Save Energy and Water Kits 2018 – 2019 Evaluation Report

Submitted to Duke Energy Carolinas and Progress by Nexant in partnership with Opinion Dynamics

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1 Executive Summary

1.1 Program Summary

The Save Energy and Water Kit Program (SEWKP) is a Duke Energy offering that provides free energy saving and water efficiency kits to pre-selected households in the Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) jurisdictions. The kits include aerators for kitchen and bathroom sink faucets, showerheads, and insulating water heater pipe tape.

1.2 Evaluation Objectives and Results

This report presents the results and findings of evaluation activities for DEC and DEP SEWKP conducted by the evaluation team, collectively Nexant Inc. and our subcontracting partner Opinion Dynamics, for the program year of September 2018 – August 2019.

1.2.1 Impact Evaluation

The evaluation team conducted the evaluation as detailed in this report to estimate energy and demand savings attributable to the programs. The evaluation was divided into two research areas - to determine gross savings and net savings (or impacts). Gross impacts are energy and demand savings estimated at a participant's home that are the direct result of the homeowner's installation of the measures included in the SEWKP kit. Net impacts reflect the degree to which the gross savings are a result of the program efforts and funds.

Table 1-1, Table 1-2, and Table 1-3 present the summarized findings of the impact evaluation for the DEC jurisdiction. All totals in Table 1-1, excluding the population, are weighted averages based on the 2018-2019 evaluation sample and represent expected savings from the average participant.

Table 1-1: DEC Energy Savings per Kit

Kit Size	Population	Reported Energy (kWh)	Energy Realization Rate	Gross Verified Energy (kWh)
Small	26,364	333	104%	347
Medium	17,750	564	87%	489
Program Total	**44,114**	**426**	**95%**	**404**

Table 1-2: DEC Demand Savings per Kit

Kit Size	Summer Demand (kW)			Winter Demand (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Small	0.114	26%	0.030	0.073	112%	0.082
Medium	0.188	22%	0.042	0.129	97%	0.125
Program Total	**0.144**	**24%**	**0.035**	**0.096**	**104%**	**0.099**

Table 1-3: DEC Program Level Savings

Measurement	Population	Reported	Realization Rate	Gross Verified
Energy (kWh)	44,114	18,797,312	95%	17,834,056
Summer Demand (kW)		6,342	24%	1,541
Winter Demand (kW)		4,217	104%	4,371

The portion of gross verified savings by measure type are presented in Figure 1-1. Per unit energy and demand savings by measure and the program net to gross ratio, with free ridership and spillover components, are presented in Table 1-4.

Figure 1-1: DEC Portion of Program Verified Savings by Measure

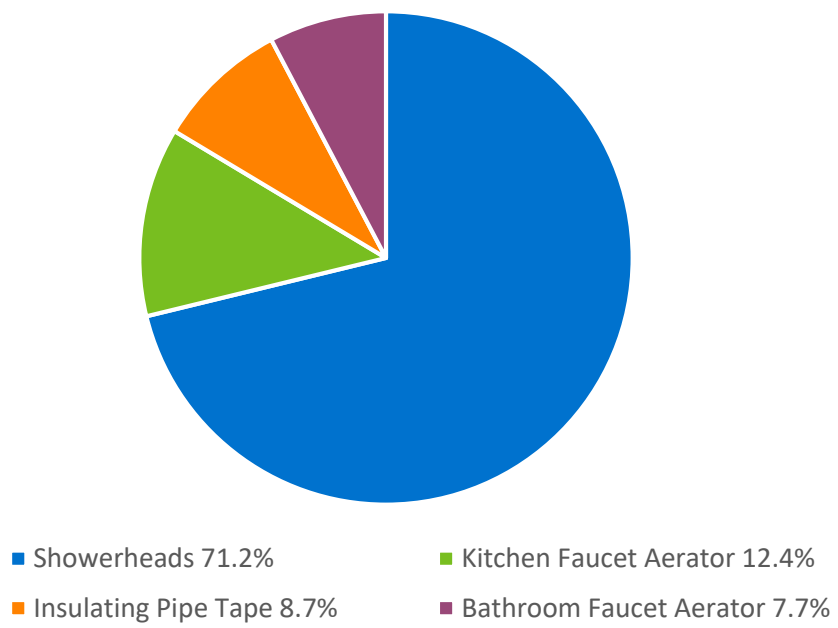


Table 1-4: DEC Verified Impacts by Measure

Measure	Energy Savings per unit (kWh)	Summer Demand Savings per unit (kW)	Winter Demand Savings per unit (kW)	Free Ridership	Spillover	Net to Gross Ratio
Low-flow Showerhead	205.3	0.0174	0.0625	9.2%	18.2%	109.0%
Low-flow Kitchen Aerator	50.2	0.0035	0.0040			
Low-flow Bathroom Aerator	15.5	0.0015	0.0017			
Insulating Pipe Tape*	7.0	0.0008	0.0008			

* Savings for pipe tape is a per linear foot measurement

Table 1-5, Table 1-6, and Table 1-7 present the summarized findings of the impact evaluation for the DEP jurisdiction.

Table 1-5: DEP Energy Savings per Kit

Kit Size	Population	Reported Energy (kWh)	Energy Realization Rate	Gross Verified Energy (kWh)
Small	14,479	428	88%	376
Medium	11,633	738	72%	533
Program Total	**26,112**	**566**	**79%**	**446**

Table 1-6: DEP Demand Savings per Kit

Kit Size	Summer Demand (kW)			Winter Demand (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Small	0.143	23%	0.033	0.107	82%	0.087
Medium	0.242	19%	0.046	0.191	71%	0.135
Program Total	**0.187**	**21%**	**0.038**	**0.144**	**75%**	**0.108**

Table 1-7: DEP Program Level Savings

Measurement	Population	Reported	Realization Rate	Gross Verified
Energy (kWh)	26,112	14,785,941	79%	11,647,379
Summer Demand (kW)		4,886	21%	1,004
Winter Demand (kW)		3,761	75%	2,833

The portion of gross verified savings by measure type are presented in Figure 1-2. Per unit energy and demand savings by measure and program net to gross ratio, with free ridership and spillover components, are presented in Table 1-8.

Figure 1-2: DEP Portion of Program Verified Savings by Measure

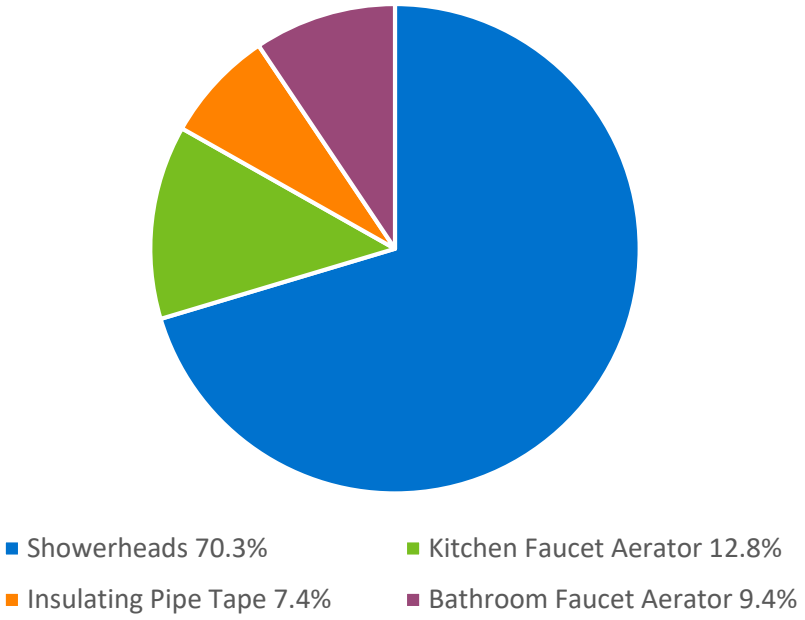


Table 1-8: DEP Verified Impacts by Measure

Measure	Energy Savings per unit (kWh)	Summer Demand Savings per unit (kW)	Winter Demand Savings per unit (kW)	Free Ridership	Spillover	Net to Gross Ratio
Low-flow Showerhead	217.1	0.0184	0.0661	7.8%	25.7%	117.9%
Low-flow Kitchen Aerator	57.3	0.0040	0.0045			
Low-flow Bathroom Aerator	20.9	0.0020	0.0023			
Insulating Pipe Tape*	6.9	0.0008	0.0008			

* Savings for pipe tape is a per linear foot measurement

1.2.2 Process Evaluation

The process evaluation assessed opportunities for improving the program's design and delivery in the DEC and DEP service territories. It specifically documented participant experiences by exploring participating household feedback and the extent to which the kits effectively motivate households to save energy.

The evaluation team conducted telephone and web surveys with households that received a kit (DEC n=320; DEP n=343). The team also conducted in-depth interviews with the Duke Program Team and kit provider staff.

Program Successes

The 2018-2019 DEP/DEC SEWKP evaluation found successes in the following areas:

Most participants are satisfied with kit items and report high satisfaction with the overall program. Less than 10% of participants in each jurisdiction reported dissatisfaction with any specific measure they installed, and the vast majority reported they were highly satisfied with the overall program (83% DEC; 86% DEP).

Kit instructions are perceived as highly helpful among SEWKP participants. Eighty-five percent of participants in each jurisdiction said they read the instructional insert from their kit that offers detailed instructions on self-installing the measures, and most of them said the instructions were very helpful (81% DEC; 84% DEP). These paper instructions are likely sufficient for most participants, as most reported high satisfaction and very few took advantage of the toll-free hotline.

The updated propensity model scoring used to select households is effective in identifying homes with electric water heaters. Customers with electric water heaters are able to realize electric savings from water-saving equipment. Thanks at least in part to propensity model updates, the percentage of participants with electric water heaters increased in both jurisdictions from less than 80% in 2017 to nearly 90% in 2019.

The program influenced households to install kit measures. Most participating households installed at least one measure from the kit (79% DEC; 83% DEP), and the vast majority of measures, once installed, remained installed (92% DEC; 91% DEP). Participants were highly influenced by the program to install kit measures, as demonstrated by low free ridership rates. In addition, more than one-third of participants in each jurisdiction reported purchasing and installing additional energy efficiency measures since receiving their kit (37% DEC; 35% DEP).

Program Challenges

The 2018-2019 DEC and DEP SEWKP evaluations found some challenges in the following areas:

Insulating pipe tape is the least popular measure. Pipe tape was the least installed measure type, with just over one-third of participants (36%) reportedly installing it in each jurisdiction.

Low water pressure is a significant contributor to dissatisfaction and uninstalls. Complaints of excessively low water pressure was the primary driver of dissatisfaction and uninstallation among a relatively small number of participants who were dissatisfied with or uninstalled any items.

Increased penetration and saturation of measures included in the kits could contribute to lower installation rates in the future. Among participants who had yet to install at least one measure and had no immediate plans to do so, more than 20% in each jurisdiction indicated they already had at least one of the efficient measures installed.

1.3 Evaluation Conclusions and Recommendations

The evaluation findings led to the following conclusions and recommendations for the program.

Conclusion 1: The program model is highly successful: it leverages low-cost measures to foster energy savings that would not have happened otherwise. Duke Energy's easy process for requesting and receiving a kit with free energy and water-saving items motivated thousands of customers to request and install energy saving measures in their home during the evaluation period. Most participants installed at least one measure from the kit, relatively few measures get uninstalled, and many participants reported installing additional energy saving items since receiving the kit. The majority of participants said they would not have installed any of the items on their own, as represented by low free ridership rates, and the program is reaching a diverse range of customers in terms of household characteristics and demographics.

> **Recommendation**: Continue using SEWKP to encourage Duke Energy customers to save energy and water.

Conclusion 2: The water saving measures' low flow water pressure results in some minor dissatisfaction and uninstallation issues. Complaints of excessively low water pressure was the primary driver of water-saving measure dissatisfaction and uninstallation. However, only a minority of participants were dissatisfied with or uninstalled any items.

> **Recommendation**: Monitor how showerhead upgrades affect satisfaction and uninstallation rates going forward.

Conclusion 3: Recent program improvements have been largely successful. Updates to the propensity model contributed to an increase in the percentage of participants that have electric water heaters from less than 80% in 2017 to nearly 90% in 2019 (from 70% to 88% for the DEC program and from 79% to 89% for the DEP program). The new instructional materials provided with the kits also appear to denote a significant improvement from the prior instructions. Recent participants rated the instructions as considerably more helpful than participants in the last evaluated program year: the percentage of customers who rated instructions as "very helpful" increased since 2017 (from 70% to 81% among DEC participants and 80% to 84% among DEP participants).

Conclusion 4: Increased penetration and saturation of measures included in the kits may limit installation rates going forward. Among participants who had yet to install measures and had no immediate plans to do so, more than 20% indicated they already had at least one of the efficient measures installed. For insulating pipe tape, more than 30% of those without plans to install the measure reported they already had some installed (34% for DEC and 32% for DEP). These rates were nearly as high for showerheads, for which 32% of DEC respondents and 25% of DEP respondents with no plans to install indicated that they already an efficient one installed.

Recommendation: Monitor installation rates going forward and consider excluding measures that show high rates of prior ownership.

2 Introduction and Program Description

2.1 Program Description

2.1.1 Overview

The Save Energy and Water Kit Program (SEWKP) is a Duke Energy program that provides free energy and water efficiency kits to pre-selected households in Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) territories. The kits include low-flow aerators for kitchen and bathroom sink faucets, low-flow showerheads, and insulating water heater pipe tape.

2.1.2 Energy Efficiency Kit Measures

Table 2-1 lists the kit's contents included in the evaluation scope. There are two kit sizes, which dictate the number of showerheads the participant receives. In addition to the measures below, the kit includes plumbing tape, a rubber gasket opener to remove old aerators and showerheads, and an instructional insert that has detailed installation instructions. Duke Energy has additional installation instruction information available on their website.

Table 2-1: Kit Measures and Quantity

Measures	Small Kit	Medium Kit
Low-flow Showerhead (1.5 gpm)	1	2
Low-flow Bathroom Faucet Aerator (1.0 gpm)	2	2
Low-flow Kitchen Faucet Aerator (1.0 gpm)	1	1
Insulating Pipe Tape (up to 10' of coverage)	1	1

2.2 Program Implementation

2.2.1 Participant Identification and Recruitment

Every month Duke Energy's internal analytics department identifies households to recruit into the program. They look through customer accounts for single family electric-only accounts that have not participated in SEWKP or any other programs with similar measures (specifically, the Energy Efficiency Education in Schools and Home Energy House Call programs). Pre-selected households are then assigned either a small or medium kit based on household square footage. Next, Duke Energy approaches these customers through either emails, if the pre-selected customer has an email address on file, or business reply cards (BRC). Simultaneously, Duke Energy sends the implementer – Energy Federation, Inc. (EFI) – a list of pre-selected accounts that received an offer to participate in the SEWKP that month. Email messages provide a link for the customer to join the program and households that receive the BRC simply detach the reply

form and put it back in the mail (postage is pre-paid). Alternatively, customers may also call a toll free number, provided on the email or BRC, to confirm eligibility and request their free kit. EFI then ships the appropriate kit (small or medium) to registered households.

2.2.2 Participation

For the defined evaluation period of September 1st, 2018 through August 31st, 2019, the program recorded a total of 49,353 kit recipients in DEC and 10.6% of our sample stated they did not remember receiving the kit. The program population was reduced by 10.6% to 44,114 for the evaluated estimate of kit participants. For DEP the program reported 27,939 kit recipients with 6.5% of our sample stated they did not remember receiving the kit; leading to an evaluated estimate of 26,112 DEP participants.

2.3 Key Research Objectives

Over-arching project goals will follow the definition of impact evaluation established in the "Model Energy-Efficiency Program Impact Evaluation Guide – A Resource of the National Action Plan for Energy Efficiency," November 2007:

> *"Evaluation is the process of determining and documenting the results, benefits, and lessons learned from an energy-efficiency program. Evaluation results can be used in planning future programs and determining the value and potential of a portfolio of energy-efficiency programs in an integrated resource planning process. It can also be used in retrospectively determining the performance (and resulting payments, incentives, or penalties) of contractors and administrators responsible for implementing efficiency programs".*

Evaluation has two key objectives:

1) To document and measure the effects of a program and determine whether it met its goals with respect to being a reliable energy resource.
2) To help understand why those effects occurred and identify ways to improve the program.

2.3.1 Impact

As part of evaluation planning, the evaluation team outlined the following activities to assess the impacts of the DEC-DEP SEWKP:

- Quantify accurate and supportable energy (kWh) and demand (kW) savings for energy efficient measures implemented in participants' homes;
- Assess the rate of free riders from the participants' perspective and determine spillover effects;
- Benchmark verified measure-level energy impacts to applicable technical reference manual(s) and other Duke-similar programs in other jurisdictions.

2.3.2 Process

The process evaluation assessed opportunities for improving the design and delivery of the program in both DEC and DEP service territories. It specifically documented participant experiences by investigating participant responses to the energy efficiency kits and the extent to which the kits effectively motivate households to save energy and water.

The evaluation team assessed several elements of the program delivery and customer experience, including:

Motivation:

- What motivated participants to request and install the measures in the kit?
- In what ways, if any, did the program motivate participants to adopt new energy and water saving behaviors?

Program experience and satisfaction:

- How satisfied are participants with the overall program experience and kit items in terms of ease of use and measure quality?

Challenges and opportunities for improvement:

- Are there any inefficiencies or challenges with the delivery of the program?
- Are there any measures that have particularly low installation rates? If so, why?
- Are there any measures that have particularly high uninstallation rates? If so, why?

Participant household characteristics:

- What are demographic characteristics of those who received the kits?

2.4 Evaluation Overview

The evaluation team divided its approach into key tasks to meet the goals outlined:

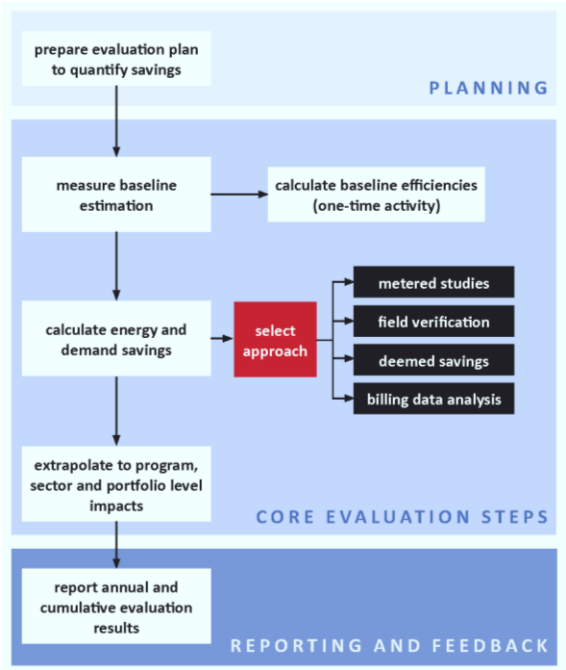
- Task 1 – Develop and manage evaluation work plan to describe the processes that will be followed to complete the evaluation tasks outlined in this project;
- Task 2 – Conduct a process review to determine how successfully the programs are being delivered to participants and to identify opportunities for improvement;
- Task 3 – Verify gross and net energy and peak demand savings resulting from SEWKP through verification activities of a sample of 2018-2019 program participants.

2.4.1 Impact Evaluation

The primary determinants of impact evaluation costs are the sample size and the level of rigor employed in collecting the data used in the impact analysis. The accuracy of the study findings is in turn dependent on these parameters. Techniques that we used to conduct our evaluation, measurement, and verification (EM&V) activities, and to meet the goals for this evaluation, included telephone and web-based surveys with program participants, best practice review, and interviews with implementation and program staff.

Figure 2-1 demonstrates the principal evaluation team steps organized through planning, core evaluation activities, and final reporting.

Figure 2-1: Impact Evaluation Process



The evaluation is generally comprised of the following steps, which are described in further detail throughout this report:

- **Participant Surveys:** The file review for all sampled and reviewed program participation concluded with a telephone and/or web-based survey with the participants. Table 2-2 below summarizes the number of surveys completed. The samples were drawn to meet a 90% confidence and 10% precision level based upon the expected and actual significance (or magnitude) of program participation, the level of certainty of savings, and the variety of measures.
- **Calculate Impacts:** Data collected via surveys enabled the evaluation team to calculate gross verified energy and demand savings for each measure.
- **Estimate Net Savings**: Net impacts are a reflection of the degree to which the gross savings are a result of the program efforts and incentives. The evaluation team estimated free-ridership and spillover based on self-report methods through surveys with program participants. The ratio of net verified savings to gross verified savings is the net-to-gross ratio as an adjustment factor to the reported savings.

2.4.2 Process Evaluation

Process evaluation examines and documents:

- Program operations
- Stakeholder satisfaction

- Opportunities to improve the efficiency and effectiveness of program delivery

To satisfy the EM&V objectives for this research effort, the evaluation team reviewed program documents and conducted telephone and web surveys with participating households who received a kit. The team also held in-depth interviews (IDI) with utility and implementation staff. Table 2-2 provides a summary of the activities the evaluation team conducted as part of the DEC (Table 2-2) and DEP (Table 2-3) SEWKP process and impact evaluations.

Table 2-2: DEC SEWKP Summary of Evaluation Activities

Target Group	Population	Sample	Confidence /Precision	Method
Impact Activities				
DEC Participants	49,353	320	90% ± 4.6%	Telephone/Web Survey
Process Activities				
DEC Participants	49,353	320	90% ± 4.6%	Telephone/Web Survey
Duke Energy Program Staff	n/a	1	n/a	Telephone IDI
Implementer Staff: EFI	n/a	1	n/a	Telephone IDI

Table 2-3: DEP SEWKP Summary of Evaluation Activities

Target Group	Population	Sample	Confidence /Precision	Method
Impact Activities				
DEP Participants	27,939	343	90% ± 4.5%	Telephone/Web Survey
Process Activities				
DEP Participants	27,939	343	90% ± 4.5 %	Telephone/Web Survey
Duke Energy Program Staff	n/a	1	n/a	Telephone IDI
Implementer Staff: EFI	n/a	1	n/a	Telephone IDI

3 Impact Evaluation

3.1 Methodology

The evaluation team's impact analysis focused on the energy and demand savings attributable to the SEWKP for the period of September 2018 through August 2019. The evaluation was divided into two research areas: to determine gross savings and net savings (or impacts). Gross impacts are energy and demand savings estimated at a participant's home that are the direct result of the homeowner's installation of a measure included in the program-provided energy saving kit. Net impacts are a reflection of the degree to which the gross savings are a result of the program efforts and funds. The evaluation team verified energy and demand savings attributable to the program by conducting the following impact evaluation activities:

- Review of DEC and DEP participant database.
- Completion of telephone and web-based surveys to verify key inputs into savings calculations.
- Estimation of gross verified savings using primary data collected from participants.
- Comparison of the gross-reported savings to program-evaluated results to determine kit-level realization rates.
- Application of attribution survey data to estimate net-to-gross ratios and net-verified savings at the program level.

3.2 Sampling Plan and Achievement

To provide representative results and meet program evaluation goals, a sampling plan was created to guide all evaluation activity. A random sample was created to target 90/10 confidence and precision at the program level assuming a coefficient of variation (C_v) equal to 0.5.

After reviewing the program database, we identified populations of 49,353 (DEC) and 27,939 (DEP) participants within our defined evaluation period. Based on this population, the evaluation team established sub-sample frames for phone and web-based survey administration. Customers who were flagged as "do not contact" in the participation database were excluded from the sample frame. As illustrated in Table 3-1 below, we completed 320 (DEC) and 343 (DEP) surveys among program participants between October 14th and 28th, 2019. This sample size resulted in a precision of ±4.6 (DEC) and ±4.5 (DEP) at a 90% confidence interval.

Table 3-1: DEC-DEP Impact Sampling

Jurisdiction	Survey Mode	Sample Frame	Sampled Participants	Achieved Precision at 90% Confidence
Carolinas	Phone	1,499	70	90% ± 4.6%
	Web-based	2,000	250	
	Total	**3,499**	**320**	
Progress	Phone	1,591	70	90% ± 4.5%
	Web-based	2,000	273	
	Total	**3,591**	**343**	

3.3 Description of Analysis

3.3.1 Telephone and web-based surveys

The evaluation team performed telephone and web-based surveys to gather key pieces of information used in the savings calculations. Results of the completed surveys were used to inform our program-wide assumptions as detailed in Table 3-2.

Table 3-2: Participant Data Collected and Used for Analysis

Measure	Data Collected	Assumption
Showerhead Bathroom Faucet Aerator Kitchen Faucet Aerator	Units Installed	In-Service Rate
	Units Later Removed	
	Hot Water Fuel Type	% Electric DHW
	Frequency of Showers	Hot Water Consumption
	Duration of Showers	
Insulating Pipe Tape	Pipe Tape Used	In-Service Rate
	Pipe Tape Removed	
	Hot Water Fuel Type	% Electric DHW
	Length of Insulated Pipe	Pipe Length

3.3.2 In-Service Rate

The in-service rate (ISR) represents the ratio of equipment installed and operable to the total pieces of equipment distributed and eligible for installation. For example, if 15 telephone surveys were completed for customers receiving 1 bathroom aerator each, and five customers reported to still have the aerator installed and operable, the ISR for this measure would be five out of 15 or 33%. In some instances equipment was installed, but may have been removed later due to homeowner preferences. In these cases the equipment is no longer operable and therefore contributes negatively to the ISR. In-service rates for each measure from all eligible survey respondents are detailed in Table 3-3.

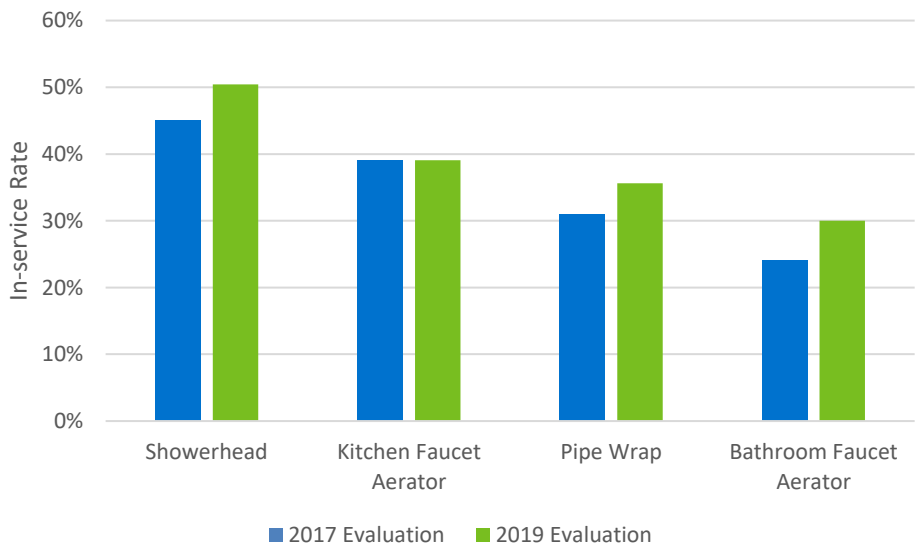
Table 3-3: DEC-DEP SEWKP Sample In-Service Rates

Jurisdiction	Measure	Distributed	Installed	Removed	ISR
Carolinas	Showerhead	436	244	24	50%
	Kitchen Faucet Aerator	320	142	17	39%
	Insulating Pipe Tape*	320	115	1	36%
	Bathroom Faucet Aerator	640	202	10	30%
Progress	Showerhead	481	278	31	51%
	Kitchen Faucet Aerator	343	159	15	42%
	Bathroom Faucet Aerator	686	270	11	38%
	Insulating Pipe Tape*	343	124	4	35%

*Quantity of pipe tape packages

In-service rates for all measures in the Carolinas jurisdiction (Figure 3-1) are greater than, or in-line with, the verified rates from the previous evaluation.[1]

Figure 3-1: DEC Equipment In-Service Rates

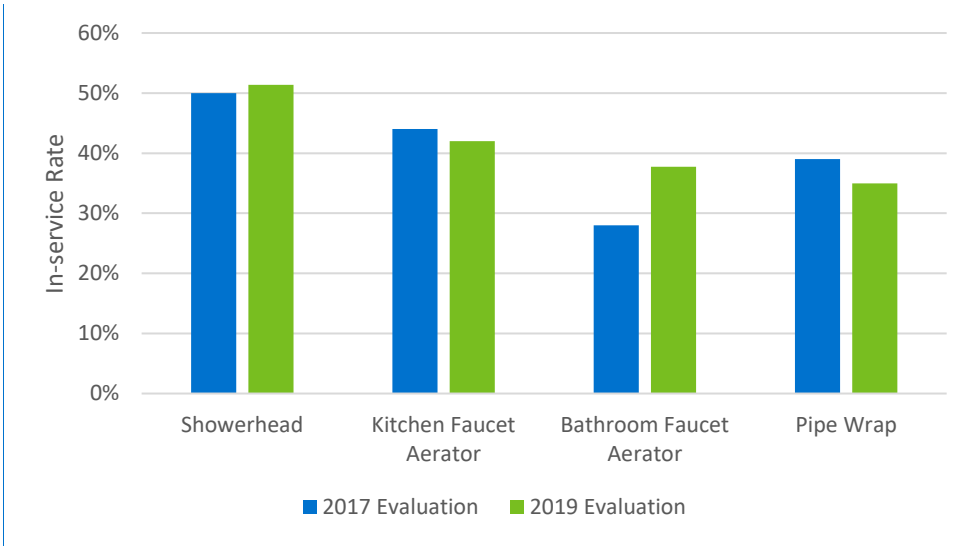


For the Progress jurisdiction (Figure 3-2) in-service rates for bathroom faucet aerators increased by 10% driven by a program change that reduced the number of bathroom faucet aerators provided through the medium kit from four to two. This evaluation (along with the previous 2016-2017 evaluation) has shown measure level in-service rates go down as the number of identical kit measures increases. Removing these items with low in-service rates increased the per unit

[1] Save Energy and Water Kits 2016 Program Year Evaluation Report, November 29th, 2017

savings attributed to bathroom faucet aerators. All other measure have similar in-service rates to the 2017 evaluation.

Figure 3-2: DEP Equipment In-Service Rates



3.3.3 Kit Measure Savings

The next section of the evaluation report provides a summary of the algorithms used to estimate energy and demand savings for each of the kit items. Input parameters were provided by program participant responses in the surveys. For more technical inputs the evaluation applied deemed values provided by the Mid-Atlantic TRM v9.

Demand savings coincident factors (CF) for the summer and winter seasons were estimated to align with peak demand periods[2] for each jurisdiction using the study on residential domestic hot water use referenced by the Mid-Atlantic TRM[3]. This method takes into account the average hot water use by fixture type (showerhead, faucet aerator) during the peak period along with the probability of the evaluated daily hours of use occurring at the same time.

3.3.3.1 Showerheads

The Save Energy and Water Kit contained either one or two low-flow showerheads, with the quantity depending on the size of the kit received. Small kit participants received one showerhead; those qualifying for a medium kit received two showerheads. The equations below outline the algorithms utilized to estimate savings accrued by the showerhead measure with parameters defined in Table 3-4.

[2] Both the Carolinas and Progress jurisdictions define their demand peaks as July, 4pm to 5pm (Summer) and January, 7am to 8am (Winter)

[3] Aquacraft, DeOreo and Mayer, *The End Uses of Hot Water in Single Family Homes from Flow Trace Analysis*

Equation 3-1: Showerhead Energy Savings Algorithm

$$\Delta kWh = ISR \times ELEC \times \frac{\Delta GPM \times HOU \times \Delta T \times 8.3 \frac{BTU}{gal \cdot °F}}{3{,}412 \frac{BTU}{kWh} \times RE}$$

$$HOU = \frac{T_{shower} \times N_{persons} \times Showers_{per\ person} \times 365 \frac{days}{year}}{Showers_{per\ home}}$$

Equation 3-2: Showerhead Demand Savings Algorithm

$$\Delta kW = CF \times \frac{\Delta kWh}{HOU}$$

Table 3-4: Inputs for Showerhead Savings Calculations

Input	Units	Showerhead Savings Input		Source
		DEC	DEP	
ISR, showerhead 1	n/a	56%	57%	Participant survey responses
ISR, showerhead 2	n/a	34%	37%	Participant survey responses
ELEC	n/a	88%	89%	Participant survey responses
ΔGPM	gpm	1.0		Baseline, Mid-Atlantic TRM v9 Retrofit, product specification sheet
T_{shower}	minutes/shower	9.1	9.8	Participant survey responses
$N_{persons}$	people/home	2.60	2.71	Participant survey responses
$Showers_{per\ person}$	showers/person/day	0.66	0.64	Participant survey responses
$Showers_{per\ home}$	showers/home	1.34	1.42	Participant survey responses
ΔT	°F	44.1°		Mid-Atlantic TRM v9
RE	n/a	98%		Mid-Atlantic TRM v9
CF, summer	n/a	0.0060	0.0062	Mid-Atlantic TRM v9, adjusted
CF, winter	n/a	0.0216	0.0222	Mid-Atlantic TRM v9, adjusted

The number of showerheads provided to each participant is dependent on the size of the kit received; with small kits providing a single showerhead and medium kits providing two. Since the evaluation demonstrated that equipment in-service rates drop as additional items are provided (i.e. a second showerhead) it is important to show the difference in estimated savings between the first and second showerhead provided to a participant. Savings for each showerhead, as shown in Table 3-5, are calculated at the jurisdiction level using all the same measure inputs from Table 3-4 expect for the in-service rate. This single change accounts for the full difference in energy and demand savings for the measure. Weighted averages presented here align with previous per unit savings shown in Table 1-4 and Table 1-8 and represent the average savings for each showerhead provided through the program.

Table 3-5: Showerhead Savings, per unit

Jurisdiction	Item	Program Population	Verified Savings, per unit		
			Energy (kWh)	Summer Demand (kW)	Winter Demand (kW)
DEC	Showerhead 1	44,114	231	0.020	0.070
	Showerhead 2	17,750	142	0.012	0.043
	Weighted Avg		205	0.017	0.063
DEP	Showerhead 1	26,112	244	0.021	0.074
	Showerhead 2	11,633	158	0.013	0.048
	Weighted Avg		217	0.018	0.066

3.3.3.2 Faucet Aerators

The Save Energy and Water Kit contained one kitchen faucet aerator and two bathroom faucet aerators. The equations below outline the algorithms utilized to estimate savings accrued by the faucet aerator measures with parameters defined in Table 3-6 and Table 3-8.

