Duke Energy Multifamily Energy Efficiency Program

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DISCLAIMER

This report was prepared by Navigant Consulting, Inc., n/k/a Guidehouse Inc. ("Navigant"),[1] for Duke Energy. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, because of their reliance on the report, or the data, information, findings, and opinions contained in the report.

[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

1. EVALUATION SUMMARY

1.1 Program Summary

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment to multifamily housing properties at no cost to the property managers or tenant end-users. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. The program consists of lighting and water measures.

- **Lighting measures:** LED bulbs installed in permanent fixtures. Program measures include A-line, globe, and candelabra lighting products installed onsite at the tenant's premise.
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap.

For this evaluation cycle, Navigant assessed lighting and water measures installed through the program in the Duke Energy Ohio (DEO) jurisdiction between April 1, 2018 through July 8, 2019.

Franklin Energy is the implementation contractor for the program. Customers (i.e., property managers) have the option to choose self-installation or direct installation through Franklin Energy. All installation was completed through the direct-install pathway during the period covered by this evaluation. After measures are installed, third-party quality control inspections are completed on about 20 percent of properties in any given month. Within a selected property, the quantity of units to inspect is based on property size as defined by the number of housing units.

1.2 Evaluation Objectives and Program-Level Findings

Navigant's evaluation included assessing the program impacts, structure and delivery. For this Evaluation, Measurement, and Verification (EM&V) effort, the evaluation approach and objectives can be described as follows:

- **Impact evaluation:** To quantify the net and gross energy and coincident demand savings associated with program activity at both the measure level and program level
- **Process evaluation:** To assess program delivery and customer satisfaction

By performing both components of the EM&V effort, Navigant provides Duke Energy with verified energy and demand impacts, as well as a set of recommendations that are intended to aid Duke Energy with improving or maintaining the satisfaction with program delivery while meeting energy and demand reduction targets in a cost-effective manner.

As in the previous 2015 evaluation, Navigant found that Duke Energy is successfully delivering the Multifamily Energy Efficiency Program to customers, participant satisfaction is generally favorable, and the reported measure installations are accurate.

For the evaluation period covered by this report, there were a total of 1,700 housing units at 18 participating properties. The program-level evaluation findings are presented in Table 1 though Table 4. As shown in Table 1, Navigant found the realization rate for gross energy savings to be 91 percent, meaning that total verified gross energy savings were found to be somewhat lower than claimed in the

tracking database provided by Duke Energy. When adjusted to account for Ohio's Senate Bill 310 (SB 310), the realization rate for gross energy savings is 103 percent as shown in Table 2. SB 310 indicates that DEO can claim the higher of the ex ante (i.e. deemed) or ex post (i.e. verified) impacts for each measure.

Navigant found the net-to-gross (NTG) ratio to be 0.98, meaning that for every 100 kWh of reported energy savings, 98 kWh can be attributed directly to the program. The results shown in Table 3 and Table 4 include the verified program impacts before and after adjustments for SB 310, respectively. These findings will be discussed in greater detail throughout this report.

Table 1. Program Claimed and Evaluated Gross Energy and Demand Impacts

DEO Gross Impacts	Reported (ex ante)	Verified (ex post)	Realization Rate
Energy Savings (MWh)	1,340	1,214	91%
Summer Peak Demand Savings (MW)	0.133	0.099	75%
Winter Peak Demand Savings (MW)	0.212	0.132	62%

Source: Navigant analysis, totals subject to rounding.

Table 2. Program Impacts Claimable Under SB 310

DEO Gross Impacts (Claimable Under SB 310)	Reported (ex ante)	Verified (ex post)	Realization Rate
Energy Savings (MWh)	1,340	1,385	103%
Summer Peak Demand Savings (MW)	0.133	0.145	109%
Winter Peak Demand Savings (MW)	0.212	0.219	103%

Source: Navigant analysis, totals subject to rounding.

Table 3. Program Evaluated Net Energy and Demand Impacts

DEO Net Impacts	Verified Net Impact
Energy Savings (MWh)	1,187
Summer Peak Demand Savings (MW)	0.097
Winter Peak Demand Savings (MW)	0.129

Source: Navigant analysis, totals subject to rounding.

Table 4. Program Evaluated Net Energy and Peak Demand Impacts Claimable Under SB 310

DEO Net Impacts (Claimable Under SB 310)	Verified Net Impact
Energy Savings (MWh)	1,354
Summer Peak Demand Savings (MW)	0.141
Winter Peak Demand Savings (MW)	0.214

Source: Navigant analysis, totals subject to rounding.

1.3 Evaluation Parameters and Sample Period

To accomplish the evaluation objectives, Navigant performed an engineering review of measure savings algorithms, field verification to assess installed quantities and characteristics, as well as surveys with

tenants and property managers to assess satisfaction and decision-making processes.[2] The evaluated parameters are summarized in Table 5. For field and phone verification, the expected sampling confidence and precision was 90 percent ± 10 percent, and the achieved was 90 percent ± 11.6 percent.

Table 5. Evaluated Parameters

Evaluated Parameter	Description	Details
Efficiency Characteristics	Inputs and assumptions used to estimate energy and demand savings	1. LED wattage 2. LED operating hours 3. Aerator flow rates (gpm) 4. Showerhead flow rates (gpm) 5. Water temperature (F) 6. Pipe wrap length (ft)
In-Service Rates	The percentage of program measures in use as compared to reported	1. LED, aerator, and showerhead quantities 2. Pipe wrap length
Satisfaction	Customer satisfaction	1. Satisfaction with program 2. Satisfaction with contractor 3. Satisfaction with program measures
Free Ridership	Fraction of reported savings that would have occurred anyway, even in the absence of the program	1. Property Manager Interviews
Spillover	Additional, non-reported savings that occurred as a result of participation in the program	1. Property Manager Interviews 2. Tenant Phone Surveys

This evaluation covers program participation from April 1, 2018 through July 8, 2019, and is the first evaluation of this program in DEO since LEDs were introduced as a measure offering. Table 6 shows the start and end dates of Navigant's sample period for evaluation activities.

Table 6. Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification	September 16, 2019	October 11, 2019
Tenant Phone Surveys	September 6, 2019	September 20, 2019
Property Manager Interviews	September 9, 2019	October 23, 2019

[2] A billing analysis was also considered, but Navigant determined that the engineering-based approach was appropriate for the evaluation objectives due to the frequency of tenant turnover at multifamily facilities and the small impact of energy savings from program measures relative to annual facility energy consumption.

1.4 Evaluation Considerations and Recommendations

Navigant developed a few recommendations for Duke Energy to consider. These recommendations are intended to assist Duke Energy with enhancing the program delivery and customer experience, as well as to support future EM&V activities and possibly increase program impacts.

1. Navigant recommends that Duke Energy should adopt the ex post, per-unit energy and demand impacts from this evaluation and use them going forward. We recommend that Duke Energy use the impacts claimable under Ohio SB 310.
2. Duke Energy should consider improving the program materials distributed to tenants that describe the program measures and energy savings that might be achieved due to the installation of the new equipment. Communicating tips to save energy and water with the new equipment could increase customer satisfaction and continue to build the strong trust and rapport Duke Energy has established with their customer base.
3. Duke Energy should consider leaving a few cases of backup LED bulbs with property managers. LEDs were the only measure removed by tenants and burn out was the primary reason for the removal. Leaving additional LEDs with property managers could help increase the customer satisfaction rate for this measure.
4. Duke Energy should consider whether smart thermostats or other HVAC-related measures would be reasonable offerings for this program. About 25 percent of survey respondents who did not have a smart thermostat indicated they would like to get one. Also, three out of four property managers recommended adding exterior and common area lighting to the program, so they can continue to make their properties energy efficient.
5. Duke Energy should consider making modifications to the Multifamily Energy Efficiency Program Direct Installation Service Agreement to include information about EM&V activities that may occur in the months or years following program participation. Navigant experienced significant resistance from property managers while recruiting for onsite field verification and process evaluation interviews. Many property managers indicated they had already received multiple site visits during the implementation phase and subsequent QC inspections, and that it was a challenge to accommodate additional inspections and interviews for EM&V.

2. PROGRAM DESCRIPTION

2.1 Design

The Multifamily Energy Efficiency Program is designed to provide energy efficiency to a sector that is often underserved or difficult to reach via traditional, incentive-based energy efficiency programs. This market can be difficult to penetrate because multifamily housing units are often tenant-occupied rather than owner-occupied, meaning that the benefits of performing energy efficiency upgrades may be realized by the tenant whereas the incremental costs are absorbed by the owner.

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment at no cost to multifamily housing property owners. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. The program consists of lighting and water measures.

- **Lighting measures:** LED bulbs installed in permanent fixtures. Program measures include A-line, globe, and candelabra lighting products installed onsite at the tenant's premise.
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap.

2.2 Implementation

Franklin Energy is the implementation contractor for the program. To recruit participants, Franklin Energy conducts onsite visits, in combination with internet searches, and SalesGenie[3] lists, to identify properties, property managers, or property management companies that it believes are likely to participate. Franklin Energy then sends an outreach team of Energy Advisors to coordinate with property managers and explain the program delivery and benefits. This is considered an Energy Assessment. This is the time for Energy Advisors to determine the type of measures along with associated quantities that can be installed. One potential delay in committing to the program is the need for the property manager to get approval to participate from their corporate office.

Once a property has been fully assessed and a service agreement has been signed, the project is handed over to a different group at Franklin Energy to schedule the installations. The installation crew performs the work as scheduled, while displaying Duke Energy branded clothing, badges, and vehicle decals as directed. The installation crews record the quantities and locations of installed measures for each housing unit via a tablet device, which are entered into a tracking database.

When energy efficient program measures are installed, Franklin Energy removes the existing or baseline equipment and generally disposes of it onsite. If the property management previously requested to keep the existing equipment, Franklin Energy will package it up and leave it behind with property management or maintenance personnel. Franklin Energy records the baseline characteristics (e.g. lamp type wattage, aerator flow rates) for a sample of measures removed and makes that information available to Duke Energy and Navigant for evaluation purposes.

[3] SalesGenie is a business and consumer lead generation tool that sales and marketing professionals can use to search for targeted leads, get contact names and phone numbers, and view detailed information. The tool also provides marketing and data solutions designed to help businesses reach their intended audiences more effectively.

There can be logistical complications associated with performing these types of retrofits at multifamily housing properties. Franklin Energy indicated that some units may be skipped at a property due to safety issues, lack of access to equipment, pet barriers, or refusal from tenants.

Franklin Energy stated that they have internal and external forms of quality control (QC) to ensure consistent measure installation. On the internal side, a Franklin Energy supervisor may accompany installation crews to ensure quality work. On the external side, a third-party inspector, Thorpe Services, conducts inspections on a least five percent of participating housing units each year. The QC inspections are required to happen within 22 business days of installation. If a property is selected for a QC inspection, at least 20 percent of the units at the property are targeted for inspection.

During each month of QC inspections, Franklin Energy is provided with a discrepancy report that indicates when measures were missing, installed incorrectly, or if there were missed opportunities. Franklin Energy attempts to address the discrepancies, and subsequently updates the tracking data to reflect the QC findings. The tracking data is ultimately provided to Duke Energy, and subsequently to Navigant for EM&V.

3. KEY RESEARCH OBJECTIVES

As outlined in the Statement of Work, the key research objectives were to conduct impact and process evaluations, as well as a net-to-gross (NTG) analysis.

The primary purpose of the evaluation, measurement, and verification (EM&V) assessment is to estimate net annual energy and demand impacts associated with participation from April 1, 2018 through July 8, 2019. Secondary objectives include the following:

- Estimate net and gross impacts by measure
- Perform detailed review of deemed savings estimates for each measure, and provide updates if necessary
- Assess the installed quantities and efficiency characteristics of program measures
- Evaluate the strengths and weaknesses of current program processes and customer perceptions of the program offering and delivery
- Recommend improvements to program rules and processes that support greater savings, enhanced cost-effectiveness, and improved customer satisfaction

Key impact and process research questions to be explored include:

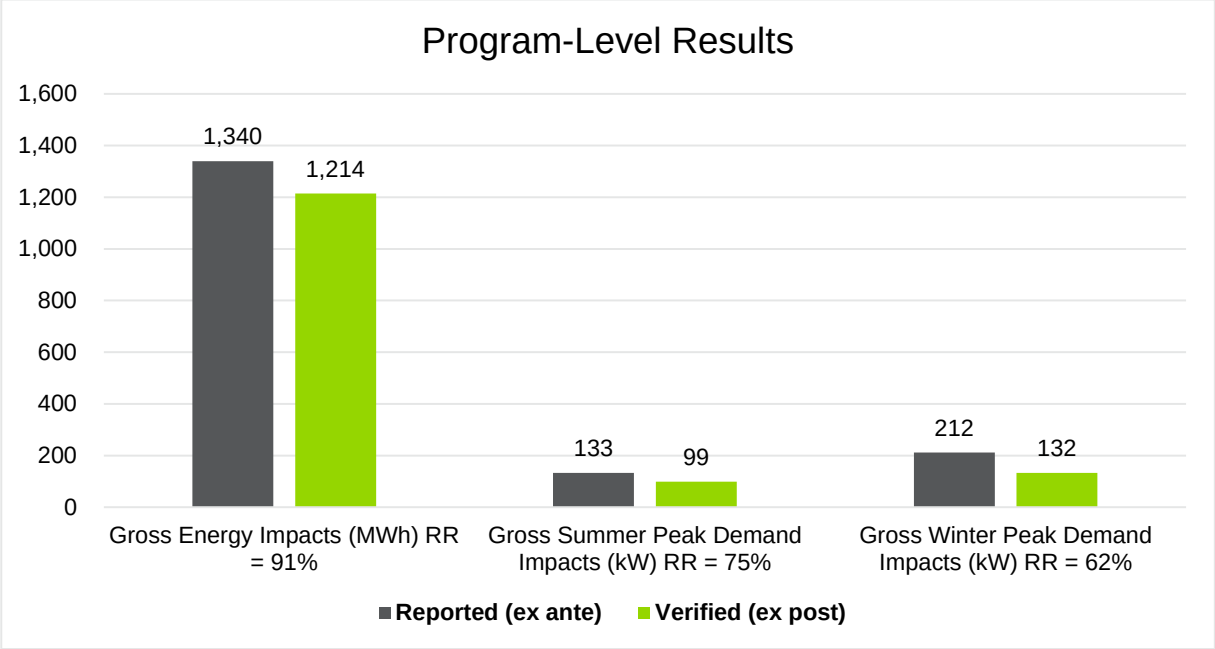
- Is the program achieving targeted energy and demand savings at the measure level?
- How do customers learn about the program, and can participation be increased?
- How is the persistence of savings impacted by participant removal of measures installed through the program?
- Are there opportunities for additional measure offerings through the program?
- Provide the effect on baseline lamp wattage from EISA, including some discussion on the projected degradation of baseline lamp wattage in future years.