Equation 3-3: Faucet Aerator Energy Savings Algorithm

$$\Delta kWh = ISR \times ELEC \times \frac{(GPM_{base} \times Throttle_{base} - GPM_{low} \times Throttle_{low}) \times HOU \times 8.3 \frac{BTU}{gal \cdot °F} \times \Delta T}{3{,}412 \frac{BTU}{kWh} \times RE}$$

$$HOU = T_{faucet} \times N_{persons} \times 365 \frac{days}{year} \times DR$$

Equation 3-4: Faucet Aerator Demand Savings Algorithm

$$\Delta kW = CF \times \frac{\Delta kWh}{HOU}$$

Table 3-6: Inputs for Kitchen Faucet Aerator Measures Savings Calculations

Measurement	Units	Kitchen Aerator Savings Input		Source
		DEC	DEP	
ISR	n/a	39%	42%	Participant survey responses
ELEC	n/a	88%	89%	Participant survey responses

Measurement	Units	Kitchen Aerator Savings Input		Source
		DEC	DEP	
GPM_{base}	gpm	2.2		Mid-Atlantic TRM v9
GPM_{low}	gpm	1.0		Product specification sheet
$Throttle_{base}$	n/a	83%		Mid-Atlantic TRM v9
$Throttle_{low}$	n/a	95%		Mid-Atlantic TRM v9
T_{faucet}	minutes/day	4.5		Mid-Atlantic TRM v9
$N_{persons}$	persons/home	2.54	2.67	Participant survey responses
DR	n/a	50%		Mid-Atlantic TRM v9
ΔT	°F	32.1		Mid-Atlantic TRM v9
RE	n/a	98%		Mid-Atlantic TRM v9
CF, summer	n/a	0.0048	0.0051	Mid-Atlantic TRM v9, adjusted
CF, winter	n/a	0.0055	0.0058	Mid-Atlantic TRM v9, adjusted

Table 3-7: Kitchen Faucet Aerator Savings, per unit

Jurisdiction	Item	Verified Savings, per unit		
		Energy (kWh)	Summer Demand (kW)	Winter Demand (kW)
DEC	Kitchen Aerator	50	0.003	0.004
DEP	Kitchen Aerator	57	0.004	0.005

Table 3-8: Inputs for Bathroom Faucet Aerator Measures Savings Calculations

Measurement	Units	Bathroom Aerator Savings Input		Source
		DEC	DEP	
ISR, bath aerator 1	n/a	42%	48%	Participant survey responses
ISR, bath aerator 2	n/a	18%	27%	Participant survey responses
ELEC	n/a	88%	89%	Participant survey responses
GPM_{base}	gpm	2.2		Mid-Atlantic TRM v9
GPM_{low}	gpm	1.0		Product specification sheet
$Throttle_{base}$	n/a	83%		Mid-Atlantic TRM v9
$Throttle_{low}$	n/a	95%		Mid-Atlantic TRM v9
T_{faucet}	minutes/day	1.6		Mid-Atlantic TRM v9
$N_{persons}$	persons/home	2.63	2.78	Participant survey responses
DR	n/a	70%		Mid-Atlantic TRM v9
ΔT	°F	25.1°		Mid-Atlantic TRM v9

Measurement	Units	Bathroom Aerator Savings Input		Source
		DEC	DEP	
RE	n/a	98%		Mid-Atlantic TRM v9
CF, summer	n/a	0.0025	0.0026	Mid-Atlantic TRM v9, adjusted
CF, winter	n/a	0.0028	0.0030	Mid-Atlantic TRM v9, adjusted

Both kits (small and medium) include two bathroom aerators. It is important to show the difference in estimated savings between the first and second bathroom faucet aerator in a kit so savings for each bathroom aerator (Table 3-9) are calculated at the jurisdiction level using all the same measure inputs fromTable 3-8, with in-service rate as the only exception. Weighted averages presented here align with previous per unit savings shown in Table 1-4 and Table 1-8 and represent the average savings for each bathroom faucet provided through the program.

Table 3-9: Bathroom Faucet Aerator Savings, per unit

Jurisdiction	Item	Verified Savings, per unit		
		Energy (kWh)	Summer Demand (kW)	Winter Demand (kW)
DEC	Bathroom Aerator 1	21.7	0.0021	0.0024
	Bathroom Aerator 2	9.4	0.0009	0.0010
	Average Per Unit Savings	15.5	0.0015	0.0017
DEP	Bathroom Aerator 1	26.6	0.0026	0.0029
	Bathroom Aerator 2	15.2	0.0015	0.0017
	Average Per Unit Savings	20.9	0.0020	0.0023

3.3.3.3 Insulating Pipe Tape

All participants received a 15 foot roll of insulating pipe tape with their kit. To estimate the impacts resulting from the installation of the pipe tape measure, the evaluation team used the algorithms presented below.

Equation 3-5: Insulating Pipe Tape Energy Savings Algorithm

$$\Delta kWh = ISR \times ELEC \times \frac{\left(\frac{1}{R_{ex}} - \frac{1}{R_{new}}\right) \times L \times C \times \Delta T \times 8{,}760}{\eta DHW \times 3{,}413}$$

Equation 3-6: Insulating Pipe Tape Demand Savings Algorithm

$$\Delta kW = \frac{\Delta kWh}{8{,}760}$$

Table 3-10: Inputs for Insulating Pipe Tape Savings Calculations

Input	Units	Pipe Tape Savings Input		Source
		DEC	DEP	
ISR	n/a	36%	35%	Participant survey responses
ELEC	n/a	88%	89%	Participant survey responses
R_{ex}	n/a	1.00		Mid-Atlantic TRM v9
R_{new}	n/a	3.00		Product specification sheet
L	linear feet	5.01	4.78	Participant survey responses*
C	feet	0.20		Average outer diameter of 0.5” and 0.75” pipe
ΔT	°F	65°		Mid-Atlantic TRM v9
ηDHW	n/a	98%		Mid-Atlantic TRM v9

*Participant-provided estimated lengths of hot water pipe covered by the pipe tape was used to estimate verified savings.

Table 3-11: Insulating Pipe Tape Savings, per linear foot

Jurisdiction	Item	Verified Savings		
		Energy (kWh)	Summer Demand (kW)	Winter Demand (kW)
DEC	Pipe Tape	7.0	0.0008	0.0008
DEP	Pipe Tape	6.9	0.0008	0.0008

3.4 Billing Regression Analysis

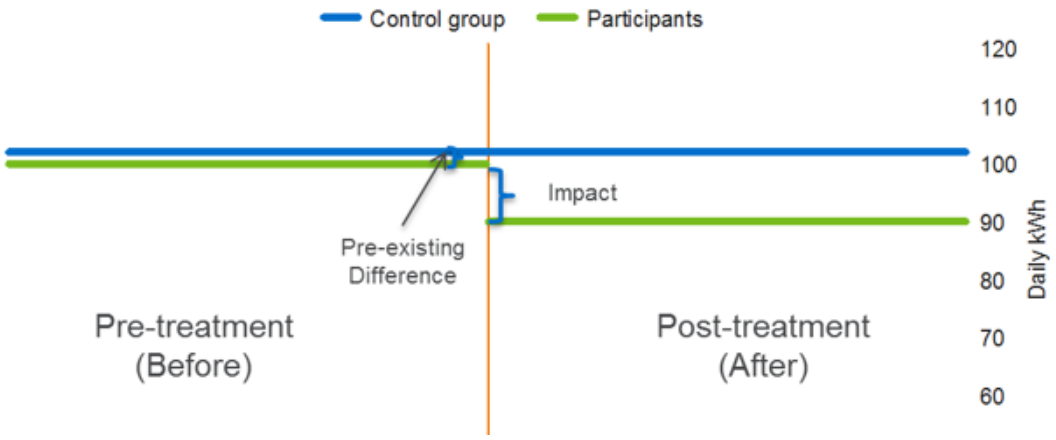
In addition to engineering analysis, the evaluation team attempted to estimate energy savings by analyzing energy use patterns before and after participation in the SEWKP – commonly referred to as billing analysis. After a thorough investigation, which is described in more detail below, we concluded that, absent a randomized control trial, billing analysis was unable to reliably detect energy savings associated with the kit effort. When the percent change in household energy use is small the only reliable way to estimate energy savings using billing analysis is through a randomized control trial with large treatment and control groups and pre- and post-data. Thus, the evaluation team’s recommendation is to rely on the engineering analysis and findings as the source of the verified gross and net savings for the program. Below we discuss how we attempted to complete a billing analysis and how we ultimately determined such an analysis was not feasible.

To estimate energy savings with billing data, it is necessary to estimate what energy consumption would have occurred in the absence of SEWKP – the counterfactual or baseline. To infer that the program led to energy savings, it is necessary to systematically eliminate plausible alternative explanations for differences in electricity use patterns.

The basic framework for the analysis is illustrated in Figure 3-3 and relies on both a control group and pre- and post-enrollment billing data. The analysis is implemented in two parts via weather-normalized pre-post and difference-in-differences (DID) techniques. The former utilizes observed weather patterns to assess changes in normalized electric consumption during the pre-treatment and post-treatment periods, while the latter compares program participants to a matched comparison group, and removes any pre-existing differences between the treatment and control groups. If the program's kit lead to reductions in consumption, we should observe:

- A change in consumption for households that participated in the SEWKP
- No similar change in consumption for the control group
- The timing of the change should coincide with the receipt of kits

Figure 3-3: Framework for Billing Analysis with Comparison Groups



While the SEWKP did not have a randomly assigned control group, the evaluation team did develop a comparison group to use in its analysis. However, there were several key challenges to producing reliable energy savings estimates using billing analysis. The two challenges that could not be addressed despite the use of a comparison group were the small effect size and selection bias. On a percentage basis, the expected energy savings from each kit were less than 2% of annual household energy consumption, and therefore it proved difficult to isolate the impacts of the program from other potential explanations, including random chance. Second, households that signed up for the kit self-selected from their peers. Despite using a comparison group, it could only account for observable characteristics like pre-treatment energy use patterns. As a result, while the participant and comparison group may have had similar energy use patterns in the pre-treatment period, their energy use trajectories absent program participation were not necessarily the same due to differences in the household use patterns.

From a practical standpoint, the use of billing analysis as the primary evaluation approach poses a number of possible challenges.

- Effect size - on a percentage basis, expected impacts from the program are small (0.5% to 1.5%) and thus difficult to distinguish from the inherent “noise” in the billing data;
- Timing of intervention - changes in the mix of participants and/or the timing of individual measure installations can be confused with natural changes in energy use;
- Self-selection - customers who enroll in SEWKP are inherently different than customers who do not:
  - They likely have different water use technology, household occupancy, and/or water consumption needs that can yield different responses to program intervention(s);
  - In order to be effective, the kits rely on customers to correctly install the individual fixtures themselves

In order to assess if the billing analysis produced reliable results, we implemented a series of placebo pressure tests. The approach consisted of simulating fake enrollments prior to actual participation in the program and assessing if the models detected an effect when using data from the false “pre” period to estimate the counterfactual for the false “post” period. Because enrollment dates were fictitious and actual post periods were excluded, we knew impacts were actually zero and any estimated impacts were due to modeling error. The evaluation team used two years of pre-treatment data for the placebo tests and each participant’s enrollment date was simulated to have occurred between three to nine months prior to actual participation, in increments of one month. The placebo tests were implemented using both a fixed-effects pre-post panel regression model (using only treatment group data) and a DID panel regression that made use of the matched comparison group.

Figure 3-4 shows the results from the pre-post placebo tests. Rather than produce zero impacts, the models estimated that the simulated enrollments led to changes in energy use when in fact no intervention had taken place. Moreover, the models incorrectly concluded that the erroneous impacts were statistically significant in several instances – an example of false precision. The pre-post model without a comparison group consistently estimated changes in energy consumption when impacts were in fact zero. The DID (Figure 3-5) that made use of the comparison group had less variable results, but it estimated energy increases in the range of roughly 1% to 1.5% when no intervention had taken place. Hence, neither method produced reliable energy savings estimates.

Figure 3-4: Placebo Pressure Test Results (Pre-Post)

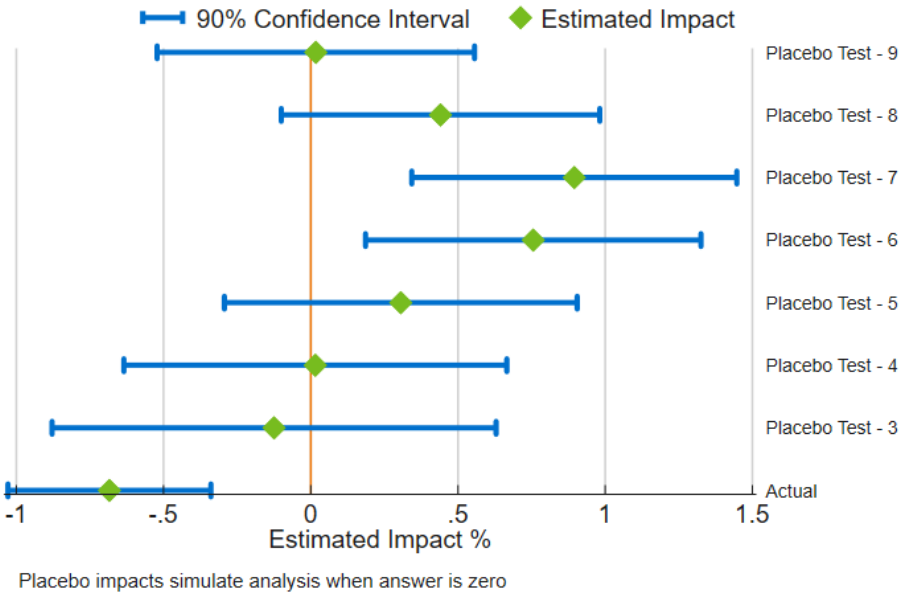
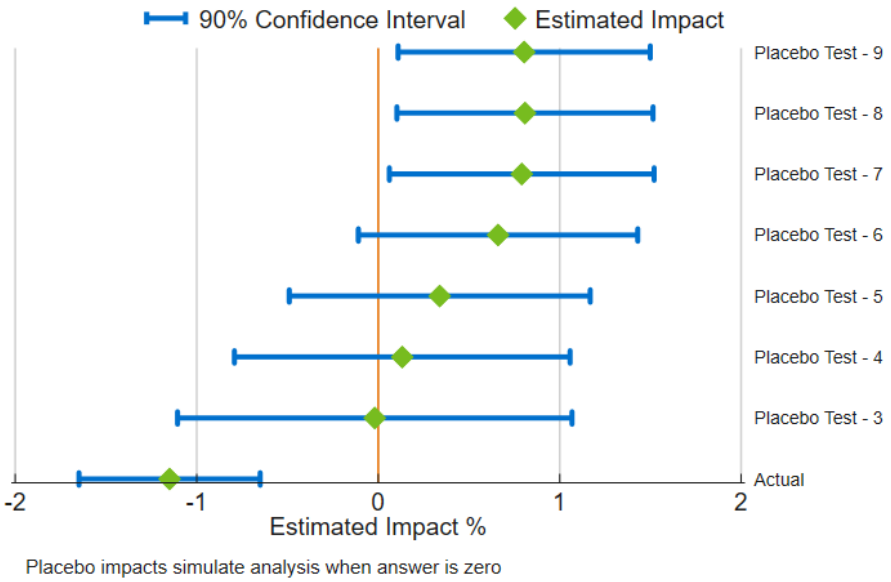


Figure 3-5: Placebo Pressure Test Results (Difference-in-Differences)



When the percent change in household energy use is small, as it is with the SEWKP, the only reliable way to estimate energy savings using billing analysis is through a randomized control trial (RCT) using large treatment and control groups combined with pre- and post-enrollment billing data. The most critical component of a well-designed RCT is to guarantee there are no differences between the treatment and control groups, other than the treatment of the program. This is a critical step to ensure that the analysis is able to accurately estimate the counterfactual

– or what would have happened absent the treatment. If inherent differences exist between the treatment group and control group, any changes in the post-treatment period could be due to these differences, rather than the treatment itself. In order to verify that effects are purely the result of the treatment intervention, the two groups must be ostensibly identical in every way except for the intervention.

Guaranteeing homogeneity between treatment and control groups is not achievable with an opt-in enrollment method. The fact that one group of customers chose to enroll in the program while the other did not implies that some intrinsic difference between them does exist. These differences may include:

- Behavioral preferences or predispositions for energy and water efficiency measures
- Information about the program that is not accessible to non-enrollees
- Higher energy needs and therefore a greater incentive to curb their consumption

Any of these characteristics are likely to contribute to consumption responses or patterns that cannot be attributable to the program intervention. A well-designed RCT includes randomly selected customers in the treatment and control groups, thereby ensuring that the analysis avoids adverse effects of selection bias and/or lurking confounding variables. Due to these variables, RCTs are impracticable for opt-in programs.

After a thorough investigation, we concluded that, absent a RCT, billing analysis was unable to reliably detect energy savings resulting from participation in the program. We consider the Pre-Post and Difference-in-Differences methodologies to provide complementary analyses; although a few of the Pre-Post placebo tests indicate statistically significant changes in energy usage the comparison group (DID) results indicate a greater level of uncertainty. The statistically significant treatment results from the pre-post analysis (101 kWh) is equivalent to 0.68% of total home energy consumption and is far too small to be considered definitive when conservative thresholds for billing analysis are set at 5% of consumption. Neither the Pre-Post or DID approach provides conclusive evidence of savings from the Program, thus calling into question the results from either analysis.

Low levels of savings compared to consumption will remain a consistent issue for the SEWKP and will continue to inhibit the accuracy of results provided through a billing analysis. The evaluation team's conclusion is not that there were no energy savings generated by the SEWKP, but rather that billing analysis was not the correct tool for estimating the small percentage of energy savings attributable to the program. Thus, the evaluation team's recommendation is to rely on the engineering analysis, which is supported by a regionally specific Technical Reference Manual and participant defined inputs that inform their use of the kit measures, and findings as the source of our verified gross and net savings for the programs.

3.5 Targeted and Achieved Confidence and Precision

We developed the SEWKP evaluation plan with the goal of achieving a target of 10% relative precision at the 90% confidence interval across both jurisdictions at the program level. Due to a high response rate from the web-based surveys, the evaluation team was able to surpass this target and achieve a high level of statistical precision. The final sample yielded a relative precision of ±4.6% for DEC and ±4.5% for DEP at the 90% confidence level (Table 3-12).

Table 3-12: Targeted and Achieved Confidence and Precision

Jurisdiction	Targeted Confidence/Precision	Achieved Confidence/Precision
DEC	90% ± 10%	90% ± 4.6%
DEP		90% ± 4.5%

3.6 Results

Measure-level and kit-level energy savings values for DEC and DEP Save Energy and Water Kit Programs are detailed in the following charts and tables.

3.6.1 Duke Energy Carolinas

Participant survey responses in DEC led to energy savings adjustments with a program realization rate of 95%. Two of the four measures verified energy savings above the program reported values.

Figure 3-6: DEC Gross Verified Energy Savings

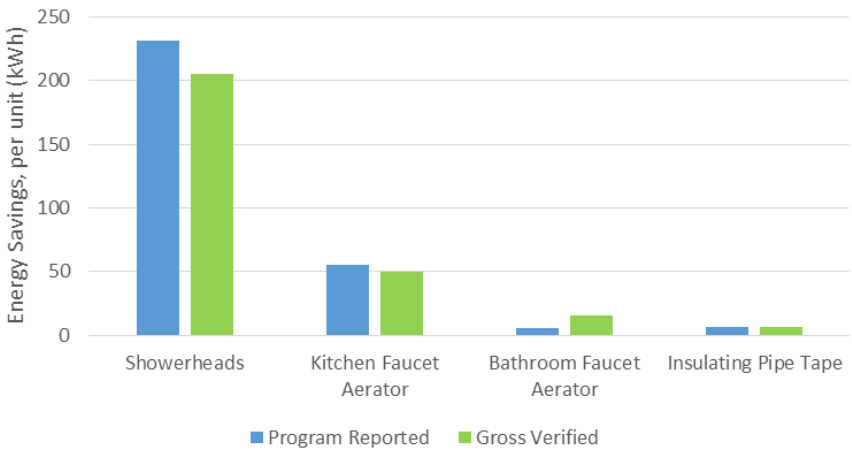


Table 3-13: DEC Measure-Level Reported and Verified Gross Energy Savings

Measure	Reported Energy Savings, per unit (kWh)	Realization Rate	Verified Energy Savings, per unit (kWh)
Low-flow Showerhead	231.4	89%	205.3
Low-flow Kitchen Aerator	55.2	91%	50.2
Low-flow Bathroom Aerator	5.7	272%	15.5
Insulating Pipe Tape*	7.0	100%	7.0

* Savings for pipe tape is a per linear foot measurement

Measure-level demand savings are detailed in Table 3-14.

Table 3-14: DEC Measure-Level Reported and Verified Demand Gross Savings

Measure	Summer Demand, per unit (kW)			Winter Demand, per unit (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Low-flow Showerhead	0.0740	24%	0.0174	0.0556	113%	0.0625
Low-flow Kitchen Aerator	0.0300	12%	0.0035	0.0133	30%	0.0040
Low-flow Bathroom Aerator	0.0030	50%	0.0015	0.0014	125%	0.0017
Insulating Pipe Tape*	0.0008	100%	0.0008	0.0017	48%	0.0008

* Savings for pipe tape is a per linear foot measurement

The impact evaluation for the 2018-2019 DEC SEWKP program resulted in a program energy realization rate of 95% and demand realization rates of 24% (summer) and 104% (winter) as presented in Table 3-15 and Table 3-16.

Table 3-15: DEC Energy Savings per Kit

Kit Size	Population	Reported Energy (kWh)	Energy Realization Rate	Gross Verified Energy (kWh)
Small	26,364	333	104%	347
Medium	17,750	564	87%	489
Program Total	**44,114**	**426**	**95%**	**404**

Table 3-16: DEC Demand Savings per Kit

Kit Size	Summer Demand (kW)			Winter Demand (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Small	0.114	26%	0.030	0.073	112%	0.082
Medium	0.188	22%	0.042	0.129	97%	0.125
Program Total	**0.144**	**24%**	**0.035**	**0.096**	**104%**	**0.099**

Table 3-17 presents the reported and verified energy and demand savings for the 2018-2019 program year.

Table 3-17: DEC Program Level Savings

Measurement	Population	Reported	Realization Rate	Gross Verified
Energy (kWh)	44,114	18,797,312	95%	17,834,056
Summer Demand (kW)		6,342.5	24%	1,541.5
Winter Demand (kW)		4,216.8	104%	4,371.2

3.6.2 Duke Energy Progress

Participant survey responses in DEP led to energy savings adjustments with a program realization rate of 79%.

Figure 3-7: DEP Gross Verified Energy Savings

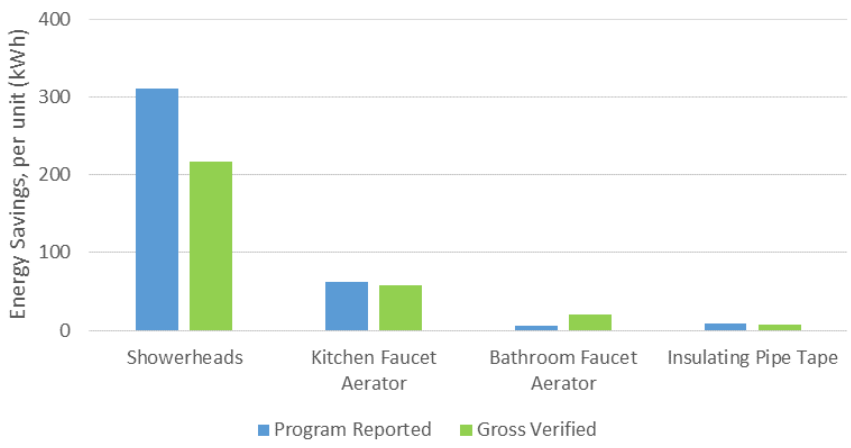


Table 3-18: DEP Measure-Level Reported and Verified Gross Energy Savings

Measure	Reported Energy Savings, per unit (kWh)	Realization Rate	Verified Energy Savings, per unit (kWh)
Low-flow Showerhead	310.1	70%	217.1
Low-flow Kitchen Aerator	62.2	92%	57.3
Low-flow Bathroom Aerator	5.9	354%	20.9
Insulating Pipe Tape*	8.8	79%	6.9

* Savings for pipe tape is a per linear foot measurement

Measure-level and kit-level demand savings are detailed in Table 3-19.

Table 3-19: DEP Measure-Level Reported and Verified Demand Gross Savings

Measure	Summer Demand, per unit (kW)			Winter Demand, per unit (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Low-flow Showerhead	0.0990	19%	0.0184	0.0841	79%	0.0661
Low-flow Kitchen Aerator	0.0330	12%	0.0040	0.0169	27%	0.0045
Low-flow Bathroom Aerator	0.0030	68%	0.0020	0.0016	144%	0.0023
Insulating Pipe Tape*	0.0010	79%	0.0008	0.0024	33%	0.0008

* Savings for pipe tape is a per linear foot measurement

The impact evaluation for the 2018-2019 DEP SEWKP program resulted in a program energy realization rate of 79% and demand realization rates of 21% (summer) and 75% (winter) as presented in Table 3-20 and Table 3-21.

Table 3-20: DEP Energy Savings per Kit

Kit Size	Population	Reported Energy (kWh)	Energy Realization Rate	Gross Verified Energy (kWh)
Small	14,479	428	88%	376
Medium	11,633	738	72%	533
Program Total	**26,112**	**566**	**79%**	**446**

Table 3-21: DEP Demand Savings per Kit

Kit Size	Summer Demand (kW)			Winter Demand (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Small	0.143	23%	0.033	0.107	82%	0.087
Medium	0.242	19%	0.046	0.191	71%	0.135
Program Total	**0.187**	**21%**	**0.038**	**0.144**	**75%**	**0.108**

Table 3-22 presents the reported and verified energy and demand savings for the 2018-2019 program year.

Table 3-22: DEP Program Level Savings

Measurement	Population	Reported	Realization Rate	Gross Verified
Energy (kWh)	26,112	14,785,941	79%	11,647,379
Summer Demand (kW)		4,885.7	21%	1,004.2
Winter Demand (kW)		3,760.8	75%	2,833.0

4 Net-to-Gross Methodology and Results

The evaluation team used participant survey data to calculate a net-to-gross (NTG) ratio for SEWKP. NTG reflects the effects of free ridership (FR) and spillover (SO) on gross savings. Free ridership refers to the portion of energy savings that participants would have achieved in the absence of the program through their own initiatives and expenditures (U.S. DOE, 2014).[4] Spillover refers to the program-induced adoption of additional energy-saving measures by participants who did not receive financial incentives or technical assistance for the additional measures installed (U.S. DOE, 2014). The evaluation team used the following formula to calculate the NTG ratio:

$$NTG = 1 - FR + SO$$

4.1 Free Ridership

Free ridership estimates how much the program influenced participants to install the energy-saving items included in the energy efficiency kit. Free ridership ranges from 0 to 1, with 0 being no free ridership and 1 being total free ridership.

The evaluation team used participant survey data to estimate free ridership. The survey used several questions to identify items that a given participant installed and did not later uninstall: respondents were only asked free ridership questions about items that remained installed by the date of the survey.

The evaluation team's methodology for calculating free ridership consists of two components, free ridership change (FRC) and free ridership influence (FRI), both of which range from 0 to .5 in value.

$$FR = FRC + FRI$$

4.1.1 Free Ridership Change

FRC reflects what participants reported they would have done if the program had not provided the items in the kit. For each respondent, the survey assessed FRC for each measure that the respondent installed and did not later uninstall.

Specifically, the survey asked respondents which, if any, of the currently installed items they would have purchased and installed on their own within the next year if Duke Energy had not provided them. For respondents who installed more than one of a given measure (bathroom

[4] The U.S. Department of Energy (DOE) (2014). *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 23: Estimating Net Savings: Common Practices*

aerators or showerheads) that indicated they would have installed either of the multi-count measures on their own, we asked them a follow up question that determined how many of the number installed through the program that they would have installed on their own.

For each measure, the evaluation team assigned one of the FRC values shown in the Table 4-1, based on the respondents' responses. FRC values range from 0.0 to 0.5.

Table 4-1: Free Ridership Change Values

What Respondent Would Have Done Absent the Program*	FRC Value
Would ***not*** have purchased and installed the item within the next year	0.00
Would have purchased and installed the item within the next year	$\frac{\text{Count respondent said would install on their own}}{\text{Count respondent installed through program}}$

*Survey response to: If you had not received the free efficiency items in the kit, would you have purchased and installed any of these same items within the next year?

4.1.2 Free Ridership Influence

FRI assesses how much influence the program had on a participant's decision to install (and keep installed) the items in the kit. The survey asked respondents to rate how much influence four program-related factors had on their respective decisions to install the measures, using a scale from 0 ("not at all influential") to 10 ("extremely influential"). The program-related factors included:

- The fact that the items were free
- The fact that the items were mailed to their home
- Information provided by Duke Energy about how the items would save energy and water
- Other information or advertisements from Duke Energy, including its website

Asking respondents to separately rate the influence of each of the four above items had on the decision to install each measure would have been overly burdensome. Therefore, while the survey assessed FRC for each measure type, it assessed collective FRI for all measures.

FRI is based on the highest-rated item in the FRI battery. The evaluation team assigned the following FRI scores, based on that rating (Table 4-2).

Table 4-2: Free Ridership Influence Values

Highest Influence Rating	FRI Value
0	0.50
1	0.45
2	0.40
3	0.35

Highest Influence Rating	FRI Value
4	0.30
5	0.25
6	0.20
7	0.15
8	0.10
9	0.05
10	0.00

4.1.3 Total Free Ridership

The evaluation team calculated total free ridership by measure by calculating

- First, measure-specific FR scores for each respondent by summing each respondent's measure-specific FRC score with their FRI score.
- Second, a measure-specific average FR score across all respondents, weighted by the number of units installed by each respondent.

The evaluation team then estimated overall program-level free ridership by calculating a savings-weighted mean of the measure-specific FR scores. Table 4-3 presents the measure-specific and overall FR estimates.

Table 4-3: Measure-Specific Free Ridership Scores

End-use	Measure-Specific Free Ridership	
	Carolinas	Progress
Showerhead	9.5%	8.2%
Kitchen Faucet Aerator	9.6%	8.1%
Bathroom Faucet Aerator	6.3%	4.8%
Insulating Pipe Tape	8.3%	7.6%
Overall	**9.2%**	**7.8%**

4.2 Spillover

Spillover estimates energy savings from additional energy improvements made by participants who are influenced by the program to do so and is used to adjust gross savings. The evaluation team used participant survey data to estimate spillover. The survey asked respondents to indicate what energy-saving measures they had implemented since participating in the program. The evaluation team then asked participants to rate the influence the program had on their decision to purchase these additional energy-saving measures on a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential."

The evaluation team converted the ratings to a percentage representing the program-attributable percentage of the measure savings, from 0% to 100%. The team then applied the

program-attributable percentage to the savings associated with each reported spillover measure to calculate the participant measure spillover (PMSO) for that measure. We defined the per-unit energy savings for the reported spillover measures based on previous Duke Energy Smart$aver evaluations, ENERGY STAR® calculators, and algorithms and parameter assumptions listed in the Mid-Atlantic TRM v9.

Since Duke Energy offered program incentives for a variety of energy-saving measures throughout the evaluation period, we compared the list of customers reporting measures as spillover against participation records for other Duke Energy programs that offered the measure. To avoid double-counting savings for measures already claimed by another Duke Energy offering, we excluded savings from measures that appeared in another program's tracking data from our estimation of spillover savings.

Participant measure spillover is calculated as follows:

$$PMSO = Deemed\ Measure\ Savings * Program\ Attributable\ Percentage$$

The evaluation team summed all PMSO savings values for each jurisdiction (Table 4-4 and Table 4-5).

Table 4-4: DEC Sample PMSO, by Measure by Category

Measure Category	Total kWh for Category	Percent Share of kWh
LEDs	5,532	24%
Duct Sealing	4,553	20%
Appliance	3,850	17%
HVAC	3,632	16%
Insulation	2,108	9%
Windows	1,695	7%
Water Heater	1,616	7%
CFLs	167	1%
Total	**23,153**	**100%**

Table 4-5: DEP Sample PMSO, by Measure by Category

Measure Category	Total kWh for Category	Percent Share of kWh
LEDs	19,868	51%
ENERGY STAR Home	5,157	13%
HVAC	4,678	12%
Appliance	3,293	8%
Duct Sealing	1,680	4%
Water Heater	1,385	4%
CFLs	980	3%
Windows	945	2%
Insulation	754	2%
Total	**38,740**	**100%**

The evaluation team then calculated gross program savings associated with sampled participants by summing the products of each measure's average per household savings and the total sample size (Table 4-6 and Table 4-7).

Table 4-6: DEC Sample Gross Program Savings (n=131)

Measure	Average per Household Savings (kWh)	Verified Sample Savings(kWh)
Showerhead	282	90,329
Kitchen Faucet Aerator	50	16,077
Bathroom Faucet Aerator	31	9,930
Insulating Pipe Tape	35	11,225
Total	**399**	**127,561**

Table 4-7: DEP Sample Gross Program Savings (n=114)

Measure	Average per Household Savings (kWh)	Verified Sample Savings (kWh)
Showerhead	307	105,290
Kitchen Faucet Aerator	57	19,658
Bathroom Faucet Aerator	42	14,324
Insulating Pipe Tape	33	11,392
Total	**439**	**150,664**

The evaluation team then divided the summed jurisdictional PMSO values by the sample's gross program savings to calculate an estimated spillover percentage for the program:

$$Program\ SO = \frac{\sum PMSO}{\sum Sample\ Gross\ Program\ Savings}$$

$$DEC\ SO = \frac{23{,}153}{127{,}561} = 18.2\%$$

$$DEP\ SO = \frac{38{,}740}{150{,}664} = 25.7\%$$

These calculations produced a spillover estimate of 18.2% for the DEC program and 25.7% for the DEP program. Lower spillover in the Carolinas territory is partially due to Duke Energy's Free LED Program that allows many participants to install new LED lamps in their home at no cost. Since these free LEDs are provided by Duke Energy they are excluded from any spillover estimates.

4.3 Net-to-Gross

Inserting the FR and SO estimates into the NTG formula (NTG = 1 – FR + SO) produces an NTG value of 109% for the DEC program and 118% for the DEP program (Table 4-8). The evaluation team applied this NTG ratio to program-wide verified gross savings to calculate SEWKP kit net savings for the jurisdiction (Table 4-9 and Table 4-10).

Table 4-8: Net-to-Gross Results

Jurisdiction	Free Ridership	Spillover	NTG
Carolinas	9.2%	18.2%	**109.0%**
Progress	7.8%	25.7%	**117.9%**

Table 4-9: DEC Program Level Savings

Measurement	Population	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	44,114	17,834,056	109.0%	19,434,623
Summer Demand (kW)		1,541.5		1,679.8
Winter Demand (kW)		4,371.2		4,763.5

Table 4-10: DEP Program Level Savings

Measurement	Population	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	26,112	11,647,379	117.9%	13,729,595
Summer Demand (kW)		1,004.2		1,183.8
Winter Demand (kW)		2,833.0		3,339.5

5 Process Evaluation

5.1 Summary of Data Collection Activities

The process evaluation is based on interviews and surveys with program staff, implementer staff, and households who received a kit during the program year (Table 5-1).

Table 5-1: Summary of Process Evaluation Data Collection Activities

Target Group	Method	Sample Size	Population	Confidence / Precision
Duke Energy program staff	Phone in-depth interview	1	n/a	n/a
Implementation staff: EFI	Phone in-depth interview	1	n/a	n/a
DEC participants	Mixed mode (web/phone) survey	320	49,353	90% ± 4.6%
DEP participants	Mixed mode (web/phone) survey	343	27,939	90% ± 4.5%

5.2 DEC Process Evaluation Findings

Installation Rates

Most kit recipients (79%) installed at least one measure, installing an average of two measures from the kit. A majority of kit recipients (63%) initially installed at least one of the showerheads, and slightly less than half initially installed at least one of the bathroom faucet aerators (46%) or kitchen faucet aerators (44%) with a smaller proportion reporting installing pipe tape (36%). Of the respondents who received a medium-sized kit, 36% installed both showerheads.[5] Regardless of kit size received, participants installed an average of one bathroom aerator and one showerhead.

Of the respondents who installed at least one item from the kit, 15% said they later uninstalled at least one of the measures, but no participants uninstalled everything they had installed. In total, 8% of all installed measure types were later uninstalled. Showerheads and kitchen faucet aerators had the highest uninstallation rates, with 12% of respondents who initially installed each later uninstalling them. In most cases, respondents said they uninstalled these water saving measures because they did not like how they worked, later elaborating that the water pressure provided was insufficient to their preferences.