4. IMPACT EVALUATION

4.1 Impact Results

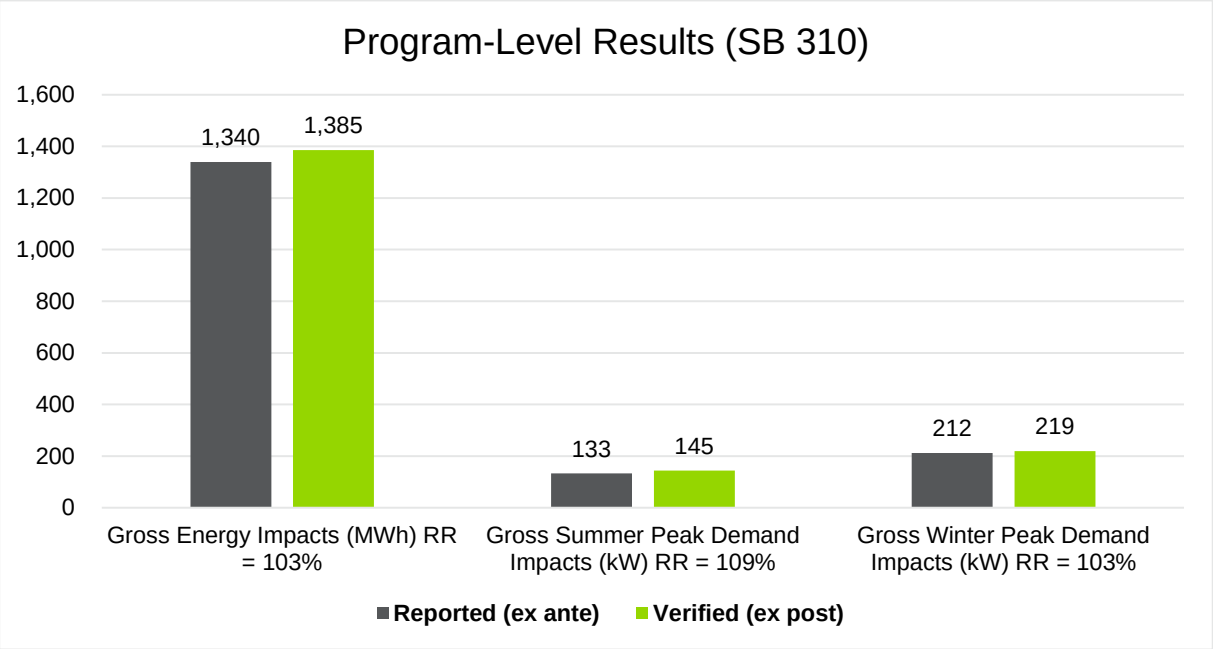
Figure 1 shows the program-level results for gross energy and demand savings, and Figure 2 shows the corresponding results using the impacts claimable under SB 310. Table 7 shows a more complete list of program-level findings, separated by the unmodified evaluation findings and those claimable by SB 310. The evaluation team calculated the results in Table 7 by multiplying the measure quantities found in the tracking database by the verified energy and demand savings estimated during the EM&V process for each measure. The net impacts were found by multiplying the gross impacts by the NTG ratio of 0.98. The NTG methodology and results are discussed in detail in Section 5 of this report. To arrive at the SB 310 adjusted results shown in Figure 2 and Table 7, Navigant used the higher of ex ante or ex post impacts for each measure.

Figure 1. Reported and Verified Gross Program-Level Impacts



Source: Navigant analysis, totals subject to rounding.

Figure 2. Reported and Verified Gross Program-Level Impacts Claimable Under SB 310



Source: Navigant analysis, totals subject to rounding.

Table 7. Summary of Program Impacts

	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
Verified Gross Impacts	1,214	0.099	0.132
Verified Net Impacts	1,187	0.097	0.129
Verified Gross Impacts (SB 310)	1,385	0.145	0.219
Verified Net Impacts (SB 310)	1,354	0.141	0.214

Source: Navigant analysis, totals subject to rounding.

A summary of each measure's contribution to program energy savings and realization rate between reported savings and verified savings is shown in Table 8. At the measure level, there were considerable differences between ex ante and ex post impacts. This is because LEDs had not been previously evaluated for this program, and because many factors that affect the ex post calculations for water measures are different than they were during the previous evaluation cycle, which was the source for ex ante water impacts. The driving factors for these differences include:

- The availability of baseline flow rate data for water measures, and baseline wattage data for LED measures improved the impact estimates by incorporating primary data.
- Updated impact algorithms for water measures that leverage the 2015 Indiana Technical Reference Manual (TRM)[4]

[4] Navigant believes the Indiana TRM is a more robust reference than the 2010 Ohio TRM because it includes calculation parameters that are specific to the multifamily housing sector whereas the Ohio TRM does not.

Table 8. Distribution of Program Gross Energy Savings by Measure

Measure	Measure Count from Tracking Data	Total Ex Ante Savings from Tracking Data (MWh)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MWh)	Realization Rate
A-Line LED	11,294	572	43%	552	97%
Candelabra LED	2,299	60	4%	71	119%
Globe LED	3,339	84	6%	102	121%
Bathroom Faucet Aerator	1,005	59	4%	40	67%
Kitchen Faucet Aerator	738	86	6%	103	119%
Low Flow Showerhead	944	320	24%	291	91%
Water Heater Pipe Wrap (ft)	3,077	158	12%	55	35%
Total	22,696	1,340	100%	1,214	91%

Source: Navigant analysis, totals subject to rounding.

The results for gross summer coincident demand by measure are shown in Table 9.

Table 9. Distribution of Summer Coincident Demand Savings by Measure

Measure	Total Savings from Tracking Data (kW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (kW)	Realization Rate
A-Line LED	56	42%	45	81%
Candelabra LED	6	4%	10	183%
Globe LED	8	6%	15	194%
Bathroom Faucet Aerator	8	6%	3	36%
Kitchen Faucet Aerator	11	9%	7	60%
Low Flow Showerhead	26	20%	13	49%
Water Heater Pipe Wrap (ft)	18	14%	6	34%
Total	133	100%	99	75%

Source: Navigant analysis, totals subject to rounding.

The results for gross winter coincident demand by measure are shown in Table 10.

Table 10. Distribution of Winter Coincident Demand Savings by Measure

Measure	Total Savings from Tracking Data (kW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (kW)	Realization Rate
A-Line LED	105	50%	72	69%
Candelabra LED	6	3%	13	228%
Globe LED	18	9%	18	100%
Bathroom Faucet Aerator	11	5%	3	25%
Kitchen Faucet Aerator	16	8%	7	42%
Low Flow Showerhead	37	17%	13	35%
Water Heater Pipe Wrap (ft)	18	9%	6	34%
Total	212	100%	132	62%

Source: Navigant analysis, totals subject to rounding.

4.2 Impact Evaluation Methodology

Navigant's methodology for evaluating the gross and net energy and demand impacts of the program included the following components:

1. Detailed review of deemed savings estimates including: engineering algorithms, key input parameters, and supporting assumptions.
2. Onsite field verification to assess measure characteristics and in-service rates (ISRs)
3. Net-to-gross (NTG) analysis
4. Incorporating supplemental impact findings from tenant surveys

4.2.1 Detailed Review of Ex Ante Deemed Savings

Navigant reviewed the ex-ante savings and supporting documentation used to estimate ex ante program impacts. Duke Energy provided Navigant with a spreadsheet containing the deemed savings estimates for LED and water measures, as well as some of the inputs used to develop those estimates. The deemed savings for LED measures are shown in Table 11 below.

Table 11. Ex Ante Savings Estimates for LED Measures

LED Measure	Annual Gross Energy Savings (kWh)	Winter Coincident Demand Impacts (kW)	Summer Coincident Demand Impacts (kW)	Annual Non-Coincident Demand Impacts (kW)
Candelabra (per lamp)	26.0	0.002	0.002	0.005
Globe (per lamp)	25.2	0.006	0.002	0.006
A-Line (per lamp)	50.7	0.009	0.005	0.011

Source: Duke Energy

Duke Energy provided Navigant with wattages from both the program LEDs and the average baseline lamps, as recorded in the sampled data by Franklin Energy, shown in Table 12.

Table 12. Baseline and Efficient Wattage Values for LEDs

Measure	Baseline Lamp Wattage	Efficient (LED) Lamp Wattage
Candelabra (per lamp)	40.0	5
Globe (per lamp)	40.6	6
A-Line (per lamp)	59.9	9

Source: Duke Energy, values subject to rounding

This is the first program evaluation since Duke Energy began offering LEDs. In the spreadsheet provided by Duke Energy, the deemed savings values were sourced from recent evaluation reports completed by a different evaluator for DEO's Online Savings Store and Free LED programs. Navigant performed a high-level review of the evaluation reports for the Online Savings Store and Free LED programs, and recommended some adjustments to the impact analysis that would be more appropriate for the Multifamily Energy Efficiency Program. A key distinction is the Multifamily Energy Efficiency Program is a direct install program targeting multifamily properties, whereas the Online Savings Store and Free LED programs rely on customer action for installation targeting primarily single-family housing sector.

Similar to the other evaluation reports and the 2015 Indiana TRM, Navigant used standard lighting equations to assess impacts for LED measures, as shown in Equation 1 and Equation 2.

Equation 1. Energy Savings Algorithm for LEDs

$$kWh\ savings = \left[\frac{(Watts_{base} - Watts_{EE})}{1000}\right] \times ISR \times HOU \times (1 + HVAC_C)$$

Equation 2. Coincident Demand Savings Algorithm for LEDs

$$kW\ savings = \left[\frac{Watts_{base} - Watts_{EE}}{1000}\right] \times ISR \times CF\ x\ (1 + HVAC_D)$$

Where the parameters are defined as:

$Watts_{base}$ = wattage of baseline lamp removed
$Watts_{EE}$ = wattage of LED lamp installed
ISR = in-service rate
HOU = annual operating hours
$HVAC_C$ = HVAC system interaction factor for energy
$HVAC_D$ = HVAC system interaction factor for demand
CF = coincidence factor (summer and winter)

Navigant's review of the LED ex ante savings found that the estimates were reasonable, but that the ex post values were likely to differ because the measures had not been evaluated before.

Duke Energy also provided Navigant with the deemed savings estimates for water measures shown in Table 13. These deemed savings were sourced from Navigant's previous 2015 evaluation of this program. Navigant also expected all ex post values to differ from these previous evaluations because Duke Energy provided Navigant with data for baseline water measure flow rates from the sample collected by Franklin Energy, and Navigant updated several impact calculation parameters (discussed in Section 4.3.2.

Table 13. Ex Ante Savings Estimates for Water Measures

Measure	Annual energy savings (kWh)	Annual Winter Coincident demand savings (kW)	Annual Summer Coincident demand savings (kW)	Annual Non-Coincident demand savings (kW)
Faucet Aerators MF Direct 1.0 GPM - bath (per aerator)	58.7	0.011	0.008	0.161
Faucet Aerators MF Direct 1.0 GPM – kitchen (per aerator)	116.8	0.022	0.015	0.320
LF Showerhead MF Direct 1.5 GPM (per showerhead)	339.0	0.039	0.028	0.929
Pipe Wrap MF Direct (per linear foot)	51.5	0.006	0.006	0.013

Source: Duke Energy

4.2.2 Onsite Field Verification and Phone Verification

Navigant performed onsite field verification at 36 housing units across 3 participating properties, as well as phone verification with 34 individual tenants at properties that received program measures. Navigant faced recruiting challenges in both the field and phone verification efforts. For field visits, some property managers who recently participated in the program didn't want to further inconvenience tenants with another verification visit. Field and phone verification efforts were designed to assess the measure characteristics as reported in the tracking data and to assess measure parameters that can be used to verify inputs and assumptions used to estimate energy and demand savings for individual measures. Table 14 shows a summary of the parameters assessed by Navigant during field verification, and used to evaluate ISRs for each measure. Table 15 shows the sample disposition for field and phone verification.

Table 14. Parameters Evaluated During Field Verification

	LEDs	Faucet Aerators	Water-saving Showerheads	Hot Water Pipe Wrap
Installed quantity	x	x	x	x
Installed wattage	x			
Flow rates (gpm)		x	x	
Water heating system characteristics		x	x	x
Water Temperatures		x	x	x
Pipe length				x
Measure location	x	x	x	x

Table 15. Field and Phone Verification Sample

Program Measure	Number of Housing Units in Sample	Number of Measures Reported in Sample
LEDs	64	591
Bathroom Faucet Aerators	37	47
Kitchen Faucet Aerators	43	43
Showerheads	43	48
Pipe Wrap	30	169 ft

Source: Navigant analysis

A summary of findings from field verification is included in Section 4.3.

4.2.3 Tenant Surveys

Navigant incorporated supplemental findings from 34 tenant phone surveys to inform the impact analysis where applicable. The findings from the tenant surveys will be addressed later in this report.

4.3 Impact Evaluation Findings

The impact evaluation findings for lighting measures and water measures are discussed separately.

4.3.1 LED Lighting Measures

Table 16 shows a summary of Navigant's ex-post, verified findings for LEDs. To calculate verified energy and demand impacts, Navigant applied the parameters from Table 16 to the algorithms from Equation 1 and Equation 2.

Table 16. Summary of LED findings

Evaluation Parameter	Source	A-Line	Candelabra	Globe
In-Service Rate	Navigant field and phone verification	0.97	1.00	1.00
Baseline Lamp Wattage	Duke Energy	60	40	41
Efficient Lamp Wattage	Navigant field verification	9	5	6
Annual Operating Hours	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	1,001	888	888
Summer Coincidence Factor	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	0.07	0.11	0.11
Winter Coincidence Factor	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	0.13	0.16	0.16
$HVAC_C$	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	-0.0058	-0.0058	-0.0058
$HVAC_D$ (summer)	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	0.167	0.167	0.167
$HVAC_D$ (winter)	2018 Evaluation Report of DEO's Online Savings Store and Free LED programs	0	0	0
Gross Energy Savings Per Lamp (kWh)		48.9	30.9	30.5
Gross Summer Coincident Demand Savings Per Lamp (kW)		0.0040	0.0045	0.0044
Gross Winter Coincident Demand Savings Per Lamp (kW)		0.0064	0.0056	0.0055

Source: Navigant analysis, totals subject to rounding

The evaluated impacts per lamp shown in Table 16 differ from the deemed impacts shown in Table 11. SB 310 indicates that DEO can claim the higher of the two impacts for each measure. Table 17 shows the impacts claimable for each LED measure under SB 310, which include the higher impact for each measure from Table 11 or Table 16.

Table 17. LED Impacts Claimable Under SB 310

Program Measure	A-Line	Candelabra	Globe
Gross Energy Savings Per Lamp (kWh)	50.7	30.9	30.5
Gross Summer Coincident Demand Savings Per Lamp (kW)	0.0049	0.0045	0.0044
Gross Winter Coincident Demand Savings Per Lamp (kW)	0.0093	0.0056	0.0055

Source: Navigant analysis, totals subject to rounding

4.3.1.1 In-Service Rate

At the 36 housing units inspected by Navigant that had LEDs, there were a total of 262 reported program LEDs in the tracking database. During the inspections, Navigant found 257 of the program LEDs. Additionally, during phone surveys with tenants, Navigant interviewed customers representing an additional 329 LEDs, and respondents indicated having removed 10 program LEDs for reasons ranging from burnout to personal preference. Navigant used a weighted average to combine the ISR from field verification with the ISR from phone surveys to calculate a final ISR.

4.3.1.2 Wattage

Duke Energy provided Navigant with wattage data from lamps removed during the retrofit process. This data was collected by Franklin Energy from a sample of participant sites. Since this program is a direct install program, we used this data for the baseline wattage in the impact calculations.

4.3.1.3 Waste Heat and Coincidence Factors

Navigant used the waste heat factors from the DEO's 2018 evaluation of the Online Savings Store and Free LED programs.

4.3.1.4 Lighting Hours of Use

Navigant used the annual hours of use from the DEO's 2018 evaluation of the Online Savings Store and Free LED programs. Those evaluations included lighting logger studies in the DEO territory, and results were similar to those found in the 2015 Indiana TRM.

4.3.1.5 Effect of Baseline Wattage Requirements for EISA

Due to the EISA standards and changing market for lighting, the baseline wattage for energy efficiency lighting programs will continue to decrease. If Duke Energy continues to collect baseline wattage information from removed lamps during the retrofit process, Navigant believes it is reasonable to use those values in future evaluations as necessary because this is a direct install program. In the absence of baseline data, it will be reasonable to incorporate EISA standards into baseline wattage values.

4.3.2 Water Flow Regulation Measures

For field verification of program water measures, Navigant collected information to validate the efficiency characteristics of the equipment. This included verifying the reported number of measures and specified flow rates of the retrofit equipment.

4.3.2.1 In-Service Rate

The ISRs for water measures are shown in Table 18. These were calculated using a weighted average of results from the onsite field verification inspections and the tenant phone surveys.

Table 18. In-Service Rates for Water Measures

Measure	ISR
Kitchen aerators	0.95
Bathroom aerators	0.87
Showerheads	0.98
Pipe wrap	0.96

Source: Navigant analysis, values subject to rounding

4.3.2.2 Energy Savings

To calculate verified savings for aerators and showerheads, Navigant used the algorithms from the 2015 Indiana Technical Reference Manual, shown in Equation 3, Equation 4, Equation 5 and Equation 6.[5] Navigant subsequently applied inputs collected during field verification or assumptions as listed below in Table 19. The resulting estimates for impacts of aerators and showerheads are presented in Table 20.

Equation 3. Algorithm for Calculating Energy Savings for Faucet Aerators

$$\textit{Annual kWh savings faucet aerators} = ISR \times (GPM_{base} - GPM_{low}) \times \text{MPD} \times \frac{PH}{FH} \times DR \times 8.3 \frac{Btu}{gal \cdot °\text{F}} \times (T_{mix} - T_{in}) \times \frac{365 \frac{days}{yr}}{RE \times 3,412}$$

Equation 4. Algorithm for Calculating Energy Savings for Showerheads

$$\textit{Annual kWh savings for low flow showerheads} = ISR \times (GPM_{base} - GPM_{low}) \times MS \times SPD \times \frac{PH}{FH} \times 8.3 \frac{Btu}{gal \cdot °\text{F}} \times (T_{mix} - T_{in}) \times \frac{365 \frac{days}{yr}}{RE \times 3,412}$$

Equation 5. Algorithm for Calculating Coincident Demand Savings for Faucet Aerators

$$\textit{Coincident kW savings for faucet aerators} = ISR \times (GPM_{base} - GPM_{low}) \times 60 \times DR \times 8.3 \frac{Btu}{gal \cdot °\text{F}} \times \frac{(T_{mix} - T_{in})}{RE \times 3,412} \times CF$$

Equation 6. Algorithm for Calculating Coincident Demand Savings for Showerheads

$$\textit{Coincident kW savings for low flow showerheads} = ISR \times (GPM_{base} - GPM_{low}) \times 60 \times 8.3 \frac{Btu}{gal \cdot °\text{F}} \times \frac{(T_{mix} - T_{in})}{RE \times 3,412} \times CF$$

[5] Navigant believes the Indiana TRM is the most appropriate regional source to use for this evaluation because it includes calculation parameters that are specific to the multifamily housing segment.

Table 19. Input Parameters and Assumptions for Aerator Savings Calculations

Input	Definition	Value	Source
ISR	In-service rate	Refer to Table 18	Navigant field verification and phone surveys
GPM_{base}	Baseline flow rate	Bathroom Aerators 2.0 Kitchen Aerator 2.2 Shower 2.5	Data Provided by Duke Energy from Franklin Energy Sample
GPM_{low}	Retrofit flow rate	Bathroom Aerators 1.0 Kitchen Aerator 1.0 Shower 1.5	Navigant field verification[a]
MPD	Minutes of aerator use per day	Kitchen 4.5 Bathroom 1.6	2015 Indiana TRM
MS	Minutes of shower use per person per shower	7.8	2015 Indiana TRM
PH	Number of people per household	1.83	2015 Indiana TRM
FH	Average number of aerators or showerheads per household	Kitchen 1.0 Bathroom 1.1 Shower 1.0	Navigant field verification
SPD	Number of showers per person per day	0.6	2015 Indiana TRM
DR	Percent of water flowing down drain	Kitchen 50% Bathroom 70% Shower 100%	2015 Indiana TRM
T_{mix}	Temp of water flowing from faucets (F)	Kitchen 93 Bathroom 86 Shower 101	2015 Indiana TRM
T_{in}	Temp of water entering water heater (F)	60	Building American Benchmark annual mains temp for Cincinnati
RE	Recovery efficiency of water heater	0.98	2015 Indiana TRM
CF	Coincidence Factor	Kitchen 0.0033 Bathroom 0.0012 Shower 0.0023	2015 Indiana TRM
60	Minutes per hour		

a. *Navigant measured flow rates during onsite field verification and found them to be lower than the nameplate value of the program devices. However, since the baseline values provided by Duke Energy are also nameplate and the Indiana TRM equation does not include a throttling factor, Navigant used the nameplate flow rates for impact calculations.*

Table 20. Verified Per Unit Impacts for Aerators and Showerheads[6]

Measure	Kitchen aerator (1.0 GPM)	Bathroom aerator (1.0 GPM)	Low flow showerhead (1.5 GPM)
Gross Energy Savings Per Device (kWh)	139.3	39.5	308. 8
Gross Summer Coincident Demand Savings Per Device (kW)	0.0092	0.0028	0.0136
Gross Winter Coincident Demand Savings Per Device (kW)	0.0092	0.0028	0.0136

Source: Navigant analysis, values subject to rounding

The evaluated impacts for aerators and showerheads shown in Table 20 differ from the ex-ante values shown in Table 13. SB 310 indicates that DEO can claim the higher of the two impacts for each measure. Table 21 shows the impacts claimable for each measure under SB 310, which include the higher impact for each measure from.

Table 21. Aerator and Showerhead Impacts Claimable Under SB 310

Measure	Kitchen aerator (1.0 GPM)	Bathroom aerator (1.0 GPM)	Low flow showerhead (1.5 GPM)
Gross Energy Savings Per Device (kWh)	139.3	58.7	339.0
Gross Summer Coincident Demand Savings Per Device (kW)	0.0154	0.0077	0.0279
Gross Winter Coincident Demand Savings Per Device (kW)	0.0221	0.0111	0.0390

Source: Navigant analysis, values subject to rounding

4.3.3 Water Heater Pipe Wrap

During field verification, Navigant found some instances where pipe wrap was installed at lengths greater than three feet on the cold water pipe. Industry standards are to install pipe wrap on all hot water pipes, and only the first three feet of the cold-water pipe because savings are minimal from insulating cold water pipes.[7] Therefore, when calculating the ISR, Navigant did not attribute savings to greater than three feet of pipe wrap installed on cold water pipes.

To estimate impacts from the pipe wrap measure, Navigant used algorithms from the 2015 Indiana TRM shown in Equation 7 and Equation 8 below. The ex-post impacts are shown Table 22.

Equation 7. Energy savings for water heater pipe wrap

$$\Delta kWh = ISR \times \left(\frac{1}{R_e} - \frac{1}{R_n}\right) \times (L \times C) \times \Delta T \times 8760 \div nDHW \div 3413$$

[6] The program may offer aerators and showerheads at other flow rates in the future. However, the tracking data indicated that 100 percent of the water measures installed during the period covered by this evaluation cycle were the flow rates shown in **Table 20**, so a verified savings are shown here for only those measures.

[7] In apartments, Navigant recognizes there's a higher likelihood of limited exposed pipe, therefore pipe wrap may be found on both the hot and cold inlet pipes. http://www.energy.gov/energysaver/projects/savings-project-insulate-hot-water-pipes-energy-savings

Equation 8. Demand savings from water heater pipe wrap

$$\Delta kW = \Delta kWh \div 8760$$

The following list defines the parameters used in the equations above:

ISR = in-service rate (0.96 from Navigant field and phone verification)
R_e = R-value of existing, uninsulated pipe (R = 1 from Indiana TRM)
R_n = insulation R-value of pipe after retrofit (R = 3 from Indiana TRM)
L = length of pipe (per foot)
C = circumference of pipe (Navigant assumed average of 0.5" and 0.75" diameter pipe)
ΔT = temperature difference between water in pipe and ambient air (65F from Indiana TRM)
nDHW = heat recovery efficiency (0.98 from Indiana TRM)
3,413 = conversion from Btu to kWh

Table 22. Verified Impacts for Water Heater Pipe Wrap

Measure	Water Heater Pipe Wrap (per foot)
Gross Energy Savings Per Foot (kWh)	17.8
Gross Summer Coincident Demand Savings Per Foot (kW)	0.0020
Gross Winter Coincident Demand Savings Per Foot (kW)	0.0020

Source: Navigant analysis, values subject to rounding

Table 23 shows the pipe wrap impacts claimable under SB 310, which match the ex-ante values shown in Table 13 because the ex-ante values are the higher of the two.

Table 23. Pipe Wrap Impacts Claimable Under SB 310

Measure	Water Heater Pipe Wrap (per foot)
Gross Energy Savings Per Foot (kWh)	51.5
Gross Summer Coincident Demand Savings Per Foot (kW)	0.0059
Gross Winter Coincident Demand Savings Per Foot (kW)	0.0059

Source: Navigant analysis, values subject to rounding

5. NET-TO-GROSS ANALYSIS

Navigant conducted an NTG analysis to estimate the share of program savings that can be attributed to participation in or influence from the program. Table 24 shows the results of Navigant's NTG analysis. Navigant anticipated low free ridership and spillover given that the program is structured to offer energy efficient equipment at no cost to multifamily housing units, which are typically not owner-occupied. The results shown here are in line with expectations and very similar to our previous evaluations of this program. Navigant chose to present a program-level NTG ratio rather than measure level due to the difficulty in estimating spillover by measure. Navigant believes it is more appropriate to present the NTG ratio in aggregate.

Table 24. NTG Results

Estimated Free Ridership	3.5%
Estimated Spillover	1.3%
Estimated NTG	0.98

Source: Navigant analysis, values subject to rounding

5.1 Overview of Net-to-Gross Methodology

As indicated in the evaluation plan, Navigant used a survey-based, self-report methodology to estimate free ridership and spillover for the Multifamily Energy Efficiency Program. A self-report approach is outlined in the Universal Methods Protocol (UMP), and Navigant has previously used this method to estimate a NTG ratio for several other Duke Energy programs. Navigant primarily targeted property managers for the NTG surveys, because they are the decision makers for participation in the program.[8] Navigant also incorporated supplemental data gathered during tenant phone surveys into the analysis.

5.1.1 Definitions of Free Ridership, Spillover, and NTG Ratio

The methodology for assessing the energy savings attributable to a program is based on a NTG ratio. The NTG ratio has two main components: free ridership and spillover.

Free ridership is the share of the gross savings that is due to actions participants would have taken anyway (i.e., actions that were not induced by the program). This is meant to account for naturally occurring adoption of energy efficiency measures. The Multifamily Energy Efficiency Program and most other Duke Energy programs cover a wide range of energy efficiency measures and are designed to advance the overall energy efficiency market. However, it is likely that, for various reasons, some participants would have wanted to install some high-efficiency measures even if they had not participated in the program or been influenced by the program in any way.

Spillover captures program savings that go beyond the measures installed through the program. Also called market effects, the term spillover is often used because it reflects savings that extend beyond the bounds of the program records. Spillover adds to a program's measured savings by incorporating indirect (i.e., non-incentivized) savings and effects that the program has had on the market above and beyond the directly incentivized or directly induced program measures.

[8] Navigant recognizes that some property managers may have been instructed to participate by higher-level decision makers at the corporate level. Although we do not think this was the case very often, we do think that the local property managers were still privy to the decision-making process.

The overall NTG ratio accounts for both the net savings at participating projects and spillover savings that result from the program but are not included in the program's accounting of energy savings. When the NTG ratio is multiplied by the estimated gross program savings, the result is an estimate of energy savings that are attributable to the program (i.e., savings that would not have occurred without the program). The NTG formula is shown in Equation 9:

Equation 9. Net-to-Gross Formula

$$NTG = 1 - free\ ridership + spillover$$

The underlying concept inherent in the application of the NTG formula is that only savings caused by the program should be included in the final net program savings estimate but that this estimate should include all savings caused by the program.

5.1.2 Estimating Free Ridership

Data to assess free ridership was gathered through the self-report method using a series of survey questions asked to the property managers at participating properties. The survey assessed free ridership using both direct questions, which aimed to obtain respondent estimates of the appropriate free ridership rate that should be applied to them, and supporting or influencing questions, which could be used to verify whether the direct responses were consistent with participants' views of the program's influence.

Each respondent to the survey provided perspectives on the measures that they had installed through the program. The core set of questions addressed the following three categories:

- **Likelihood:** To estimate the likelihood that they would have incorporated measures "of the same high level of efficiency," if not for the assistance of the program. In cases where respondents indicated that they might have incorporated some but not all of the measures, they were asked to estimate the share of measures that would have been incorporated anyway at high efficiency. This flexibility in how respondents could conceptualize and convey their views on free ridership allowed respondents to give their most informed response, thus improving the accuracy of the free ridership estimates.
- **Prior planning:** To further estimate the probability that a participant would have implemented the measures without the program. Participants were asked the extent to which they had considered installing the energy efficient measure prior to participating in the program. The general approach holds that if customers were not definitively planning to install all of the efficiency measures prior to participation then the program can reasonably be credited with at least a portion of the energy savings resulting from the high-efficiency measures. Strong free ridership is reflected by those participants who indicated they had already allocated funds for the purchase and selected the equipment and an installer.
- **Program importance:** To clarify the role that program components (e.g., information, incentives) played in decision-making and to provide supporting information on free ridership. Responses to these questions were analyzed for each respondent, not just in aggregate, and were used to identify whether the direct responses on free ridership were consistent with how each respondent rated the influence of the program.

Free ridership scores were calculated for each of the three categories.[9] Navigant then calculated a weighted average from each respondent based on their share of sample energy savings, and divided by 100 to convert the scores into a free ridership percentage. Next, a timing multiplier was applied to the average of the three scores to reflect the fact that respondents indicating that their energy efficiency actions would not have occurred until far into the future may be overestimating their level of free ridership. Participants were asked when they would have installed the equipment without the program. Respondents who indicated that they would not have installed the equipment for at least two years were not considered free riders and received a timing multiplier of 0.[10] If they would have installed at the same time as they did, they received a timing multiplier of 1; within one year, a multiplier of 0.67; and between one and two years, a multiplier of 0.33. Participants were also asked when they learned about the financial incentive; if they learned about it after the equipment was installed then they received a timing multiplier of 1.