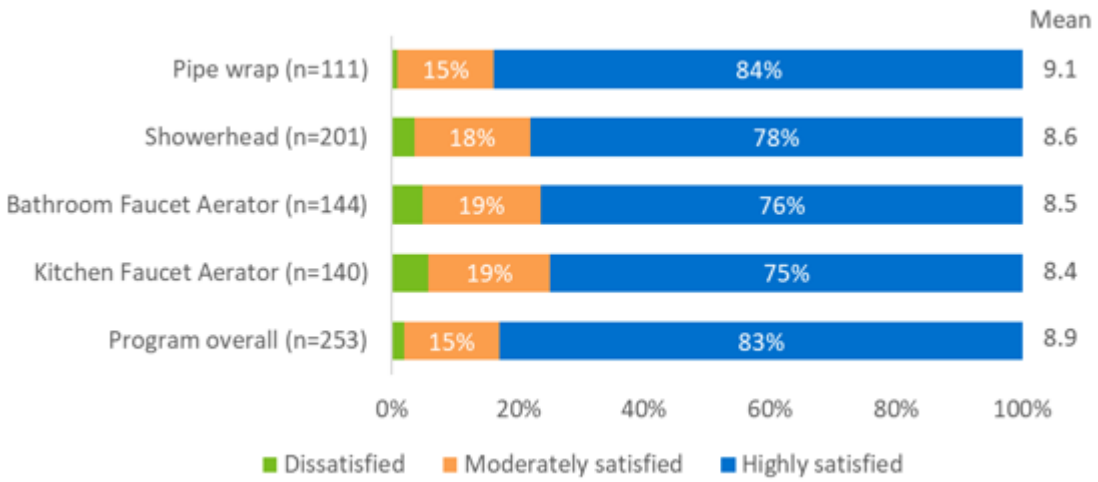
Fifteen percent of respondents reported installing all measure types. Of the respondents who did not install all measure types, 74% said they plan to install at least one of the items they had not yet installed. Respondents who indicated they don't plan to install one or more of the measures typically said they would not install the remaining items because they had not "gotten around to it" (27%), they already had the item (24%), or their current one is still working (17%).

[5] 66% of medium kit recipients installed at least one showerhead, 55% of whom installed both that came with the kit.

Measure Satisfaction

Nearly all kit recipients reported moderate to high satisfaction with the items they installed from their kit (Figure 5-1). To best gauge the experience with the measures, we asked respondents to rate their satisfaction with all measures they installed, including those they later uninstalled. Respondents were most satisfied with the pipe tape and were least satisfied with the kitchen faucet aerator. Open-ended comments revealed that those customers who were dissatisfied with water-saving measures most often pointed to low water pressure as the reason for dissatisfaction.

Figure 5-1: DEC Participant Satisfaction with Installed Measures*



* Respondents rated their satisfaction with the measures on a scale ranging from 0 ("very dissatisfied") to 10 ("very satisfied"). Dissatisfied indicates 0-4 ratings, moderately satisfied indicates 5-7 ratings, and highly satisfied indicates 8-10 ratings.

Kit Instructional Materials

In addition to energy-saving measures, the Save Energy and Water Kit includes a detailed instructional booklet that provides information on how to install the provided measures. The vast majority of respondents (85%) said they read the booklet, and most of them (81%) found it highly helpful. Duke Energy also offers a customer care hotline that participants can call for additional assistance, but just 1% of respondents took advantage of the service.

Additional Energy Saving Actions

More than one-third of participants (37%) reported purchasing and installing additional energy efficiency measures since receiving their kit (Table 5-2). Participants most commonly reported purchasing LEDs (24%), efficient appliances (16%), or air sealing (14%), and 83% of those who installed additional energy-saving measures said the program at least partially influenced their decision.

Table 5-2: Additional Energy Saving Measures Purchased by DEC Participants

	Percent of Respondents Reporting Purchases After Receiving the Kit	Percent Reporting at Least Some DEC Program Influence on Purchase
At least one measure	37%	31%
LEDs	24%	21%
Efficient appliances	16%	13%
Air sealing	14%	13%
Insulation	8%	7%
CFLs	6%	6%
Efficient heating or cooling equipment	6%	5%
Efficient water heater	6%	4%
Duct sealing	4%	4%
Efficient windows	4%	3%
Other	5%	3%

*Multiple Responses Allowed; n=320

5.3 DEP Process Evaluation Findings

Installation Rates

The majority (83%) of kit recipients installed at least one measure, installing an average of two measures from the kit. Most kit recipients initially installed at least one of the showerheads (65%), and slightly more than half initially installed at least one of the bathroom faucet aerators (53%). Slightly less than half installed kitchen faucet aerators (46%), and a smaller proportion reporting installing pipe tape (36%). Of the respondents who received a medium-sized kit, 39% installed both showerheads.[6] Regardless of kit size received, participants installed an average of one bathroom aerator and one showerhead.

Of the respondents who installed at least one item from the kit, 15% said they later uninstalled at least one of the measures, just one of whom uninstalled everything they had installed. In total, 9% of all installed measure types were later uninstalled. Showerheads and kitchen faucet aerators had the highest uninstallation rates, with 13% of those who installed showerheads and 9% of those who installed kitchen aerators later uninstalling them. In most cases, respondents said they uninstalled these water saving measures because they did not like how they worked, later elaborating that the water pressure provided was insufficient to their preferences.

About one-tenth (13%) of respondents reported installing all measure types. Of the respondents who did not install all measure types, 78% said they plan to install at least one of the items they had not yet installed. Respondents who indicated they don't plan to install one or more of the

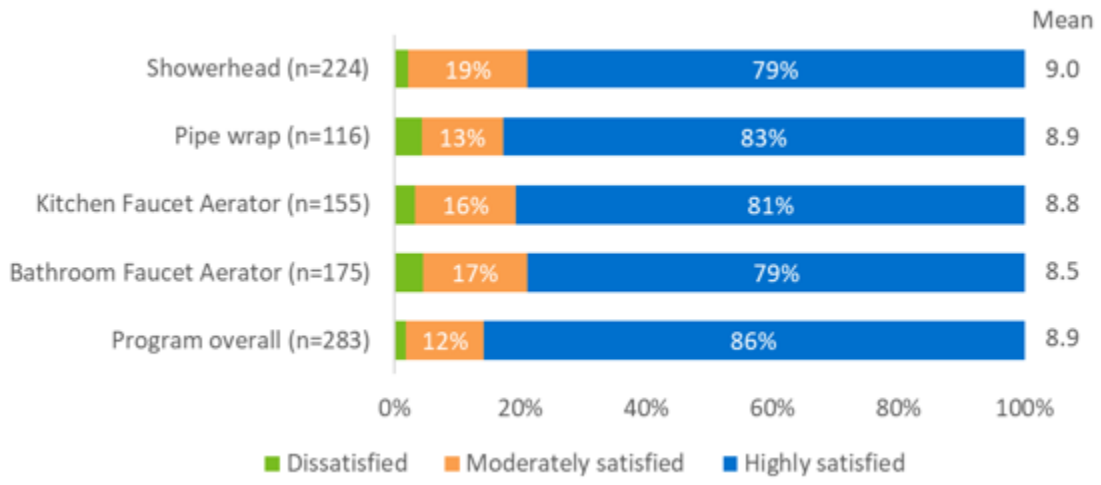
[6] 70% of medium kit recipients installed at least one showerhead, 56% of which installed both that came with the kit.

measures typically said they would not install the remaining items because they had not "gotten around to it" (24%), already had the item (22%), or their current one is still working (21%).

Measure Satisfaction

Nearly all kit recipients reported moderate to high satisfaction with the items they installed from their kit (Figure 5-2). To best gauge the experience with the measures, we asked respondents to rate their satisfaction with all measures they installed, including those they later uninstalled. Respondents reported similar levels of satisfaction with all four measures. Open-ended comments revealed that the few customers who were dissatisfied with water-saving measures mostly pointed to low water pressure as the source of dissatisfaction.

Figure 5-2: DEP Participant Satisfaction with Installed Measures*



* Respondents rated their satisfaction with the measures on a 0 ("very dissatisfied") to 10 ("very satisfied") scale. Dissatisfied indicates 0-4 ratings, moderately satisfied indicates 5-7 ratings, and highly satisfied indicates 8-10 ratings.

Instructional Materials in the Kit

In addition to energy-saving measures, the Save Energy and Water Kit includes a detailed instructional booklet that provides information on how to install the provided measures. The vast majority of respondents (85%) said they read the booklet, and most of them (84%) reported they found it highly helpful. Duke Energy also offers a customer care hotline that participants can call for additional assistance, but just 1% of respondents took advantage of the service.

Additional Energy Saving Actions

Over one-third of participants (35%) reported purchasing and installing additional energy efficiency measures since receiving their kit (Table 5-3). Participants most commonly reported purchasing LEDs (25%), efficient appliances (13%), or air sealing (12%), and 78% of those who installed additional energy-saving measures said the program at least partially influenced their decision.

Table 5-3: Additional Energy Saving Measures Purchased by DEP Participants*

	Count of Respondents Reporting Purchases After Receiving the Kit	Count Reporting at Least Some DEP Program Influence on Purchase
At least one measure	35%	27%
LEDs	25%	20%
Efficient appliances	13%	10%
Air sealing	12%	10%
Insulation	7%	5%
Efficient heating or cooling equipment	7%	4%
Energy efficient water heater	4%	3%
Efficient windows	4%	2%
CFLs	3%	3%
Duct sealing or insulation	3%	2%
Moved into ENERGY STAR home	1%	1%
Other	5%	4%

*Multiple Responses Allowed; n=343

6 Conclusions and Recommendations

The evaluation findings led to the following conclusions and recommendations for the program.

Conclusion 1: The program model is highly successful: it leverages low-cost measures to foster energy savings that would not have happened otherwise. Duke Energy's easy process for requesting and receiving a kit with free energy and water-saving items motivated thousands of customers to request and install energy saving measures in their home during the evaluation period. Most participants installed at least one measure from the kit, relatively few measures get uninstalled, and many participants reported installing additional energy saving items since receiving the kit. The majority of participants said they would not have installed any of the items on their own, as represented by low free ridership rates, and the program is reaching a diverse range of customers in terms of household characteristics and demographics.

> **Recommendation**: Continue using SEWKP to encourage Duke Energy customers to save energy and water.

Conclusion 2: The water saving measures' low flow water pressure results in some minor dissatisfaction and uninstallation issues. Complaints of excessively low water pressure was the primary driver of water-saving measure dissatisfaction and uninstallation. However, only a minority of participants were dissatisfied with or uninstalled any items.

> **Recommendation**: Monitor how showerhead upgrades affect satisfaction and uninstallation rates going forward.

Conclusion 3: Recent program improvements have been largely successful. Updates to the propensity model contributed to an increase in the percentage of participants that have electric water heaters from less than 80% in 2017 to nearly 90% in 2019 (from 70% to 88% for the DEC program and from 79% to 89% for the DEP program). The new instructional materials provided with the kits also appear to denote a significant improvement from the prior instructions. Recent participants rated the instructions as considerably more helpful than participants in the last evaluated program year: the percentage of customers who rated instructions as "very helpful" increased since 2017 (from 70% to 81% among DEC participants and 80% to 84% among DEP participants).

Conclusion 4: Increased penetration and saturation of measures included in the kits may limit installation rates going forward. Among participants who had yet to install measures and had no immediate plans to do so, more than 20% indicated they already had at least one of the efficient measures installed. For pipe tape, more than 30% of those without plans to install the measure reported they already had some installed (34% for DEC and 32% for DEP). These rates were nearly as high for showerheads, for which 32% of DEC respondents and 25% of DEP respondents with no plans to install indicated that they already an efficient one installed.

Recommendation: Monitor installation rates going forward and consider excluding measures that show high rates of prior ownership.

Appendix A Summary Form

Save Energy and Water Kit Program

Completed EMV Fact Sheet

Description of program

The Duke Energy Save Energy and Water Kit Program (SEWKP) is an energy efficiency program that offers energy efficient water fixtures and water pipe insulation to residential customers. The program is designed to reach customers who have not adopted energy efficient water devices. The kits are provided to residents through a Direct Mail Campaign, allowing eligible customers to request to have the items shipped directly to their homes, free of charge.

Date	April 23, 2020
Region(s)	Carolinas and Progress
Evaluation Period	September 1st, 2018 – August 31st, 2019
Annual Gross MWh Savings	DEC: 17,834 DEP: 11,647
Per Kit Gross kWh Savings	DEC: 404 DEP: 446
Annual Gross MW Savings	DEC: 1.54 (summer), 4.37 (winter) DEP: 1.00 (summer), 2.83 (winter)
Net-to-Gross Ratio	DEC: 109.0% DEP: 117.9%
Process Evaluation	Yes
Previous Evaluation(s)	2016

Evaluation Methodology

Impact Evaluation Activities

- Telephone/web surveys (DEC n=320, DEP n=343) and analysis of 4 unique measures

Impact Evaluation Findings

- Realization rates:
  - DEC: 95% (energy); 24% (summer demand); 104% for (winter demand)
  - DEP: 79% (energy); 21% (summer demand); 75% for (winter demand)
- Net-to-gross ratio: 109.0% (DEC), 117.9% (DEP)

Process Evaluation Activities

- Telephone/web surveys (DEC n=320, DEP n=343)
- 1 interview with program staff
- 1 interview with implementation staff

Process Evaluation Findings

- The SEWKP influences participants to install kit measures and adopt new behaviors.
- Participants are generally satisfied with kit items and report high satisfaction with overall program.
- Kit size assignment algorithm is fairly accurate.
- Low water pressure is the leading contributor to dissatisfaction with water-saving items among a relatively small number of participants.
- The toll-free customer care hotline is used by a very small number of SEWKP participants

Appendix B Measure Impact Results

Table B-1: DEC Per Unit Verified Impacts by Measure – Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Summer Demand (kW)	Gross Winter Demand (kW)	Realization Rate (Energy)	Free Ridership	Spillover	Net to Gross Ratio	M&V Factor (Energy) (RR x NTG)	Measure Life
Low-flow Showerhead (1.5 gpm)	205.3	0.0174	0.0625	88.7%	9.5%	18.2%	109.0%	96.7%	10
Kitchen Faucet Aerator (1.0 gpm)	50.2	0.0035	0.0040	91.0%	9.6%			99.2%	10
Bathroom Faucet Aerator (1.0 gpm)	15.5	0.0015	0.0017	272.2%	6.3%			296.6%	10
Insulating Pipe Tape*	7.0	0.0008	0.0008	100.2%	8.3%			109.2%	15

* Per linear foot

Table B-2: DEP Per Unit Verified Impacts by Measure – Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Summer Demand (kW)	Gross Winter Demand (kW)	Realization Rate (Energy)	Free Ridership	Spillover	Net to Gross Ratio	M&V Factor (Energy) (RR x NTG)	Measure Life
Low-flow Showerhead (1.5 gpm)	217.1	0.0184	0.0661	70.0%	8.2%	25.7%	117.9%	82.6%	10
Kitchen Faucet Aerator (1.0 gpm)	57.3	0.0040	0.0045	92.1%	8.1%			108.7%	10
Bathroom Faucet Aerator (1.0 gpm)	20.9	0.0020	0.0023	353.9%	4.8%			417.6%	10
Insulating Pipe Tape*	6.9	0.0008	0.0008	75.5%	7.6%			89.1%	15

* Per linear foot

Appendix C Program Performance Metrics

This appendix provides key program performance metrics, or PPIs. See Chapter 5 for the underlying results and more detailed findings.

Figure C-1: DEC Program Experience PPIs

	Participants	
	%	n
Program experience & satisfaction PPIs		
Overall satisfaction with program	83%	253
Usefulness of kit instructions	81%	272
Satisfaction with kit measures		
Showerhead	78%	201
Kitchen faucet aerator	75%	140
Bathroom faucet aerator	76%	144
Pipe wrap	84%	111
Program influence on behavior PPIs		
Installed at least one kit measure	79%	320
Most common measure installed: *showerhead*	63%	320
Respondents reporting program attributable spillover	19%	320
Challenges and opportunities for improvement PPIs		
Measure with lowest installation rate: pipewrap	36%	320
Measure with highest uninstallation rate: kitchen faucet aerator	12%	142
Measure with highest dissatisfaction: kitchen faucet aerator	6%	142

Figure C-2: DEC Participant Demographics

Ownership Status	
Own	85%
Rent	11%

Household Size	
One to two	58%
Three	16%
Four	12%
Five +	10%

Education	
High school or less	18%
Some college	31%
Bachelor's degree	25%
Graduate degree	20%

Income	
<$30k	17%
$30k to <$60k	24%
$60k to <$75k	15%
$75k to <$100k	11%
$100k+	11%

Age	
18 to 34	13%
35 to 44	15%
45 to 64	34%
65 and older	19%

Note: Refusals and "don't know" responses are not shown.

Figure C-3: DEC Participant Household Characteristics

Housing Type	
Detached	78%
Attached	5%
Mobile	12%
Apartment or condo	1%
Duplex or triplex	3%

Water Heater Fuel Type	
Electric	87%
Natural Gas	11%
Other	1%

Home Square Feet		
	Small Kit	Medium Kit
Less than 1,000	17%	1%
1,000-1,499	34%	24%
1,500-1,999	23%	34%
2,000-2,999	15%	28%
3,000+	2%	8%

Number of Showers		
	Small Kit	Medium Kit
1	35%	12%
2	57%	69%
3	6%	16%
4+	0%	3%

Number of Kitchen Faucets		
	Small Kit	Medium Kit
1	93%	89%
2	4%	11%
3+	2%	0%

Number of Bathroom Faucets		
	Small Kit	Medium Kit
1-2	67%	47%
3-4	28%	41%
5+	4%	11%

Figure C-4: DEP Program Experience PPIs

	Participants	
	%	n
Program experience & satisfaction PPIs		
Overall satisfaction with program	86%	283
Usefulness of kit instructions	84%	291
Satisfaction with kit measures		
Showerhead	79%	224
Kitchen faucet aerator	81%	155
Bathroom faucet aerator	79%	175
Pipe wrap	83%	116
Program influence on behavior PPIs		
Installed at least one kit measure	83%	343
Most common measure installed: *showerhead*	65%	343
Respondents reporting program attributable spillover	21%	343
Challenges and opportunities for improvement PPIs		
Measure with lowest installation rate: pipewrap	36%	343
Measure with highest uninstallation rate: showerhead	16%	224
Measure with highest dissatisfaction: bathroom faucet aerator	4%	181

Figure C-5: DEP Participant Demographics

Ownership Status	
Own	88%
Rent	9%

Household Size	
One to two	54%
Three	17%
Four	16%
Five +	8%

Education	
High school or less	13%
Some college	31%
Bachelor's degree	28%
Graduate degree	19%

Income	
<$30k	15%
$30k to <$60k	25%
$60k to <$75k	11%
$75k to <$100k	12%
$100k+	11%

Age	
18 to 34	11%
35 to 44	17%
45 to 64	31%
65 and older	15%

Note: Refusals and "don't know" responses are not shown.

Figure C-6: DEP Participant Household Characteristics

Housing Type	
Detached	77%
Attached	6%
Mobile	12%
Apartment or condo	1%
Duplex or triplex	2%

Water Heater Fuel Type	
Electric	88%
Natural Gas	9%
Other	2%

Home Square Feet		
	Small Kit	Medium Kit
Less than 1,000	13%	1%
1,000-1,499	31%	32%
1,500-1,999	22%	24%
2,000-2,999	19%	29%
3,000+	3%	8%

Number of Showers		
	Small Kit	Medium Kit
1	23%	6%
2	64%	79%
3	10%	12%
4+	2%	3%

Number of Kitchen Faucets		
	Small Kit	Medium Kit
1	91%	92%
2	6%	4%
3+	2%	3%

Number of Bathroom Faucets		
	Small Kit	Medium Kit
1-2	54%	36%
3-4	39%	54%
5+	6%	9%

Note: Refusals and “don’t know” responses are not shown.

Appendix D Instruments

D.1 Program Staff In-Depth Interview Guide

Introduction

Today, we'll be discussing your role in the SEWKP or water kit program. We would like to learn about your experiences in administering this program.

Your comments are confidential. If I ask you about areas you don't know about, please feel free to tell me that and we will move on. Also, if you want to refer me to specific documents to answer any of my questions, that's great – I'm happy to look things up if I know where to get the information.

I would like to record this interview for my note-taking purposes. Do I have your permission?

Roles & Responsibilities

Q1. Please describe your position at Duke Energy and your role in the water kit program.

Q2. How long have you been in this role?

Program Delivery

Next, I'd like to learn more about how this program was delivered since your involvement. If the program implementation is different in 2017, please let me know.

Q3. How is Duke Energy targeting households to participate in this program? Does this vary by jurisdiction?

[*IF NEEDED*:]

1. What marketing and outreach activities did Duke Energy conduct in the 2016 program year? [*Interviewer: we know they market the program through direct-mail campaign. Probe to inquire if they market the program in any other way.*]
2. In 2016, what proportion requested a kit among those targeted by the direct mail campaign? Are you satisfied with this response rate? If not, why not?
3. In terms of marketing, what is planned for 2017? [*If not mentioned:* Do you all plan to have a customer facing website for the program? If yes, when and what would it entail? If not, why not?]

Q4. What feedback, if any, did you receive from kit recipients on why they decided to request a kit?

Q5. Please describe the kit distribution process, including the responsibilities of your vendors: Relationship 1 (R1) and EFI.

[*IF NEEDED*:]

1. Can the kit form be submitted online? If not, is Duke considering this option?
2. Who checks whether customers who submitted the kit form are eligible for the program? What is the eligibility criteria?
3. How do you identify customers who have an electric water heating? [*Interviewer: Prior evaluation states that customers with electric water heating are eligible for this program.*]
4. Who tracks kit processing and distribution?
5. How are kits customized? [*IF NEEDED:*] Can you describe what is included in the small, medium, and large kit? (Confirm kit contents as seen below)

Kit 1 (small)	bath aerator	2
	kitchen aerator	1
	shower head	1
	pipe tape	5
Kit 2 (medium)	bath aerator	4
	kitchen aerator	1
	shower head	2
	pipe tape	5
Kit 3 (large)	bath aerator	5
	kitchen aerator	1
	shower head	3
	pipe tape	5

6. [*If not mentioned*] Are large kits still offered to customers? (If so, does this vary by jurisdiction?)
7. Prior to January 2016, documentation shows the kitchen aerator to have 1.0 GPM, but according to a Duke staff person, the aerator is now rated at 1.5 GPM. Can you please confirm the current GPM for kitchen aerators, and when that changed over (if at all)?
8. What energy saving educational materials are included in the kit?

Q6. What type of feedback have you received from kit recipients about the measures in the kit? [*IF ANY ISSUES REPORTED:*] How have you addressed those issues?

Program Goals

Q7. In 2016 and 2017 program year, what were/are Duke Energy targets in terms of:

1. Number of water kits distributed in Carolinas, Progress, Ohio, Indiana, and Kentucky
2. Number of kits distributed by customer segments – if applicable

3. Cost of distributing the kits [*Probe: Does this vary by jurisdiction?*]
4. Anything else?

Q8. How were those targets set, and by whom?

Q9. Compared to the previous program years, have these targets been the same or have they changed? [*If changed:*] Why have they changed?

Q10. Were/are you on track to meet 2016/2017 targets? [*If not on track, probe why not on track and how far behind are they in meeting their targets.*]

1. Number of water kits distributed in each jurisdiction
2. Number of kits distributed by customer segments – if applicable
3. Cost of distributing the kits
4. Anything else?

Q11. How about savings targets? Are you on track to meet the savings targets in Carolinas, Progress, Ohio, Indiana, and Kentucky? If not, why not?

Q12. Does the program have any process or non-impact goals? *(Probe: low-income, renter, or non-English speaking population targeting, increased kit recipient knowledge of how to save energy, etc.)*

[*IF YES:*]

1. How are these goals established?
2. How are they measured?

Communication

Q13. Can you describe how your vendors communicate about the program with Duke Energy? Who do you communicate with, how often, and what about? Does this vary by jurisdiction?

Q14. How often do you or vendors have to resolve an issue with kits? What types of issues come up?

Data Tracking of Kits

Let's talk about the kits a little bit.

Q15. Were there any changes to the items in the small, medium, or large kit during 2016 and 2017 program year? Any changes for 2018 program year? Are these changes for all jurisdictions?

Q16. We heard that customers must complete a short survey/form to receive a kit. Would it be possible to receive/see this survey data?

Q17. From the moment a customer requests a kit, how long does it take to receive a kit? Is this time frame typical in terms of how long it takes to receive a kit? [*IF NOT TYPICAL, PROBE to get more information on this topic.*] Does it vary by jurisdiction?

Q18. Can you tell us how your vendor reports the number of kits sent out to customers to Duke Energy? Is there information on kit distribution that you need but are not getting? What?

We are almost done. I have a few more questions.

Tape Up

Q19. What would you say are the greatest strengths of this program?

Q20. What would you say is the biggest challenge in administering this program?

Q21. How can this program be improved?

Q22. Is there anything else about the program that we have not discussed that you feel should be mentioned?

Q23. What would you like to learn from the program evaluation?

Those are all of my questions. Thank you very much for your time.

D.2 Implementer Staff In-Depth Interview Guide

Introduction

[*Note: Opinion Dynamics staff will schedule calls ahead of time through email contact.*]

[*If needed:*] We are conducting an evaluation of Duke Energy Save Energy and Water Kit Program (SEWKP). Because your organization is involved with this program, we would like to get your perspective on how the program works to help guide us in our efforts.

I would like to record this interview for my note-taking purposes. Do I have your permission?

Roles & Responsibilities

Q1. Can you describe your role in the SEWKP or water kit program?

Q2. Can you describe your program processes? (From receipt of kit forms to notifying EFI to send kits)

Q3. We have been told that your organization processes kit submission forms for Duke Energy water kit program. Do you provide any other services to Duke Energy?

1. Do you provide these services in all jurisdictions where this program is offered: Progress, Carolinas, Ohio, Indiana, and Kentucky?

Program Goals

Q4. In jurisdictions where you are providing services to Duke Energy, do you know what are Duke Energy targets in terms of:

1. Number of water kits distributed
2. Cost of the kits
3. Education goals
4. Anything else?

Q5. Do you know if Duke Energy is on track to achieve those targets? If so, how do you know?

Data Tracking of Kits and Eligibility

Q6. Based on what we heard, households must complete a short survey/form to receive a kit. Do you track the information that is on the survey form in a database? If so, what exactly do you track?

1. Do you track the same information for each jurisdiction?

2. How do you report this information to Duke Energy?
3. [*If not addressed:*] Do you maintain a dashboard that tracks number of kits and possibly other information. If so, can you send us a screen shot of that dashboard so we can see what is tracked on that dashboard?
4. Could you provide us with one of the forms so we can see what participants are filling out?

Q7. Can you describe to us who is eligible to receive the kit – that is, eligibility criteria? Do eligibility criteria vary by jurisdiction?

Q8. Can you tell us what proportion of households who sent in a kit survey form were ineligible to receive a kit in 2016 in each jurisdiction? What are the most common reasons as to why customers are ineligible? Do you think the proportion of ineligible applications will increase in 2017? If so, why?

Q9. From the moment households request a kit, do you know how long it takes to receive a kit? Is this time frame typical in terms of how long it takes to receive a kit? [*IF NOT TYPICAL, PROBE to get more information on this topic.*]

Q10. What challenges have you encountered with processing of the kit forms? [*Probe about missing information or other errors.*] [*If challenges:*] What could be done to address these challenges? Any suggestions on how to change the form? Are some of these challenges more prevalent in certain jurisdictions? If so, why?

Q11. How many forms, on average, do you process per week or annually?

Q12. [*If not addressed:*] What demographic data do you collect from households that request the kits? Which demographic segments are more likely to request the kits? Does this vary by jurisdiction?

Communication

Q13. Can you describe how you communicate with Duke Energy about the kit form submissions or anything else? Who do you communicate with, how often, and what about?

Q14. Have there been any challenges in your interactions with Duke Energy? If so, what were they? How did you address them? Were they resolved? If not, what do you think might resolve them?

Tape Up

I have only a couple of more questions left.

Q15. What would you say is the biggest challenge in processing kit submission forms and distributing kits? What could be done to improve this process?

Q16. Is there anything else about the program that we have not discussed that you feel should be mentioned?

Those are all of my questions. Thank you very much for your time.

D.3 Participant Survey

Introduction/ Screening

[ASK FOR PHONE SURVEY]
Q1. Hi, I'm _____, calling on behalf of Duke Energy. We are calling about the Save Energy and Water Kit you got from Duke Energy. This kit included faucet aerators, one or two showerheads, and pipe wrap that can help you save water and energy in your home. Do you recall receiving this kit?
1. Yes
2. No
98. Don't know
[IF NEEDED: Can I speak with someone who may know something about this kit?]
[IF NO KNOWLEDGEABLE CONTACT, THANK AND TERMINATE]

[ASK FOR WEB SURVEY]
Q2. We are conducting surveys about the Save Energy and Water Kit you got from Duke Energy. This kit included faucet aerators, one or two showerheads, and pipe wrap that can help you save water and energy in your home. Do you recall receiving this kit?
1. Yes
2. No [TERMINATE]
3. Don't know [TERMINATE]

Motivation and Collateral

Q3. [deleted]

Q4. Did you read the included instructions on how to install the items that came in the kit?
1. Yes
2. No
98. Don't remember

[ASK IF Q3=1]
Q5. [ASK IF 4=1] On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were the instructions on how to install the items that came in the kit?
0. Not at all helpful
1.
2.
3.
4.
5.
6.
7.
8.
9.
10. Very helpful
98. Don't know

[ASK IF Q5<7]
Q6. What might have made the instructions more helpful?
[RECORD VERBATIM ANSWER]

Q7. [deleted]
Q8. [deleted]
Q9. [deleted]

Assessing Measure Installation

[DISPLAY IF KIT_SIZE=SMALL:] We'd like to ask you about the energy and water saving items included in your kit. The kit contained a showerhead, faucet aerators for the bathroom and kitchen, and pipe wrap.

[DISPLAY IF KIT_SIZE=MEDIUM:] We'd like to ask you about the energy and water saving items included in your kit. The kit contained two showerheads, faucet aerators for the bathroom and kitchen, and pipe wrap.

Q10. Have you or anyone else installed any of those items in your home, even if they were taken out later? [Interviewer: Throughout interview, remind respondent as needed to report whether someone else in the home installed or uninstalled any items]
1. Yes
2. No [SKIP TO Q23]
98. Don't know [TERMINATE]

[ASK IF Q10=1]
Q11. Which of the items did you install, even if they were taken out later? [MULTIPLE RESPONSE]
[Interviewer: Record each response, then prompt with the list items.]
1. Showerhead
2. Kitchen faucet aerator
3. Bathroom faucet aerator
4. Pipe wrap
98. I don't remember which items were installed [TERMINATE]

[ASK IF Q11=1 AND KIT_SIZE=MEDIUM]
Q12. Your kit contained two showerheads. Did you install one or both of the showerheads in the kit, even if one or both were taken out later?
1. I installed both
2. I only installed one showerhead
98. Don't know

[ASK IF Q11=3]
Q13. How many of the bathroom faucet aerators from the kit did you install in your home, even if one or more were taken out later?
1. One
2. Two
98. Don't know

[ASK IF Q11=4]
Q14. Did you install all of the pipe insulation that was included with the kit?
1. Yes
2. No
98. Don't know

[ASK IF Q11=4]
Q15. About how many feet of the hot water pipe exiting your water heater did you wrap with the insulation that came in the kit? Please go over to your water heater if you need to check.
1. About three feet or less
2. About four to five feet
3. About six feet or more
98. Don't know

[ASK IF Q11=1,2,3,4]
Q16. Overall, how satisfied are you with the item(s) you installed? [0-10 SCALE FOR EACH; 98=DK]
[DISPLAY IF MODE=PHONE: Please use a 0 to 10 scale, where 0 is very dissatisfied and 10 is very satisfied. How satisfied are you with...]
1. [SHOW IF Q11=1] Showerhead
2. [SHOW IF Q11=2] Kitchen faucet aerator
3. [SHOW IF Q11=3] Bathroom faucet aerator
4. [SHOW IF Q11=4] Pipe wrap

[ASK IF Q16_1<7 OR Q16_2<7 OR Q16_3<7 OR Q16_4<7]
Q16a. Can you please explain any dissatisfaction you had with the following measures?
[SHOW LIST OF Q16 ITEMS THAT WERE RATED LESS THAN 7]
[OPEN END: RECORD VERBATIM]

Q17. Overall, how satisfied are you with Duke Energy's Save Energy and Water Kit Program?
[DISPLAY IF MODE=PHONE: IF NEEDED: Please use that same 0 to 10 scale, where 0 is very dissatisfied and 10 is very satisfied.]
0. Very dissatisfied
1.
2.
3.
4.
5.
6.
7.
8.
9.
10. Very satisfied
98. Don't know

[ASK IF ANY PART OF Q11=1]
Q18. Have you (or anyone in your home) removed any of the items from the kit that you had previously installed?
1. Yes
2. No
98. Don't know

[ASK IF Q18=1]
Q19. Which of the items did you remove? [MULTIPLE RESPONSE]
Q19_1. [DISPLAY IF Q11_1=1] Showerhead[s]
Q19_2. [DISPLAY IF Q11_2=1] Kitchen faucet aerator
Q19_3. [DISPLAY IF Q11_3=1] Bathroom faucet aerator[s]
Q19_4. [DISPLAY IF Q11_4=1] Pipe wrap

Q19_7. Don’t know [EXCLUSIVE ANSWER]

[ASK IF Q19=1 AND Q12=1]
Q20. Did you remove one or both of the showerheads you had previously installed?
1. I uninstalled both
2. I only uninstalled one of the showerheads
98. Don't know

[ASK IF Q19=3 AND Q13=2]
Q21. How many bathroom faucet aerators did you remove?
1. One
2. Two
98. Don't know

[CALCULATE SHOWER:
IF Q12=1, THEN SHOWER=2;
IF Q12=2 OR (Q11_1=1 AND KIT_SIZE=SMALL), THEN SHOWER=1;
ELSE SHOWER=0]

[CALCULATE KITCH:
IF Q11_2=1, THEN KITCH=1, ELSE KITCH=0]

[CALCULATE BATH:
IF Q13=2, THEN BATH=2;
IF Q13=1, THEN BATH=1;
ELSE BATH=0]

[CALCULATE PIPE:
IF Q11_4=1, THEN PIPE=1, ELSE PIPE=0]

[CALCULATE SHOWER1:
IF SHOWER=1 AND Q19_1=1, THEN SHOWER1=0;
IF Q19_1=1 AND (Q20=1 OR Q20=98), THEN SHOWER1=0;
IF Q19_1=1 AND Q20=2, THEN SHOWER1=1;
ELSE SHOWER1=SHOWER]

[CALCULATE KITCH1:
IF Q19_2=1, THEN KITCH1=0;
ELSE KITCH1=KITCH]

[CALCULATE BATH1:
IF BATH=1 AND Q19_3=1, THEN BATH1=0;
IF Q19_3=1 AND (Q21=2 OR Q21=98), THEN BATH1=0;
IF Q19_3=1 AND Q21=1, THEN BATH1=1;
ELSE BATH1=BATH]

[CALCULATE PIPE1:
IF Q19_4=1, THEN PIPE1=0;
ELSE PIPE1=PIPE]

CALCULATE CALCTOTAL1:
[SHOWER1 + BATH1 + KITCHEN1 + PIPE1]

[ASK IF Q19=1,2,3,4—REPEAT FOR EACH SELECTED ITEM]
Q22. Why was the [Q19 SELECTION] removed? [MULTIPLE RESPONSE]
1. It was broken
2. I didn't like how it worked
3. I didn't like how it looked, or
4. Some other reason (please specify): [OPEN END]
98. Don't know

[ASK IF Q10=2 OR Q11_1=0 OR Q11_2=0 OR Q11_3=0 OR Q11_4=0]
Q23. You said you haven't installed the following items. Which of the following do you plan to install in the next three months? [MULTIPLE RESPONSE]
1. [SHOW IF Q10=2 OR Q11_1=0] Showerhead
2. [SHOW IF Q10=2 OR Q11_2=0] Kitchen faucet aerator
3. [SHOW IF Q10=2 OR Q11_3=0] Bathroom faucet aerator
4. [SHOW IF Q10=2 OR Q11_4=0] Pipe wrap
96. I'm not planning to install any of these in the next three months [EXCLUSIVE ANSWER]
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q23_1=0 OR ((Q10=2 OR Q11_1=0) AND Q23_96=1)]
Q24_1. What's preventing you from installing the showerhead(s)?
[Interviewer: do not read response options, code responses]
1. Didn't know what that was
2. Tried it, didn't fit
3. Tried it, didn't work as intended (please specify): [OPEN-END]
4. Haven't gotten around to it
5. Current one is still working
6. Takes too much time to install or too busy
7. Too difficult to install it, don't know how to do it
8. Don't have the tools I need
9. Don't have the items any longer (threw away, gave away)
10. [SHOW FOR Q24_1] Already have efficient showerhead
96. Other (please specify): [OPEN END]
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q23_2=0 OR ((Q10=2 OR Q11_2=0) AND Q23_96=1)]
Q24_2. What's preventing you from installing the showerhead(s)?
[Interviewer: do not read response options, code responses]
1. Didn't know what that was
2. Tried it, didn't fit
3. Tried it, didn't work as intended (please specify): [OPEN END]
4. Haven't gotten around to it
5. Current one is still working
6. Takes too much time to install or too busy
7. Too difficult to install it, don't know how to do it
8. Don't have the tools I need
9. Don't have the items any longer (threw away, gave away)
11. [SHOW FOR Q24_2] Already have efficient kitchen faucet aerator
96. Other (please specify): [OPEN END]
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q23_3=0 OR ((Q10=2 OR Q11_3=0) AND Q23_96=1)]
Q24_3. What's preventing you from installing the showerhead(s)?