5.1.3 Estimating Spillover

The basic method for assessing participant spillover was an approach that asked a set of questions to determine the following:

- **Whether spillover exists at all.** These were yes-or-no questions that asked, for example, whether the respondent incorporated energy efficiency measures or designs that were not recorded in program records and did not receive any rebates from Duke Energy.
- **The savings that could be attributed to the influence of the program.** Participants were asked to list the extra measures they installed, and the evaluation team assigned a savings value. See below for the method of assigning savings.
- **Program attribution**. Estimates were derived from a question asking the program importance on a 0 to 10 scale. Participants were also asked how the program influenced their decisions to incorporate additional energy efficiency measures.

If respondents said no, they did not install additional measures, they were assigned a 0 score for spillover. If they said yes, then Navigant estimated the energy spillover savings on a case-by-case basis.

[9] Scores were calculated by the following formulas:

- Likelihood: The likelihood score is 0 for those that "definitely would NOT have installed the same energy efficient measure" and 1 for those that "definitely WOULD have installed the same energy efficient measure." For those that "MAY HAVE installed the same energy efficient measure," the likelihood score is their answer to the following question: "On a scale of 0 to 10, where 0 is DEFINITELY WOULD NOT have installed and 10 is DEFINITELY WOULD have installed the same energy efficient measure, can you tell me the likelihood that you would have installed the same energy efficient measure?" If more than one measure was installed in the project, then this score was also multiplied by the respondent's answer to what share they would have done.
- Prior Planning: If participants stated they had considered installing the measure prior to program participation, then the prior planning score is the average of their answers to the following two questions: "On a scale of 0 to 10, where 0 means you 'Had not yet planned for equipment and installation' and 10 means you 'Had identified and selected specific equipment and the contractor to install it,' please tell me how far along your plans were" and "On a scale of 0 to 10, where 0 means 'Had not yet budgeted or considered payment' and 10 means 'Already had sufficient funds budgeted and approved for purchase,' please tell me how far along your budget had been planned and approved."
- Program Importance: This score was calculated by taking the maximum importance on a 0 to 10 scale of the four program importance questions and subtracting from 10 (i.e., the higher the program importance, the lower the influence on free ridership).

[10] Navigant believes a two-year horizon is appropriate for assessing free ridership as it likely reduces certain types of bias and it becomes difficult for respondents to predict behavior beyond that horizon.

It is important to note that although free ridership questions were only asked of property managers, Navigant surveyed both property managers and tenants for spillover.[11]

5.1.4 Combining Results Across Respondents

The evaluation team determined free ridership estimates for each of the following:

- Individual respondents, by evaluating the responses to the relevant questions and applying the rules-based approach discussed above.
- The program as a whole, by taking a weighted average of the individual results based on each respondent's share of reported energy savings.

5.2 Results for Free Ridership, Spillover, and Net-to-Gross

5.2.1 Review of Data Collection Efforts for Attribution Analysis

Surveys were conducted with decision makers to provide the information to estimate free ridership, and thus, NTG ratios. Navigant completed surveys with 4 property managers, who represented 5 of the 18 participating properties.[12]

5.2.2 Free Ridership Results

As described above, surveyed participants responded to a series of questions intended to elicit explicit estimates of free ridership, as well as ratings of program influence. Estimates are based on questions regarding the likelihood, scope, and timing of the investments in energy efficiency if the respondent had not participated in the program. For the Multifamily Energy Efficiency Program, free ridership was estimated at 3.5 percent, which is in-line with other evaluations of direct install programs.

Navigant developed the free ridership estimate presented above based on responses to a variety of questions that related to survey respondents' intentions prior to participating in the program and to the influence of the program itself. Below are summaries by scoring component.

Prior Planning: Two of the respondents indicated they had some level of prior plans for installing some of the energy efficient measures, but both indicated their plans were not well-developed. The other two respondents indicated that they did not have plans.

Program Importance: Respondents stated that the program was very important in having the measures installed. All property managers noted that their decision to install energy efficient equipment at their property was highly influenced by Duke Energy's program.

Likelihood: Respondents were asked in the absence of the program, if they would have had at least some of the work done. One respondent stated they "definitely would have" installed the water measures in the absence of the program because he/she was responsible for water payments, and three said they "definitely would not have" installed any measures in the absence of the program.

[11] The reason for not assessing free ridership at the tenant level is because tenants generally participated in the program via their property managers rather than personal choice. It is possible that tenants would have installed the same measures themselves, but Navigant does not believe they should be considered free riders to the program because the timing of those installations would have been difficult to evaluate and tenants would still have the ability to install LEDs in non-retrofitted fixtures. If a tenant already had equivalent measures in place, it is unlikely that the implementer would have replaced them with program measures.

[12] One property manager was responsible for two properties.

Timing: The respondent who stated they would have done some of the work in the absence of the program stated the installation would have occurred within one year, but that the work would have only applied to water measures and not LED measures.

In summary, respondents indicated that the program was very important in their decisions to have the energy efficient measures installed. Some indicated that they did have some prior plans to install the measures, and the free ridership estimates account for those responses.

5.2.3 Spillover Results

One of the surveyed property managers indicated that the program influenced him/her to install additional, non-incentivized energy efficiency measures at the property. The additional measures included a small number of LEDs in outdoor spaces. In addition to the one property manager reporting spillover, a few tenants reported installing a small number of LEDs and reducing the hours they use their lights as a result of participating in the program.

Navigant estimated spillover from the equipment reported by property managers and tenants by applying simple engineering equations along with the self-reported measure quantities and characteristics. Navigant calculated the total spillover to be 1.3 percent.

5.2.4 NTG Results

The NTG ratio was calculated as written in Equation 10:

Equation 10. Net-to-Gross Ratio

$$NTG = 1 - free\ ridership + spillover = 1 - 0.035 + 0.013 = 0.978$$

This suggests that for every one kWh reduced from program measures, about 0.98 kWh of savings can be directly attributed to the program.

6. PROCESS EVALUATION

Navigant conducted a process evaluation of the Multifamily Energy Efficiency Program to assess program delivery and customer satisfaction. The process findings summarized in this section are based on the results of customer surveys with 34 program participants, and detailed surveys with 4 property managers. The property manager interviews and tenant surveys were also used to inform the NTG analysis.

6.1 Key Findings

Overall, property managers and tenants are pleased with the program. Some key findings from the property manager interviews and tenant phone surveys are listed below:

- Most tenants (71 percent) learned about the program through their property managers, while about 3 percent of tenants reported learning about the program through Duke Energy's website. Some participants also recall learning about the program because they saw representatives onsite, indicating that onsite visits are an effective way of marketing the program and reaching new customers.
- 32 percent of tenants reported they noticed savings on their energy bills since the installation of the measures, but 26 percent are unsure if their bill has decreased. The phone survey was conducted shortly after the measure installations at some properties, meaning some customers may not have recognized savings at the time of the survey.
- A majority of program tenants were satisfied with the program. On a scale of 0 to 10, where 0 indicates "very dissatisfied" and 10 indicates "very satisfied":
    - About 62 percent of tenants reported an 8 -10 satisfaction score with the overall program. The mean satisfaction score was 8.1 out of 10.
    - About 71 percent of tenants indicated 8 - 10 for satisfaction with the installer's quality of work.
    - About 79 percent of tenants indicated 8 - 10 for satisfaction with Duke Energy.
- High satisfaction ratings by tenants were often associated with money savings as the primary benefit. Low satisfaction ratings were often associated with complaints about the equipment, such as low water pressure and water spray from aerator measures.
- Tenant satisfaction was higher for pipe wrap and kitchen faucet aerators than for LEDs, low flow showerheads and bathroom faucet aerators.
- On a scale of 0 to 10, where 0 indicates "very dissatisfied" and 10 indicates "very satisfied", the average satisfaction rating from property managers was 7.8 for the program.
- Property managers expressed high satisfaction with the free program measures and free installation by an external contractor. Property managers noted the contractor's quality of work as "efficient."
- Three out of the four property managers mentioned they were slightly frustrated with the number of requests to audit the installation of program measures.
    - "It seems like there are a lot of people wanting to come back to review. I have to keep bothering the tenants. A third party has gone onsite twice to audit this year."
    - "There were multiple requests to come back and get into the units."

- One property manager indicated that installation staff did not properly install aerator equipment, which resulted in leaks.
- General suggestions for program improvement from property managers and maintenance staff included adding exterior or common space lighting.

6.2 Documentation Review

Navigant requested program documentation and tracking data to conduct a complete review of current processes. The program tracking data was sufficient to identify the measure characteristics and quantities of installed measures for each tenant at the participating properties.

Navigant performed a detailed review of the following:

Multifamily Energy Efficiency Program Direct Installation Service Agreement – this document provides a reasonable summary of program expectations, eligibility requirements for each measure, and customer responsibilities. However, it does not include any mention of subsequent EM&V activities, which may be an added benefit for facilitating efficient EM&V.

Site Assessment Reports – these documents include a summary of program measure characteristics and facility floorplan information for each participating property.

6.3 Coordination with Duke Energy Program Manager and Franklin Energy Implantation Staff

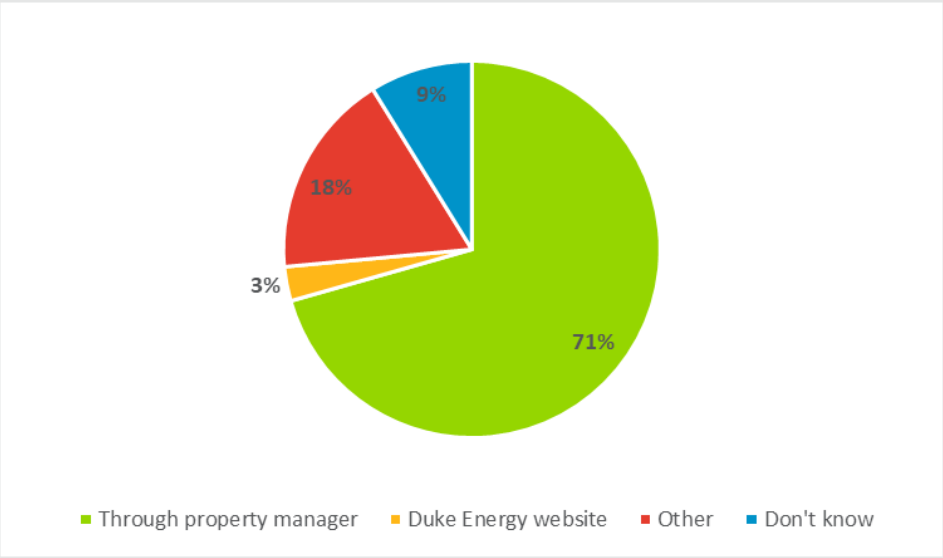
Navigant coordinated with Duke Energy's program manager and Franklin Energy implementation staff while recruiting for onsite field verification. Both were helpful with assisting Navigant in customer outreach for EM&V.

6.4 Tenant Surveys

Navigant conducted phone surveys with 34 residential tenants to assess program satisfaction. Navigant had the goal of receiving 60 survey responses. However, due to limited sample and numerous call back attempts through a survey house, overall survey completes fell short of the target. The surveys contained a number of questions to assess satisfaction with program participation, satisfaction with new equipment, as well as questions to assess measure baseline and any measures removed by the tenant after participation. This section discusses findings gleaned from survey results.

It is critical for programs to be aware of their marketing channels, as outreach leads to continued participation, so several questions in the tenant survey and property manager interviews were included to address this. Figure 3 show how tenants learned about the program. Survey results showed tenant participants were asked to indicate all of the sources through which they learned about the program, and about 71 percent indicated they had learned about the program through property managers as would be expected given the program model and design. Tenants also indicated they learned about the program through Duke Energy's website, and other resources, which includes mail, phone, and in-person installers who visit the location to install equipment.

Figure 3. How Tenant Learned About the Program (n=34)



Source: Navigant analysis, values subject to rounding

Survey results revealed customer satisfaction with the program is high. On a scale of 0 to 10, where 0 indicates "very dissatisfied" and 10 indicates "extremely satisfied," about 6 out of 10 tenants rated satisfaction with the program as an 8-10 as shown in Figure 4. The average overall tenant satisfaction rating with the program was 8.1 out of 10. Verbatim responses reflected this high satisfaction rating.

- "I think it is a great thing to do. I save money and it's good for the environment."
- "Because it has saved me money on my bill, dramatically."

Some participants ranked their overall satisfaction low because they disliked the products or did not recognize monetary savings from their participation.

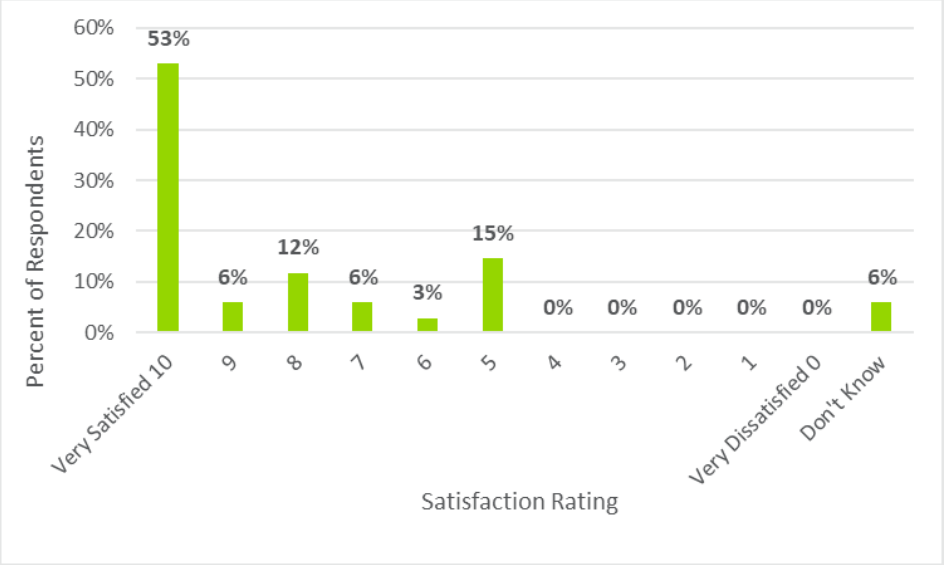
- "Duke Energy doesn't send out notices, practical mathematical numbers regarding what you should see as expected in energy savings. They don't tell you what kind of LEDs you are getting."
- "Because, again, I knew about the equipment long before [the] landlord [participated in the] program, and the [LEDs I bought myself] are better."
- "I don't have many complaints. I did not give it a 10 because I did not see any cut back on energy."

Figure 4. Tenant Satisfaction with Overall Program Experience (n=34)

Source: Navigant analysis, values subject to rounding

Tenant satisfaction with the contractor quality of work was also high, as shown by Figure 5. The mean satisfaction rating for the contractor's quality of work was 8.6 out of 10. No participant expressed dissatisfaction with the quality of the installation.