[Interviewer: do not read response options, code responses]
1. Didn't know what that was
2. Tried it, didn't fit
3. Tried it, didn't work as intended (please specify): [OPEN END]
4. Haven't gotten around to it
5. Current one is still working
6. Takes too much time to install or too busy
7. Too difficult to install it, don't know how to do it
8. Don't have the tools I need
9. Don't have the items any longer (threw away, gave away)
12. [SHOW FOR Q24_3] Already have efficient bathroom faucet aerators
96. Other (please specify): [OPEN END]
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q23_4=0 OR ((Q10=2 OR Q11_4=0) AND Q23_96=1)]
Q24_4. What's preventing you from installing the showerhead(s)?
[Interviewer: do not read response options, code responses]
1. Didn't know what that was
3. Tried it, didn't work as intended (please specify): [OPEN END]
4. Haven't gotten around to it
6. Takes too much time to install or too busy
7. Too difficult to install it, don't know how to do it
8. Don't have the tools I need
9. Don't have the items any longer (threw away, gave away)
13. Already have pipe wrap on my hot water pipe
96. Other (please specify): [OPEN END]
98. Don't know [EXCLUSIVE ANSWER]

Q24a. Customers that need additional assistance with their items can call a toll-free customer care hotline. Did you call the customer care hotline to seek assistance in installing any of your items?
1. Yes
2. No
98. Don't know

[ASK IF Q24A=1]
Q24b. Did you call the customer care hotline to seek assistance in installing your kitchen faucet aerator?
1. Yes
2. No
98. Don't know

[ASK IF Q24B=1]
Q24c. Did the customer care hotline offer to send you an adapter for the kitchen faucet aerator?
1. Yes
2. No
98. Don't know

[ASK IF Q24A=1]
Q24d. Did you call the customer care hotline to seek assistance in installing your bathroom faucet aerator?
1. Yes

2. No
98. Don't know

[ASK IF Q24D=1]
Q24e. Did the customer care hotline offer to send you an adapter for the bathroom faucet aerator?
1. Yes
2. No
98. Don't know

Q25. [deleted]
Q26. [deleted]
Q27. [deleted]
Q28. [deleted]

[ASK IF SHOWER1 > 0]
Q29. On average, what is the typical shower length in your household?
1. One minute or less
2. Two to four minutes
3. Five to eight minutes
4. Nine to twelve minutes
5. Thirteen to fifteen minutes
6. Sixteen to twenty minutes
7. Twenty-one to thirty minutes
8. More than thirty minutes
98. Don’t know

[ASK IF SHOWER1 > 0]
Q30. [DISPLAY IF SHOWER1=2] Thinking of the efficient showerhead you installed that gets the most usage, on average, how many showers per day are taken in this shower? [DISPLAY IF SHOWER1=1] Thinking of the efficient showerhead currently installed in your home, on average, how many showers per day are taken in this shower?
1. Less than one
2. One
3. Two
4. Three
5. Four
6. Five
7. Six
8. Seven
9. Eight or more
98. Don’t know

[ASK IF SHOWER1=2]
Q31. Thinking of the other efficient showerhead you installed, on average, how many showers per day are taken in this shower?
1. Less than one
2. One
3. Two
4. Three
5. Four
6. Five
7. Six

8. Seven
9. Eight or more
98. Don't know

Q32. [This question was moved to demographics section – but not renumbered for programming purposes]

NTG

[SKIP TO Q40 IF CALCTOTAL1=0]

Q33. If you had not received the free efficiency items in the kit, would you have purchased and installed any of these same items within the next year?
1. Yes
2. No
4. Don't know

[ASK IF Q33=1]
Q34. What items would you have purchased and installed within the next year? [MULTIPLE RESPONSES]
Q34_1. [IF SHOWER1 > 0] Energy-efficient showerhead[s]
Q34_2. [IF KITCH1 > 0] Energy-efficient kitchen faucet aerator
Q34_3. [IF BATH1 > 0] Energy-efficient bathroom faucet aerator[s]
Q34_4. [IF PIPEWRAP1 > 0] Pipe wrap
Q34_7. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q34_1=1 AND SHOWER1=2]
Q35. If you had not received them in your free kit, how many energy-efficient showerheads would you have purchased and installed within the next year?
1. One
2. Two
98. Don't know

[ASK Q36 IF Q34_3=1 AND BATH1=2]
Q36. If you had not received them in your free kit, how many energy-efficient bathroom aerators would you have purchased and installed within the next year?
1. One
2. Two
98. Don't know

Q37. Now, thinking about the energy and water savings items that were provided in the kit - using a scale from 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how influential were the following factors on your decision to install the items from the kit? How influential was… [0-10 SCALE FOR EACH; 98=DK]
1. The fact that the items were free
2. The fact that the items were mailed to your house
3. Information provided by Duke Energy about how the items would save energy and water
0. Other information or advertisements from Duke Energy, including its website

Q38. [DELETED]
Q39. [DELETED]

Q40. Since receiving your kit from Duke Energy, have you purchased and installed any other products or made any improvements to your home to help save energy?
1. Yes
2. No
98. Don't know

[ASK Q41 IF Q40=1]
Q41. What products have you purchased and installed to help save energy in your home? [MULTIPLE RESPONSE]
[INTERVIEWER: Do not read list. After each response, ask, “Anything else?”]
4. Bought energy efficient appliances
5. Moved into an ENERGY STAR home
6. Bought efficient heating or cooling equipment
7. Bought efficient windows
8. Added insulation
9. Sealed air leaks in windows, walls, or doors
10. Sealed or insulated ducts
11. Bought LEDs
12. Bought CFLs
13. Installed an energy efficient water heater
15. Other (please specify): [OPEN END]
96. None – no other actions taken [EXCLUSIVE ANSWER]
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q41=5]
Q42. Is Duke Energy still your gas or electricity utility?
1. Yes
2. No
98. Don’t know

Q43. [DELETED]
Q44. [DELETED]
Q45. [DELETED]

[ASK IF Q41=4,5,6,7,8,9,10,11,12,13,15—REPEAT FOR EACH SELECTED ITEM]
Q46. On a scale of 0 to 10, where 0 means “not at all influential” and 10 means “extremely influential”, how much influence did the Duke Energy Save Energy and Water Kit Program have on your decision to… [0-10 SCALE FOR EACH; 98=DK]
4. [IF Q41=4] Buy energy efficient appliances
5. [IF Q41=5] Move into an ENERGY STAR home
6. [IF Q41=6] Buy efficient heating or cooling equipment
7. [IF Q41=7] Buy efficient windows
8. [IF Q41=8] Add insulation
9. [IF Q41=9] Seal air leaks in windows, walls, or doors
10. [IF Q41=10] Seal or insulate ducts
11. [IF Q41=11] Buy LEDs
12. [IF Q41=12] Buy CFLs
13. [IF Q41=13] Install an energy efficient water heater
15. [IF Q41=15] [Q41_15 OPEN END RESPONSE]

[ASK IF Q41=4 AND 46_4 > 0]
Q47. What kinds of appliance(s) did you buy? [MULTIPLE RESPONSE]
[Do not read list]

1. Refrigerator
2. Stand-alone Freezer
3. Dishwasher
4. Clothes washer
5. Clothes dryer
6. Oven
7. Microwave
0. Other (please specify): [OPEN END]
98. Don't know

[ASK IF Q47=1,2,3,4,5,7,0—REPEAT FOR EACH SELECTED ITEM]
Q48. Was the [INSERT Q47 RESPONSE] an ENERGY STAR or high-efficiency model?
1. Yes
2. No
98. Don't know
99. Refused

[ASK IF Q47=5]
Q49. Does the new clothes dryer use natural gas?
1. Yes - it uses natural gas
2. No – does not use natural gas
98. Don't know

[ASK IF Q41=6 AND Q46_6 > 0]
Q50. What type of heating or cooling equipment did you buy?
[MULTIPLE RESPONSE] [Do not read list]
4. Central air conditioner
5. Window/room air conditioner unit
6. Wall air conditioner unit
7. Air source heat pump
8. Geothermal heat pump
9. Boiler
10. Furnace
11. Wi-Fi thermostat
12. Other (please specify): [OPEN END]
98. Don't know

[ASK IF Q50=9 OR 10]
Q51. Does the new [INSERT Q50 RESPONSE] use natural gas?
1. Yes – it uses natural gas
2. No – does not use natural gas
98. Don't know

[ASK IF Q50=4,5,6,7,8,9,10,12—REPEAT FOR EACH SELECTED ITEM]
Q52. Was the [INSERT Q50 RESPONSE] an ENERGY STAR or high-efficiency model?
1. Yes - it is an ENERGY STAR or high-efficiency model
2. No - it is not an ENERGY STAR or high-efficiency model
98. I don't know if it is an ENERGY STAR or high-efficiency model

[ASK IF Q41=7 AND Q46_7 > 0]
Q53. Do you know how many windows you installed??
1. Yes (please specify how many you installed in the box below)
[NUMERIC RESPONSE 1 – 100]

2. No

[ASK IF Q41=8 AND Q46_8 > 0]
Q54. Please let us know what spaces you added insulation to. Also, let us know the proportion of each space for which you added insulation (for example, if you added insulation that covered your entire attic space, you would type in 100%).
1. Attic [NUMERIC RESPONSE 0 – 100]%
2. Walls [NUMERIC RESPONSE 0 - 100]%
3. Below the floor [NUMERIC RESPONSE 0 – 100]%

[ASK IF Q41= 11 AND Q46_11 > 0]
Q55. Do you know how many LEDs you installed at your property?
1. Yes (please specify how many you installed in the box below) [NUMERIC RESPONSE 1 – 100]
2. No

[ASK IF Q41=12 AND Q46_12 > 0]
Q56. Do you know how many CFLs you installed at your property?
1. Yes (please specify how many you installed in the box below) [NUMERIC RESPONSE 1 – 100]
2. No

[ASK IF Q41=13 AND Q46_13 > 0]
Q57. Does the new water heater use natural gas?
1. Yes – it uses natural gas
2. No – does not use natural gas
98. Don’t know

[ASK IF Q41= 13. AND Q46_13 > 0]
Q58. Which of the following water heaters did you purchase?
1. A traditional water heater with a large tank that holds the hot water
2. A tankless water heater that provides hot water on demand
3. A solar water heater
0. Other (please specify): [OPEN END]
98. Don’t know

[ASK IF Q41= 13 AND Q46_13 > 0]
Q59. Is the new water heater an ENERGY STAR model?
1. Yes
2. No
98. Don't know

Demographics

Q60. Which of the following types of housing units would you say best describes your home?
1. Single-family detached house
2. Single-family attached home (such as a townhouse or condo)
3. Duplex, triplex or four-plex
4 Apartment or condominium with 5 units or more
5. Manufactured or mobile home
0. Other (please specify): [OPEN END]
98. Don't know

Q61. How many showers are in your home? Please include both stand-up showers and bathtubs with showerheads.
1. One
2. Two
3. Three
4. Four
5. Five or more
98. Don't know

Q62. How many bathroom sink faucets are in your home? (Keep in mind that some bathrooms may have multiple bathroom sink faucets in them)
1. One
2. Two
3. Three
4. Four
5. Five
6. Six
7. Seven
8. Eight or more
98. Don't know

Q63. How many kitchen faucets are in your home?
1. One
2. Two
3. Three
4. Four or more
98. Don't know

[ASK IF Q63=2,3,4]
Q63a. You mentioned that you have more than one kitchen faucet. Where is/are your other kitchen faucet(s) located in your home?
[OPEN-ENDED: RECORD VERBATIM RESPONSE]

Q32. What fuel type does your water heater use?
1. Electric
2. Natural Gas
3. Other (please specify): [OPEN END]
4. Don't know

Q64. How many square feet of living space are there in your residence, including bathrooms, foyers and hallways (exclude garages, unfinished basements, and unheated porches)?
1. Less than 500 square feet
2. 500 to under 1,000 square feet
3. 1,000 to under 1,500 square feet
4. 1,500 to under 2,000 square feet
5. 2,000 to under 2,500 square feet
6. 2,500 to under 3,000 square feet
7. Greater than 3,000 square feet
98. Don't know
99. Prefer not to say

Q65. Do you or members of your household own your home, or do you rent it?
1. Own / buying

2. Rent / lease
3. Occupy rent-free
98. Don't know
99. Prefer not to say

Q66. Including yourself, how many people currently live in your home year-round?
1. I live by myself
2. Two people
3. Three people
4. Four people
5. Five people
6. Six people
7. Seven people
8. Eight or more people
98. Don't know
99. Prefer not to say

Q67. What was your total annual household income for 2018, before taxes?
1. Under $20,000
2. 20 to under $30,000
3. 30 to under $40,000
4. 40 to under $50,000
5. 50 to under $60,000
6. 60 to under $75,000
7. 75 to under $100,000
8. 100 to under $150,000
9. 150 to under $200,000
10. $200,000 or more
98. Don't know
99. Prefer not to say

Q68. What is the highest level of education achieved among those living in your household?
1. Less than high school
2. Some high school
3. High school graduate or equivalent (such as GED)
4. Trade or technical school
5. Some college (including Associate degree)
6. College degree (Bachelor’s degree)
7. Some graduate school
8. Graduate degree, professional degree
9. Doctorate
98. Don't know
99. Prefer not to say

Q69. Finally, what is your year of birth?
[Scroll box with years 1900-2011; 9998=Prefer not to say]

Appendix E DEC Participant Survey Results

This section reports the results from each question in the DEC participant survey. Since the results reported in this appendix represent the "raw" data (that is, none of the open-ended responses have been coded and none of the scale questions have been binned), some values may be different from those reported in the Process Evaluation Findings chapter (particularly: percentages in tables with "Other" categories and scale response questions). Only respondents who completed the survey are included in the following results.

Q1. [Read if mode = phone] Hi, I'm _____ , calling on behalf of Duke Energy. We are calling about the Save Energy and Water Kit you got from Duke Energy.

This kit included faucet aerators, one or two showerheads, and pipe tape that can help you save water and energy in your home. Do you recall receiving this kit?

Response Option	Percent (n=35)
Yes	100%
No	0%
Don't know	0%

Q2. [Display if mode = web] We are conducting surveys about the Save Energy and Water Kit you got from Duke Energy. This kit included faucet aerators, one or two showerheads, and pipe tape that can help you save water and energy in your home.

Do you recall receiving this kit?

Response Option	Percent (n=285)
Yes	100%
No	0
Don't know	0

Q3. DELETED

Q4. Did you read the included instructions on how to install the items that came in the kit?

Response Option	Percent (n=320)
Yes	85%
No	10%
Don't remember	5%

Q5. [Ask if Q4 = YES] On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were the instructions on how to install the items that came in the kit?

Response Option	Percent (n=272)
0- Not at all helpful	0%
1	0%
2	0%
3	0%
4	0%

5	3%
6	5%
7	9%
8	15%
9	18%
10 - Very helpful	48%
Don't Know	2%

Q6. [Ask if Q5<7] What might have made the instructions more helpful?

Verbatim Response	Count (n=22)
They were fine	1
They said everything very well	1
There were no washers that were talked about in the instructions just teflon tape and no directions to use the tape.	1
step-by-step diagram for the show head installation	1
Specific use case or online video tutorials for individuals that are less likely to apply the items in the kit in the correct manner.	1
sheesh	1
Nothing, I know how to install	1
Nothing that remember. They went helpful to me because I already knew how to use the things that came.	1
Nothing	3
not sure	1
Na	1
More thoroughness	1
More diagrams	1
More details	1
Little more detail or more pics	1
Did not understand at all how to install would have had to call a plumber	1
Clear talk	1
Better pictures	1
Basic pin points	1
A little more simplified.	1

Q7. DELETED

Q8. DELETED

Q9. DELETED

Q10. Have you or anyone else installed any of those items in your home, even if they were taken out later?

Response Option	Percent (n=320)
Yes	79%
No	21%
Don't Know	0%

Q11. [Ask if Q10 = YES] Which of the items did you install, even if they were taken out later?

Response Option	Percent (n=254)*
Showerhead	80%
Kitchen faucet aerator	56%
Bathroom faucet aerator	58%
Pipe tape	45%
I don't remember	0%

*Multiple responses were allowed for this question

Q12. [Ask if Q11 = SHOWERHEAD AND KIT_SIZE= MEDIUM] Your kit contained two showerheads. Did you install one or both of the showerheads in the kit, even if one or both were taken out later?

Response Option	Percent (n=77)
I installed both	55%
I only installed one showerhead	46%
Don't know	0%

Q13. [Ask if Q11 = BATHROOM FAUCET AERATOR] How many of the bathroom faucet aerators from the kit did you install in your home, even if one or more were taken out later?

Response Option	Percent (n=146)
One	56%
Two	41%
Don't know	3%

Q14. [Ask if Q11 = PIPEWRAP] Did you install all of the pipe insulation that was included with the kit?

Response Option	Percent (n=116)
Yes	74%
No	21%
Don't know	5%

Q15. [Ask if Q14 is displayed] About how many feet of the pipe extruding from your water heater did you tape with the insulation **that came in the kit**? Please go over to your water heater if you need to check.

Response Option	Percent(n=116)
About three feet or less	39%
About four to five feet	24%
About six feet or more	10%
Don't know	27%

Q16. [Ask if any part of Q11 = YES] Overall, how satisfied are you with the item[s] you installed?

Showerhead

Response Option	Percent (n=202)
0 - Very dissatisfied	2%
1	1%
2	1%
3	1%
4	1%
5	4%
6	3%
7	11%
8	13%
9	11%
10 - Very satisfied	54%
Don't know	1%

Kitchen Faucet Aerator

Response Option	Percent (n=142)
0 – Very dissatisfied	2%
1	0%
2	4%
3	0%
4	0%
5	5%
6	3%
7	11%
8	13%
9	11%
10 - Very satisfied	50%
Don't know	1%

Bathroom Faucet Aerator

Response Option	Percent (n= 146)
0 – Very dissatisfied	2%
1	0%
2	1%
3	2%
4	1%
5	4%
6	3%
7	11%
8	16%
9	11%
10 - Very satisfied	49%
Don't know	1%

Pipe Tape

Response Option	Percent (n= 116)
0 – Very dissatisfied	0%
1	0%
2	0%
3	1%
4	0%
5	3%
6	2%
7	10%
8	10%
9	11%
10 - Very satisfied	59%
Don't know	4%

Q16a. Can you please explain any dissatisfaction you had with [DISPLAY ALL ITEMS IN Q16 THAT ARE <7]?

Showerhead

Verbatim Response	Count (n=21)
Was smaller than I prefer	1
Very low pressure decreases the enjoyment of a shower	1
They didn't make any difference	1
sheesh	1
Reduced pressure	1
Pressure changes during shower	1
Options	1
Not very strong pressure.	1
None	1
No water pressure at all. How are you supposed to shower with that??	1
no dissatisfaction	1
It reduced the pressure to the point of making the experience unenjoyable.	1
It had very little water pressure.	1
it does not fit my hand held device	1
It does not allow enough water flow.	1
I ordered the upgraded shower head with hose The hose is too short to comfortably spray yourself off I have stand very close and barely more to keep from tugging on the hose The head seems to high It cannot be adjusted to hang lower Also the material the	1
Even for my kids it was to reduced amount of flow to adequately rinse off.	1
Does not fit well with shower wand.	1
difficult to put own; also have two bathrooms, one that's not being used	1
Didn't have any	1
Did not let enough water through, Limited the flow	1

Kitchen Faucet Aerator

Verbatim Response	Count (n=19)
Worked OK but not excited about it.	1
Water didn't have enough pressure while use the filter, I guess wasn't good enough.	1
Takes forever for the water to heat up due to decreased flow.	1
sheesh	1
Reduced pressure	1
none	1
It's ok looks cheap I like products that look good and last a long time	1
It would not work as it should, and did not fit the faucet exactly.	1
It would make the water come at a good flow, got molded, would fall often	1
It seemed much louder than the original.	1
It has a continuous spray and sometimes I would like it to not have a continuous spray, just a regular spray	1
It doesn't do very well when you have sediment in your pipe lines (currently working on having the sediment taken care of)	1
I like to have a water filter on my sink	1
Hard to change from normal to shower flow	1
Didn’t make a difference	1
Did not let enough water through, Limited the flow	1
Did not fit spigot	1
Did not fit our delta faucet	1
Broke	1

Bathroom Faucet Aerator

Verbatim Response	Count (n=18)
Would not screw on straight, constant leak	1
Would not connect to faucet correctly.	1
Takes forever for the water to heat up.	1
same as the other	1
same as the kitchen filter problems in the kit	1
Reduced pressure	1
Not enough water coming out for me	1
None	1
n/a	1
Lose water pressure	1
It works fine	1
I didn't notice any difference	1
Flow too restrictive. I know it has to be, but it just wasn't sufficient	1

Fair	1
Drastically reduces the water pressure	1
Didn't make a difference	1
Did not let enough water through, Limited the flow	1
Broke	1

Pipe tape

Verbatim Response	Count (n=7)
Not enough provided	1
None	2
It deteriorated after two years.	1
I used that type wrap before and can't say it is much good.	1
DIDNT STICK	1
All good	1

Q17. Overall, how satisfied are you with Duke Energy's Save Energy and Water Kit Program?

Response Options	Percent (n=254)
0 - Very dissatisfied	1%
1	0%
2	1%
3	1%
4	3%
5	4%
6	8%
7	11%
8	15%
9	57%
10 - Very satisfied	0%
Don't know	1%

Q18. [Ask if any part of Q11 = YES] Have you (or anyone in your home) uninstalled any of the items from the kit that you had previously installed?

Response Option	Percent (n=254)
Yes	15%
No	82%
Don't know	4%

Q19. [Ask if Q18 = YES] Which of the items did you uninstall?

Response Option	Count (n= 37)*
Showerhead	24
Kitchen faucet aerator	17
Bathroom faucet aerator	9
Pipe tape	1

Don't know	1

*Multiple responses were allowed for this question

Q20. [Ask if Q19 = SHOWERHEAD and Q12 = INSTALLED BOTH] Did you uninstall one or both of the showerheads you had previously installed?

Response Option	Percent (n=2)
I uninstalled both	0%
I only uninstalled one of the showerheads	100%
Don't know	0%

Q21. [Ask if Q19 = BATHROOM FAUCET AERATOR and Q13 = 2-4] How many bathroom faucet aerators did you uninstall?

Response Option	Percent (n=2)
One	50%
Two	50%
Don't know	0%

Q22. [Ask if any item of Q19 is selected] Why were those items uninstalled?

Showerhead

Response Option	Percent (n=26)*
It was broken	0%
Didn't like how it worked	50%
Didn't like how it looked	4%
Other	46%
Don't know	8%

*Multiple responses were allowed for this question

Verbatim "Other" Responses	Count (n=12)
Too small	1
the well water had calcium build up on it	1
The flow is more reduced than I like (I have very long, thick hair). I am trying another low flow for another 30 days before deciding which to leave on.	1
Remodel to complete system	1
NO WATER PRESSURE	1
It did not remove	1
It got clogged up.	1
it does not fit my hand held	1
It did not fit very well	1
I got one that is larger	1
Hard water caused deposits to clog	1
Didn't make a difference	1

Kitchen faucet aerator

Response Options	Percent (n=17)*
It was broken	6%
Didn't like how it worked	53%
Didn't like how it looked	12%
Other	24%
Don't know	6%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=5)
the well water had calcium build up on it	1
new faucet and it would not fit	1
It made the water flow loud.	1
Didn't make difference	1
Didn't fit	1

Bathroom faucet aerator

Response Options	Percent (n=9)*
It was broken	0%
Didn't like how it worked	89%
Didn't like how it looked	0%
Other	11%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=2)
My water has rust (iron) particles that embed in the aerator and close it off.	1
Didn't make difference	1

Pipe tape

Response Options	Percent (n=1)*
It was broken	100%
Didn't like how it worked	0%
Didn't like how it looked	0%
Other	0%
Don't know	0%

*Multiple responses were allowed for this question

Q23. [Ask if any items not selected in Q11 or Q10 = NO] You said you haven't installed the following items. Which of the following do you plan to install in the next three months?

Response Option	Percent (n=256)*
Showerhead	29%
Kitchen faucet aerator	32%

Bathroom faucet aerator	34%
Pipe tape	31%
I'm not planning on installing any of these in the next three months	26%
Don't know	27%

*Multiple responses were allowed for this question

Q24. [Ask if any 1-6 options were not selected in Q23 or option "none" was selected] What's preventing you from installing those items?

Showerhead

Response Option	Percent (n=72)*
Already have an efficient showerhead	32%
Current one is still working	40%
Tried it, didn't fit	4%
Too difficult to install it, don't know how to do it	6%
Takes too much time to install it / No time / Too busy	0%
Tried it, didn't work as intended (please explain in the box below)	0%
Don't have the items any longer (threw away, gave away)	0%
Haven't gotten around to it	11%
Don't have the tools I need	1%
Didn't know what that was	0%
Other	13%
Don't know	1%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=9)
We have a shower head that is removable. We won't be switching to any other kinds.	1
We have a rainshower shower head and LOVE it. The sink part doesn't work with our fancy faucet in the kitchen.	1
We don't have a shower.	1
Too narrow, my wife likes the wide showerheads because they water isn't as harsh.	1
Need one with hose so I can wash my dogs	1
Need movable shower head with handheld option.	1
I have installed	1
End up taking longer showers so it seems I actually use more water with this type.	1
don't have help	1

Kitchen faucet aerator

Response Option	Percent (n=111)*
Tried it, didn't fit	18%
Current one is still working	23%
Already have an efficient kitchen faucet aerator	20%

Haven't gotten around to it	22%
Didn't know what that was	5%
Tried it, didn't work as intended (please explain in the box below)	1%
Too difficult to install it, don't know how to do it	3%
Takes too much time to install it / No time / Too busy	1%
Don't have the items any longer (threw away, gave away)	0%
Don't have the tools I need	0%
Other	6%
Don't know	8%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=16)
No applicable to my installation.	1
need a new kitchen faucet	1
it was the wrong thread It was male I needed female	1
I'll have to read the instructions again.	1
I have a water purification system	1
I don't know if it will work on the faucets I have in my kitchen & bath	1
I didn't receive that	1
Have portable dishwasher that has specific connection on sink.	1
Have an extender attached with spray features doesn't fit	1
Have a combo sprayer style kitchen faucet, so this will not fit on our existing fixture.	1
Don't have one	1
don't know if I need it	1
Does not fit with my faucet type.	1
didn't get tape	1
Buying a new faucet soon.	1
Bought a new system for kitchen	1

Bathroom Faucet Aerator

Response Option	Percent (n=105)*
Tried it, didn't fit	16%
Haven't gotten around to it	31%
Current one is still working	16%
Already have an efficient bathroom faucet aerator	12%
Didn't know what that was	5%
Takes too much time to install it / No time / Too busy	0%
Don't have the items any longer (threw away, gave away)	0%
Too difficult to install it, don't know how to do it	6%
Tried it, didn't work as intended (please explain in the box below)	1%
Don't have the tools I need	2%
Other	5%
Don't know	8%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=11)
Will not fit the Moen bathroom fixtures we have, aerator thread pattern doesn't match-up.	1
Need one in the 1/2 bath. haven't gotten to it yet	1
It does not match my current style or color	1
I've been sick, still under Dr's care and need somebody to do it for me	1
I'm not sure if it will work with my faucet	1
I needed the female threads not the male	1
I didn't get it in my box	1
Going to remodel soon	1
Faucet is decorative and this does not look right	1
Don't have one	1
don't know if I need it	1

Pipe Tape

Response Option	Percent (n=130)*
Haven't gotten around to it	37%
Already have pipe tape on my hot water pipe	34%
Didn't know what that was	11%
Too difficult to install it, don't know how to do it	6%
Takes too much time to install it / No time / Too busy	2%
Don't have the items any longer (threw away, gave away)	0%
Tried it, didn't work as intended (please explain in the box below)	1%
Don't have the tools I need	2%
Other	6%
Don't know	9%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=16)
There isn't enough tape to wrap enough pipe to make it worthwhile	1
Physically unable to get to pipes.	1
no need for it the crawl space is insulated and sealed up good	1
Nice	1
Need to replace water heater soon. Waiting to get new one.	1
My aerators don't need to be replace yet.	1
I hurt too much to crawl around under the house.	1
I don't know if I need the pipe wrap we haven't had cold weather, extreme enough to burst pipes	1
I didn't receive pipe wrap	1
I already have pipe wrap	1
Haven't needed it yet, already have the foam slip on kind	1
Don't have access to these pipes in our apartment.	1

Don't need pipe wrap	1
DON'T KNOW WHAT TO DO WITH IT	1
Didn't know. What it was for but know now and will wrap my hot water pipe	1
Didn't get around to it.	1

Q24a. Customers that need additional assistance with their items can call a toll-free customer care hotline. Did you call the customer care hotline to seek assistance in installing any of your items?

Response Option	Percent (n=320)
Yes	1%
No	98%
Don't know	1%

Q24b. [ASK IF Q24a = 1] Did you call the customer care hotline to seek assistance in installing your kitchen faucet aerator?

Response Option	Percent (n=2)
Yes	0%
No	100%
Don't know	0%

Q24c. [ASK IF Q24b = 1] Did the customer care hotline offer to send you an adapter for the kitchen faucet aerator?

[No valid responses]

Q24d. [ASK IF Q24a = 1] Did you call the customer care hotline to seek assistance in installing your bathroom faucet aerator?

Response Option	Percent (n=2)
Yes	0%
No	100%
Don't know	0%

Q24e. [ASK IF Q24d = 1] Did the customer care hotline offer to send you an adapter for the bathroom faucet aerator?

[No valid responses]

Q25. DELETED

Q26. DELETED

Q27. DELETED

Q28. DELETED

Q29. [Ask if Q11 = SHOWERHEAD and at least one showerhead is still installed] On average, what is the typical shower length in your household?

Response Option	Percent (n=180)
One minute or less	1%
Two to four minutes	9%
Five to eight minutes	37%
Nine to twelve minutes	32%
Thirteen to fifteen minutes	12%
Sixteen to twenty minutes	5%
Twenty-one to thirty minutes	2%
More than thirty minutes	1%
Don't know	1%

Q30. [DISPLAY IF TWO SHOWERHEADS STILL INSTALLED: Thinking of the efficient showerhead you installed that gets the most usage…]

[DISPLAY IF ONE SHOWERHEAD STILL INSTALLED: Thinking of the efficient showerhead currently installed in your home…]

On average, how many showers per day are taken in this shower?

Response Option	Percent (n=180)
Less than one	4%
One	38%
Two	42%
Three	10%
Four	3%
Six	1%
Seven	1%
Eight or more	1%
Don't know	4%

Q31. [Ask if two showerheads still installed] Thinking of the other efficient showerhead you installed…

On average, how many showers per day are taken in this shower?

Response Option	Percent (n=40)
Less than one	28%
One	38%
Two	23%
Three	5%
Four	3%
Five	0%
Six	0%
Seven	0%

Eight or more	3%
Don't know	3%

Q32. What fuel type does your water heater use?

Response Option	Percent (n=320)
Electric	86%
Natural gas	11%
Other (please specify in the box below)	1%
Don't know	2%

Q33. [Ask if any item was selected in Q11 and it's not the case that all parts of Q19 are selected (that is, they installed anything and did not uninstall everything they installed)] If you had not received the free efficiency items in the kit, would you have purchased and installed any of these same items within the next year?

Response Option	Percent (n=243)
Yes	22%
No	52%
Don't know	26%

Q34. [Ask if Q33 = YES] What items would you have purchased and installed within the next year?

Response Option	Count (n=54)*
Showerhead	30
Kitchen faucet aerator	21
Bathroom faucet aerator	14
Pipe tape	15
Don't know	5

*Multiple responses were allowed for this question

Q35. [Ask if Q34 = SHOWERHEAD and two showerheads are still installed] If you had not received them in your free kit, how many energy-efficient showerheads would you have purchased and installed within the next year?

Response Option	Percent (n=9)
One	33%
Two	67%
Don't know	0%

Q36. [Ask if Q34 = BATHROOM FAUCET AERATOR and if more than one bathroom aerator is still installed] If you had not received them in your free kit, how many energy-efficient bathroom aerators would you have purchased and installed within the next year?

Response Option	Percent (n=9)
One	33%
Two	67%
Don't know	0%

Q37. [If Q33 was displayed] Now, thinking about the energy and water savings items that were provided in the kit - using a scale from 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how influential were the following factors on your decision to install the items from the kit? *How influential was…*

The fact that the items were free

Response Option	Percent (n=243)
0- Not at all influential	2%
1	0%
2	0%
3	0%
4	1%
5	3%
6	3%
7	2%
8	8%
9	13%
10 - Extremely influential	69%
Don't know	0%

The fact that the items were mailed to your home

Response Option	Percent (n=243)
0- Not at all influential	1%
1	0%
2	0%
3	0%
4	0%
5	1%
6	2%
7	4%
8	7%
9	14%
10 - Extremely influential	70%
Don't know	1%

Information provided by Duke Energy about how the items would save energy and water

Response Option	Percent (n=243)
0- Not at all influential	2%
1	0%
2	0%
3	0%
4	0%
5	6%
6	5%
7	5%
8	9%
9	13%

10 - Extremely influential	58%
Don't know	1%

Other information or advertisements from Duke Energy, including its website

Response Option	Percent (n=243)
0- Not at all influential	9%
1	1%
2	2%
3	3%
4	5%
5	8%
6	3%
7	5%
8	11%
9	14%
10 - Extremely influential	32%
Don't know	%

Q38. DELETED

Q39. DELETED

Q40. Since receiving your kit from Duke Energy, have you purchased and installed any other **products** or made any improvements to your home to help save energy?

Response Option	Percent (n=320)
Yes	37%
No	58%
Don't know	5%

Q41. [If Q40 = YES] What **products** have you purchased and installed to help save energy in your home?

Response Option	Percent (n=118)*
Bought energy efficient appliances	42%
Moved into an ENERGY STAR home	0%
Bought efficient heating or cooling equipment	16%
Bought efficient windows	10%
Added insulation	23%
Sealed air leaks in windows, walls, or doors	38%
Sealed or insulated ducts	11%
Bought LEDs	66%
Bought CFLs	16%
Installed an energy efficient water heater	15%
None – no other actions taken	0%
Other	13%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim Other Responses	Count (n=15)
water filtration system	1
smart thermostat	1
smart thermostat	1
Programmable thermostat	1
new thermostat	1
New roof	1
Nest thermostat	1
More pipe wrap in the garage to the hot water tap out there.	1
Installed new kitchen faucet.	1
Installed a metal roof	1
Got Led bulbs from Duke Energy	1
gas stove	1
Fixed the leaking water pipe	1
bought more insulation for the water heater pipe	1
Bought 2 nest thermostats	1

Q42. [If Q41 = MOVED INTO AN ENERGY STAR HOME] Is Duke Energy still your gas or electricity utility?

Response Option	Count (n=320)
Yes	0
Not asked	320

Q43. DELETED

Q44. DELETED

Q45. DELETED

Q46. [Ask if any item in Q41 was selected] On a scale of 0 to 10, where 0 means “not at all influential” and 10 means “extremely influential”, how much influence did the Duke Energy Save Energy and Water Kit Program have on your decision to…

	0	1	2	3	4	5	6	7	8	9	10	Don’t Know	Total (n)
Buy energy efficient appliances	14%	2%	0%	6%	4%	6%	4%	14%	4%	8%	36%	2%	50
Move into an ENERGY STAR home	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
Buy efficient heating or cooling equipment	16%	0%	0%	5%	5%	5%	0%	16%	0%	11%	42%	0%	19
Buy efficient windows	25%	0%	0%	8%	8%	0%	8%	8%	8%	8%	25%	0%	12

Add insulation	19%	4%	0%	7%	0%	4%	4%	4%	15%	15%	30%	0%	27
Seal air leaks	11%	2%	0%	0%	2%	4%	2%	9%	11%	20%	38%	0%	45
Seal ducts	8%	0%	0%	8%	0%	0%	0%	8%	15%	15%	46%	0%	13
Buy LEDs	15%	1%	0%	5%	1%	9%	5%	5%	8%	12%	37%	1%	78
Buy CFLs	5%	0%	0%	5%	0%	21%	5%	11%	5%	5%	42%	0%	19
Install an energy efficient water heater	28%	6%	0%	6%	11%	0%	6%	0%	0%	6%	28%	11%	18
Other	27%	0%	0%	7%	0%	7%	7%	7%	7%	0%	40%	0%	4

Q47. [Ask if Q41 = BOUGHT ENERGY EFFICIENT APPLIANCES and Q46_BUY ENERGY EFFICIENT APPLIANCES <> 0] What kinds of appliance(s) did you buy?

Response Option	Percent (n=43)*
Refrigerator	58%
Stand-alone freezer	9%
Dishwasher	30%
Clothes washer	37%
Clothes dryer	33%
Oven	26%
Microwave	21%
Other	7%
Don't know	2%

*Multiple responses were allowed for this question

Q48. [Ask if Q47 <> DON'T KNOW OR REFUSED] Was the [INSERT Q47 RESPONSE] an ENERGY STAR or high-efficiency model?

Response Option	Microwave	Refrigerator	Stand-alone Freezer	Dishwasher	Clothes washer	Clothes dryer	Oven	Other
Yes	8	22	4	13	12	11	0	3
No	0	1	0	0	1	0	0	0
Don't know	1	2	0	0	3	3	0	0
Total	9	25	4	13	16	14	0	3

Q49. [Ask if Q47 = CLOTHES DRYER] Does the new clothes dryer use natural gas?

Response Option	Percent (n=14)
Yes	7%
No	93%
Don't know	0%

Q50. [Ask if Q41 = BOUGHT EFFICIENT HEATING OR COOLING EQUIPMENT and Q46_BUY EFFICIENT HEATING OR COOLING EQUIPMENT > 0] What type of heating or cooling equipment did you buy?

Response Option	Percent (n=16)*

Central air conditioner	38%
Window/room air conditioner unit	13%
Wall air conditioner unit	0%
Air source heat pump	44%
Geothermal heat pump	0%
Boiler	0%
Furnace	6%
Wi-Fi thermostat	19%
Other	13%
Don't know	0%

*Multiple responses were allowed for this question

Q51. [Ask if Q50 = BOILER OR FURNACE] Does the new [INSERT Q50 RESPONSE] use natural gas?

Response Option	Percent (n=1)
Yes	100%
No	0%
Don't know	0%
Refused	0%

Q52. [Ask if Q50 <> WIFI-ENABLED THERMOSTAT, DON'T KNOW, OR REFUSED] Was the [INSERT Q50 RESPONSE] an ENERGY STAR or high-efficiency model?

Response Option	Other	Central air conditioner	Window / room air conditioner unit	Wall air conditioner unit	Air source heat pump	Geothermal heat pump	Boiler	Furnace
Yes	5	2	1	0	7	0	0	1
No	0	0	0	0	0	0	0	0
Don't know	1	0	1	0	0	0	0	0
Total	6	2	2	0	7	0	0	1

Q53. [Ask if Q41= BOUGHT EFFICIENT WINDOWS and Q46_BUY EFFICIENT WINDOWS >0] Do you know how many windows you installed?

Response Option	Percent (n=320)
Yes	3%
No	0%
Don't know	0%
Not asked	97%

Please specify how many you installed:

Verbatim Response	Percent (n=9)
7	22%
10	11%
13	22%

14	11%
18	11%
19	11%
20	11%

Q54. [Ask if Q41 = ADDED INSULATION and Q46_ADD INSULATION > 0] Please let us know what spaces you added insulation to. Also, let us know the proportion of each space you added insulation to (for example, if you added insulation that covered your entire attic space, you would type in 100%).

Response Option	Percent (n=22)*
Attic	64%
Walls	18%
Below the floor	64%

*Multiple responses were allowed for this question

Attic

Verbatim Response	Count (n=14)
40	2
50	5
60	1
80	1
90	1
100	4

Walls

Verbatim Response	Count (n=4)
50	3
100	1

Below the floor

Verbatim Response	Count (n=14)
10	1
30	1
50	4
75	1
100	7

Q55. [Ask if Q41 = BOUGHT LEDS and Q46_BUY LEDS > 0] Do you know how many LEDs you installed at your property?

Response Option	Percent (n=66)
Yes	83%

No	17%

[Please specify how many you installed in the box below:]

Verbatim Response	Count (n=55)
2	2
3	2
4	2
5	7
6	4
7	1
8	5
9	1
10	8
12	8
14	2
15	2
16	2
20	4
24	1
25	1
27	1
31	1
40	1

Q56. [Ask if Q41 = BOUGHT CFLS and Q46_BUY CFLS > 0] Do you know how many CFLs you installed at your property?

Response Option	Percent (n=18)
Yes	89%
No	11%

[Please specify how many you installed in the box below:]

Verbatim Response	Count (n=16)
2	1
3	2
4	3
5	2
6	1
7	2
9	1
10	1
12	1
15	1
20	1

Q57. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Does the new water heater use natural gas?

Response Option	Percent (n=13)
Yes	0%
No	100%
Don't know	0%

Q58. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Which of the following water heaters did you purchase?

Response Option	Percent (n=13)
A traditional water heater with a large tank that holds the hot water	77%
A tankless water heater that provides hot water on demand	15%
A solar water heater	0%
Other	8%
Don't know	0%

Q59. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Is the new water heater an ENERGY STAR model?

Response Option	Percent (n=13)
Yes	85%
No	0%
Don't know	15%

Q60. Which of the following types of housing units would you say best describes your home? It is . . .?

Response Option	Percent (n=320)
Single-family detached house	78%
Single-family attached home (such as a townhouse or condo)	5%
Duplex, triplex or four-plex	1%
Apartment or condo with 5 units or more	3%
Manufactured or mobile home	12%
Other	1%
Don't know	1%

Verbatim Other Response	Count (n=3)
Single family home with separate guest house	1
New construction	1
A house 4 bedrooms	1

Q61. How many showers are in your home? Please include both stand-up showers and bathtubs with showerheads.

Response Option	Percent (n=320)
One	27%
Two	62%
Three	10%

Four	1%
Five or more	0%
Don't know	1%

Q62. How many bathroom sink faucets are in your home? (Keep in mind that some bathrooms may have multiple bathroom sink faucets in them)

Response Option	Percent (n=320)
One	18%
Two	43%
Three	22%
Four	12%
Five	4%
Six	1%
Seven	1%
Eight or more	0%
Don't know	0%

Q63. How many kitchen faucets are in your home?

Response Option	Percent (n=320)
One	92%
Two	7%
Three	1%
Four or more	1%
Don't know	0%

Q63a. You mentioned that you have more than one kitchen faucet. Where is/are your other kitchen faucet(s) located in your home?

Verbatim Response	Frequency (n=28)
Laundry room	9
Basement/ lower level	9
Kitchen	2
Other	3
Misread question- only one kitchen faucet	5

Q64. How many square feet of living space are there in your residence, including bathrooms, foyers and hallways (exclude garages, unfinished basements, and unheated porches)?

Response Option	Percent (n=320)
Less than 500 square feet	0%
500 to under 1,000 square feet	11%
1,000 to under 1,500 square feet	28%
1,500 to under 2,000 square feet	27%
2,000 to under 2,500 square feet	14%
2,500 to under 3,000 square feet	6%
Greater than 3,000 square feet	4%
Prefer not to say	1%

Don't know	9%

Q65. Do you or members of your household own your home, or do you rent it?

Response Option	Percent (n=320)
Own / buying	85%
Rent / lease	11%
Occupy rent-free	1%
Prefer not to say	3%
Don't know	0%

Q66. Including yourself, how many people currently live in your home year-round?

Response Option	Percent (n=320)
I live by myself	17%
Two people	41%
Three people	16%
Four people	12%
Five people	6%
Six people	3%
Seven people	0%
Eight or more people	1%
Prefer not to say	4%
Don't know	0%

Q67. What was your total annual household income for 2016, before taxes?

Response Option	Percent (n=320)
Under $20,000	7%
$20,000 to under $30,000	9%
$30,000 to under $40,000	8%
$40,000 to under $50,000	11%
$50,000 to under $60,000	4%
$60,000 to under $75,000	15%
$75,000 to under $100,000	11%
$100,000 to under $150,000	7%
$150,000 to under $200,000	3%
$200,000 or more	1%
Prefer not to say	22%
Don't know	1%

Q68. What is the highest level of education achieved among those living in your household?

Response Option	Percent (n=320)
Less than high school	2%
Some high school	1%
High school graduate or equivalent (such as GED)	15%
Trade or technical school	4%
Some college (including Associate degree)	27%

College degree (Bachelor's degree)	22%
Some graduate school	3%
Graduate degree, professional degree	18%
Doctorate	2%
Prefer not to say	7%
Don't know	0%

Q69. Finally, what is your year of birth?

Response Option	Frequency (n=320)
18-24	2
25-34	39
35-44	49
45-54	54
55-64	53
65+	60
Prefer not to say	62

Appendix F DEP Participant Survey Results

This section reports the results from each question in the DEP participant survey. Since the results reported in this appendix represent the "raw" data (that is, none of the open-ended responses have been coded and none of the scale questions have been binned), some values may be different from those reported in the Process Evaluation Findings chapter (particularly: percentages in tables with "Other" categories and scale response questions). Only respondents who completed the survey are included in the following results.

Q1. [Read if mode = phone] Hi, I'm _____ , calling on behalf of Duke Energy. We are calling about the Save Energy and Water Kit you got from Duke Energy.

This kit included faucet aerators, one or two showerheads, and pipe tape that can help you save water and energy in your home. Do you recall receiving this kit?

Response Option	Percent (n=35)
Yes	100%
No	0%
Don't know	0%

Q2. [Display if mode = web] We are conducting surveys about the Save Energy and Water Kit you got from Duke Energy. This kit included faucet aerators, one or two showerheads, and pipe tape that can help you save water and energy in your home.

Do you recall receiving this kit?

Response Option	Percent (n=308)
Yes	100%
No	0%
Don't know	0%

Q3. DELETED

Q4. Did you read the included instructions on how to install the items that came in the kit?

Response Option	Percent (n=343)
Yes	85%
No	11%
Don't remember	4%

Q5. [Ask if Q4 = YES] On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were the instructions on how to install the items that came in the kit?

Response Option	Percent (n=291)
1- Not at all helpful	0%
1	0%
2	0%
3	0%
4	0%
5	3%
6	2%
7	8%
8	16%
9	17%
10 - Very helpful	51%
Don't Know	1%

Q6. [Ask if Q5<7] What might have made the instructions more helpful?

Verbatim Response	Count (n=20)
We already knew how to install	1
Very clear details, with pictures and diagrams. Most I understood, but some items, such as the pipe wrap, I wasn't sure I would do right so didn't try. I am waiting for a friend to help me.	1
Tools that are actually needed	1
To give Troubleshooting tips. I couldn't get the shower faucet to attach...,	1
They may have help people without construction knowledge	1
The instructions were fine, it was the quality of the product that was sub-par.	1
Simple	1
Nothing really.	1
Nothing	1
N/A	1
More tools	1
More precise	1
More pictures	1
more photos	1
I didn't really need instructions.	1
easier way to attach them	1
Don't have good response	1
details	1
Clearer	1
?	1

Q7. DELETED

Q8. DELETED

Q9. DELETED

Q10. Have you or anyone else installed any of those items in your home, even if they were taken out later?

Response Option	Percent (n=343)
Yes	83%
No	17%
Don't Know	0%

Q11. [Ask if Q10 = YES] Which of the items did you install, even if they were taken out later?

Response Option	Percent (n=285)*
Showerhead	79%
Bathroom faucet aerator	56%
Kitchen faucet aerator	64%
Pipe tape	44%
I don't remember	0%

*Multiple responses were allowed for this question

Q12. [Ask if Q11 = SHOWERHEAD AND KIT_SIZE= MEDIUM] Your kit contained two showerheads. Did you install one or both of the showerheads in the kit, even if one or both were taken out later?

Response Option	Percent (n=97)
I installed both	56%
I only installed one showerhead	44%
Don't know	0%

Q13. [Ask if Q11 = BATHROOM FAUCET AERATOR] How many of the bathroom faucet aerators from the kit did you install in your home, even if one or more were taken out later?

Response Option	Percent (n=181)
One	45%
Two	52%
Don't know	3%

Q14. [Ask if Q11 = PIPEWRAP] Did you install all of the pipe insulation that was included with the kit?

Response Option	Percent (n=125)
Yes	77%
No	18%
Don't know	5%

Q15. [Ask if Q14 is displayed] About how many feet of the pipe extruding from your water heater did you tape with the insulation **that came in the kit**? Please go over to your water heater if you need to check.

Response Option	Percent (n=240)
About three feet or less	41%
About four to five feet	23%
About six feet or more	8%
Don't know	28%

Q16. [Ask if any part of Q11 = YES] Overall, how satisfied are you with the item[s] you installed?

Showerhead

Response Option	Percent (n=224)
0 - Very dissatisfied	0%
1	1%
2	0%
3	1%
4	1%
5	5%
6	5%
7	7%
8	11%
9	11%
10 - Very satisfied	57%
Don't know	0%

Kitchen Faucet Aerator

Response Option	Percent (n= 159)
0 – Very dissatisfied	0%
1	1%
2	0%
3	2%
4	1%
5	3%
6	4%
7	8%
8	11%
9	11%
10 - Very satisfied	57%
Don't know	3%

Bathroom Faucet Aerator

Response Option	Percent (n= 181)
0 – Very dissatisfied	1%
1	2%
2	0%

3	2%
4	2%
5	5%
6	3%
7	6%
8	12%
9	13%
10 - Very satisfied	51%
Don't know	3%

Pipe Tape

Response Option	Percent (n= 124)
0 – Very dissatisfied	0%
1	0%
2	1%
3	3%
4	2%
5	0%
6	3%
7	7%
8	10%
9	15%
10 - Very satisfied	53%
Don't know	7%

Q16a. Can you please explain any dissatisfaction you had with [DISPLAY ALL ITEMS IN Q16 THAT ARE <7]?

Showerhead

Verbatim Response	Count (n=32)
Truthfully the one I have already had better settings as far as adjusting the type of flow from the shower head and has a light to let you know when the temperature is correct. I really loved the original shower heads we had so they are now back on.	1
Too little water to take a shower in.	1
They reduced the water flow at first, but I can no longer see a reduction.	1
The water pressure coming out of the showerhead	1
The shower head was nice, we just prefer a shower head with a corded handset. That makes cleaning or washing the dog easier.	1
Style	1
Showering was not as enjoyable with the lower pressure.	1
Reduced water stream too much	1
pressure seems to be variable from time to time	1
Pressure	1

On aa well they didn't perform well I purchased another online word much better	1
not really adjustable	1
Not enough water pressure	1
Not adjustable enough	1
NONE	1
No water pressure	1
Need more pressure	1
My water pressure was not very strong during the use of the showerhead	1
My husband thinks the water pressure is too low with this shower head. It doesn't bother me. I prefer to shower at the YMCA anyway.	1
My husband didn't like it because he said the flow was not strong enough.	1
it's to slow of a flow	1
It was to small	1
It made for a miserable shower.	1
It didn't match my current faucet set up.	1
I prefer a handheld	1
I like more options with my shower head	1
Flimsy	1
Don't remember	1
Doesn't spray very hard	1
Didn't fit	1
Did not like the water pressure.	1
Can be better products	1

Kitchen Faucet Aerator

Verbatim Response	Count (n=18)
Worked ok	1
Too small	1
There wasn't enough water pressure. It made the water pressure very low in the sink.	1
Not adjustable enough	1
No water pressure	1
N/A	1
LOVE IT	1
It works fine, but restricted water flow presser when trying to rinse things off	1
It served its purpose of lowering water which is why I disliked it	1
It didn't seem to fit very well on our faucet.	1
I needed more pressure coming out	1
has very low pressure	1
Had to replace kitchen faucets not due to the aerator, it limits the water too much.	1
Don't remember	1

Didn't last long	1
Didn't like pressure	1
Couldn't get a correct fit even with the tape and wateoulhoot	1
Can be better	1

Bathroom Faucet Aerator

Verbatim Response	Count (n=26)
Worked ok	1
too big	1
The water pressure was reduced so much it makes it difficult to wash hands and brush teeth. It seems we use as lot more water this way.	1
The water pressure was really was really low	1
same as kitchen. both faucets ended up being replaced but not do to the aerator.	1
poor water flow	1
One seems to be working OK, but the other restricts water flow too much. Thinking about replacing it.	1
Not really sure I could tell the difference since it was installed with the new head	1
None	3
No water pressure	1
Neutral. Not dissatisfied.	1
Less pressure	1
Its ok for washing hands but if I have to fill up a cup or anything it takes too long	1
It was okay	1
It leaked and you couldn't get enough water to do anything with it.	1
It actually leaks a bit around the seal.	1
I wasn't dissatisfied just took some getting used to	1
I realize its purpose, but it needs more flow	1
Don't remember	1
Didn't like pressure	1
Didn't fit	1
Cheaply made	1
Cheap, there are better ones	1
Cheap feeling and were very tall. They were about twice the height as the original.	1

Pipe Tape

Verbatim Response	Count (n=11)
Unhappy with the way it looks	1
There was not enough	1
Really need long lengths of foam pipe wrap. I have long runs of piping underneath of my home.	1
Not enough	1
Need more. Not enough in Kit.	1
It was good but the stuff you can buy at Lowe's is better	1

It did not adhere very well, even to clean pipe.	1
Don't remember	1
Didn't use	1
Averange	1
adhesive didn't stick very well	1

Q17. Overall, how satisfied are you with Duke Energy's Save Energy and Water Kit Program?

Response Options	Percent (n=285)
0 - Very dissatisfied	1%
1	0%
2	0%
3	0%
4	1%
5	3%
6	2%
7	7%
8	13%
9	14%
10 - Very satisfied	58%
Don't know	1%

Q18. [Ask if any part of Q11 = YES] Have you (or anyone in your home) uninstalled any of the items from the kit that you had previously installed?

Response Option	Percent (n=285)
Yes	15%
No	82%
Don't know	3%

Q19. [Ask if Q18 = YES] Which of the items did you uninstall?

Response Option	Count (n=45)*
Showerhead	9
Kitchen faucet aerator	4
Bathroom faucet aerator	4
Pipe tape	1
Don't know	0

*Multiple responses were allowed for this question

Q20. [Ask if Q19 = SHOWERHEAD and Q12 = INSTALLED BOTH] Did you uninstall one or both of the showerheads you had previously installed?

Response Option	Percent (n=3)
I uninstalled both	67%
I only uninstalled one of the showerheads	33%
Don't know	0%

Q21. [Ask if Q19 = BATHROOM FAUCET AERATOR and Q13 = 2-4] How many bathroom faucet aerators did you uninstall?

[No valid responses]

Q22. [Ask if any item of Q19 is selected] Why were those items uninstalled?

Showerhead

Response Option	Percent (n=32)*
It was broken	7%
Didn't like how it worked	50%
Didn't like how it looked	10%
Other	37%
Don't know	3%

*Multiple responses were allowed for this question

Verbatim "Other" Responses	Count (n=11)
the flow was to slow	1
the cord wasn't long enough	1
Not enough pressure	1
Moved	1
Lower water flow	1
It was smaller than the one I had on the shower	1
It leaked really bad	1
It didn't fit right with the faucet.	1
I wanted the handset with hose. I will be installing this shower head at our vacation home.	1
i removed both shower heads and installed both	1
I felt like it didn't put out the same amount of water as the old one	1

Kitchen faucet aerator

Response Options	Percent (n=18)*
It was broken	13%
Didn't like how it worked	53%
Didn't like how it looked	13%
Other	40%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Responses	Count (n=6)
Water would shoot out sides, couldn't get good long term fit. Was able to temporarily get a seal and was still	1
replaced faucets	1

Our water pressure is already bad and this device made it worse	1
Installed a kegan water filtration system.	1
I didn't remove it	1
Because we install a water filter	1

Bathroom faucet aerator

Response Options	Percent (n=10)*
It was broken	8%
Didn't like how it worked	33%
Didn't like how it looked	8%
Other	25%
Don't know	8%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=6)
Replaced the lavatory and faucet with a new one.	1
replaced faucets	1
Lower water flow	1
It kealed	1
I removed one bathroom aerator and replace on	1
I didn't remove it	1

Pipe Tape

Response Options	Percent (n=4)*
It was broken	0%
Didn't like how it worked	0%
Didn't like how it looked	%
Other	100%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=4)
Needs to have foam wrap. Also concerned if the pipe may start sweating or not due to condinsation	1
It wasn't removed	1
insulation	1
I wrapped my pipes with it	1

Q23. [Ask if any items not selected in Q11 or Q10 = NO] You said you haven't installed the following items. Which of the following do you plan to install in the next three months?

Response Option	Percent (total n=288)*
Showerhead	33%
Kitchen faucet aerator	26%

Bathroom faucet aerator	25%
Pipe tape	32%
I'm not planning on installing any of these in the next three months	22%
Don't know	33%

*Multiple responses were allowed for this question

Q24. [Ask if any 1-6 options were not selected in Q23 or option "none" was selected] What's preventing you from installing those items?

Showerhead

Response Option	Percent (n=73)*
Already have an efficient showerhead	25%
Current one is still working	36%
Too difficult to install it, don't know how to do it	4%
Tried it, didn't fit	12%
Takes too much time to install it / No time / Too busy	0%
Tried it, didn't work as intended (please explain in the box below)	1%
Don't have the items any longer (threw away, gave away)	1%
Haven't gotten around to it	15%
Don't have the tools I need	1%
Didn't know what that was	0%
Other	86%
Don't know	1%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=14)
we like ours better	1
the water pressure	1
seems cheap	1
Quality isn't as good as what we currently have.	1
Not very attractive	1
Like the pull down one I have	1
it hideous	1
i have new shower heads currently	1
I have a dual head shower nozzle that I like better. It has colors to reflect safe temperatures so I don't have to worry about my son burning himself.	1
Have been ill with extended illness.	1
Have a multi head that is detachable for washing the dog.	1
Didn't like the style, color of the showerheads. Wasn't sure what the kit would actually look like. Should have realized they'd be plain chrome.	1
because I tried the aerators and I felt the shower would have too little water pressure	1
All I received was the shower head	1

Kitchen faucet aerator

Response Option	Percent (n=129)*
Tried it, didn't fit	21%
Current one is still working	26%
Already have an efficient kitchen faucet aerator	22%
Haven't gotten around to it	16%
Too difficult to install it, don't know how to do it	2%
Tried it, didn't work as intended (please explain in the box below)	2%
Didn't know what that was	5%
Takes too much time to install it / No time / Too busy	1%
Don't have the items any longer (threw away, gave away)	2%
Don't have the tools I need	2%
Other	6%
Don't know	2%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=7)
Would not fit	1
Wont fit the faucet I have	1
the aerator is not threaded the same. I would have to replace the whole faucet.	1
only have 1 shower	1
my husband passed away so I have no one to install them.	1
my home just got rem	1
My faucet does not support this type of aerator	1
make flow too low	1
Landlord has not installed yet	1
it's not compatible with our kitchen faucet	1
I only received the one for the bathroom, there wasn't a one for the kitchen	1
I no longer live at the residence.	1
I like the faucet I have and you aerator doesn't work with it	1
I like my faucet and it isn't compatible	1
I have a water filter that prevents me from using the kitchen faucet aerator.	1
I don't think it fit ours. We have faucet that pulls down to turn into the sprayer.	1
I am replacing the entire shower and waiting to do it all at once.	1
I already have a water filter and the aerator wont fit	1
Have an attachment for my water filter	1
Have a Pur water filter installed, will not fit because of that. Will use when sink is replaced.	1
getting to it	1
Gave this item away.	1
Gave it to a friend at work.	1
Doesn't match	1

Does not fit on current sink faucet.	1
does not fit my spray head	1
Did not get that item	1
Current kitchen faucet is the type that has retractable hose and faucet.	1
couldn't remove the other one	1
Also ugly.	1

Bathroom Faucet Aerator

Response Option	Percent(n=114)*
Tried it, didn't fit	18%
Current one is still working	32%
Already have an efficient bathroom faucet aerator	7%
Haven't gotten around to it	24%
Too difficult to install it, don't know how to do it	3%
Takes too much time to install it / No time / Too busy	0%
Don't have the items any longer (threw away, gave away)	3%
Don't have the tools I need	4%
Tried it, didn't work as intended (please explain in the box below)	2%
Didn't know what that was	4%
Other	4%
Don't know	4%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=17)
Won't work with my current bathroom faucet.	1
we were having renovations done on the bathrooms, the whole house.	1
the aerator is not threaded the same. I would have to replace the whole faucet.	1
my husband passed away so I have no one to install them.	1
make flow too low	1
Landlord hasn't installed yet	1
I no longer live at the residence.	1
I just installed new fixtures,	1
getting tpo ti	1
Gave this item away	1
Gave it to a friend at work.	1
Faucet does not support this type of aerator	1
Don't want to lose water pressure	1
doesn't match	1
Did not get one	1
Did not get item	1
Been installed	1

Pipe Tape

Response Option	Percent (n=63)*
Already have pipetape	32%
Haven't gotten around to it	35%
Too difficult to install it, don't know how to do it	9%
Didn't know what that was	8%
Tried it, didn't work as intended (please explain in the box below)	0%
Takes too much time to install it / No time / Too busy	5%
Don't have the tools I need	1%
Don't have the items any longer (threw away, gave away)	1%
Other	2%
Don't know	2%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=3)
Using	1
unable to access pipes	1
too small. didn't fit all the way around.	1
They didn't fit my pipes	1
The piping is to hard to reach.	1
Replaced to tankless water heater	1
not enouph to wrap	1
No pipes eased to cold.	1
no need for the pipe wrap	1
My pipes are not exposed. Home is on a slab.	1
my husband passed away so I have no one to install them.	1
Kit didn't include it	1
Im not sure we got the pipe wrap or I just don't remember it	1
I no longer live at the residence.	1
I don't have any piping exposed requiring pipe wrap. I wish it came with a water heater wrap	1
I don't remember getting the pipe wrap, I have to look for it and I will install it. I was disappointed with the aerators and did not look in the box much	1
I didn't see a pipe wrap in the box	1
I didn't receive pipe wrap.	1
Have read that it's not really very efficient	1
Hard to get to	1
Gave it to a friend at work.	1
Don't think it's needed, but will check.	1
DIDNT RECIEVE IT	1
Didn't have it in my kit.	1
did not get item	1
Did not get it	1
Can't get under the house	1

can't access pipe	1

Q24a. Customers that need additional assistance with their items can call a toll-free customer care hotline. Did you call the customer care hotline to seek assistance in installing any of your items?

Response Option	Percent (n=343)
Yes	2%
No	98%
Don't know	1%

Q24b. [ASK IF Q24a = 1] Did you call the customer care hotline to seek assistance in installing your kitchen faucet aerator?

Response Option	Percent (n=5)
Yes	40%
No	60%
Don't know	0%

Q24c. [ASK IF Q24b = 1] Did the customer care hotline offer to send you an adapter for the kitchen faucet aerator?

Response Option	Percent (n=2)
Yes	100%
No	0%
Don't know	0%

Q24d. [ASK IF Q24a = 1] Did you call the customer care hotline to seek assistance in installing your bathroom faucet aerator?

Response Option	Percent (n=5)
Yes	60%
No	40%
Don't know	0%

Q24e. [ASK IF Q24d = 1] Did the customer care hotline offer to send you an adapter for the bathroom faucet aerator?

Response Option	Percent (n=3)
Yes	0%
No	67%
Don't know	33%

Q25. DELETED

Q26. DELETED

Q27. DELETED

Q28. DELETED

Q29. [Ask if Q11 = SHOWERHEAD and at least one showerhead is still installed] On average, what is the typical shower length in your household?

Response Option	Percent (n=196)
Two to four minutes	5%
Five to eight minutes	48%
Nine to twelve minutes	24%
Thirteen to fifteen minutes	10%
Sixteen to twenty minutes	9%
Twenty-one to thirty minutes	2%
Don't know	2%

Q30. [DISPLAY IF TWO SHOWERHEADS STILL INSTALLED: Thinking of the efficient showerhead you installed that gets the most usage…]

[DISPLAY IF ONE SHOWERHEAD STILL INSTALLED: Thinking of the efficient showerhead currently installed in your home…]

On average, how many showers per day are taken in this shower?

Response Option	Percent (n=196)
Less than one	8%
One	31%
Two	37%
Three	13%
Four	6%
Five	3%
Six	91%
Don't know	1%

Q31. [Ask if two showerheads still installed] Thinking of the other efficient showerhead you installed…

On average, how many showers per day are taken in this shower?

Response Option	Percent (n=51)
Less than one	22%
One	43%
Two	22%
Three	10%
Four	4%
Five	0%
Six	0%

Seven	0%
Eight or more	0%
Don't know	0%

Q32. What fuel type does your water heater use?

Response Option	Percent (n=343)
Electric	88%
Natural gas	9%
Other (please specify in the box below)	2%
Don't know	1%

Verbatim "Other" Response	Count (n=6)
Propane and heating oil	1
Propane	5

Q33. [Ask if any item was selected in Q11 and it's not the case that all parts of Q19=selected (that is, they installed anything and did not uninstall everything they installed)] If you had not received the free efficiency items in the kit, would you have purchased and installed any of these same items within the next year?

Response Option	Percent (n=270)
Yes	22%
No	57%
Don't know	22%

Q34. [Ask if Q33 = YES] What items would you have purchased and installed within the next year?

Response Option	Count (n=58)*
Showerhead	31
Kitchen faucet aerator	19
Bathroom faucet aerator	15
Pipe tape	16
Don't know	5

*Multiple responses were allowed for this question

Q35. [Ask if Q34 = SHOWERHEAD and two showerheads are still installed] If you had not received them in your free kit, how many energy-efficient showerheads would you have purchased and installed within the next year?

Response Option	Percent (n=10)
One	30%
Two	60%
Don't know	10%

Q36. [Ask if Q34 = BATHROOM FAUCET AERATOR and if more than one bathroom aerator is still installed] If you had not received them in your free kit, how many energy-efficient bathroom aerators would you have purchased and installed within the next year?

Response Option	Percent (n=9)
One	11%
Two	78%
Don't know	11%

Q37. [If Q33 was displayed] Now, thinking about the energy and water savings items that were provided in the kit - using a scale from 0 to 10, where 0 means “not at all influential” and 10 means “extremely influential,” how influential were the following factors on your decision to install the items from the kit? *How influential was…*

The fact that the items were free

Response Option	Percent (n=270)
1- Not at all influential	1%
1	0%
2	1%
3	0%
4	2%
5	2%
6	3%
7	2%
8	8%
9	11%
10 - Extremely influential	69%
Don't know	1%

The fact that the items were mailed to your home

Response Option	Percent (n=270)
0- Not at all influential	2%
1	1%
2	0%
3	0%
4	1%
5	1%
6	2%
7	2%
8	7%
9	10%
10 - Extremely influential	74%
Don't know	1%

Information provided by Duke Energy about how the items would save energy and water

Response Option	Percent (n=270)
0- Not at all influential	1%
1	0%
2	1%
3	0%
4	1%
5	3%
6	2%

7	9%
8	10%
9	16%
10 - Extremely influential	56%
Don't know	1%

Other information or advertisements from Duke Energy, including its website

Response Option	Percent (n=270)
0- Not at all influential	11%
1	2%
2	3%
3	2%
4	3%
5	10%
6	4%
7	7%
8	7%
9	13%
10 - Extremely influential	33%
Don't know	6%

Q38. DELETED

Q39. DELETED

Q40. Since receiving your kit from Duke Energy, have you purchased and installed any other **products** or made any improvements to your home to help save energy?

Response Option	Percent (n=343)
Yes	35%
No	62%
Don't know	3%

Q41. [If Q40 = YES] What **products** have you purchased and installed to help save energy in your home?

Response Option	Percent (n=120)*
Bought energy efficient appliances	38%
Moved into an ENERGY STAR home	3%
Bought efficient heating or cooling equipment	19%
Bought efficient windows	11%
Added insulation	19%
Sealed air leaks in windows, walls, or doors	35%
Sealed or insulated ducts	8%
Bought LEDs	71%
Bought CFLs	8%
Installed an energy efficient water heater	11%

None – no other actions taken	2%
Other	15%
Don't know	1%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=18)
use powerstrips on all electronics and turn them off when the units are not in use	1
Solar outdoor light	1
pool pump	1
new window	1
New roof installation	1
new roof and calked the windows	1
new doors	1
Installed storm door	1
Installed some new lightbulbs.	1
Installed screen doors	1
Installed insulated siding	1
I had someone come to my home and do an energy evaluation once a long time ago. i also bought a cover to seal the attic.	1
EchoBee thermostat,	1
Changed to a hand held shower head. It works great!	1
Bought curtains	1
Bought 2 new toilets that use 1.1-1.6 gallons of water and a new efficient water heater	1
Blanket for water heater.	1
Added weather stripping to the door	1

Q42. [If Q41 = MOVED INTO AN ENERGY STAR HOME] Is Duke Energy still your gas or electricity utility?

Response Option	Percent (n=3)
Yes	100%
No	0%
Don't know	0%

Q43. DELETED

Q44. DELETED

Q45. DELETED

Q46. [Ask if any item in Q41 was selected] On a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential", how much influence did the Duke Energy Save Energy and Water Kit Program have on your decision to…

Response Option	0	1	2	3	4	5	6	7	8	9	10	Don't Know	Total (n)
Buy energy efficient appliances	28%	4%	0%	0%	2%	11%	2%	7%	11%	11%	24%	0%	46
Move into an ENERGY STAR home	0%	0%	0%	33%	0%	0%	0%	0%	33%	33%	0%	0%	3
Buy efficient heating or cooling equipment	39%	0%	0%	0%	0%	8%	0%	8%	13%	4%	22%	4%	23
Buy efficient windows	39%	0%	0%	8%	0%	8%	0%	0%	8%	8%	23%	8%	13
Add insulation	22%	0%	0%	0%	13%	0%	4%	9%	4%	13%	30%	4%	23
Seal air leaks	17%	0%	0%	2%	2%	2%	5%	5%	12%	17%	33%	5%	42
Seal ducts	22%	11%	0%	0%	0%	0%	0%	0%	0%	11%	44%	11%	9
Buy LEDs	19%	1%	1%	0%	2%	11%	4%	7%	6%	13%	33%	4%	85
Buy CFLs	10%	0%	0%	0%	0%	0%	0%	10%	10%	30%	30%	10%	10
Install an energy efficient water heater	15%	0%	0%	0%	0%	15%	8%	15%	15%	8%	23%	0%	13
Other	28%	6%	0%	0%	0%	22%	0%	0%	6%	0%	28%	11%	18

Q47. [Ask if Q41 = BOUGHT ENERGY EFFICIENT APPLIANCES and Q46_BUY ENERGY EFFICIENT APPLIANCES <> 0] What kinds of appliance(s) did you buy?