Figure 5. Tenant Satisfaction with Contractor's Quality of Work (n=34)

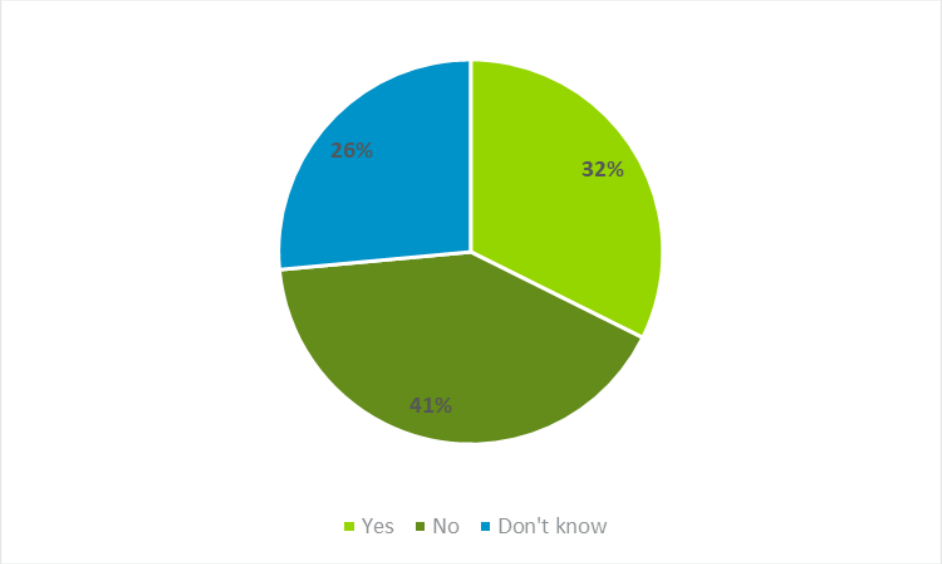


Source: Navigant analysis, values subject to rounding

As shown in Figure 6, 32 percent of tenants noticed a decrease in their energy bills after the new measures were installed, while 26 percent are unsure if they are saving energy. The surveys were conducted shortly after the measure installations at some properties, which may explain why some tenants may not have recognized monetary savings. Nevertheless, 41 percent of tenants did not notice a

decrease in their bill. This represents an opportunity for Duke Energy to communicate energy savings to tenants and help provide them with guidance and tips to save energy and water after the new measure have been installed in their home.

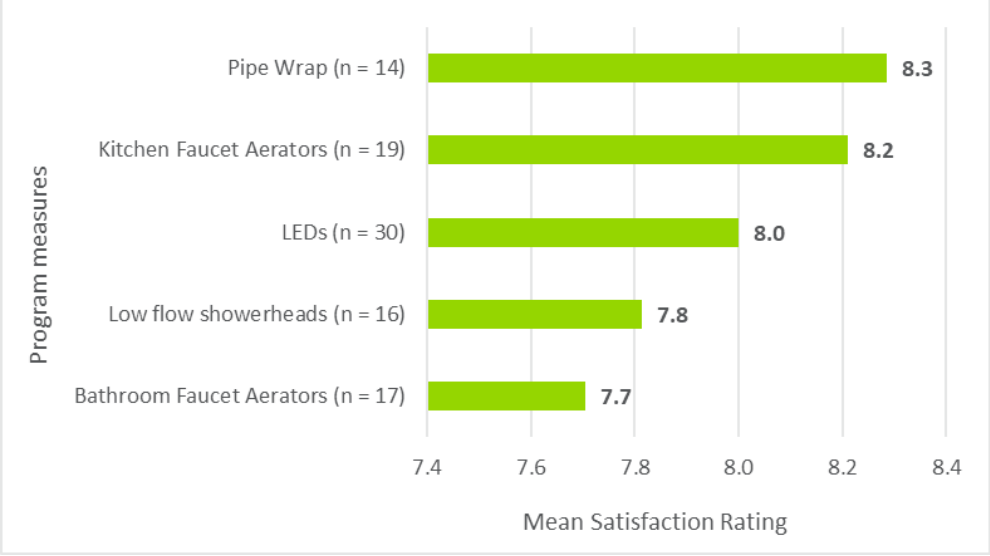
Figure 6. Tenants Who Noticed a Decrease in Their Energy Bill After Installing Program Measures (n=34)



Source: Navigant analysis, values subject to rounding

While a majority of tenants were satisfied with the new measures, some were not. Navigant asked the tenants to rate their satisfaction for each measure installed in their home. Average satisfaction ratings ranged across the product offering. Pipe wrap received the highest overall satisfaction rating, 8.3 out 10. On the other hand, bathroom faucet aerators received the lowest satisfaction rating, 7.7 out of 10.

Figure 7. Tenant Satisfaction Rating for Each Measure



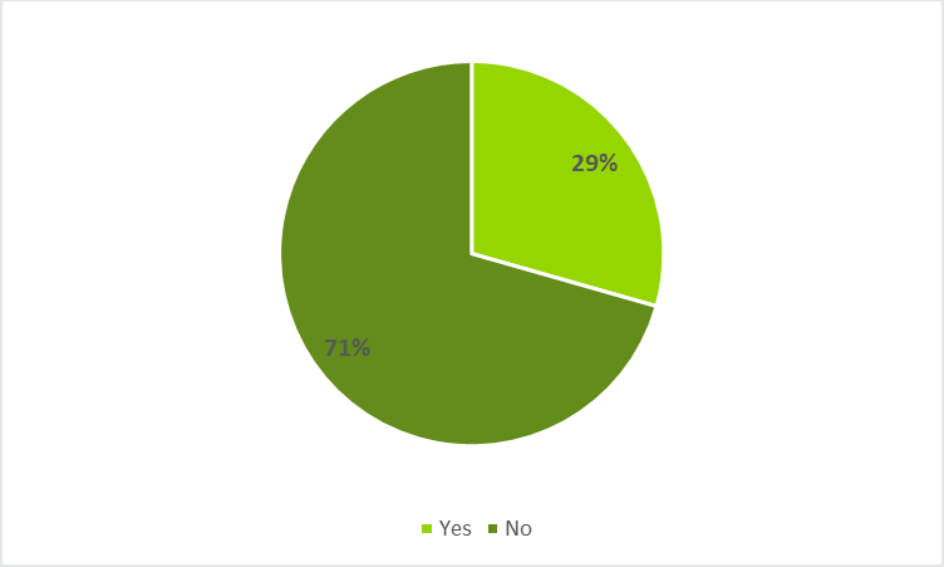
Source: Navigant analysis, values subject to rounding. Don't know responses were excluded from analysis.

Tenants expressed slight dissatisfaction with bathroom and kitchen faucet aerators as well as low flow showerheads due to poor water pressure or leaks. Some respondents were less satisfied with the LEDs because they disliked dim lighting. However, these were isolated responses, and overall customers are pleased with the products.

Despite slight dissatisfaction with some program measures, a small percentage of tenants reported removing some of their program measures. Three respondents reported removing a total of 10 LEDs, for a few different reasons. One respondent removed lamps because they burned out. One respondent removed lamps because they were not bright enough. One respondent disliked the quality of the product. Although some tenants expressed dissatisfaction for low flow showerheads and bathroom faucet aerators, LEDs were the only type of program measure that customers removed.

As a result of particpation in the program, some tenants (29 percent) purchased additional energy efficiency equipment where they did not receive a rebate, as shown in Figure 8.

Figure 8. Tenants Who Purchased Additional Energy Efficient Equipment (n = 10)



Source: Navigant analysis, values subject to rounding.

Of the tenants who reported purchasing additional energy efficient equipment, most tenants (60 percent) indicated they made a behavior change, while 30 percent purchased additional LEDs. The primary motivation for customers decision to purchase additional equipment and to change their behavior is to save energy and money.

When asked how important program participation was in their decision to install additional energy efficiency measures, the mean importance rating was 6.2 out of 10, indicating that the program partially influenced tenants. As discussed previously, Navigant incorporated these responses into the spillover calculations used in the NTG analysis.

6.4.1.1 Participant Suggestions

Navigant also included a question in the tenant satisfaction survey that allowed respondents to offer suggestions for improving the program. About 21 percent of respondents offered suggestions, which can be summarized as follows:

- Several respondents asked for more information about the program and better advertising of the program.
- Two tenants requested that different types of light be offered through the program, but did not offer specific suggestions.
- One respondent suggested having a different type of showerhead available as the low flow showerhead product had inconsistent water pressure.
- One respondent requested offering windows as a new program measure.

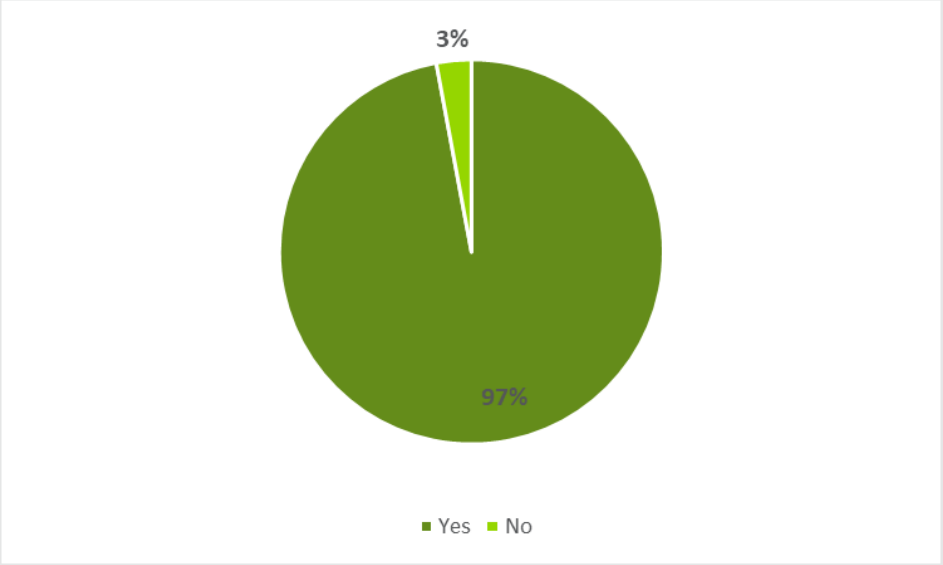
6.4.1.2 Participant Familiarity with Duke Energy

Navigant asked tenants a series of questions about their perception of Duke Energy and their awareness of other Duke Energy programs. As shown in Figure 9, 97 percent of respondents said they consider Duke Energy as a resource for energy efficiency information, positively reflecting on the utility. When asked why they consider Duke Energy to be a resource for information, verbatim responses indicated that tenants trust Duke Energy to provide them with exceptional customer service and reliable information.

- "I would say because they never let me down."
- "When I call them and work with them, they give you knowledgeable information."
- "Because they take the initiative to change all the lights and the water and to save money on energy."

One respondent, did not consider Duke Energy to be a trusted resource, indicating they, "don't trust I am getting the best rate for the services I get."

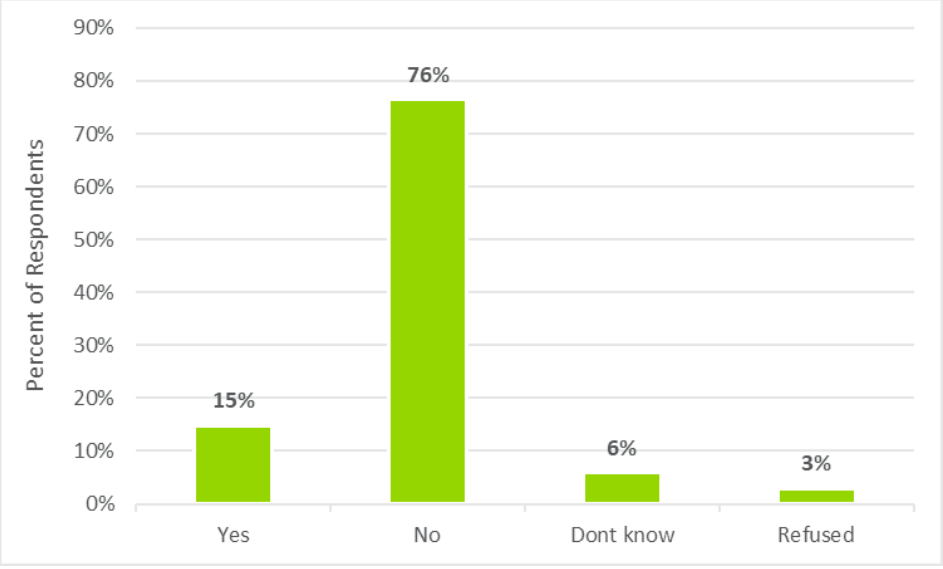
Figure 9. Tenants Who Consider Duke Energy a Resource for Energy Efficiency Information (n=34)



Source: Navigant analysis, values subject to rounding

When asked about their awareness of other Duke Energy programs, tenants were not able to list any other programs solutions, as shown in Figure 10. This represents a large opportunity for Duke Energy to increase channeling to drive awareness in other programs and increase participation across their portfolio.

Figure 10. Tenants Who Could Name Other Duke Energy Solutions/Programs to Help Them Save Energy and Money (n=34)



Source: Navigant analysis, values subject to rounding

Navigant also asked tenants about their preferences related to other technologies such as smart thermostats, solar and electric vehicles. Responses showed that:

- 18 percent of respondents currently have a smart thermostat (15% were unsure or preferred not to respond)
- Of the respondents who do not have a smart thermostat, about one out of every four are interested in smart thermostats
- Over half of respondents say they would like to see solar PV installed at their property
- None of the respondents currently own an electric vehicle (EV), but about 15 percent are interested in purchasing an EV in the future and about 9 percent of respondents are aware of EV charging stations at their properties

6.5 Property Manager Surveys

The evaluation team conducted interviews with property managers from the participating properties to assess decision-making (which will ultimately feed into the NTG analysis) and overall satisfaction with the program. The evaluation team interviewed four of the 16 property managers. Navigant made extensive attempts to complete additional interviews but faced numerous challenges when scheduling interviews. Some property managers expressed frustration towards the number of calls they had received for onsite visit verifications and interviews regarding their experience with the program (this includes QC inspections during the implementation phase). As a result, they refused to participate in EM&V site visits. This section presents details of the interviews Navigant was able to complete with property managers.