Response Option	Percent (n33)*
Refrigerator	61%
Stand-alone freezer	6%
Dishwasher	42%
Clothes washer	42%
Clothes dryer	39%
Oven	21%
Microwave	27%
Other	3%
Don't know	0%

*Multiple responses were allowed for this question

Q48. [Ask if Q47 <> DON'T KNOW OR REFUSED] Was the [INSERT Q47 RESPONSE] an ENERGY STAR or high-efficiency model?

Response Option	Microwave	Refrigerator	Stand-alone Freezer	Dishwasher	Clothes washer	Clothes dryer	Other
Yes	8	19	2	12	12	12	1
No	0	0	0	1	0	0	0
Don't know	1	0	0	0	1	1	0
Total	9	19	2	13	13	13	1

Q49. [Ask if Q47 = CLOTHES DRYER] Does the new clothes dryer use natural gas?

Response Option	Percent (n=3)
Yes	8%
No	92%
Don't know	0%

Q50. [Ask if Q41 = BOUGHT EFFICIENT HEATING OR COOLING EQUIPMENT and Q46_BUY EFFICIENT HEATING OR COOLING EQUIPMENT > 0] What type of heating or cooling equipment did you buy?

Response Option	Percent (n=14)*
Central air conditioner	57%
Window/room air conditioner unit	0%
Wall air conditioner unit	7%
Air source heat pump	29%
Geothermal heat pump	7%
Boiler	0%
Furnace	7%
Wifi thermostat	29%
Other	7%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=1)
fans and heaters	1

Q51. [Ask if Q50 = BOILER OR FURNACE] Does the new [INSERT Q50 RESPONSE] use natural gas?

Response Option	Percent (n=1)
Yes	0%
No	0%
Don't know	100%

Q52. [Ask if Q50 <> WIFI-ENABLED THERMOSTAT, DON'T KNOW, OR REFUSED] Was the [INSERT Q50 RESPONSE] an ENERGY STAR or high-efficiency model?

Response Option	Other	Central air conditioner	Window / room air conditioner unit	Wall air conditioner unit	Air source heat pump	Geothermal heat pump	Boiler	Furnace
Yes	1	5	0	0	4	1	0	1
No	0	0	0	1	0	0	0	0
Don't know	0	3	0	0	0	0	0	0
Total	1	8	0	1	4	1	0	1

Q53. [Ask if Q41= BOUGHT EFFICIENT WINDOWS and Q46_BUY EFFICIENT WINDOWS >0] Do you know how many windows you installed?

Response Option	Percent (n=8)
Yes	75%
No	25%
Don't know	0%
Not asked	100%

Please specify how many you installed:

Verbatim Response	Percent (n=6)
9	13%
10	25%
13	25%
15	13%

Q54. [Ask if Q41 = ADDED INSULATION and Q46_ADD INSULATION > 0] Please let us know what spaces you added insulation to. Also, let us know the proportion of each space you added insulation to (for example, if you added insulation that covered your entire attic space, you would type in 100%).

Response Option	Percent (n=18)*
Attic	33%
Walls	33%
Below the floor	44%

*Multiple responses were allowed for this question

Attic

Verbatim Response	Count (n=6)
100	3
50	1
30	1
25	1

Walls

Verbatim Response	Count (n=6)
100	1
75	1
50	1
30	1
15	1
14	1

Below the floor

Verbatim Response	Count (n=8)
100	4
25	1
20	2
10	1

Q55. [Ask if Q41 = BOUGHT LEDS and Q46_BUY LEDS > 0] Do you know how many LEDs you installed at your property?

Response Option	Percent (n=69)
Yes	77%
No	23%

[Please specify how many you installed in the box below:]

Verbatim Response	Count (n=53)
2	1
3	2
4	3
5	5
6	5
7	1
8	2
10	8
11	1
12	3
15	6
16	1
18	1
20	5
25	5
30	2
35	1
56	1

Q56. [Ask if Q41 = BOUGHT CFLS and Q46_BUY CFLS > 0] Do you know how many CFLs you installed at your property?

Response Option	Percent (n=9)
Yes	67%
No	33%

[Please specify how many you installed in the box below:]

Verbatim Response	Count (n=6)
2	1
3	2
4	1
10	2
15	1

Q57. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Does the new water heater use natural gas?

Response Option	Percent (n=4)
Yes	18%
No	82%
Don't know	0%

Q58. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Which of the following water heaters did you purchase?

Response Option	Percent (n=11)
A traditional water heater with a large tank that holds the hot water	73%
A tankless water heater that provides hot water on demand	18%
A solar water heater	0%
Other	9%
Don’t know	0%

Q59. [Ask if Q41 = INSTALLED AN ENERGY EFFICIENT WATER HEATER and Q46_INSTALL AN ENERGY EFFICIENT WATER HEATER > 0] Is the new water heater an ENERGY STAR model?

Response Option	Percent (n=11)
Yes	91%
No	9%
Don't know	0%

Q60. Which of the following types of housing units would you say best describes your home? It is . . .?

Response Option	Percent (n=343)
Single-family detached house	77%
Single-family attached home (such as a townhouse or condo)	6%
Duplex, triplex or four-plex	1%
Apartment or condo with 5 units or more	2%
Manufactured or mobile home	12%
Other	1%
Don't know	1%

Q61. How many showers are in your home? Please include both stand-up showers and bathtubs with showerheads.

Response Option	Percent (n=343)
One	16%
Two	70%
Three	11%
Four	2%
Five or more	1%
Don’t know	1%

Q62. How many bathroom sink faucets are in your home? (Keep in mind that some bathrooms may have multiple bathroom sink faucets in them)

Response Option	Percent (n=343)
One	9%
Two	38%
Three	30%
Four	15%
Five	4%
Six	2%
Seven	0%
Eight or more	1%
Don’t know	1%

Q63. How many kitchen faucets are in your home?

Response Option	Percent (n=343)
One	92%
Two	5%
Three	2%
Four or more	1%
Don’t know	1%

Q63a. You mentioned that you have more than one kitchen faucet. Where is/are your other kitchen faucet(s) located in your home?

Response Option	Frequency (n=27)
Laundry room	11%
Basement/lower level	19%
Kitchen	33%
Other	22%
Misread question-only one kitchen faucet	22%

Q64. How many square feet of living space are there in your residence, including bathrooms, foyers and hallways (exclude garages, unfinished basements, and unheated porches)?

Response Option	Percent (n=343)
Less than 500 square feet	1%
500 to under 1,000 square feet	7%
1,000 to under 1,500 square feet	31%
1,500 to under 2,000 square feet	23%
2,000 to under 2,500 square feet	16%
2,500 to under 3,000 square feet	7%
Greater than 3,000 square feet	5%
Prefer not to say	1%
Don't know	9%

Q65. Do you or members of your household own your home, or do you rent it?

Response Option	Percent (n=343)
Own / buying	88%
Rent / lease	9%
Occupy rent-free	0%
Prefer not to say	3%
Don't know	1%

Q66. Including yourself, how many people currently live in your home year-round?

Response Option	Percent (n=343)
I live by myself	18%
Two people	36%
Three people	17%
Four people	16%
Five people	5%
Six people	2%
Seven people	0%
Eight or more people	1%
Prefer not to say	4%
Don't know	1%

Q67. What was your total annual household income for 2016, before taxes?

Response Option	Percent (n=343)

Under $20,000	7%
$20,000 to under $30,000	8%
$30,000 to under $40,000	8%
$40,000 to under $50,000	10%
$50,000 to under $60,000	8%
$60,000 to under $75,000	11%
$75,000 to under $100,000	12%
$100,000 to under $150,000	7%
$150,000 to under $200,000	2%
$200,000 or more	3%
Prefer not to say	23%
Don't know	2%

Q68. What is the highest level of education achieved among those living in your household?

Response Option	Percent (n=343)
Less than high school	0%
Some high school	0%
High school graduate or equivalent (such as GED)	12%
Trade or technical school	8%
Some college (including Associate degree)	23%
College degree (Bachelor's degree)	25%
Some graduate school	3%
Graduate degree, professional degree	16%
Doctorate	4%
Prefer not to say	9%
Don't know	1%

Q69. Finally, what is your year of birth?

Response Option	Frequency (n=343)
18-24	1
25-34	39
35-44	58
45-54	52
55-64	54
65+	53
Prefer not to say	86

Appendix G Participant Demographics by State

	DEC				DEP			
Home type	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
Single-family detached	76%	176	83%	72	77%	229	78%	35
Single-family attached	5%	12	3%	3	7%	21	2%	1
Duplex, triplex, four-plex	2%	4	0%	0	1%	4	0%	0
Apartment or condo 5 units or more	3%	6	2%	2	2%	6	0%	0
Manufactured or mobile home	14%	32	8%	7	11%	33	18%	8
Other	1%	2	1%	1	1%	2	2%	1
Don't know	0%	1	2%	2	1%	3	0%	0
Home size	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
Less than 500 square feet	0%	1	0%	0	1%	2	4%	2
500 to under 1,000 square feet	12%	28	8%	7	8%	23	4%	2
1,000 to under 1,500 square feet	31%	71	23%	20	31%	93	31%%	14
1,500 to under 2,000 square feet	28%	64	25%	22	24%	71	18%	8
2,000 to under 2,500 square feet	14%	32	14%	12	16%	48	18%	8
2,500 to under 3,000 square feet	5%	11	10%	9	7%	21	4%	2
Greater than 3,000 square feet	3%	7	7%	6	5%	15	4%	2
Don't know	8%	18	12%	10	7%	22	16%	7
Prefer not to say	0%	1	1%	1	1%	3	0%	0
Ownership Status	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
Own / buying	85%	197	86%	75	87%	259	96%	43
Rent / lease	12%	28	9%	8	0%	27	4%	2
Occupy rent-free	1%	2	0%	0	0%	1	0%	0
Don't know	0%	0	1%	1	1%	2	0%	0
Prefer not to say	3%	6	3%	3	3%	9	0%	0
Water Heater Fuel Type	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
Electric	86%	201	87%	76	87%	260	93%	42
Natural Gas	12%	27	9%	8	9%	28	7%	3
Other	0%	1	1%	1	2%	6	0%	0
Don't know	2%	4	2%	2	1%	4	0%	0
Household Size	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
I live by myself	19%	44	12%	10	18%	53	18%	8
Two people	37%	87	52%	45	36%	107	38%	17
Three people	18%	41	13%	11	18%	53	13%	6
Four people	12%	29	9%	8	16%	47	20%	9
Five people	5%	11	9%	8	5%	15	4%	2
Six people	3%	8	2%	2	2%	5	2%	1
Seven people	0%	1	0%	0	0%	1	0%	0
Eight or more people	1%	2	0%	0	0%	1	2%	1
Don't know	0%	0	1%	1	1%	2	0%	0
Prefer not to say	4%	10	2%	2	5%	14	2%	1

Household Income	NC (%)	NC (n)	SC (%)	SC (n)	NC (%)	NC (n)	SC (%)	SC (n)
Under $20,000	9%	20	3%	3	6%	18	13%	6
20 to under $30,000	8%	19	13%	11	7%	20	13%	6
30 to under $40,000	9%	21	7%	6	8%	24	4%	2
40 to under $50,000	12%	27	10%	9	10%	29	13%	6
50 to under $60,000	5%	12	2%	2	8%	24	4%	2
60 to under $75,000	14%	32	17%	15	12%	35	9%	4
75 to under $100,000	9%	21	16%	14	11%	34	16%	7
100 to under $150,000	8%	19	5%	4	8%	23	2%	1
150 to under $200,000	2%	5	3%	3	2%	6	0%	0
$200,000 or more	1%	2	1%	1	3%	9	0%	0
Don't know	1%	3	1%	1	2%	6	2%	1
Prefer not to say	22%	52	21%	18	24%	70	22%	10
Education Level	**NC (%)**	**NC (n)**	**SC (%)**	**SC (n)**	**NC (%)**	**NC (n)**	**SC (%)**	**SC (n)**
Less than high school	2%	4	1%	1	0%	0	2%	1
Some high school	1%	3	1%	1	0%	0	2%	1
High school graduate or equivalent (such as GED)	15%	35	14%	12	11%	33	20%	9
Trade or technical school	5%	11	3%	3	6%	18	18%	8
Some college (including Associate degree)	26%	61	28%	24	25%	75	11%	5
College degree (Bachelor's degree)	21%	48	26%	23	26%	76	20%	9
Some graduate school	3%	8	1%	1	2%	7	4%	2
Graduate degree, professional degree	18%	42	16%	14	16%	48	11%	5
Doctorate	2%	5	2%	2	4%	11	2%	1
Don't know	0%	0	1%	1	1%	2	0%	0
Prefer not to say	7%	16	6%	5	9%	28	9%	4
Age	**NC (%)**	**NC (n)**	**SC (%)**	**SC (n)**	**NC (%)**	**NC (n)**	**SC (%)**	**SC (n)**
18-24	1%	2	0%	0	0%	1	0%	0
25-34	12%	29	17%	15	11%	34	11%	5
35-44	16%	38	11%	10	17%	52	13%	6
45-54	18%	43	15%	13	16%	49	7%	3
55-64	17%	40	14%	12	13%	40	31%	14
65+	16%	38	21%	18	14%	42	24%	11
Prefer not to say	18%	43	22%	19	27%	80	13%	6

Appendix H Participant Responses by State

Measurement	Carolinas		Progress	
	NC	SC	NC	SC
Survey Responses	233	87	297	45
Small Kit	155	49	167	24
Medium Kit	78	38	116	13
Average Occupants per Home	2.61	2.58	2.60	2.73
Electric Water Heater %	88%	89%	88%	93%
Showerheads				
Provided	311	125	422	59
Installed	179	65	241	37
Installed %	58%	52%	57%	63%
Removed %	5%	6%	7%	5%
In-service Rate	52%	46%	50%	58%
Shower per Day (per person)	0.65	0.69	0.63	0.71
Minutes per Shower	8.93	9.66	9.76	9.85
Showerheads per Home	1.33	1.36	1.42	1.38
Kitchen Faucet Aerator				
Provided	233	87	297	45
Installed	100	42	135	24
Installed %	43%	48%	45%	53%
Removed %	11%	14%	10%	4%
In-service Rate	38%	41%	41%	51%
Bathroom Faucet Aerator				
Provided	466	174	594	90
Installed	139	63	230	40
Installed %	30%	36%	39%	44%
Removed %	5%	5%	5%	0%
In-service Rate	28%	34%	37%	44%
Pipe Wrap				
Provided	233	87	297	45
Installed	88	27	106	18
Installed %	38%	31%	36%	40%
Removed %	1%	0%	3%	6%
In-service Rate	37%	31%	35%	38%
Length Installed	5.10	4.70	4.68	5.39

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

Prepared for:

Duke Energy Progress, Duke Energy Carolinas

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DISCLAIMER

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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, candelabra, recessed and track 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 Consulting, Inc., n/k/a Guidehouse Inc. ("Navigant")[1] assessed lighting and water measures installed through the program in both the Duke Energy Progress (DEP) and Duke Energy Carolinas (DEC) jurisdictions. This evaluation includes program participation for the following dates:

- Water measures: January 1, 2017 through May 1, 2018
- Lighting measures: January 1, 2017 through June 30, 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. Duke Energy also informed Navigant that third-party quality control inspections are completed on 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

Duke Energy selected Navigant to provide independent Evaluation, Measurement, and Verification (EM&V) for the Multifamily Energy Efficiency Program in the DEP and DEC jurisdictions. EM&V is a term used to describe the process of evaluating a program to assess the impacts as well as the program structure and delivery. For this 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

[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.

- **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 previous evaluations, 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 37,094 housing units at 323 participating properties in the DEP jurisdiction. There were 60,913 housing units at 500 properties in the DEC jurisdiction. The program-level evaluation findings are presented in Table 1 though Table 4. For the DEP jurisdiction, Navigant found the realization rate for gross energy savings to be 79 percent, meaning that total verified gross energy savings were found to be somewhat lower than claimed in the tracking database provided by Duke Energy. For DEC, the realization rate for gross energy savings was 85 percent. Navigant found the net-to-gross (NTG) ratio to be 0.93, meaning that for every 100 kWh of reported energy savings, 93 kWh can be attributed directly to the program. These findings will be discussed in greater detail throughout this report.

Table 1. Program Claimed and Evaluated Gross Energy Impacts

	Claimed	Evaluated	Realization Rate
DEP Gross Energy Impacts (MWh)	28,504	22,376	79%
DEC Gross Energy Impacts (MWh)	36,780	31,266	85%

Source: Navigant analysis, values subject to rounding.

Table 2. Program Claimed and Evaluated Gross Peak Demand Impacts

	Claimed	Evaluated	Realization Rate
DEP Gross Summer Peak Demand Impacts (MW)	4.15	3.08	74%
DEP Gross Winter Peak Demand Impacts (MW)	2.73	3.68	135%
DEC Gross Summer Peak Demand Impacts (MW)	3.85	4.22	109%
DEC Gross Winter Peak Demand Impacts (MW)	5.60	5.31	95%

Source: Navigant analysis, values subject to rounding.

Table 3. Program Net Energy Impacts

	MWh
DEP Net Energy Impacts	20,792
DEC Net Energy Impacts	29,053

Source: Navigant analysis, values subject to rounding.

Table 4. Program Net Peak Demand Impacts

	MW
DEP Net Summer Peak Demand Impacts	2.86
DEP Net Winter Peak Demand Impacts	3.42
DEC Net Summer Peak Demand Impacts	3.92
DEC Net Winter Peak Demand Impacts	4.93

Source: Navigant analysis, values 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, a metering study to record lighting hours of use and coincidence factors, as well as surveys with tenants and property managers to assess satisfaction and decision-making processes.[2] Navigant conducted an initial lighting logger study in the summer of 2018 to estimate hours of use and coincidence factors for lighting measures. A follow-up logger study was conducted between July of 2019 and February of 2020 to explore further sampling dimensions, extend the duration of the logger study, and perform logging of the track and recessed measure offerings which were not included in the 2018 study. This report includes results from the second logger study. The evaluated parameters are summarized in Table 5. For field verification, the expected sampling confidence and precision was 90 percent ± 10 percent, and the achieved was 90 percent ± 9.2 percent.

[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.

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) 7. Baseline characteristics
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	
Spillover	Additional, non-reported savings that occurred as a result of participation in the program	

Source: Navigant

This evaluation covers program participation from January 1, 2017 through May 1, 2018 for water measures, and from January 1, 2017 through June 30, 2019 for lighting measures. This is the first evaluation of this program in DEP and DEC since LEDs were introduced as a measure offering.[3] Table 6 shows the start and end dates of Navigant's sample period for evaluation activities.

Table 6. EM&V Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification[4]	June 4, 2018 July 30, 2019	June 20, 2018 September 19, 2019
Lighting Logger Study	July 30, 2019	February 14, 2020
Tenant Phone Surveys	August 2, 2018	August 14, 2018
Property Manager Interviews	August 13, 2018	August 30, 2018

Source: Navigant

[3] LEDs were introduced in the program at the very end of 2016, and new track and recessed lighting measures were introduced in early 2018.

[4] Navigant conducted field verification during both the 2018 and 2019 lighting logger studies, and this report contains field verification findings from both studies.

1.4 Evaluation Considerations and Recommendations

Navigant developed a series of recommendations during the EM&V effort. These recommendations are intended to assist Duke Energy with enhancing the program delivery and customer experience, as well as to possibly increase program impacts. Further explanation for each recommendation can be found later in this report.

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.
2. Duke Energy should consider whether additional marketing material can be distributed to tenants during participation in this program, to educate participants about other Duke Energy program offerings and services.
3. Duke Energy should consider whether smart thermostats or other HVAC-related measures would be reasonable offerings for this program.

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, candelabra, recessed and track 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[5] 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

[5] 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.

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.

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, High Performance Building Solutions, 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 during the following dates:

- Water measures: January 1, 2017 through May 1, 2018.
- Lighting measures: January 1, 2017 through June 30, 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
- Update measure life assumptions, if applicable

Key impact and process research questions to be explored include:

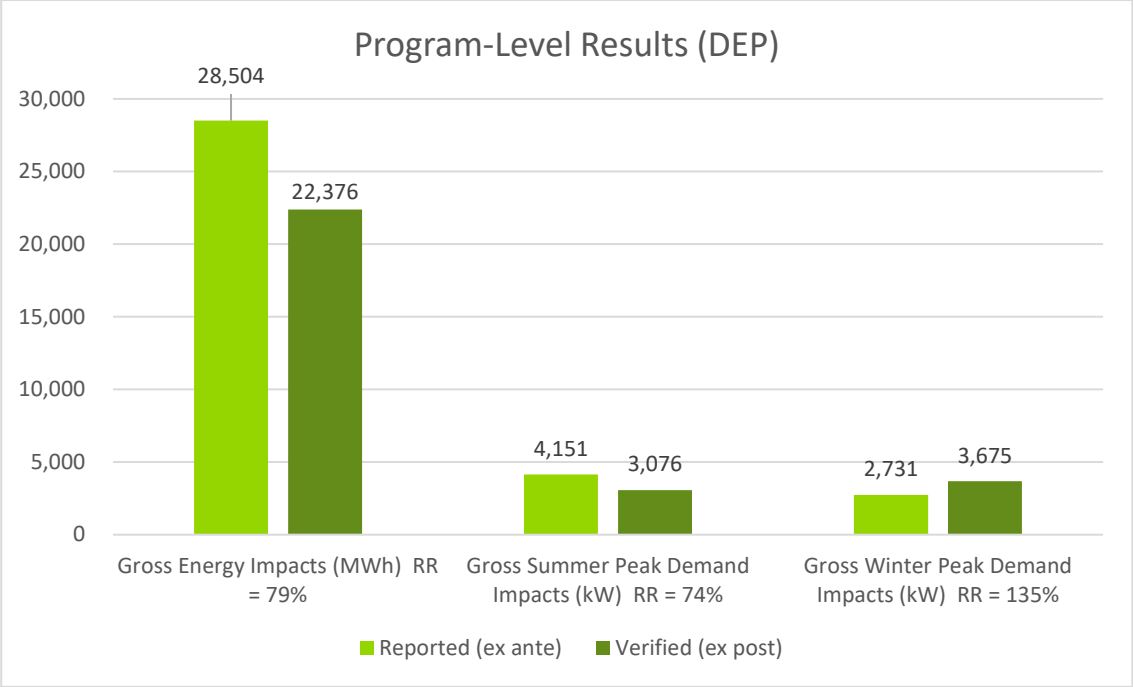
- Is the program achieving targeted energy and demand savings at the measure level?
- How do customers learn about the program, and can participation be increased?
- How is the persistence of savings impacted by participant removal of measures installed through the program?
- Are there opportunities 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

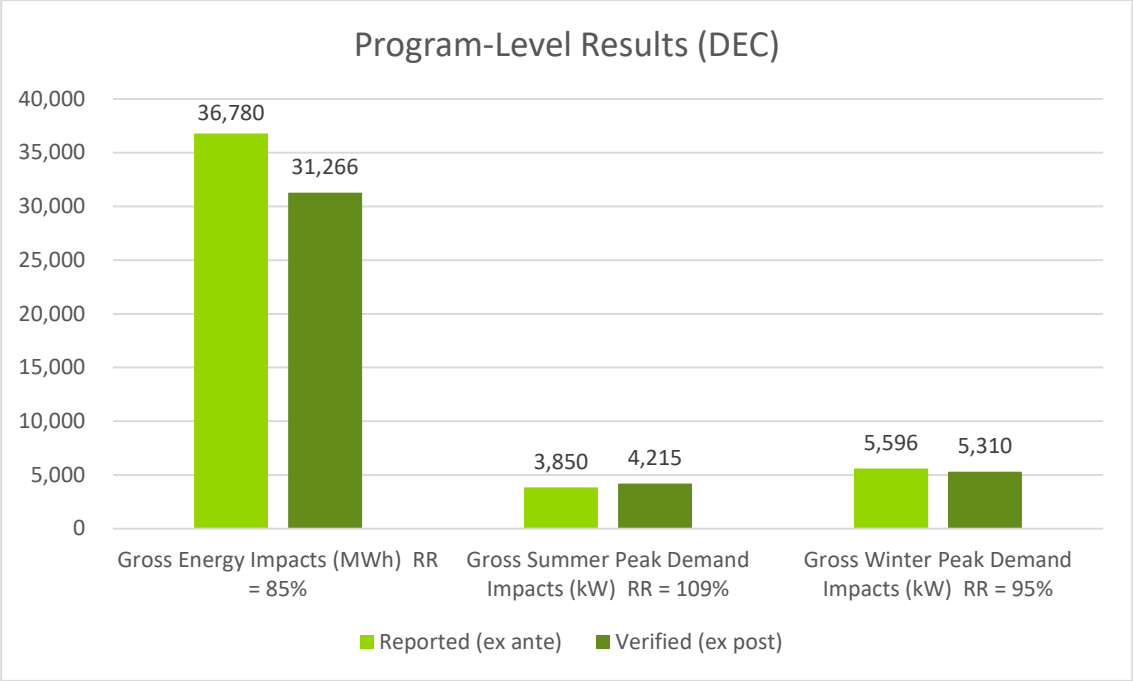
Figure 1 shows the program-level results for gross energy and demand savings for DEP, and Figure 2 shows the corresponding results for DEC. Table 7 shows a more complete list of program-level findings. The evaluation team calculated the results in Table 7 by multiplying the measure quantities found in 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 0.93. The NTG methodology and results are discussed in detail in Section 5 of this report.

Figure 1. Reported and Verified Program-Level Impacts (DEP)



Source: Navigant

Figure 2. Reported and Verified Program-Level Impacts (DEC)



Source: Navigant

Table 7. Summary of Program Impacts

	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
DEP Verified Gross Impacts	22,376	3.08	3.68
DEP Verified Net Impacts	20,792	2.86	3.42
DEC Verified Gross Impacts	31,266	4.22	5.31
DEC Verified Net Impacts	29,053	3.92	4.93

Source: Navigant analysis, values subject to rounding.

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 cycles, which are the source for ex ante water impacts. The driving factors for these differences include:

- The lighting logger study to measure operating hours and coincidence factors for LED measures
- The availability of baseline flow rate data for water measures, and baseline wattage data for LED measures

- Significant changes to the impact algorithms for water measures in the 2018 Mid-Atlantic Technical Reference Manual

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 for DEP, and Table 9 for DEC.

Table 8. Distribution of Program Gross Energy Savings by Measure (DEP)

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	322,430	11,607	41%	8,914	77%
Candelabra LED	57,928	1,495	5%	810	54%
Globe LED	77,612	3,126	11%	2,551	82%
Recessed LED	19,807	1,335	5%	891	67%
Track LED	19,692	569	2%	474	83%
Bathroom Faucet Aerator	20,138	796	3%	1,109	139%
Kitchen Faucet Aerator	11,700	1,011	4%	1,341	133%
Low Flow Showerhead	17,966	4,254	15%	5,050	119%
Water Htr Pipe Wrap (ft)	64,330	4,312	15%	1,235	29%
Total	611,603	28,504	100%	22,376	79%

Source: Navigant analysis, values subject to rounding.

Table 9. Distribution of Program Gross Energy Savings by Measure (DEC)

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	397,706	14,744	40%	10,996	75%
Candelabra LED	82,201	2,124	6%	1,149	54%
Globe LED	128,715	5,193	14%	4,230	81%
Recessed LED	31,214	2,107	6%	1,405	67%
Track LED	32,470	637	2%	782	123%
Bathroom Faucet Aerator	27,178	1,173	3%	1,497	128%
Kitchen Faucet Aerator	15,737	1,431	4%	1,804	126%
Low Flow Showerhead	28,281	6,562	18%	7,950	121%
Water Htr Pipe Wrap (ft)	75,722	2,808	8%	1,454	52%
Total	819,224	36,780	100%	31,266	85%

Source: Navigant analysis, values subject to rounding.

The results for gross summer coincident demand by measure for DEP and DEC are shown in Table 10 and Table 11, respectively.

Table 10. Distribution of Summer Coincident Demand Savings by Measure (DEP)

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	1,967	47%	1,478	75%
Candelabra LED	255	6%	168	66%
Globe LED	536	13%	324	61%
Recessed LED	228	5%	158	69%
Track LED	83	2%	66	80%
Bathroom Faucet Aerator	105	3%	146	140%
Kitchen Faucet Aerator	133	3%	177	133%
Low Flow Showerhead	350	8%	417	119%
Water Htr Pipe Wrap (ft)	495	12%	141	28%
Total	4,151	100%	3,076	74%

Source: Navigant analysis, values subject to rounding.

Table 11. Distribution of Summer Coincident Demand Savings by Measure (DEC)

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	1,511	39%	1,824	121%
Candelabra LED	263	7%	239	91%
Globe LED	631	16%	538	85%
Recessed LED	256	7%	248	97%
Track LED	78	2%	109	140%
Bathroom Faucet Aerator	155	4%	198	128%
Kitchen Faucet Aerator	189	5%	238	126%
Low Flow Showerhead	540	14%	656	121%
Water Htr Pipe Wrap (ft)	227	6%	166	73%
Total	3,850	100%	4,215	109%

Source: Navigant analysis, values subject to rounding.

The results for gross winter coincident demand by measure for DEP and DEC are shown in Table 12 and Table 13, respectively.

Table 12. Distribution of Winter Coincident Demand Savings by Measure (DEP)

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	419	15%	1,110	265%
Candelabra LED	52	2%	61	116%
Globe LED	109	4%	346	319%
Recessed LED	48	2%	59	125%
Track LED	28	1%	46	168%
Bathroom Faucet Aerator	91	3%	129	143%
Kitchen Faucet Aerator	116	4%	156	135%
Low Flow Showerhead	1,374	50%	1,627	118%
Water Htr Pipe Wrap (ft)	495	18%	141	28%
Total	2,731	100%	3,675	135%

Source: Navigant analysis, values subject to rounding.

Table 13. Distribution of Winter Coincident Demand Savings by Measure (DEC)

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	1,750	31%	1,369	78%
Candelabra LED	255	5%	86	34%
Globe LED	618	11%	574	93%
Recessed LED	250	4%	93	37%
Track LED	75	1%	76	102%
Bathroom Faucet Aerator	136	2%	174	128%
Kitchen Faucet Aerator	165	3%	210	127%
Low Flow Showerhead	2,121	38%	2,561	121%
Water Htr Pipe Wrap (ft)	227	4%	166	73%
Total	5,596	100%	5,310	95%

Source: Navigant analysis, values 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. Lighting logger study to measure LED hours of use and coincidence factors
4. Net-to-gross (NTG) analysis
5. 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 14 below.

Table 14. Ex Ante Savings Estimates for LED Measures

Measure	Jurisdiction	Annual Gross Energy Savings (kWh)	Winter Coincident Demand Impacts (kW)	Summer Coincident Demand Impacts (kW)	Annual Non-Coincident Demand Impacts (kW)
Candelabra (per lamp)	DEP	25.8000	0.0009	0.0044	0.0054
	DEC	25.8450	0.0031	0.0032	0.0038
Globe (per lamp)	DEP	40.2743	0.0014	0.0069	0.0084
	DEC	40.3444	0.0048	0.0049	0.0059
A-Line (per lamp)	DEP	35.9995	0.0013	0.0061	0.0075
	DEC	37.0734	0.0044	0.0038	0.0054
Recessed (per lamp)	DEP	67.3990	0.0024	0.0115	0.0141
	DEC	67.5163	0.0080	0.0082	0.0100
Track (per lamp)	DEP	28.8845	0.0014	0.0042	0.0060
	DEC	19.6282	0.0023	0.0024	0.0029

Source: Duke Energy

Duke Energy also provided Navigant with the wattages of LED products, and the average baseline lamp wattages from the sample recorded by Franklin Energy, as shown in Table 15.

Table 15. Baseline and Efficient Wattage Values for LEDs

Measure	Baseline Lamp Wattage	Efficient (LED) Lamp Wattage
Candelabra (per lamp)	35	5
Globe (per lamp)	41	6
A-Line (per lamp)	61	9
Recessed (per lamp)	65	11
Track (per lamp)	40	6

Source: Duke Energy, values subject to rounding

Because this evaluation was the first for this program since Duke Energy began offering LEDs, the deemed savings values were sourced from Duke Energy's assumptions carried over from other program offerings or modeling. Navigant performed a high-level review of the deemed savings by using algorithms from the 2018 Mid-Atlantic Technical Reference Manual[6] for energy savings and summer coincident demand savings. Navigant modified the summer demand saving equation to develop a winter demand savings equation since the Mid-Atlantic TRM does not provide one.

Equation 1. Energy Savings Algorithm for LEDs

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

Equation 2. Summer Coincident Demand Savings Algorithm for LEDs

$$summer\ kW\ savings = \left[\frac{Watts_{base} - Watts_{EE}}{1000}\right] \times ISR \times CF_{summer}\ x\ WHF_d$$

Equation 3. Winter Coincident Demand Savings Algorithm for LEDs

$$winter\ kW\ savings^{7} = \left[\frac{Watts_{base} - Watts_{EE}}{1000}\right] \times ISR \times CF_{winter}\ x\ ((1 - WHF_d - 1) * \%electric)$$

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

[6] https://neep.org/mid-atlantic-technical-reference-manual-v8-may-2018

[7] To calculate winter coincident demand savings, Navigant assumed that the WHF_d subtracted from savings by the same proportion that it added to savings in the summer equation. We also assumed that 55% of participants have electric heating in their homes, which is based on the data from the EIA's Residential Energy Consumption Survey for the Southern Atlantic region (found at https://www.eia.gov/consumption/residential/data/2015/).

$WHFe_{Cool}$ = waste heat factor for energy to account for cooling savings from reduced waste heat from efficient lighting
$WHFe_{Heat}$ = waste heat factor for energy to account for electric heating savings from reducing waste heat from efficient lighting
WHFd = waste heat factor for demand to account for cooling savings from efficient lighting
CF_{summer} = summer coincidence factor
CF_{winter} = winter coincidence factor
%electric = percentage of homes with electric heating

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 16. The values for the DEP jurisdiction match those from Navigant's previous 2016 EM&V report for this program, and the values for the DEC jurisdiction match those from Navigant's 2015 EM&V report for 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 16. Ex Ante Savings Estimates for Water Measures

Measure	Jurisdiction	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)	DEC	43.1615	0.0050	0.0057	0.1183
	DEP	39.5210	0.0045	0.0052	0.1083
Faucet Aerators MF Direct 1.0 GPM – kitchen (per aerator)	DEC	90.9189	0.0105	0.0120	0.2491
	DEP	86.4016	0.0099	0.0114	0.2367
LF Showerhead MF Direct 1.5 GPM (per showerhead)	DEC	232.0200	0.0750	0.0191	0.6357
	DEP	236.7797	0.0765	0.0195	0.6487
Pipe Wrap MF Direct (per linear foot)	DEC	37.0873	0.0030	0.0030	0.0100
	DEP	67.0275	0.0077	0.0077	0.0077

Source: Duke Energy

4.2.2 Onsite Field Verification

Navigant performed onsite field verification at 229 housing units across 28 participating properties during the 2018 and 2019 field studies. The field verification for lighting measures includes a sample from customers who participated in the program between January 2017 through June 2019. The field

verification for water measures includes a sample from participants between January 2017 and May of 2018.

Of this total field sample, 108 housing units were located at 12 properties in DEP, and 121 housing units were located at 16 properties in DEC. Field 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 17 shows a summary of the parameters assessed by Navigant during field verification, and Table 18 shows the field verification sample.

Table 17. 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
Baseline information (where available)	x	x	x	x

Table 18. Field Verification Sample

Program Measure	Number of Housing Units in Sample[a]	Number of Measures Reported in Sample
A-Line LED	212	1,945
Candelabra LED	83	330
Globe LED	90	554
Recessed LED	44	148
Track LED	45	182
Bathroom Faucet Aerators	88	135
Kitchen Faucet Aerators	90	90
Showerheads	83	115
Pipe Wrap	66	390 ft

a. Totals exceed 229 because many sites had multiple measures

Source: Navigant analysis

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

4.2.3 Lighting Logger Study

Navigant conducted a lighting logger study in the summer of 2018 to measure the operating hours and coincidence factors for LED measures. A follow-up logger study was conducted between July of 2019 and February of 2020 to explore further sampling dimensions, extend the duration of the logger study, and perform logging of the track and recessed measure offerings which were not included in the 2018 study. This report includes results from the second logger study.

Navigant deployed 341 data loggers across 110 participant homes. Most data loggers remained in place from late July or August 2019 until February 2020, and a small portion of the loggers were in place from September 2019 until February 2020. For the subset of loggers deployed for less than six months, Navigant used a sinusoidal modeling method to annualize the logger data to account for seasonality. The remainder of this subsection describes the methodology for conducting the lighting logger study.

Sampling and Deployment

Navigant deployed data loggers to be representative of program activity across measure type, space type, housing unit floorplan, and between DEP and DEC. Table 19 shows the number of loggers deployed at field sites for each jurisdiction. Of the 341 total loggers deployed, 284 were deployed in North Carolina and 57 were deployed in South Carolina. Table 20 shows a comparison of sample disposition for logger deployment by lamp type as compared with overall program characteristics. Table 21 shows a comparison between the sample and population distribution by space type, and Table 22 shows a similar comparison by housing unit floorplan. The small differences between sample and population distributions are due to logistical considerations of the field study based on the random selection of tenant homes at each property in the field study. Navigant also attempted to achieve a sufficient number of loggers for each lamp type despite the relevant proportion of the population total.

Table 19. Number of Data Loggers Deployed at Sites for Each Jurisdiction

Location	Number of Sites	Number of Data Loggers
DEP	56	128
DEC	54	213
Total	110	341

Source: Navigant analysis, values subject to rounding

Table 20. Distribution of Logger Deployment by Measure and Jurisdiction

Measure	DEP/DEC Combined Population		DEP/DEC Field Metering Sample	
	DEP	DEC	DEP	DEC
A-Line	28%	34%	18%	35%
Candelabra	5%	7%	4%	14%
Globe	7%	11%	2%	2%
Recessed	2%	3%	5%	7%
Track	2%	3%	8%	5%

Source: Navigant analysis, values subject to rounding

Table 21. Distribution of Logger Deployment by Space Type

Space Type	Population Distribution	Logger Sample Distribution
Bedroom	11%	16%
Bathroom	38%	22%
Living Room	6%	8%
Dining Room	8%	6%
Other	3%	6%
Master BR	5%	8%
Hall	10%	12%
Kitchen	5%	11%
Unspecified	13%	13%
Total	100%	100%

Source: Navigant analysis, values subject to rounding

Table 22. Distribution of Logger Deployment by Floorplan

Housing Unit Floorplan	Population Distribution	Logger Sample Distribution
2-bedroom, 2-bathroom	35%	37%
1-bedroom, 1-bathroom	34%	46%
2-bedroom, 1-bathroom	12%	2%
3-bedroom, 2-bathroom	8%	7%
Other	11%	8%
Total	100%	100%

Source: Navigant analysis, values subject to rounding

Data QC and Cleaning

Upon retrieving the data loggers, Navigant performed a thorough visual and analytical QC of all data. Data from each logger was plotted and analyzed to identify instances of excessive lamp flickering, malfunctioning logger devices, loggers being affected by daylight, and battery failure. From the original 341 loggers, Navigant recovered 299 loggers from the field. The remaining loggers had been discarded or taken by tenants or maintenance staff at some point during the six-month duration of the study. Navigant removed all data that did not pass the QC analysis, which resulted in a final total of 285 loggers with usable data. The 14 loggers removed from the analysis experienced a mix of logger failure and flickering.

Binning Annualization to Calculate Annual Operating Hours

The majority of loggers were deployed in the field for a full six months, allowing them to capture seasonal trends in lighting usage for the summer, fall and winter months. For these loggers, Navigant used a

binning approach to extrapolate the six months of data to annual estimates for hours of use and coincidence factors. For each logger, the logging and non-logging periods were divided into bins representing weekday, weekend/holiday, daytime, and nighttime. The hourly usage for the non-logging period was determined by using the average hourly usage during the logging period for each bin. Finally, the winter and summer coincidence factors for each logger were calculated using extrapolated and actual hourly usage during the winter and summer peak periods, respectively.

Sinusoidal Annualization to Calculate Annual Operating Hours

Fifty-two data loggers were in the field from the middle of September of 2019 through the middle of February 2020, or about five months. For these 52 loggers, Navigant used a sinusoidal method to account for seasonal changes in lighting usage and extrapolate results from the metering period to a full year. Navigant used the following equation to determine each logger's daily HOU for the non-logging period.

Equation 4. Sinusoidal Annualization Equation

$$HOU_d = c_1 + c_2 \sin(\theta_d)$$

Where,

HOU_d = Daily Hours of use for non-logging period

c_1 and c_2 = Extrapolation coefficients determined using the logged hours of use and the scaling factors from the U.S. DOE Residential Lighting End-Use Consumption Study[8]

θ_d = Angle for each day (d), such that $\sin(\theta_d)$ is 0 at the spring and fall equinox and $\pi/2$ at the summer and winter solstice.

We calculated the extrapolation coefficients by using the daily average HOU measured during the month of December and the scaled daily average HOU for the month of June, as shown in the following equations.

Equation 5. Extrapolation Coefficients

$$c_1 = (HOU_{June\ Scaled} + HOU_{December\ Logged}) / 2$$
$$c_2 = (HOU_{December\ Logged} - HOU_{June\ Scaled}) / 2$$

Where,

$HOU_{December\ Logged}$ = Average daily HOU logged during the month of December for each logger

$HOU_{June\ Scaled}$ = Average daily HOU for June, which is calculated by taking the measured HOU in December and applying the scaling factor from the U.S. DOE Residential Lighting End-Use Consumption Study, as shown in Equation 6.

Equation 6. Seasonal Scaling Equation

$$HOU_{June\ Scaled} = HOU_{December\ Logged} * (HOU_{June\ DOE} / HOU_{December\ DOE})$$

[8] https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf

Where,

$HOU_{December\ DOE}$ = Average daily HOU for the month of December sourced from U.S. DOE Residential Lighting End-Use Consumption Study

$HOU_{June\ DOE}$ = Average daily HOU for the month of June sourced from U.S. DOE Residential Lighting End-Use Consumption Study

4.2.4 Tenant Surveys

Navigant incorporated supplemental findings from 150 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 23 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 23 to the algorithms from Equation 1, Equation 2, and Equation 3.

Table 23. Summary of LED findings

Evaluation Parameter	Source	A-Line	Candelabra	Globe	Recessed	Track
In-Service Rate	Navigant field verification	0.95	0.94	0.97	0.90	0.91
Baseline Lamp Wattage	Duke Energy	61	35	41	65	40
Efficient Lamp Wattage	Navigant field verification	9	5	6	8	7
Daily Operating Hours	Navigant metering study	1.6	1.4	2.7	2.4	2.2
Summer Coincidence Factor	Navigant metering study	0.08	0.09	0.10	0.13	0.09
Winter Coincidence Factor	Navigant metering study	0.08	0.04	0.15	0.07	0.09
$WHFe_{Cool}$	2018 Mid-Atlantic TRM	1.09	1.09	1.09	1.09	1.09
$WHFe_{Heat}$	2018 Mid-Atlantic TRM	0.9	0.9	0.9	0.9	0.9
WHFd	2018 Mid-Atlantic TRM	1.2	1.2	1.2	1.2	1.2
Gross Energy Savings Per Lamp (kWh)		27.6	14.0	32.9	45.0	24.1
Gross Summer Coincident Demand Savings Per Lamp (kW)		0.0046	0.0029	0.0042	0.0080	0.0034
Gross Winter Coincident Demand Savings Per Lamp (kW)		0.0034	0.0010	0.0045	0.0030	0.0024

Source: Navigant analysis, values subject to rounding

4.3.1.1 In-Service Rate

At the 224 housing units inspected by Navigant that had LEDs, there were a total of 3,159 reported program LEDs in the tracking database. During the inspections, Navigant found 2,920 of the program LEDs. Additionally, during phone surveys with tenants, Navigant interviewed customers representing an

additional 1,823 LEDs.[9] Navigant used a weighted average to combine the ISR from field verification with the ISR from phone surveys to calculate a final ISR.[10]

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. Wattage for the efficient lamps was obtained from field verification and aligned very closely with reported values from Duke Energy's tracking data.

4.3.1.3 Waste Heat and Coincidence Factors

We used the waste heat factors from the 2018 Mid-Atlantic TRM, and calculated the coincidence factors as described in Section 4.2.3.

4.3.1.4 Lighting Hours of Use

Navigant calculated the operating hours for LEDs using data from the metering study and the methods described in Section 4.2.3. The study was designed to achieve statistically significant results at the tenant site level, and the final precision was found to be ±15.6% at the 90% confidence level. Navigant did calculate operating hours at the lamp type and space type to understand how customers are using their LED measures in more detail. Table 24 shows the metering study results for LED operation hours by lamp type.

Table 24. Metered Hours of Use by Lamp Type

LED Measure	Annual HOU	Daily HOU
A-Line	572	1.6
Candelabra	502	1.4
Globe	983	2.7
Track	806	2.2
Recessed	893	2.4
Weighted Average	664	1.8

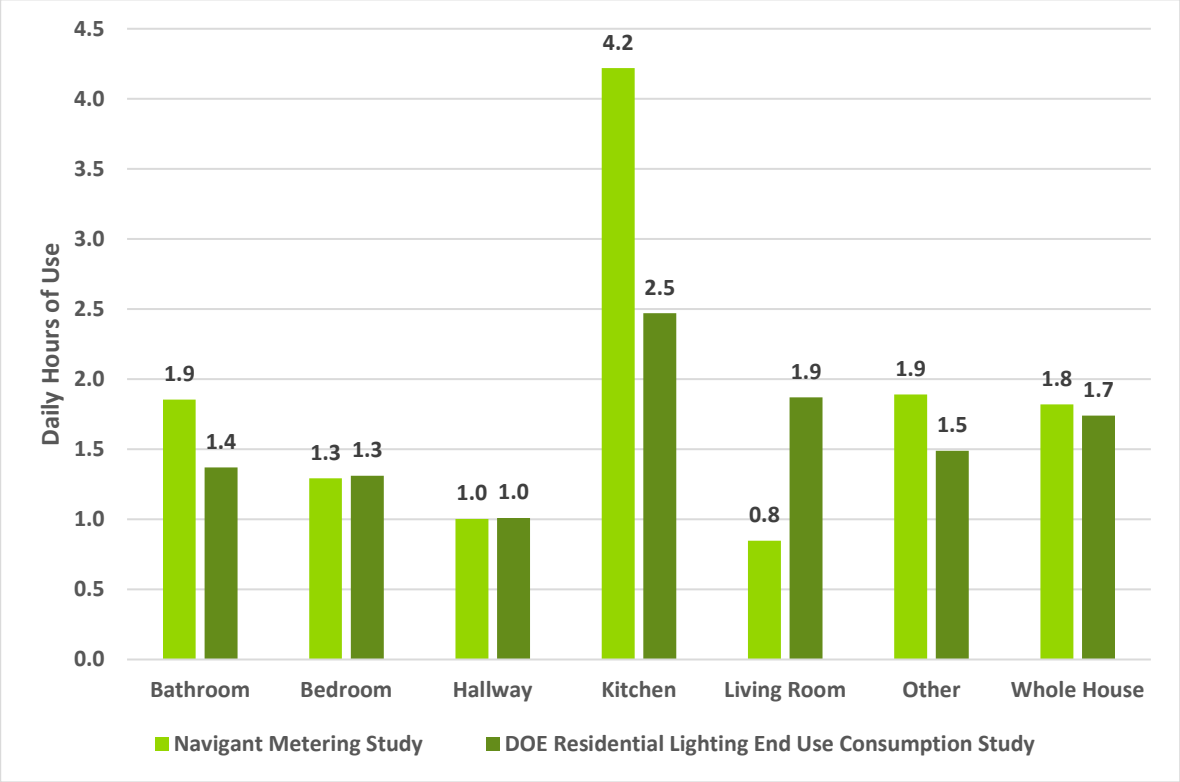
Source: Navigant analysis, values subject to rounding

[9] Six of the phone survey respondents indicated they had removed a total of 11 LEDs.

[10] The weighted results reflect a total of 4,732 verified LEDs out of a sample of 4,982. Navigant used the same approach to calculate ISRs during our 2016 evaluation of this program in DEP and DEC. We believe that combining the results from field and phone verification effectively increases the sample size, and helps to control for the time period covered by this evaluation by incorporating participant input and field observations.

Figure 3 provides the metering study results by space type, along with a comparison to results for the multifamily housing segment from the DOE Lighting End Use Consumption Study.[11] For the most part, Navigant's results followed similar trends to those in the DOE study, especially at the whole household level which represents the weighted hours of use for a typical lamp in the home. The most significant differences were in the kitchen and living room spaces.

Figure 3. Metered Hours of Use by Space Type

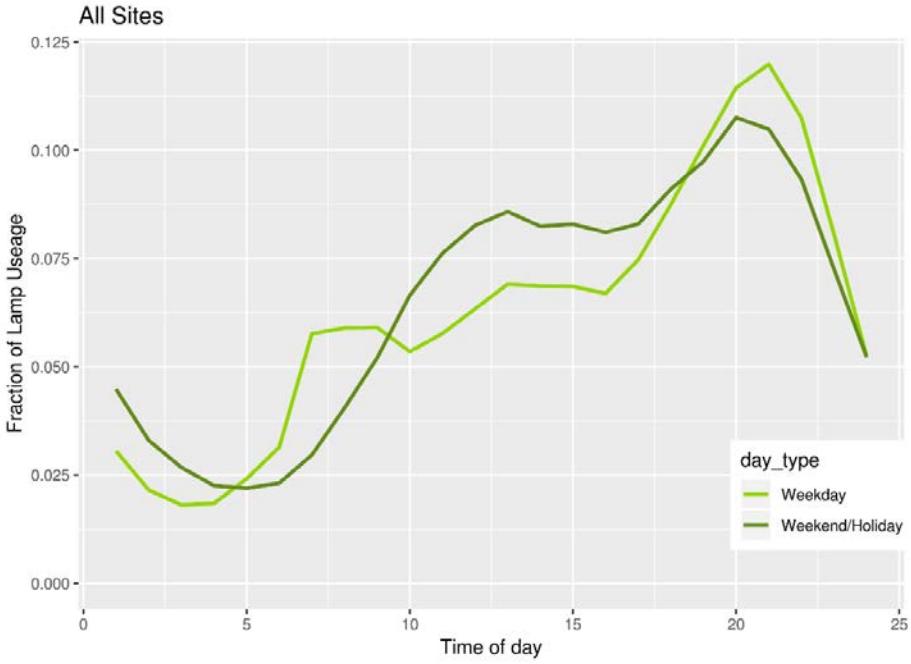


Source: Navigant analysis, values subject to rounding

Navigant also created diurnal (daily) load shapes with the lighting logger data to visualize how program participants use LEDs. Figure 4, Figure 5, Figure 6, and Figure 7 provide graphical results for the load shapes for some of the metered space types.

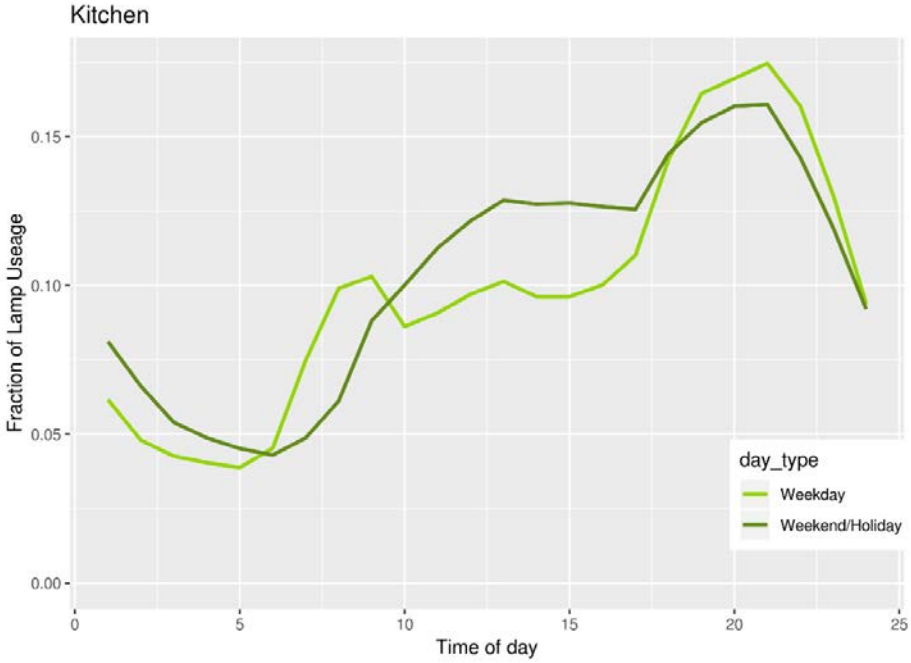
[11] https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf

Figure 4. Aggregate LED Load Shape at Site Level



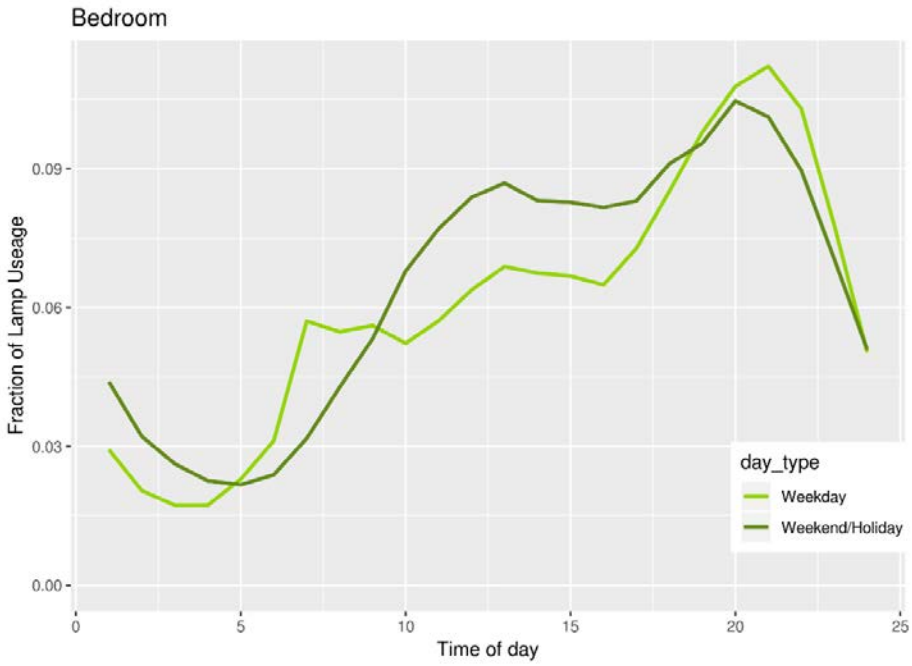
Source: Navigant analysis

Figure 5. LED Load Shape for Kitchen Spaces



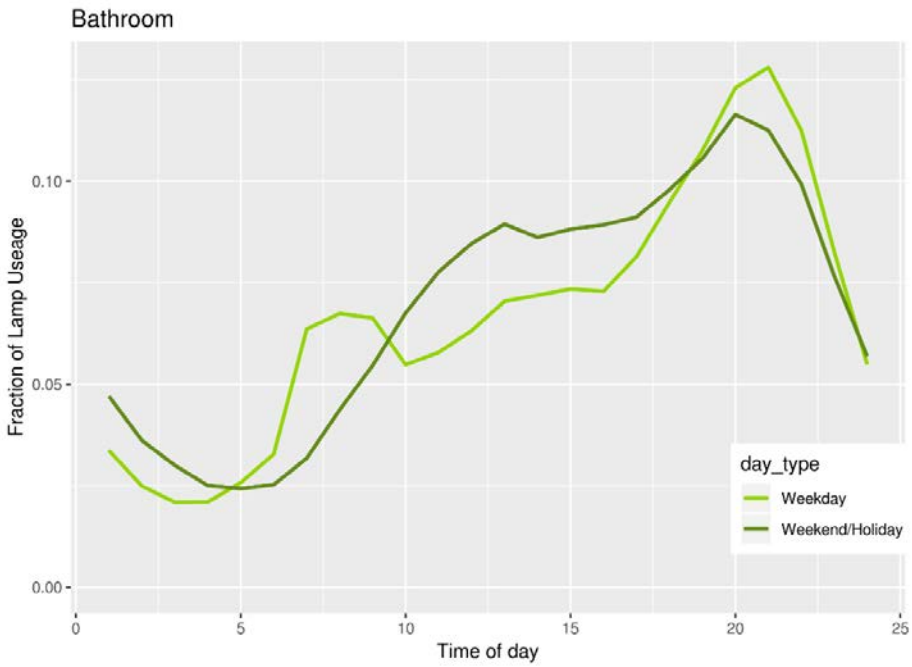
Source: Navigant analysis

Figure 6. LED Load Shape for Bedroom Spaces



Source: Navigant analysis

Figure 7. LED Load Shape for Bathroom Spaces



Source: Navigant analysis

4.3.1.5 Effect of Baseline Wattage Requirements for EISA

The EISA backstop was predicted to take effect in 2020, but is currently on hold. If the backstop does go into effect, the baseline wattage for lighting measures will continue to decrease. If Duke Energy continues to collect information about the wattage of lamps removed during the retrofit process, Navigant believes it is reasonable to use those values in future evaluations as necessary. 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 measuring actual flow rates of the retrofit equipment.

4.3.2.1 In-Service Rate

The ISRs for water measures are shown in Table 25. These were calculated using a weighted average of results from the onsite field verification inspections and the tenant phone surveys.

Table 25. In-Service Rates for Water Measures

Measure	ISR
Kitchen aerators	0.83
Bathroom aerators	0.96
Showerheads	0.92
Pipe wrap	0.91

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 2018 Mid-Atlantic Technical Reference Manual, shown in Equation 7, Equation 8, and Equation 9.[12] Navigant subsequently applied inputs collected during field verification or assumptions as listed below in Table 26. The resulting estimates for impacts of aerators and showerheads are presented in Table 27.

Equation 7. Algorithm for Estimating Energy Savings for Faucet Aerators

$$kWh\ savings\ for\ faucet\ aerators\ = ISR \times \left[\frac{((GPM_{base} \times Throttle_{base}) - (GPM_{low} \times Throttle_{low})) \times Time_{faucet} \times \#peopole \times 365\frac{days}{yr} \times DR \times (T_{ft} - T_{in}) \times 8.3\frac{Btu}{gal \cdot {}^{\circ}F}}{\#_{faucets} \times 3412\frac{Btu}{kWh} \times DHW\ Recovery\ Efficiency}\right]$$

[12] The impact equations for water measures in the 2018 Mid-Atlantic TRM were updated from those in the 2016 version, which contributed to the realization rates for water measures in this evaluation since the deemed values were based on Navigant's previous evaluation which leveraged several inputs from the 2016 Mid-Atlantic TRM. Navigant believes it is most appropriate to use the latest TRM.

Equation 8. Algorithm for Estimating Energy Savings for Low Flow Showerheads

$$kWh\ savings\ for\ low\ flow\ showerheads = ISR \times \left[\frac{((GPM_{base} - GPM_{low}) \times Time_{shower} \times \#\ people \times Showers_{person} \times 365\frac{days}{yr} \times (T_{sh} - T_{in}) \times 8.3\frac{Btu}{gal \cdot °F}}{\#_{showerheads} \times 3412\frac{Btu}{kWh} \times DHW\ Recovery\ Efficiency}\right]$$

Equation 9. Algorithm for Estimating Coincident Demand Savings for Aerators and Showerheads

$$\Delta kW_{peak} = \Delta\, kWh/Hours \times CF$$

Table 26. Input Parameters and Assumptions for Aerator Savings Calculations

Input	Definition	Value	Source
ISR	In-service rate	Refer to Table 25	Navigant field verification and phone surveys
GPM_{base}	Baseline flow rate	Bathroom Aerators 2.12 Kitchen Aerator 2.17 Shower 2.76	Data Provided by Duke Energy from Franklin Energy Sample
GPM_{low}	Retrofit flow rate	Bathroom Aerators 0.84 Kitchen Aerator 0.73 Shower 1.5	Navigant field verification[a]
Throttle	Throttle factor	Base 0.83 Low 0.95[a]	2018 Mid-Atlantic TRM
$Time_{faucet}$	Avg hot water use per day per person (minutes)	Kitchen 4.5 Bath 1.6 Shower 7.8	2018 Mid-Atlantic TRM
#People	Number of people per household	2.07	EIA RECs Study
$Showers_{person}$	Number of showers per person per day	0.6	2018 Mid-Atlantic TRM
DR	Percent of water going down drain	Kitchen 50% Bath 70%	2018 Mid-Atlantic TRM
T_{ft} or T_{Sh}	Temp of water flowing from faucets (F) Temp of water flowing from showerheads (F)	Kitchen 97 Bath 96[b] 105	Navigant field verification 2018 Mid-Atlantic TRM
T_{in}	Temp of water entering water heater (F)	66	Navigant field verification
#faucets/showers	Number of faucets in home	Kitchen 1 Bathroom 1.53 Shower 1.39	Navigant field verification

Input	Definition	Value	Source
DWH Recovery Efficiency	Recovery efficiency of water heater	0.98	2018 Mid-Atlantic TRM
CF (aerators)	Coincidence Factor	Summer 0.003 Winter 0.002	2018 Mid-Atlantic TRM & Navigant Calculation using data from Building America Benchmark
CF (showerheads)	Coincidence Factor	Summer 0.005 Winter 0.019	2018 Mid-Atlantic TRM & Navigant Calculation using data from Building America Benchmark
Hours	Hours of use per year	Kitchen 18.25 Bath 18.25 Shower 47.45	2018 Mid-Atlantic TRM & Navigant Calculation

a. *Navigant measured flow rates during onsite field verification. For faucet aerators, we used the measured flow rates to calculate impacts instead of multiplying the nameplate flowrate by the throttling factor since primary data was available. For showerheads, we used the nameplate flow rate since the equation does not include a throttling factor.*

b. *For faucet aerators, Navigant assumed that customers use water at a temperature equal to the average of the hot and cold temperatures measured during field verification.*

Table 27. Verified Estimates of per Unit Impacts for Aerators and Showerheads[13]

Measure	Kitchen aerator (1.0 GPM)	Bathroom aerator (1.0 GPM)	Low flow showerhead (1.5 GPM)
Gross Energy Savings Per Device (kWh)	115	55	281
Gross Summer Coincident Demand Savings Per Device (kW)	0.015	0.007	0.023
Gross Winter Coincident Demand Savings Per Device (kW)	0.013	0.006	0.091

Source: Navigant analysis, values subject to rounding

4.3.3 Water Heater Pipe Wrap

During field verification, Navigant found that some of the water heater pipe wrap was installed on the cold water inlet pipe to the water heater. 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

[13] 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 25, so a verified savings are shown here for only those measures. A full list of savings is shown in Section 9 and can be used for planning purposes.

cold water pipes.[14] Therefore, when calculating the ISR, Navigant did not count savings from pipe wrap of greater than three feet installed on cold water pipes.

To estimate impacts from the pipe wrap measure, Navigant used algorithms from the 2018 Mid-Atlantic TRM shown in Equation 10 and Equation 11 below.[15] The ex-post impacts are shown in Table 28.

Equation 10. Energy savings for water heater pipe wrap

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

Equation 11. 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
R_e = R-value of existing, uninsulated pipe (R = 1)
R_n = insulation R-value of pipe wrap plus R-value of uninsulated pipe (R = 4)
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)
nDHW = heat recovery efficiency (0.98)
3,413 = conversion from Btu to kWh

Table 28. Verified Impacts for Water Heater Pipe Wrap

Measure	Water Heater Pipe Wrap (per foot)
Gross Energy Savings Per Foot (kWh)	19
Gross Summer Coincident Demand Savings Per Foot (kW)	0.0022
Gross Winter Coincident Demand Savings Per Foot (kW)	0.0022

Source: Navigant analysis, values subject to rounding

[14] http://www.energy.gov/energysaver/projects/savings-project-insulate-hot-water-pipes-energy-savings

[15] http://www.neep.org/mid-atlantic-technical-reference-manual-v6

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 29 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 29. NTG Results

Estimated Free Ridership	7.2%
Estimated Spillover	0.15%
Estimated NTG	0.93

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 in the Carolinas. Navigant primarily targeted property managers for the NTG surveys, because they are the decision makers for participation in the program.[16] 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.

[16] 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.

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.

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 12:

Equation 12. Net-to-Gross Formula

$$NTG = 1 - \text{free ridership} + \text{spillover}$$

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.[17] Navigant then calculated a weighted average from each respondent based on their share of sample energy savings, and divided by 10 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.[18] 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.

[17] 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).

[18] 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.

- **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. 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.[19]

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.

[19] 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 CFLs 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.

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 24 property managers. This sample represents about 11 percent of the total reported energy savings, as shown in Table 30.

Table 30. Property Manager Sample Representation

	Program Total Reported Energy Savings (MWh)	Sample Total Energy Savings (MWh)	% of Program
LEDs	20,159	2,053	10%
Bathroom faucet aerators	1,969	237	12%
Kitchen faucet aerators	2,442	294	12%
Showerheads	10,816	1,250	12%
Pipe wrap (ft)	7,120	700	10%
Energy Savings (MWh)	42,505	4,534	11%

Source: Navigant analysis, values subject to rounding

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 7.2 percent, which is similar to previous evaluations of this program.

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: Fourteen of the respondents indicated they had some level of prior plans for installing some of the energy efficient measures, but only 6 of those indicated their plans were somewhat developed. The other 10 respondents indicated that they did not have plans.

Program Importance: Respondents stated that the program was very important in having the measures installed. Several property managers noted that their decision to participate was influenced by helping their tenants save energy and money.

Likelihood: Respondents were asked in the absence of the program, if they would have had at least some of the work done. Five respondents stated they "definitely would not have" installed some measures in the absence of the program, and 14 said they "may have". Respondents who said they may have installed some measures without the program indicated they would have only installed, on average, less than half of the measures they did install. Furthermore, those same respondents indicated there was only about a 60 percent change they would have installed those additional measures. Taken together, these findings indicate relatively low free ridership.

Timing: Twelve respondents stated they would have done the installation within two years or less in the absence of the program. But those same respondents indicated that there was about a 70 percent chance that less than half of the work would have been completed in the absence of the program.

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

Four of the 24 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 or common spaces and weather stripping. In addition to the three property managers reporting spillover, six tenants reported installing a small number of LEDs and household appliances 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 0.15 percent.

5.2.4 NTG Results

The NTG ratio was calculated as written in Equation 13:

Equation 13. Net-to-Gross Ratio

$$NTG = 1 - free\ ridership + spillover = 1 - 0.072 + 0.00147 = 0.929$$

This suggests that for every one kWh reduced from program measures, about 0.93 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 150 program participants, detailed surveys with 24 property managers, interviews with the Duke Energy Program Manager and key implementation staff from Franklin Energy, and a high-level review of the program documents and functionality. The property manager interviews and tenant surveys were also used to inform the NTG analysis.

6.1 Key Findings

- The program appears to be effectively addressing many key challenges that are inherent to delivering energy efficiency programs to non-owner-occupied multifamily housing facilities.
- About half of the property managers learned about this program through outreach by a program representative. This onsite marketing approach seems to be a successful way of gaining participants. Most tenants learned of this program through their property managers, but about 20 percent of tenants reported learning about the program through a bill stuffer or email from Duke Energy. The latter group may be confusing the bill and email outreach with other Duke Energy outreach, since no specific bill or email promotion is carried out for this program.
- Property managers indicated they chose to participate in the program to provide a service and save money for their tenants and owners as well as to capitalize on the free installation to save on internal labor costs. Over 80 percent of surveyed property managers indicated they were "very likely" to recommend the program to other property managers.
- 43 percent of DEP tenants and 54 percent of DEC tenants reported that they noticed savings on their energy bills since the installation of the measures.
- A majority of program participants were satisfied with the program. On a scale of 0 to 10, where 0 indicates "not satisfied at all" and 10 indicates "extremely satisfied":
    - About 84 percent of DEC participants and 74 percent of DEP participants indicated 8-10 for satisfaction with the overall program
    - About 86 percent of DEC participants and 88 percent of DEP participants indicated 8-10 for satisfaction with the installer's quality of work
    - About 74 percent of DEC participants and 83 percent of DEP participants 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.
- Tenant satisfaction was higher for LEDs than for showerheads and aerators. Respondents were generally happy with the brightness and quality of light provided by the LEDs.
- During the tenant phone surveys, several participants expressed dissatisfaction with the low water pressure in their showers and sinks. Additionally, several property managers indicated that they had received tenant complaints about low water pressure.

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.

6.3 Interviews with Duke Energy Program Manager and Franklin Energy Implementation Staff

Interview with Duke Energy's Program Manager
Navigant interviewed Duke Energy's Program Manager to discuss program goals and any relevant changes to delivery or offerings since the previous evaluation. This interview revealed that Duke Energy prioritizes a culture of safety at all levels of program operation, strategic partnerships and engagement to reach additional customers, and maintaining overall satisfaction by program participants. Overall Duke Energy is pleased with the program's performance and constantly seeking creating ways to improve delivery and continue meeting customer needs. Duke Energy acknowledges that EISA lighting regulations will affect the program's future, and is actively considering non-lighting measures that may be good options for program measures.

The program is making strategic changes to recruitment, regulation, measure offerings and customer interface technology. Duke Energy is focused on increasing relationships with property management companies to streamline scheduling and to reach more customers. The program also introduced specially bulbs, BR30s and MR16s, in March 2018. The utility has changed participation requirement to allow properties with as low as four housing units to be eligible for the program in DEP and DEC; this regulation approval has increased participation. Finally, a new software tool named Clipboard will provide property managers a 1-page summary report of the financial and energy savings estimates from participating in this program. Currently, the testing phases of the summary report offering have resulted in positive feedback from property managers who were on the fence about participating.

Duke Energy is satisfied with Franklin Energy's management of the program. Some areas of strength include a strong customer pipeline, program management, scheduling resources, data and quality control, and a strong measure mix offering.

Interview with Franklin Energy Implementation Staff
Navigant also interviewed program implementation staff from Franklin Energy. Franklin Energy has developed a program logic model and detailed program plan that clarifies program operations. The program logic model details the customer influence process and the proactive way that program staff recruits, engages and educates, and specifies procedures for following up with the property managers. The primary implementation steps include the process of outreach, scheduling, measure installation, quality control, and continuous improvement.

Franklin Energy reported an increase in participation because of the new measure offerings and is working with Duke Energy to introduce additional measure offerings. Franklin Energy continues to provide critical customer feedback to Duke Energy. Finally, Franklin Energy is coordinating to offer enhanced program delivery by incorporating tablet devices into their operations. They have received positive feedback from program participants after changing from paper-based to tablet-based

documentation. They also have enhanced program tracking with electronic recording during installations; this resulted in a quick data entry, upload and quality control process, where issues can be resolved swiftly.