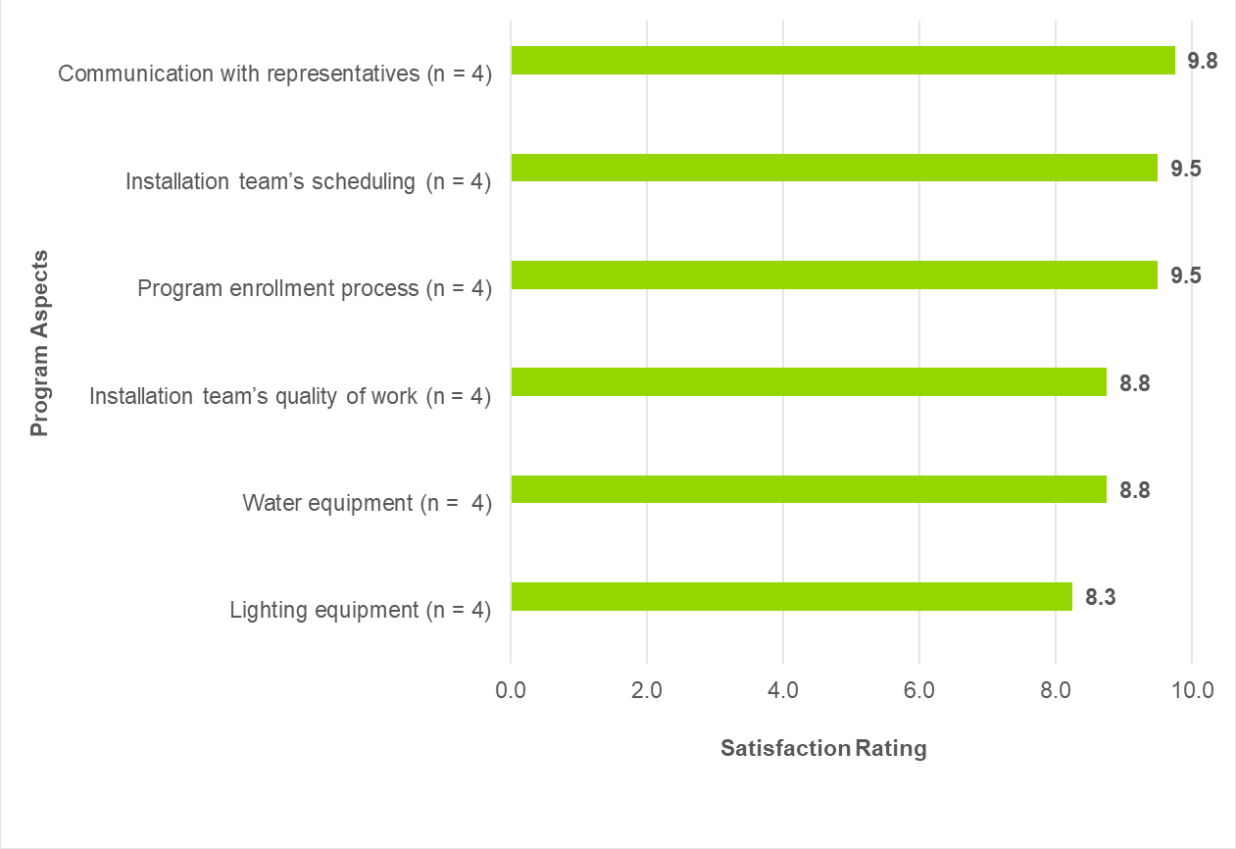
Property managers indicated the primary motivations for participating in the program included to save energy, to save water, to save money on utility/electric bills, and to improve tenant satisfactions. These motivations can help shape marketing and outreach materials.

Property managers reacted positively to their participation in the program and expressed high program satisfaction. When asked how they would rate their satisfaction on a 0 to 10 scale with 0 meaning “very dissatisfied” and 10 meaning “very satisfied”, the mean satisfaction rating for their overall experience with the program was 7.8 out of 10. This is slightly lower than the overall satisfaction rating provided by the tenants, and may be partially a result of the dissatisfaction property managers expressed due to numerous inspections during the implementation and EM&V process. Three out of four property managers expressed this in verbatim responses:

- “There were multiple requests to come back and get into the units [to inspect measures]. [I] probably would not do it again.”
- “The installation went very well. The people that did the installing did well. I did not like the follow-up audit. I was called on numerous times for a follow-up audit.”
- “It seems like there are a lot of people wanting to come back to review. I have to keep bothering the tenants.”

Overall, the property managers were very satisfied with specific aspects of the program. Communication with program representatives had the highest satisfaction rating of 9.8 out of 10 from property managers. On the other hand, tenant communications and program materials had the lowest satisfaction rating of 6.5 out of 10, as shown in Figure 11.

Figure 11. Satisfaction with Program Aspects (n = 4)



Source: Navigant analysis, values subject to rounding

Property managers were pleased with their interactions with program staff and the installation team. One property manager stated the installation team was, "really good and efficient. They all worked together." Property managers were less satisfied with LEDs because some bulbs had already burned out.

Property managers indicated they consider Duke Energy to be a resource for energy efficiency, rating Duke Energy on 8.3 out of 10. The property managers also indicated their decision to install the energy efficient equipment at the property was largely motivated by Duke Energy's program. The program influenced their decision to participate because it allowed them to install efficient LEDs and water measures much faster than they would have otherwise. All respondents indicated they would not have installed the same energy efficiency products and the same quantity without Duke Energy's technical and financial assistance, showing the program is very beneficial for property managers. As a result, property managers very likely to recommend the program to others. The average likelihood score was 9.3 out of 10.

6.5.1.1 Participant Suggestions

Navigant also captured any suggestions for improving the program from the property managers.

- Three out of four property managers suggested adding outdoor or common area lighting to the program, so they can continue to increase the energy efficiency of their property.

7. SUMMARY FORM

Multifamily Energy Efficiency Program

Completed EMV Fact Sheet

Description of program

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment to multifamily housing properties at no cost to the property managers or tenant end-users. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. Typically, measures are installed directly by the implementation contractor rather than tenants or onsite maintenance staff.

The program consists of lighting and water measures.

- **Lighting measures:** Light Emitting Diode (LED) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

Date:	December 26, 2019
Region:	Duke Energy Ohio
Evaluation Period	4/1/18 – 7/8/19
Annual kWh Savings	1,214,045 1,385,367 (adjusted for SB 310)
Per Participant kWh Savings	714 815 (adjusted for SB 310)
Net-to-Gross Ratio	0.98

Evaluation Methods

The evaluation team used engineering analysis and onsite field inspections as the primary basis for estimating program impacts. Additionally, telephone surveys were conducted with tenants and multifamily housing units to assess customer satisfaction and spillover. Detailed interviews were conducted with property managers to assess their decision-making process, and ultimately to estimate a net-to-gross ratio.

Impact Evaluation Details

- **Field inspections were conducted at 36 housing units.** The evaluation team inspected program equipment at 36 housing units to assess measure quantities and characteristics to be compared with the program tracking database.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 87% for bathroom aerators to 100% for candelabra and globe LED lamps.
- **Participants achieved an average of 714 kWh of energy savings per year, or 815 when adjusted to account for SB 310**.

8. CONCLUSIONS AND RECOMMENDATIONS

Navigant developed a few recommendations for Duke Energy to consider. These recommendations are intended to assist Duke Energy with enhancing the program delivery and customer experience, as well as to support future EM&V activities and possibly increase program impacts.

1. Navigant recommends that Duke Energy should adopt the ex post, per-unit energy and demand impacts from this evaluation and use them going forward. We recommend that Duke Energy use the impacts claimable under Ohio SB 310.
2. Duke Energy should consider improving the program materials distributed to tenants that describe the program measures and energy savings that might be achieved due to the installation of the new equipment. Communicating tips to save energy and water with the new equipment could increase customer satisfaction and continue to build the strong trust and rapport Duke Energy has established with their customer base.
3. Duke Energy should consider leaving a few cases of backup LED bulbs with property managers. LEDs were the only measure removed by tenants and burn out was the primary reason for the removal. Leaving additional LEDs with property managers could help increase the customer satisfaction rate for this measure.
4. Duke Energy should consider whether smart thermostats or other HVAC-related measures would be reasonable offerings for this program. About 25 percent of survey respondents who did not have a smart thermostat indicated they would like to get one. Also, three out of four property managers recommended adding exterior and common area lighting to the program, so they can continue to make their properties energy efficient.
5. Duke Energy should consider making modifications to the Multifamily Energy Efficiency Program Direct Installation Service Agreement to include information about EM&V activities that may occur in the months or years following program participation. Navigant experienced significant resistance from property managers while recruiting for onsite field verification and process evaluation interviews. Many property managers indicated they had already received multiple site visits during the implementation phase and subsequent QC inspections, and that it was a challenge to accommodate additional inspections and interviews for EM&V.

9. MEASURE-LEVEL INPUTS FOR DUKE ENERGY ANALYTICS

Navigant used the findings from field verification, surveys, and review of Duke Energy's deemed savings to estimate an updated set of deemed savings for Duke Energy to use for tracking program activity. Table 25 provides the measure-level inputs that can be used by Duke Energy Analytics for estimates of future program savings. The table includes both the evaluation findings and the adjusted impacts that can be claimed under SB 310.

Table 25. Gross Measure-Level Impacts

	Measure*	Unit Basis for Impacts	Annual Energy Savings Per Unit (kWh)	Annual Summer Coincident Demand Savings Per Unit (kW)	Annual Winter Coincident Demand Savings Per Unit (kW)
Evaluation Findings	A-Line LED	Per lamp	48.9	0.0040	0.0064
	Candelabra LED	Per lamp	30.9	0.0045	0.0056
	Globe LED	Per lamp	30.5	0.0044	0.0055
	Bathroom Faucet Aerator	Per aerator	39.5	0.0028	0.0028
	Kitchen Faucet Aerator	Per aerator	139.3	0.0092	0.0092
	Low Flow Showerhead	Per showerhead	308. 8	0.0136	0.0136
	Water Heater Pipe Wrap	Per foot	17.8	0.0020	0.0020
Impacts Claimable Under SB 310	A-Line LED	Per lamp	50.7	0.0049	0.0093
	Candelabra LED	Per lamp	30.9	0.0045	0.0056
	Globe LED	Per lamp	30.5	0.0044	0.0055
	Bathroom Faucet Aerator	Per aerator	58.7	0.0077	0.0111
	Kitchen Faucet Aerator	Per aerator	139.3	0.0154	0.0221
	Low Flow Showerhead	Per showerhead	339.0	0.0279	0.0390
	Water Heater Pipe Wrap	Per foot	51.5	0.0059	0.0059

Source: Navigant analysis, values subject to rounding

Multifamily DEO
DSMore table 26Dec

APPENDIX A. DETAILED SURVEY RESULTS

This appendix contains additional results from the property manager interviews and tenant surveys. It is meant as a supplement to other sections of the report.

A.1 Property Manager Interviews

Navigant conducted in-depth interviews with 4 property managers. This section presents additional details of the interviews that were not presented in the body of the report, section 6.5. The responses to each question shown are paraphrased to maintain confidentiality and summarize the key points. The information below described the properties that participated in the program.

Table 26. How many housing units does your property have?

Respondent #	Response
1	28
2	Facility 1: 40, Facility 2: 24
3	71
4	12

Source: Navigant analysis

Table 27. Can you tell me the approximate percentage of housing units at your facility that have the following number of bedrooms?

Respondent #	Response
1	One-bedroom: 97%, two-bedroom: 3%
2	Facility 1: One-bedroom: 90%, two-bedroom: 10% Facility 2: One-bedroom: 100%
3	One-bedroom: 50%, two-bedroom: 50%
4	One-bedroom: 50%, two-bedroom: 50%

Source: Navigant analysis

Table 28. Can you tell me the average number of occupants that live in a typical unit at your property?

Respondent #	Response
1	One-bedroom 1.5, two-bedroom 2
2	One-bedroom: 2, two-bedroom: 3
3	One-bedroom: 1, two-bedroom: 2
4	One-bedroom: 1, two bedrooms: 3

Source: Navigant analysis

Table 29. Can you tell me the low and high range for rent costs for a unit at your property?

Respondent #	Response
1	$500 - 700
2	Facility 1: $530 - 775 Facility 2: $515-749
3	$1084 - 1254
4	$425-750

Source: Navigant analysis

Table 30. Is there anything you would suggest to improve Duke Energy's Multifamily Energy Efficiency Program?

Respondent #	Response
1	Offer it to multifamily where landlords pay
2	Common area lighting
3	Nothing
4	The amount of time they keep wanting to come back is bothersome. Less of that would be great. Bothersome to tenants and bothersome for him to walk auditor around.

Source: Navigant analysis

APPENDIX B. TENANT SURVEY GUIDE

DUKE ENERGY MULTIFAMILY ENERGY EFFICIENCY PROGRAM
TENANT SATISFACTION SURVEY

This survey guide will be administered to residents who have received energy efficient equipment through Duke Energy's Multifamily Energy Efficiency Program (MEEP). The goal of the tenant satisfaction survey includes informing, updating and improving MEEP the. Recruiting calls for tenant surveys will be made between 10:00am-8:30pm ET on weekdays, and 10:00am-5:00pm ET on Saturdays. No calls are to be made on Sundays.

Company: _____ Telephone: _____
Name: _____ Cell phone: _____
Title: _____ Fax: _____
City: _____ State: _____ Zip: _____
Interview date: _____ Time: _____

[PROGRAMMER: INSERTS FOR "MEASURE(S)": (add MEASURE_NAME_# to sample)
IF LED_LIGHT_BULBS_1 ≥ 1, [INSERT MEASURE(S)] = "LED LIGHT BULBS"
IF BATHROOM_FAUCET_AERATORS_2 ≥ 1, [INSERT MEASURE(S)] = "BATHROOM FAUCET AERATORS"
IF KITCHEN_FAUCET_AERATORS_3 ≥ 1, [INSERT MEASURE(S)] = "KITCHEN FAUCET AERATORS"
IF HOT_WATER_HEATER_PIPE_WRAP_4 ≥ 1, [INSERT MEASURE(S)] = "HOT WATER HEATER PIPE WRAP"
IF LOW_FLOW_SHOWERHEADS_5 ≥ 1, [INSERT MEASURE(S)] = "LOW FLOW SHOWERHEAD"

INTRO **[IF COMPLEX_NAME = 2 USE THIS INTRO.]** **(individual - add "2"to sample)**
Hello, my name is (YOUR NAME) calling from Bellomy Research. I'm calling on behalf of DUKE ENERGY about the energy saving equipment that your landlord or property manager installed in your home as a part of a Duke Energy efficiency program. These may have included light bulbs, aerators, pipe wrap or showerheads. Is this the **[INSERT CONTACT_NAME FROM SAMPLE]** residence? (IF NOT AVAILABLE, SCHEDULE A CALLBACK.)

INTRO 2 **[IF COMPLEX_NAME = 1 USE THIS INTRO.]** **(complex – add to "1"sample)**
Hello, my name is (YOUR NAME) calling from Bellomy Research. I'm calling on behalf of DUKE ENERGY about the energy saving equipment that your landlord or property manager installed in your home as a part of a Duke Energy efficiency program. These may have included light bulbs, aerators, pipe

wrap or showerheads. Do you reside at a property managed by **[INSERT CONTACT_NAME FROM SAMPLE]**? (IF NOT AVAILABLE, SCHEDULE A CALLBACK.)

SC1. Safety is always first at Duke Energy. Are you able to safely take this call right now?
1. Yes **[CONTINUE]**
2. No **[SCHEDULE A CALLBACK]**
99. Refused **[THANK AND TERMINATE]**

[FOR TERMINATIONS]: I thank you for your time.

[IF RESPONDENT ASKS HOW LONG, SAY: "APPROXIMATELY 10-12 MINUTES."]

S1. I am calling for your opinion on your experience with the Multifamily Energy Efficiency Program from Duke Energy. We will keep all of your responses confidential. For quality purposes, this call may be monitored and recorded. I just need to ask a few screening questions before we get started. Our records show that your household received new energy efficient lighting and/or water-saving equipment **[IF TERRITORY = DEO "THIS YEAR OR IN 2018", IF TERRITORY = DEK "IN 2017, 2018, OR THIS YEAR"]**. Your landlord or property manager organized your participation in this program, and a work crew or maintenance staff would have installed **[INSERT MEASURE(S)]** in your home.

Do you recall these **[INSERT MEASURE(S)]** being installed in your home?

1. Yes, respondent recalls the program **[CONTINUE TO PS1.]**
2. No **[THANK AND TERMINATE]**
98. Don't know **[ASK S3]**
99. Refused **[ASK S3]**

[FOR TERMINATIONS]: I have been asked to conduct interviews with people who are familiar with the energy efficient equipment installed as part of this Duke Energy Multifamily Energy Efficiency Program. Since you do not recall this process, these are all the questions I have at this time. Thank you for your time and have a nice day.

[IF S1 = 98 OR 99, CONTINUE to S3. OTHERWISE SKIP TO PS1.]

S3. Is there anyone available who might know? (IF NOT AVAILABLE, SCHEDULE A CALL BACK).

1. Yes **[REPEAT S1 WITH NEW RESPONDENT TO CONFIRM MEASURES INSTALLED.]**
2. No
99. Refused

[IF S3 = 2 OR 99, THANK AND TERMINATE]

[FOR TERMINATIONS]: I thank you for your time.

==========

NTG Survey: Res

Notes for Client:

- Scoring and multipliers are for FR (not NTGR).
- Text in brackets {} serve as a placeholder and will be concluded with the survey firm

==========

PARTICIPATION and SATISFACTION

PS1. The following survey pertains to the energy efficiency improvements you had completed in your home: **[INSERT MEASURE(S)]**.This survey contains questions relating to your overall satisfaction with the Multifamily Energy Efficiency Program as well as questions about your experience with the energy efficient equipment that were installed.

How did you first hear about Duke Energy's Multifamily Energy Efficiency Program? (DO NOT READ LIST. RECORD ALL MENTIONS.)

1. Through property manager
3. Duke Energy website
7. Participation in other Duke Energy Programs
9. Other (Please Specify)
98. Don't know
99. Refused

PS2 TURNED OFF

PS3. On a scale of 0 to 10, with 0 being "Not at all satisfied", and 10 being "Extremely satisfied", how satisfied are you with your **[INSERT MEASURE(S)]? [REPEAT FOR EACH MEASURE INSTALLED BY PARTICIPANT.]**

Not at all satisfied										Extremely satisfied	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

[IF PS3 < 5, ASK PS4]

PS4. Why do you say that? (RECORD VERBATIM.)

_____**[OPEN-END]**

[LOOP PS3/PS4 WILL BE ASKED MULTIPLE TIMES, BASED ON NUMBER OF MEASURES INSTALLED.]

PS5A. **[IF LED_LIGHT_BULBS_1 ≥ 1, ASK. OTHERWISE, SKIP TO PS7.]**
In your own words, can you tell me about your experience ~~so far~~ with the LED Light Bulbs? This can include your opinion on quality of lighting, brightness, color, or any other observations that you have? (RECORD VERBATIM.)

_____**[OPEN-END]**

PS10. On a scale of 0 to 10, where 0 is "Not at all likely" and 10 is "Very likely", how likely are you to purchase **[IF LED_LIGHT_BULBS_1 ≥ 1, display** "additional"**]** LEDs in the future?

Not at all likely										Very likely	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

[IF PS10 < 5, ASK PS10A]

PS10a. Why do you say that? (RECORD VERBATIM.)

_____**[OPEN-END]**

[IF PS10 > 5, ASK PS10B]

PS10b. What type(s) of LED would you most likely purchase? (READ LIST ONLY IF NECESSARY. RECORD ALL MENTIONS.)

1. A-lamps
2. Globe lamps

3. Candelabra lamps
4. Track lights
5. Can lights
6. Decorative lamps
7. Other (Please Specify)
8. Don't know

PS7. Have you noticed any savings on your electric bill since the installation of your new **[INSERT MEASURE(S)]**?

1. Yes
2. No
98. Don't know
99. Refused

PS8 TURNED OFF

PS9. We understand that the energy efficient items may have been installed by a contractor hired by Duke Energy. How would you rate your satisfaction with your installer's "quality of work" on a scale of 0 to 10, with 0 meaning "Not at all satisfied" and 10 meaning "Extremely satisfied"?

Not at all satisfied										Extremely satisfied	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

[IF PS9 < 5, ASK PS9A]

PS9a. What is the main reason for your satisfaction rating? (RECORD VERBATIM.)

_____**[OPEN-END]**

PS11. Using a scale from 0 to 10, with 0 being "Not at all satisfied" and 10 being "Extremely satisfied", how satisfied are you with the Duke Energy Multifamily Energy Efficiency Program?

Not at all satisfied										Extremely satisfied	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

[IF PS11 = 0-10, ASK PS11A]

PS11a. Why do you give it that rating? (RECORD VERBATIM.)

_____**[OPEN-END]**

PS12. Do you have any suggestions to improve the Multifamily Energy Efficiency Program?

1. Yes
2. No
98. Don't know
99. Refused

[IF PS12 = 1, ASK PS12A.]

PS12a. What are those suggestions? (RECORD VERBATIM. PROBE FOR CLARIFICATION.)
_____**[OPEN-END]**

PS13. How would you rate your overall satisfaction with Duke Energy on a scale of 0 to 10, with 0 meaning "Not at all satisfied" and 10 meaning "Extremely satisfied"?

Not at all satisfied										Extremely satisfied	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

[IF PS13 < 5, ASK PS13A.]

PS13a. Why do you say that? (RECORD VERBATIM.)
_____**[OPEN-END]**

M1, M2, M3, M4, M4A, M5 TURNED OFF

Measures

Now I'd like to ask you a few questions about your experience with the energy efficient equipment installed through the Duke Energy Multifamily Energy Efficiency Program.

M6. Have you removed any of the **[INSERT MEASURE(S)]** that were installed in your home through this Duke Energy program?
1. Yes
2. No
98. Don't know

[IF M6 = 2 OR 98, SKIP TO IS1. OTHERWISE CONTINUE.]

M6aa. As I read the following measures, please tell me which ones you removed. Did you remove…(READ LIST. RECORD ALL MENTIONS)? **[INSERT MEASURE(S)] ONLY INCLUDE MEASURE INSTALLED IN THE UNIT. FOR THIS INSERT, WE NEED TO READ THE 3 LED TYPES IN THE MEASURE INSERT (INCLUDE A-LAMPS, GLOBE LAMPS, CANDELABRAS, BUT NOT TOTAL LED)**
7. LED A-lamps
8. LED Globe lamps
9. LED Candelabras

~~1. LED light bulbs~~ **TURN OFF**
2. Bathroom faucet aerators
3. Kitchen faucet aerators
4. Hot water heater pipe wrap
5. Low flow showerhead
6. (DO NOT READ) None were removed

[IF M6AA = 6, SKIP TO IS1. OTHERWISE CONTINUE.]

M6ab. Please tell me the quantity of items you removed for each of the following. How many (READ LIST) did you remove? (INTERVIEWER: RECORD-QUANTITY FOR EACH MEASURE. USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.) **[INSERT MEASURE(S)] ONLY INCLUDE MEASURE INSTALLED IN THE UNIT. FOR THIS INSERT, WE NEED TO READ THE 3 LED TYPES IN THE MEASURE INSERT (INCLUDE A-LAMPS, GLOBE LAMPS, CANDELABRAS, BUT NOT TOTAL LED)**

	Measure Description	Quantity Removed	
[IF M6aa = 2, 3, 4, 5, 7, 8 OR 9 INSERT MEASURES BELOW.]			
M6ab_7.	LED A-lamps	_____	
M6ab_8	LED Globe lamps	_____	
M6ab_9	LED Candelabras	_____	
~~M6ab_1.~~	~~LED light bulbs~~	_____	**TURN OFF**
M6ab_2.	Bathroom faucet aerators	_____	
M6ab_3.	Kitchen faucet aerators	_____	
M6ab_4.	Hot water heater pipe wrap (in feet)	_____	
M6ab_5.	Low flow showerheads	_____	

[IF M6AB_7,_8, OR _9 GT "0", CONTINUE. OTHERWISE, SKIP TO M7B.]

M7a. You told me you removed LED light bulbs. Why did you remove those items? (RECORD VERBATIM.)

_____**[OPEN-END]**

M7aa. From which rooms did you remove LEDs? (DO NOT READ. RECORD ALL MENTIONS.)

1. Bathroom(s)
2. Bedroom(s)
3. Kitchen/Pantry
4. Living room/Family room/Den/Playroom
5. Home office
6. Laundry room
7. Exterior room (garage/patio/outdoor area)
8. Dining room
9. Hall
10. Other (Please Specify)

[IF M6AB_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M7C.]

M7b. You also told me you removed bathroom faucet aerators. Why did you remove those items? (RECORD VERBATIM.)

_____**[OPEN-END]**

M7bb. Did you remove an aerator from the master bathroom or another type of bathroom? (RECORD ONE ANSWER ONLY.)

1. Master bathroom
2. Another type of bathroom

[IF M6AB_3 GT "0", CONTINUE. OTHERWISE, SKIP TO M7D.]

M7c. You also told me you removed kitchen faucet aerators. Why did you remove those items?

(RECORD VERBATIM.)
_____**[OPEN-END]**

[IF M6AB_4 GT "0", CONTINUE. OTHERWISE, SKIP TO M7E.]

M7d. You also told me you removed hot water heater pipe wrap. Why did you remove those items? (RECORD VERBATIM.)
_____**[OPEN-END]**

[IF M6AB_5 GT "0", CONTINUE. OTHERWISE, SKIP TO IS1.]

M7e. You also told me you removed low flow showerheads. Why did you remove those items? (RECORD VERBATIM.)
_____**[OPEN-END]**

M7ee. Did you remove a showerhead from the master bathroom or another type of bathroom? (RECORD ONE ANSWER ONLY.)
1. Master bathroom
2. Another type of bathroom

M8, M8A, M9, M90, M9A, M10 TURNED OFF

Spillover (INSIDE SPILLOVER)

IS1. As a result of your experience with the program, did you purchase additional energy efficiency equipment for your home or adopt any energy efficient behavior for which you did not receive a rebate/discount from any other Duke Energy program
1. Yes **[CONTINUE]**
2. No
98. Don't know

[IF IS1 = 2 OR 98, SKIP TO PS14.]

IS2. Please tell me the types of additional energy efficient items and the quantity you had installed where you did not receive a program rebate.

	Measure Description	Quantity
IS2a.	1._____	2._____
IS2b.	3._____	4._____
IS2c.	5._____	6._____
IS2d.	7._____	8._____
IS2e.	9._____	10._____

IS3. Please briefly describe how the program has influenced your decisions to incorporate additional energy efficient items in your home that were not part of a program rebate. (RECORD VERBATIM.)
_____**[OPEN-END]**

IS4. On a scale of 0 to 10, where 0 is "Not at all important" and 10 is "Extremely important," how important was your participation in the program in your decision to install additional energy efficiency measures?

Not at all important										Extremely important	Dk	Ref
0	1	2	3	4	5	6	7	8	9	10	98	99

DEMOGRAPHICS AND ADDITIONAL FEEDBACK

PS14. Thank you for your time and patience; there are only a few more questions.

Do you consider Duke Energy as a trusted resource for energy efficiency information?

1. Yes
2. No
98. Don't know
99. Refused

[IF PS14 = 1 "YES", ASK PS14A.]

PS14a. Why do you consider Duke Energy to be a trusted resource? (RECORD VERBATIM.)
_____**[OPEN-END]**

[IF PS14 = 2 "NO", ASK PS14B.]

PS14b. Why do you not consider Duke Energy to be a trusted resource? (RECORD VERBATIM.)
_____**[OPEN-END]**

PS15. Can you list any other Duke Energy solutions or programs to help you save energy and money in your apartment? (DO NOT READ LIST. RECORD ALL MENTIONS.)

1. Equipment incentives through the Smart Saver Energy Home Rebate Program, including HVAC, Water Heater, Insulation, Ductwork, Pool & Drives, and Refrigeration
2. Outdoor Lighting Solutions
3. Duke Online Savings Store for lighting measures
4. Lighting discounts at local retail stores
5. Refrigeration and Appliance Replacement
6. Heating and Cooling system replacement
7. ~~Duke Free LED Program~~ **TURN OFF**
8. Other (Please Specify)
9. No **[EXCLUSIVE]**
98. Don't Know
99. Refused

PS16, PS16O, PS16A TURNED OFF

P15a. How many bedrooms does your home have?

1. 1
2. 2
3. 3
4. More than 3
98. Don't know
99. Refused

PS15b. How many people live in your home?

1. 1
2. 2
3. 3
4. More than 3
98. Don't know
99. Refused

PS17. A smart thermostat heats or cools your home through the use of automation. Do you currently have a smart thermostat at your home?

1. Yes
2. No
98. Don't know
99. Refused

[IF PS17 = 2, ASK PS17A.]

PS17a. Would you be interested in a smart thermostat?

1. Yes
2. No
98. Don't know
99. Refused

PS18. Do you currently own an electric vehicle?

1. Yes
2. No
98. Don't know
99. Refused

[IF PS18 = 2, ASK PS18A.]

PS18a. Would you consider purchasing an electric vehicle in the next 1 to 3 years?

1. Yes
2. No
98. Don't know
99. Refused

PS19. Does your housing property have charging stations for electric vehicles?

1. Yes
2. No

98. Don't know
99. Refused

PS20. Does your housing property have solar panels?

1. Yes
2. No
98. Don't know
99. Refused

[IF PS20 = 2, ASK PS20A.]

PS20a. Would you like to see your housing property have solar panels installed?

1. Yes
2. No
98. Don't know
99. Refused

CLOSING: This completes the survey. Your responses are very important to Duke Energy and will help as we design future energy efficiency programs. We appreciate your participation and thank you for your time. Have a good day.

APPENDIX C. PROPERTY MANAGER SURVEY GUIDE

This survey guide will be administered to property managers who participated in Duke Energy's Multifamily Energy Efficiency Program (MEEP). The goal of property manager surveys includes informing, updating and improving MEEP. This survey guide walks the interviewer through the phone calls, which are to be made between 10:00am-8:30pm ET on weekdays, and 10:00am-5:00pm ET on Saturdays. No calls are to be made on Sundays. Navigant interviewer will introduce himself/herself and inform the customer about the purpose of the interview.

Company: _____ Telephone: _____
Name: _____David Wolfe_____ Cell phone: _____
Title: _____ Fax: _____
City: _____ State: _____ Zip: _____
Interview date: _____ Time: ___12:00 MT____

S1. According to our records, your property participated in Duke Energy's Multifamily Energy Efficiency Program during **2019]** and received free installation of energy efficient **lighting and water equipment**. Is that correct?

1. Yes
2. No
98. Don't know
99. Refused

[If S1 = 2 or 99, TERMINATE. Otherwise, Continue]
[*FOR TERMINATIONS]:* This study is for people who participated in Duke Energy's Multifamily Energy Efficiency Program during **[If DEK: 2017, 2018 or 2019. If DEO: 2018 or 2019]**. Since you did not, these are all the questions I have at this time, and I thank you for your time.

S2. Are you the primary person who was involved in making the decision to receive the installation for the energy efficient **lighting and/or water efficiency equipment?**

1. Yes
2. No
98. Don't know
99. Refused

[If S2 = 1, Move to PS1. If S2 = 99, Terminate. Otherwise, Continue]
[*FOR TERMINATIONS]:* This study is for people who participated in Duke Energy's Multifamily Energy Efficiency Program during **[If DEK: 2017, 2018 or 2019. If DEO: 2018 or 2019]**. Since you did not, these are all the questions I have at this time, and I thank you for your time.

S2a. I understand that the decision to install the **lighting and water equipment** may have been driven by someone other than yourself. However, if you had some involvement in the decision process

to participate in the program, your input will be helpful. Are you somewhat familiar with the program participation and installation process?

1. Yes
2. No
98. Don't know
99. Refused

[If S2a = 1, proceed to PS1. If S2 = 2 or 98, proceed to S2b. If S2a= 99, Terminate]
[*FOR TERMINATIONS]:* This study is for people who participated in Duke Energy's Multifamily Energy Efficiency Program during **[If DEK: 2017, 2018 or 2019. If DEO: 2018 or 2019]**. Since you did not, these are all the questions I have at this time, and I thank you for your time.

S2b. Can you direct me to the person who was involved in the decision making?

1. Yes [Gather correct contact information before terminating]
2. No [Terminate]
98. Don't know [Terminate]
99. Refused [Reassure participant prior to Terminating]

[If S2b = 1, Gather correct contact information before ending. If S2 = 2, 98 or 99, Terminate]
[*FOR ENDING*]: Thank you for providing us this information and thank you for your time.
[*FOR TERMINATIONS]:* This study is for people who participated in Duke Energy's Multifamily Energy Efficiency Program during **[If DEK: 2017, 2018 or 2019. If DEO: 2018 or 2019]**. Since you did not, these are all the questions I have at this time, and I thank you for your time.

Survey Introduction

My questions are about the energy efficient **lighting and water equipment** installed at **[Insert Property]** through the Duke Energy Multifamily Energy Efficiency Program in **[If DEK: 2017, 2018 or 2019. If DEO: 2018 or 2019]**: I will ask about your satisfaction with the program as well as questions relating to your decision to participate in the program. Finally, I am also interested in hearing about any decisions to pursue efficiency projects at other properties your company manages.

Participation and Satisfaction

The first set of questions relate to your satisfaction with the program. Using a scale from 0 to 10, with 0 being "not at all satisfied" and 10 being "extremely satisfied", how would you rate your satisfaction with the following aspects of Duke Energy's Multifamily Energy Efficiency program? *(INTERVIEWER: USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)*

Questions	Ratings and explanations												
PS1. Overall experience with the program	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused

PS1a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS2. Communication with program representatives	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS2 < 5, ASK] PS2a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS3. Program enrollment process	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS3 < 5, ASK] PS3a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS4. Tenant communications and program materials to help you communicate with tenants about the program	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS4 < 5, ASK] PS4a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS5. The lighting equipment offered in the program	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS5 < 5, ASK] PS5a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS6. The water-saving equipment offered in the program	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS6 < 5, ASK]PS6a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS7. Installation team's scheduling and timely installation in tenant-units	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS7 < 5, ASK] PS7a. What's the reason for your rating*? (RECORD VERBATIM)*													
PS8. Installation team's quality of work	0	1	2	3	4	5	6	7	8	9	10	98 Don't Know	99 Refused
[If PS8 < 5, ASK] PS8a. What's the reason for your rating*? (RECORD VERBATIM)*													

PS9. **[If property received lighting equipment ask PS9, otherwise skip to PS10]**

On a scale of 0 to 10, with 0 being "not at all satisfied", and 10 being "extremely satisfied", how satisfied would you say *your tenants* are with the new **lighting equipment**? (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Not at all Important										Extremely Important	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

PS9a. What is the reason for your rating? *(RECORD VERBATIM)*

_____

PS9b. Can you tell me about any feedback that you have received from your tenants about their experience with the LED lights? [Probe to understand any improvements to aesthetics in the space, reduced energy bills, etc.) (RECORD VERBATIM)

PS10. **[If property only received lighting equipment skip to PS11]** On a scale of 0 to 10, with 0 being "not at all satisfied", and 10 being "extremely satisfied", how satisfied would you say your tenants are with the new **water equipment**? (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Not at all Important										Extremely Important	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

PS10a. What is the reason for your rating? *(RECORD VERBATIM)*

_____

PS10b. Can you tell me about any feedback that you have received from your tenants about their experience with the water equipment? [Probe to understand any improvements to aesthetics in the space, reduced energy bills, etc.) (RECORD VERBATIM)

PS11. When speaking to prospective tenants, do you highlight the energy efficient features of your units?

1. Yes
2. No
98. Don't know
99. Refused

PS12. Are there other energy efficiency options you think the program should include? Some examples might be outdoor lighting solutions, heating and cooling solutions, programmable or smart thermostats (i.e. nests), electric vehicle charging stations, etc.? (RECORD VERBATIM)

PS13. On a scale of 0 to 10, where 0 is "not at all likely" and 10 is "very likely", how likely are you to

recommend the Duke Energy Multifamily Energy Efficiency Program to other property managers? (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Not at all Important										Extremely Important	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

[If PS13 <5 Ask]

PS13a. Why do you say that? (RECORD VERBATIM)

_____

Awareness Questions

The next set of questions relate to your decision to participate in the program.

A1. What was the primary reason for your decision to participate in the program? [DO NOT READ LIST. RECORD ONLY ONE MENTION.]

1. To save money on utility bills; save money on electric bills
2. Because the equipment was free to me
3. To replace old equipment
4. To replace broken equipment
5. To get more efficient equipment or the latest technology
6. To reduce maintenance costs
7. Because the program was sponsored by Duke Energy
8. Previous experience with other Duke Energy programs
9. To help protect the environment
10. To save energy
11. To improve tenant satisfaction
12. To attract new tenants
13. Part of a broader remodeling or renovation
14. Recommended by contractors/trade allies
15. Recommended by family, friend, or neighbor
16. Existing equipment was due for its regularly-scheduled checkup
17. Duke Energy Advertising
18. Advertising other than Duke Energy
19. No other reasons
20. Other [SPECIFY] _____

98. Don't know
99. Refused

A2. Are there any other reasons you decided to install **lighting and water equipment**?
[DO NOT READ LIST. RECORD ALL MENTIONS]

1. To save money on utility bills; save money on electric bills
2. Because the equipment was free to me
3. To replace old equipment
4. To replace broken equipment
5. To get more efficient equipment or the latest technology
6. To reduce maintenance costs
7. Because the program was sponsored by Duke
8. Previous experience with other Duke programs
9. To help protect the environment
10. To save energy
11. To improve tenant satisfaction
12. To attract new tenants
13. Part of a broader remodeling or renovation
14. Recommended by contractors/trade allies
15. Recommended by family, friend, or neighbor
16. Existing equipment was due for its regularly-scheduled checkup
17. Duke Advertising
18. Advertising other than Duke.
19. Federal tax credit
20. No other reasons
21. Other [SPECIFY] _____

98. Don't know
99. Refused

A3. On a scale of 0 to 10 where 0 means "strongly disagree" and 10 means "strongly agree," please rate your agreement with the following statements:

A3a. I consider Duke Energy to be a decent resource for energy efficiency information.
1. Record response 0-10
98. Don't know
99. Refused

A3b. My decision to install energy efficient equipment at my property was largely motivated by Duke Energy's program.
1. Record response 0-10
98. Don't know
99. Refused

Prior Plans

[Ask if property received lighting equipment]

PP1. Prior to participating in the Duke Energy program, had you considered installing the energy efficient **lighting equipment** at the property?

1. Yes
2. No
98. Don't know
99. Refused

[Ask if property received water equipment]

PP2. Prior to participating in the Duke Energy program, had you considered installing the energy efficient **water equipment** at the property?

1. Yes
2. No
98. Don't know
99. Refused

[If PP1 OR PP2 = 1 or 98, ASK PP2A. Otherwise ASK L3]

PP2a. Please describe any plans you had to install the **lighting and water equipment** prior to participating in the Duke Energy program.
[Record PM Response verbatim]: _____

PP3. Thinking about before you decided to participate in the Duke Energy Multifamily Energy Efficiency program. On a scale of 0 to 10, where 0 means you "had not yet started to plan for equipment or installation" and 10 means you "had identified and selected specific equipment and the contractor to install it", please tell me how far along you were in your plans to install the equipment before participating in the program. (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Had not Yet planned for Equipment and Installation										Identified and selected specific equipment and the contractor to install it	Don't know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

Own

O1. Please tell me in your own words how the program influenced your decision to install the

lighting and water equipment. (RECORD VERATIM)

_____

Likelihood

L1. Given everything you've just told me, what is the likelihood that you would have installed the same energy efficient **lighting and water equipment** without the Duke Energy program and its financial and technical assistance? Would you say you … [READ LIST]?

1. Definitely would NOT have installed the same **lighting and water equipment without the Duke Energy program**
2. MAY HAVE installed the same **lighting and water equipment**, even without the Duke Energy program
3. Definitely WOULD have installed the same **lighting and water equipment,** even without the Duke Energy program
98. (DO NOT READ) Don't know
99. Refused

[If L1 = 2, ASK L1A. Otherwise ASK L2]

L1a. You indicated you may have installed the same energy efficient **[INSERT MEASURES DENOTED ABOVE]**, even without the Duke Energy program. On a scale of 0 to 10 where 0 is "DEFINITELY WOULD NOT have installed" and 10 is "DEFINITELY WOULD have installed", can you tell me the likelihood that you would have installed the same **equipment** without the program?

Definitely Would Not										Definitely Would	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

L2. Thinking about the quantity of lighting and water equipment you installed through the program, what is the likelihood that you would have installed the same quantity of the same measures without the program's financial and technical assistance? Would you say you … [READ LIST]

1. Definitely would NOT have installed the same quantity of the same **lighting and water equipment** without the Duke Energy program
2. MAY HAVE installed the same quantity of the same energy efficient **lighting and water equipment**, even without the Duke Energy program
3. Definitely WOULD have installed the same quantity of the same energy efficient **lighting and water equipment**, even without the Duke Energy program
98. (DO NOT READ) Don't know
99. Refused

[If L2 = 2, ASK L2A. Otherwise ASK L3]

L2a. You indicated you may have installed the same quantity of the same lighting and water equipment even without the Duke Energy program. Using a scale of 0 to 10 where 0 is "DEFINITELY WOULD NOT have installed" and 10 is "DEFINITELY WOULD have installed", can you tell me the likelihood that you would have installed the same quantity of the same measures **without the program**?

Definitely Would Not										Definitely Would	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

L3. **[If L2 = 3, proceed to L3a. Otherwise, continue]**

Is there a chance you would have had at least some of the work done without the program?

1. Yes
2. No
98. Don't know

[If L3 = 2, ASK IS1. Otherwise, continue]

L3a. Could you estimate the percentage of the work that you might have had done without the program? _____%

L3b. On a scale of 0 to 10 where 0 is "DEFINITELY WOULD NOT have installed" and 10 is "DEFINITELY WOULD have installed", what is the likelihood you might have installed [INSERT L3A ANSWER] percent of the **lighting and water equipment** without the Duke Energy program? (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Not at all Important										Extremely Important	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

L3c. You mentioned you might have done some work without the program, please describe what you might have had done. (RECORD VERBATIM)

_____

L4. Without the program, about when would you have installed the **lighting and water equipment**? Would it have been… (READ LIST)?

1. At the same time as you did
2. Within 1 year of the time you did
3. Between 1 and 2 years within the time you did
4. Between 2 and 4 years within the time you did

5. Sometime after 4 years within the time you did
6. Would have never installed without the program

Spillover

Thank you for your time and patience, we are almost done and the next few questions pertain to how the program may have influenced you to perform other energy efficiency activities are your property.

IS1. Did your experience with the program in any way influence you to incorporate additional energy efficiency equipment where you did not receive a program rebate at your property?

1. Yes
2. No
98. Don't know
99. Refused

[IF IS1 = 2, SKIP TO IS2]

IS1a. Please tell me the types of additional energy efficient equipment and the quantity you had installed where you did not receive a program rebate. [INTERVIEWER: RECORD MEASURE DESCRIPTION AND QUANTITY FOR EACH. AFTER EACH QUANTITY, ASK: Any others?]

	Measure Description	Quantity
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____

100. IS1b. Please briefly describe how the program influenced your decisions to incorporate additional energy efficiency equipment at your property that were not part of a program rebate. (RECORD VERBATIM)

_____

101. IS1c. On a scale of 0 to 10, where 0 is "not at all important" and 10 is "extremely important," how important was your participation in the program in your decision to install the additional energy efficiency equipment? (USE "98" FOR DON'T KNOW. USE "99" FOR REFUSED.)

Not at all Important										Extremely Important	Don't Know	Refused
0	1	2	3	4	5	6	7	8	9	10	98	99

IS2. Aside from the primary property that participated in the program, did your experience with the program in any way influence you to incorporate additional energy efficiency equipment where you did not receive a program rebate at any other properties managed by your company?

1. Yes
2. No
98. Don't know

[IF IS2 = 2, SKIP TO P1]

102. IS2a. Please briefly describe how the program influenced your decisions to incorporate additional energy efficiency equipment at another property that were not part of a program rebate. (RECORD VERBATIM)

_____

Property Characteristics

The last few questions are about the size and occupancy characteristics of your property.

P1. How many housing units does your property have?

1. Record Verbatim
98. Don't know
99. Refused

P2. Can you tell me the approximate percentage of housing units at your facility that have the following number of bedrooms?

1. One-bedroom (record percentage of units):
2. Two-bedrooms (record percentage of units):
3. Three-bedrooms (record percentage of units):
4. More than three bedrooms (record percentage of units):
98. Don't know
99. Refused

P3. Can you tell me the average number of occupants that live in a typical unit at your property?

103. (RECORD VERBATIM AND PROBE FURTHER IF THEY HAVE OCCUPANCY BY NUMBER OF BEDROOMS)

1. One-bedroom (enter average number of occupants)
2. Two-bedrooms (enter average number of occupants)
3. Three-bedrooms (enter average number of occupants)
4. More than three bedrooms (enter average number of occupants)
98. Don't know
99. Refused

P4. Can you tell me the low and high range for rent costs for a unit at your property?

1. Record low and high range
98. Don't know
99. Refused

P5. Is there anything you would suggest to improve Duke Energy's Multifamily Energy Efficiency Program?

(RECORD VERBATIM)

_____

CLOSING:

This completes the survey. Your responses are very important to DUKE ENERGY and will help as we design future energy efficiency programs. We appreciate your participation and thank you for your time. Have a good day.