6.4 Property Manager Interviews

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 24 property managers representing over 80,000 measures or 11% of the program reported energy savings.

Overall, property managers indicated that their experience with the program was very favorable. Some key findings from the property manager interviews are listed below:

- On a scale of 0 to 10, where 10 indicates “very satisfied” and 0 indicates “not satisfied at all”, the average rating from property managers was 7.8.
- 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 “professional” and “efficient.” Other respondents indicated there were some small issues related to insufficient materials to complete retrofits at all housing units at the property.
- About 80 percent of property managers are very likely to recommend this program to other property managers. Provided are a subset of property manager responses on how the program influenced their decision to install the energy efficient measures:
    - “It was painless, and I didn’t have to do much other than send a notice to my tenants”
    - “The main thing was to save money for residents”
    - The program provided “benefits to residents, allowed upgrades to equipment, saves money, and updated the property”
- Several property managers indicated their maintenance staff had to replace some of the program showerheads due to tenant complaints about low water pressures.
- One property manager indicated that installation staff left muddy footprints in tenant homes.
- General suggestions for program improvement from property managers and maintenance staff included: adding exterior or common space lighting, improving the quality of aerator devices, improving the installation logistics such as material needs.

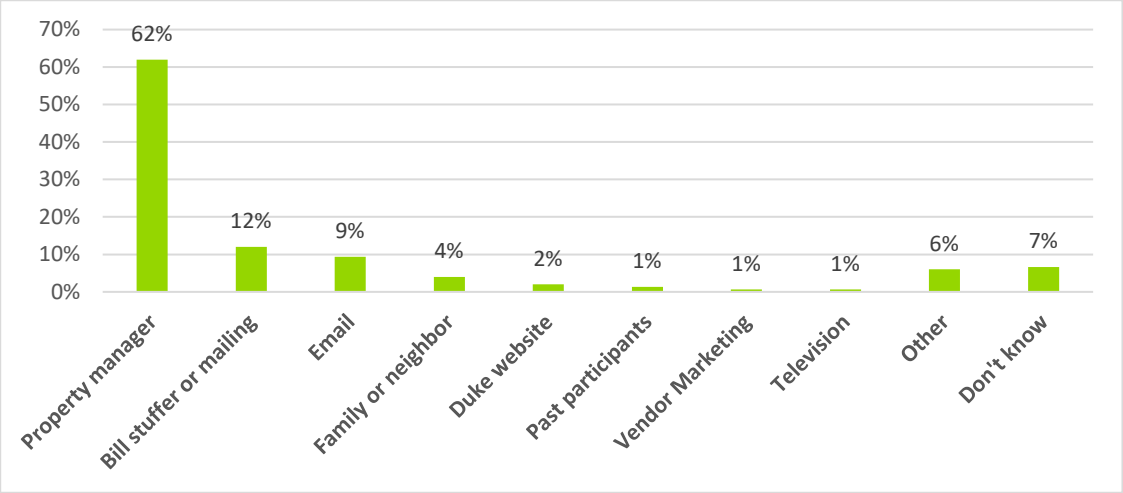
6.5 Overall Marketing and Outreach

Customer outreach is a key driver to program participation. Navigant recognizes the importance of marketing and outreach with regards to continued participation and satisfaction, so several questions in the tenant survey and property manager interviews were included to address this.

Figure 8 and Figure 9 show how tenants and property managers learned about the program, respectively. Tenant participants were asked to indicate all of the sources through which they learned about the program, and about 62 percent indicated they had learned about the program through property managers as would be expected given the program model. Tenants also indicated having received

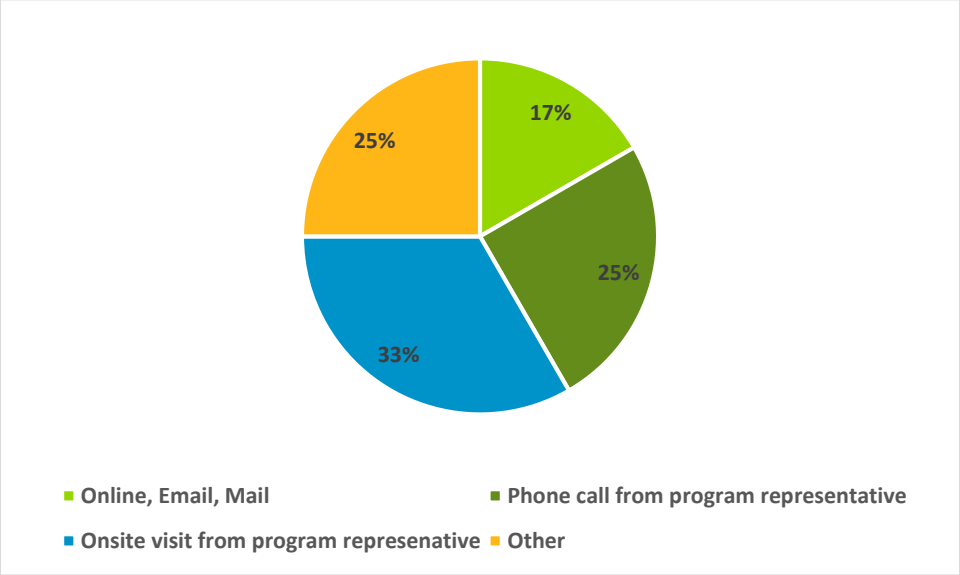
notice via a Duke Energy mailing, bill stuffer or email.[20] Property managers indicated that they were approached in-person by a program representative or received a mail or email with program details.

Figure 8. How Tenants Learned About the Program (n=150)



Source: Navigant analysis, values subject to rounding

Figure 9. How Property Managers Learned About the Program (n=24)



Source: Navigant analysis, values subject to rounding

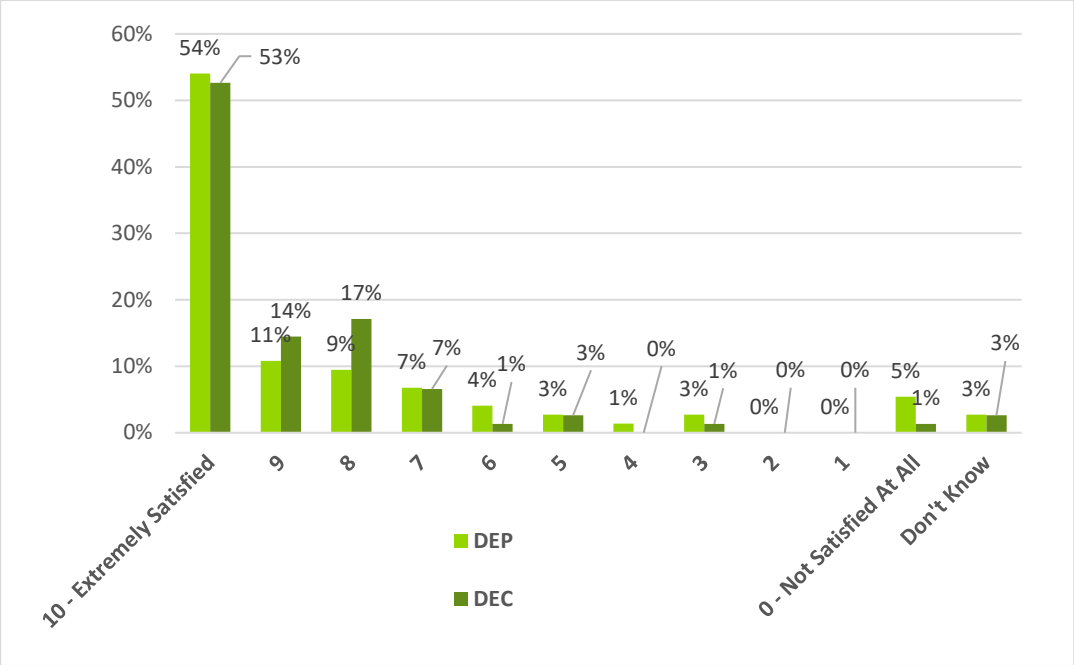
[20] Duke Energy does not promote this program through bill stuffers or emails, so it is possible that tenants were confusing this with notification received via paper or email from property managers.

6.6 Tenant Surveys

Navigant conducted phone surveys with 150 residential tenants to assess program satisfaction. 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.

Customer satisfaction with the program is high. On a scale of 0 to 10, where 0 indicates "not satisfied at all" and 10 indicates "extremely satisfied," about two-thirds of tenants rated satisfaction with the program as an 8-10 as shown in Figure 10. The average overall tenant satisfaction rating with the program was 8.62. Participants who ranked their overall satisfaction low did so because they disliked the products or did not notice any monetary savings.

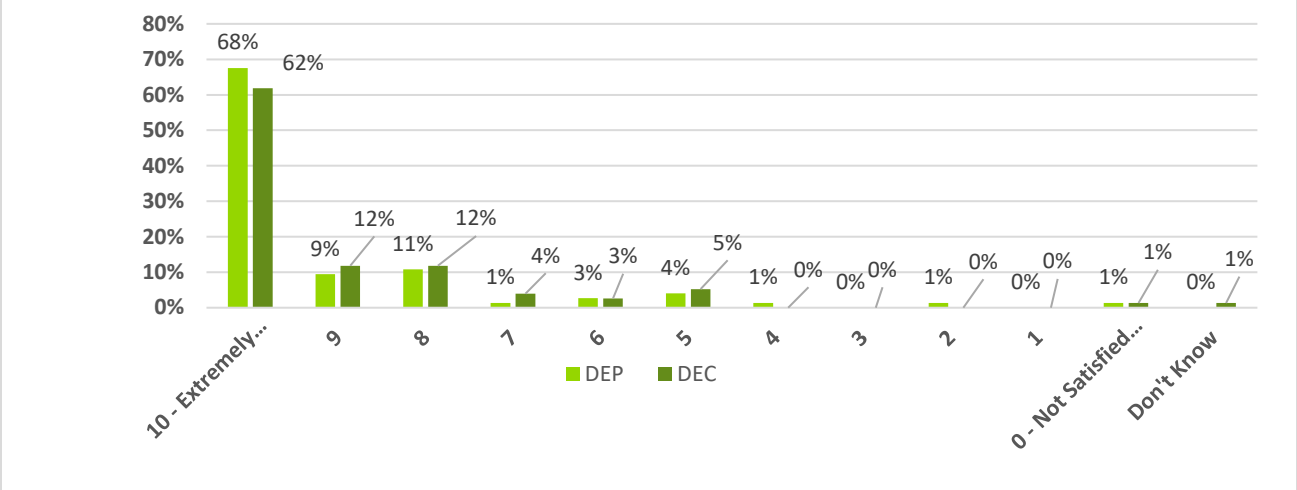
Figure 10. Tenant Satisfaction with Overall Program Experience (n=150)



Source: Navigant analysis, values subject to rounding

Customer satisfaction with the contractor quality of work was also high, as shown by Figure 11.

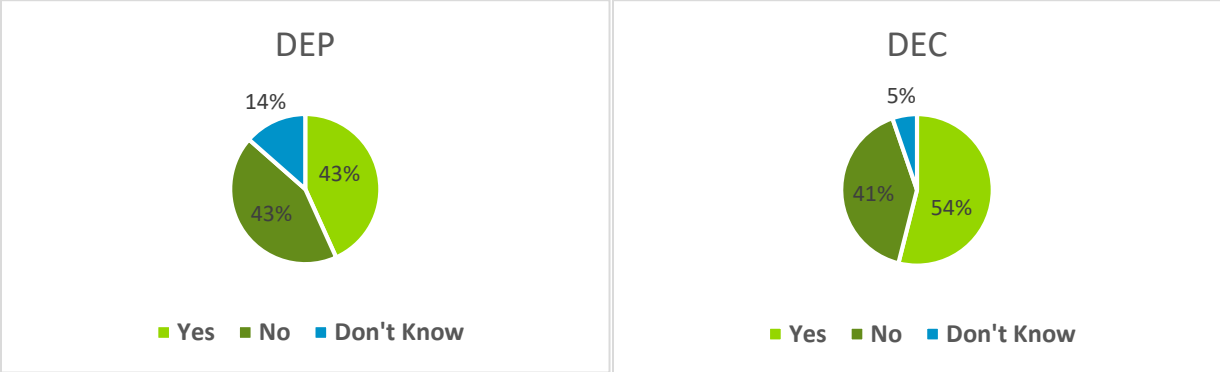
Figure 11. Tenant Satisfaction with Contractor's Quality of Work (n=150)



Source: Navigant analysis, values subject to rounding

As shown in Figure 12, 43 percent of DEP participants and 54 percent of DEC participants noticed a decrease in their energy bills after the new measures were installed.

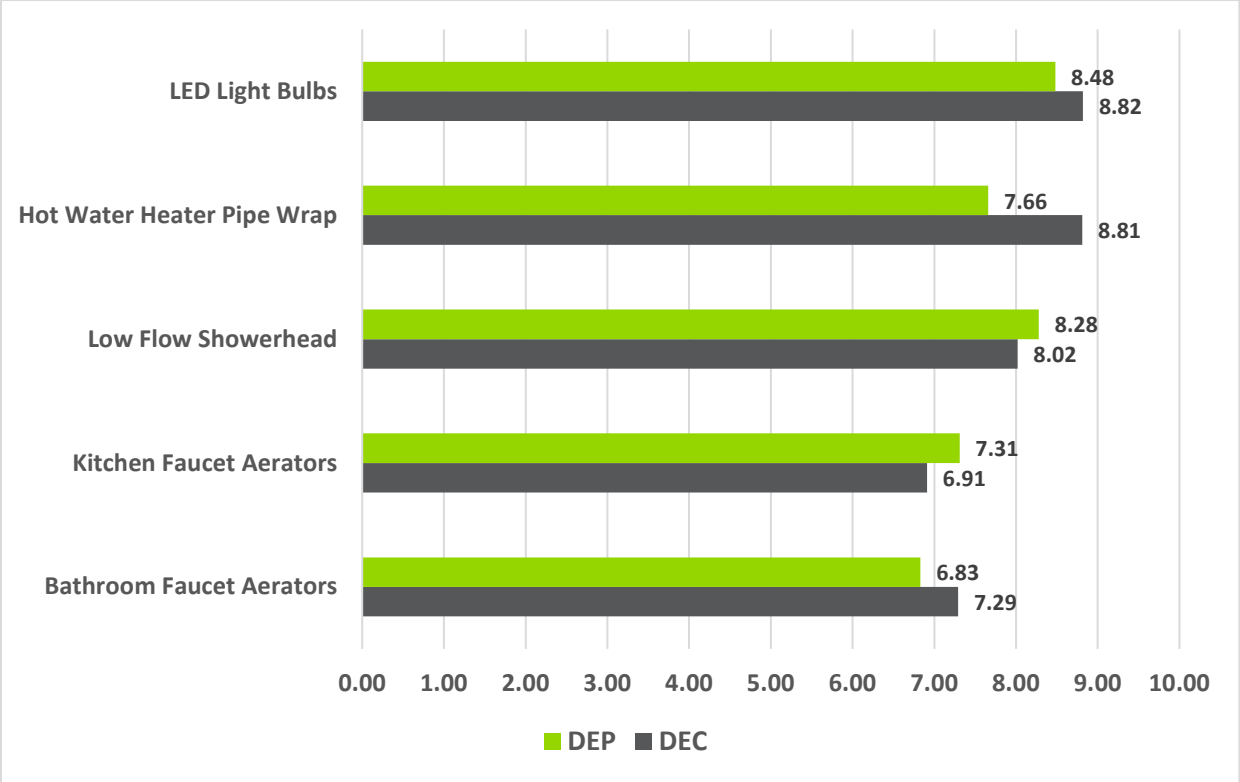
Figure 12. Participants Who Noticed a Decrease in Their Energy Bill After Installing Program Measures (N=150)



Source: Navigant analysis, values subject to rounding

While a majority of participants were satisfied with the new measures, some were not. Navigant asked the participants to rate their satisfaction for each measure installed at their home. Average satisfaction ratings ranged from as high as 8.82 of 10 for LEDs in DEC, to as low as 6.83 out of 10 for bathroom faucet aerators in DEP, as shown in Figure 13.

Figure 13. Tenant Satisfaction Rating for Each Measure (n=150)



Source: Navigant analysis, values subject to rounding

A small percentage of tenants reported they removed some of their program measures. Six respondents reported removing a total of 11 LEDs, mostly due to burnout or dissatisfaction with lighting quality. Two respondents removed a total of three bathroom aerators, and 9 respondents removed one kitchen aerator each. One person reported removing two program showerheads. Participants indicated they removed bathroom faucet areators and showerheads because of poor water pressure and excess water spray.

6.6.1.1 Participant Suggestions

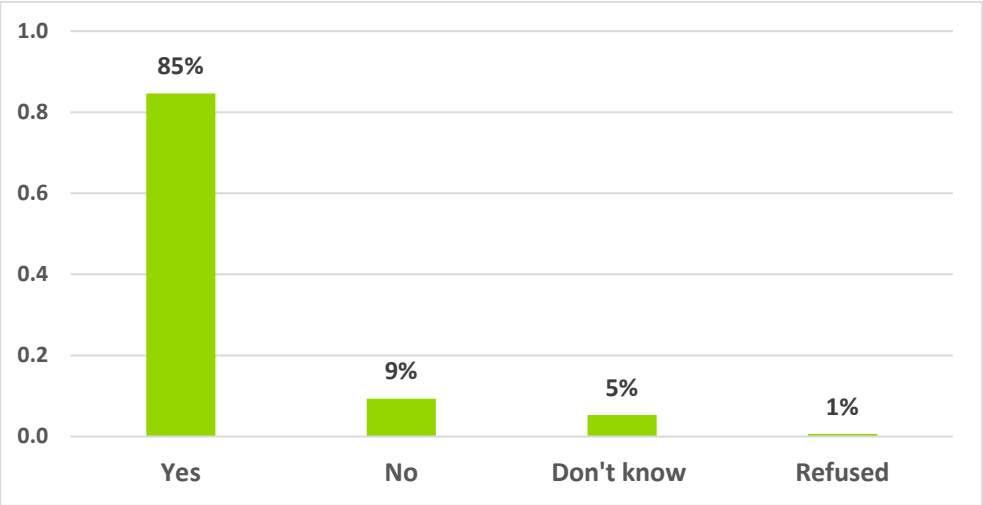
Navigant also included a question in the tenant satisfaction survey that allowed respondents to offer suggestions for improving the program. About 20 percent of respondents offered suggestions, which were as follows:

- Several respondents asked for a better quality of equipment, especially the showerheads, and aerators
- Several participants asked for better notification of installation date and time
- One respondent requested offering HVAC and thermostat measures

6.6.1.2 Participant Familiarity with Duke Energy

Navigant asked participant tenants a series of questions about their familiarity with Duke Energy's efficiency program offerings, as well as their preference for additional program offerings. As shown in Figure 14, 85 percent of respondents said they consider Duke Energy a resource for energy efficiency information. However, as shown in Figure 15, a nearly equivalent percentage of respondents were not able to specifically name other Duke Energy efficiency programs when asked without prompts.

Figure 14. Participants Who Consider Duke Energy a Resource for Energy Efficiency Information (n=150)



Source: Navigant analysis, values subject to rounding

Figure 15. Participants Who Could Name Other Duke Energy Solutions/Programs to Help Them Save Energy and Money (n=150)

Source: Navigant analysis, values subject to rounding

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

- 20% of respondents currently have a smart thermostat (16% were unsure)
- Of the respondents who do not have a smart thermostat, about half are interesting in getting one
- Nearly 60% of respondents say they would like to see solar PV installed at their property
- Less than 3% of respondents currently own an EV, and about 4% are aware of EV charging stations at their properties

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:	April 16, 2020
Region:	Duke Energy Progress Duke Energy Carolinas
Evaluation Period	1/1/17 – 5/1/18
Annual kWh Savings	DEP 22,376,274 DEC 31,266,195
Per Participant kWh Savings	DEP 797 DEC 711
Net-to-Gross Ratio	0.93

Evaluation Methods

The evaluation team used engineering analysis ,onsite field inspections, and a lighting logger study 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 229 housing units.** The evaluation team inspected program equipment at 229 housing units to assess measure quantities and characteristics to be compared with the program tracking database.
- **341 lighting loggers were deployed**. The evaluation team deployed 341 lighting loggers to measure operating hours for two months. Results were extrapolated to annual estimates using a sinusoidal modeling method. The weighted average of lamp usage across all program lamp and space types was 1.8 hours per day.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 83% for kitchen aerators to 95% for globe LED lamps.
- **Participants achieved an average of 797 kWh of energy savings per year in DEP, and 711 kWh in DEC.** Differences were driven by the mix and quantity of measures installed between the jurisdictions.

8. CONCLUSIONS AND RECOMMENDATIONS

Navigant developed a series of recommendations during the EM&V effort. 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. Further explanation for each recommendation can be found later in this report.

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.
2. Duke Energy should consider whether additional marketing material can be distributed to tenants during participation in this program, to educate participants about other Duke Energy program offerings and services. Nearly 90 percent of tenants surveyed were not able to identify other Duke Energy efficiency programs or offerings without being prompted.
3. Duke Energy should consider whether smart thermostats or other HVAC-related measures would be reasonable offerings for this program. About half of survey respondents who did not have a smart thermostat indicated they would like to get one.

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 31 provides the measure-level inputs that can be used by Duke Energy Analytics for estimates of future program savings.

Table 31. 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)
Faucet Aerators MF Direct 0.5 GPM - bath	Per Aerator	75.11	0.0099	0.0087
Faucet Aerators MF Direct 1.0 GPM - bath	Per Aerator	55.09	0.0073	0.0064
Faucet Aerators MF Direct 1.0 GPM - kitchen	Per Aerator	114.61	0.0151	0.0133
LF Showerhead MF Direct 0.5 GPM	Per Showerhead	505.00	0.0417	0.1627
LF Showerhead MF Direct 1.0 GPM	Per Showerhead	393.04	0.0324	0.1266
LF Showerhead MF Direct 1.5 GPM	Per Showerhead	281.09	0.0232	0.0906
Pipe Wrap MF Direct	Per Linear Foot	19.20	0.0022	0.0022
A-line LED Direct	Per Lamp	27.65	0.0046	0.0034
Globe LED Direct	Per Lamp	32.87	0.0042	0.0045
Candelabra LED Direct	Per Lamp	13.98	0.0029	0.0010
Track LED Direct	Per Lamp	24.08	0.0034	0.0024
Recessed LED Direct	Per Lamp	45.01	0.0080	0.0030

Source: Navigant analysis, values subject to rounding

**Duke Energy does not currently offer faucet aerators at the 0.5 gpm flow rate, nor showerheads at the 1.0 and 0.5 gpm flow rates. The values in this table are presented for planning purposes only.*

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 24 property managers. This section presents details of the interviews. The responses to each question shown are paraphrased to maintain confidentiality and summarize the key points.

Table 32. How did you learn about the Duke Energy Multifamily Energy Efficiency Program?

Respondent(s)	Response
2,6,7,9,14-17,20	Duke Energy phone call, mail or email
1,3,19,22	Corporate company mandated
4,6,8,10,11,14,16,18,20,21,23	Approached by a program representative
12	Through a family friend or neighbor
5	Don't know

Source: Navigant analysis

Table 33. What were the primary reasons to participate in the program?

Respondent(s)	Response
7,8,19	To save energy
1,18	Corporate mandated
2,3,4,5,13,15,17,20,21,23,24	To save money
6,9,10,16	To improve tenant satisfaction
11	Duke Advertising
12,22	Modernize, Replace old equipment
14	Don't Know

Source: Navigant analysis

Table 34. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied are you with your overall program experience?

Respondent(s)	Response
2,3,6,23	10
7,9,15,19	9
1,4,8,13,14,16,18,22	8
10,12,21,24	7
11,17	6
5	5
20	3

Source: Navigant analysis

Table 35. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied are you with the tenant notification and program materials?

Respondent(s)	Response
1-3,6,8-10,15,16,20,23,24	10
11,17,19,21	9
4,12,13,18,22	8
14	7
5,7	Don't Know

Source: Navigant analysis

Table 36. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied would you say your tenants are with the new energy efficient equipment?

Respondent(s)	Response
1-3,6,19,23	10
9,11,13,15	9
8,12,22	8
16,18,24	7 – low pressure from water fixtures*
10,14	6 – Aerator low flow pressure received bad feedback*
4,5,7,17	5 – water measures had multiple complaints, two properties reinstalled old showerheads; aerators didn't receive good feedback either*
20	2 –showerheads didn't have adequate pressure, so the old showerheads were reinstalled*
21	Don't Know
*Indicates feedback for lower satisfaction applied only to water measures and respondents were satisfied with LEDs	

Source: Navigant analysis

Table 37. On a scale of 0 to 10, with 0 being "not likely at all" and 10 being "very likely", how likely are you to recommend the Multifamily Energy Efficiency Program to other property managers?

Respondent(s)	Response
1-3,6-9,12,15,16,19,23	10
13,22,24	9
4,14	8
10,11,18	7
5	4
21	3
17,20	0 – feedback noted that property manager felt the installer was unprepared for 10 ft. ceiling, they didn't replace all of the lights, and had bad communication; program was unorganized and they had to replace many of the aerators and showerheads.

Source: Navigant analysis

Table 38. Prior to participating in the program, had you considered installing the same energy efficient equipment at your facility?

Respondent(s)	Response
3,4,13,17,19-21	No
2,5,7,9-12,14,-16,18,22-24	Yes
1,6,8	Don't Know

Source: Navigant analysis

Table 39. Did your experience with the program influence you to incorporate any additional energy efficiency equipment for which you did not receive a Duke Energy program rebate?

Respondent(s)	Response
2-4,6,10,11,13-15,17-24	No
7,12,16	Yes, installing LEDs
9	Yes, weather-stripping
1,5,8	Don't Know

Source: Navigant analysis

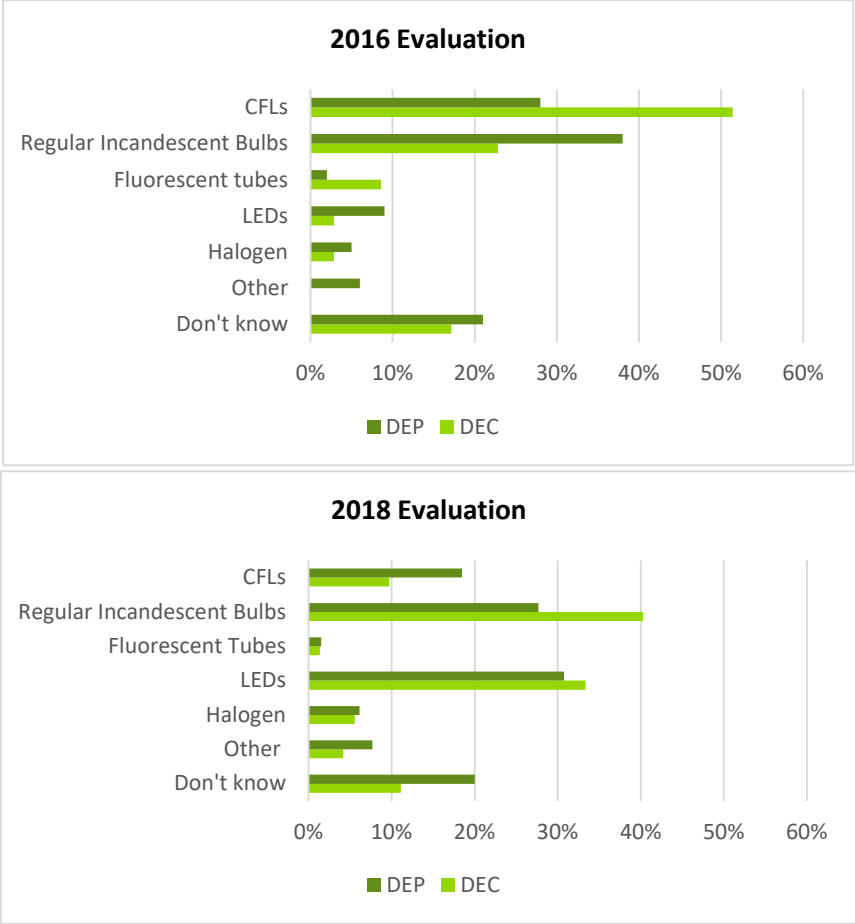
A.2 Tenant Satisfaction Surveys

Satisfaction surveys were conducted with 150 program participants. Many of the results are presented in Section 6.6 of the main report, and this section serves as a supplement.

Figure 16 shows the types of light bulbs that tenants reported as being installed in the non-retrofitted fixtures in their homes. We have included a comparison to the same question from the 2016 evaluation of this program, and the responses indicate that non-program LEDs are more prevalent in multifamily homes than they were in 2016. Key takeaways include:

- In 2018, about one-third of respondents indicated they have LEDs in fixtures that were not retrofitted through the program, as compared to less than 10 percent in 2016.
- In 2018, fewer respondents indicated that their non-retrofitted fixtures CFLs.
- Estimates for other lamp types were relatively consistent between 2016 and 2018

Figure 16. Comparison of 2016 and 2018 Results for Type of Bulbs Reported by Tenants to be in Non-Retrofitted Fixtures



Source: Navigant analysis

As noted earlier, overall tenant satisfaction with the program was very high for DEP and DEC jurisdictions, with an average rating of 8.6 on a scale of 0 to 10 with 10 as very satisfied. However, nine of the 150 tenants reported a satisfaction of five or less with the program for the following reasons:

- No noticeable money savings (n=4)
- Dislike products (n=1)
- Unspecified reason (n=4)

Tenants also reported a few suggestions for improving the program:

- Improve the kitchen faucet aerator (n=8)
- Improve tenant notification about installation times (n=7)
- Improve low flow showerhead (n=5)
- Improve the quality of LEDs (n=4)
- Improve the quality of products (n=3)
- Don’t mandate participation (n=1)
- Change all light bulbs in home (n=1)
- Add protective UV film to doors (n=1)

APPENDIX B. TENANT SURVEY GUIDE

DUKE ENERGY MULTIFAMILY ENERGY EFFICIENCY PROGRAM
TENANT SATISFACTION SURVEY

This survey guide is targeted at residents that are recipients of energy efficient equipment through Duke Energy's Multifamily Energy Efficiency Program (MEEP). The goal of the tenant satisfaction surveys includes informing, updating and improving the MEEP Program. Recruiting calls for tenant surveys will be made between 10:00am-8:30pm EST on weekdays, and 10:00am-5:00pm EST on Saturdays. No calls 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 light bulbs and other energy saving equipment that your landlord or property manager installed in your home. 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 light bulbs and other energy saving equipment that your landlord or property manager installed in your home. 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 energy efficiency program. 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 this year or in 2017. Your landlord or property manager most likely organized your participation in this program, and a work crew or maintenance staff person 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
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 had these items installed during 2017 or 2018. Since you did not, these are all the questions I have at this time. Thank you.

[IF S1 = 98 OR 99, CONTINUE. OTHERWISE SKIP TO M1.]

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.

==========

MEEP 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

==========

Measures

M1. 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 relating to your decision to participate in the program.

Did you live at this residence, prior to the installation of these efficient items in your home?

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

[IF LED_LIGHT_BULBS_1 ≥ 1, ASK. OTHERWISE, SKIP TO M3.]

M2. How many LED light bulbs were installed in your home with the program by the maintenance staff? (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.)

1. _____[ENTER A NUMBER 1 TO 90]

[IF LOW_FLOW_SHOWERHEAD_5 ≥ 1, ASK. OTHERWISE, SKIP TO M4.]

M3. How many low flow showerheads were installed in your home with the program by the maintenance staff? (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.)

1. _____[ENTER A NUMBER 1 TO 90]

[IF BATHROOM_FAUCET_AERATORS_2 ≥ 1, ASK. OTHERWISE, SKIP TO M4a.]

M4. How many bathroom faucet aerators were installed in your home with the program by the maintenance staff? (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.)

1. _____[ENTER A NUMBER 1 TO 90]

[IF KITCHEN_FAUCET_AERATORS_3 ≥ 1, ASK. OTHERWISE, SKIP TO M5.]

M4a. How many kitchen faucet aerators were installed in your home with the program by the maintenance staff? (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.)

1. _____[ENTER A NUMBER 1 TO 90]

[IF HOT_WATER_HEATER_PIPE_WRAP_4 ≥ 1, ASK. OTHERWISE, SKIP TO M6.]

M5. Was insulated pipe wrap installed on your hot water heater pipes with the program by the maintenance staff?

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

M6. Have you removed any of the **[INSERT MEASURE(S)]** installed by your property manager?

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

[TURN OFF QM6A.]

[IF M6 = 2 OR 98, SKIP TO M8. OTHERWISE CONTINUE.]

M6aa. As I read the following measures, please tell me which ones you removed. Did you remove…(READ LIST. RECORD ALL MENTIONS)?

1. LED light bulbs
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 M8. 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. USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.)

Measure Description	Quantity
[IF M6aa = 1, 2, 3, 4, OR 5, INSERT MEASURES BELOW.]	
M6ab_1. LED light bulbs	_____
M6ab_2. Bathroom faucet aerators	_____
M6ab_3. Kitchen faucet aerators	_____
M6ab_4. Hot water heater pipe wrap	_____
M6ab_5. Low flow showerheads	_____

[IF M6A_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M8.]

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

_____**[OPEN-END]**

[IF M6B_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M8.]

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

_____**[OPEN-END]**

[IF M6C_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M8.]

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

_____**[OPEN-END]**

[IF M6D_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M8.]

M7d. You also told me you removed hot water heater pipe wrap. Why did you remove those items?

(RECORD VERBATIM.)

_____**[OPEN-END]**

[IF M6E_2 GT "0", CONTINUE. OTHERWISE, SKIP TO M8.]

M7e. You also told me you removed low flow showerheads. Why did you remove those items? (RECORD VERBATIM.)

_____**[OPEN-END]**

[IF LED_LIGHT_BULBS_1 ≥ 1, ASK. OTHERWISE, SKIP TO IS1.]

M8. Of the lights used most frequently in your home, were the LED light bulbs installed in those fixtures?

1. Yes
2. No

[IF M8 = 1 "YES", SKIP TO M9. OTHERWISE CONTINUE.]

M8a. What types of light bulbs are in the lights you use the most in your home? (RECORD VERBATIM.)

_____**[OPEN-END]**

M9. Using your best estimate, about how many hours per day, on average, would you say you use your LED light bulbs in the following space types? (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.) (USE "97" IF RESPONDENT DOES NOT HAVE THAT SPACE TYPE.)

1. ____Bedrooms [ENTER A NUMBER 0 TO 24]

2. ____Bathrooms [ENTER A NUMBER 0 TO 24]
3. ____Kitchen [ENTER A NUMBER 0 TO 24]
4. ____Family or dining room [ENTER A NUMBER 0 TO 24]
5. ____Hallways [ENTER A NUMBER 0 TO 24]
6. ____Other [ENTER A NUMBER 0 TO 24]

M9a0. **[IF ANY RESPONSE TO M9 = 0, ASK M9a0. OTHERWISE SKIP TO M9a.]**

You indicated that one or more of your LEDs is used for 0 hours per day on average. Can you tell me why that is? (DO NOT READ LIST. RECORD ONE ANSWER ONLY.)

1. I don't use the space/room very often.
2. No lights are needed for that space/room.
3. I use other lights in that space/room instead of the LEDs.
4. Other (Please Specify)

M9a. To the best of your knowledge, what was the most common type and wattage of bulb removed when the LEDs were installed? (INTERVIEWER: RECORD BULB TYPE AND WATTAGE.)

(USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.) (NOTE: COMMON TYPES OF BULBS INCLUDE: REGULAR/INCANDESCENT, HALOGEN, CFLs, AND LEDS. COMMON WATTAGES INCLUDE: 13, 43, 60, 75, OR 100.)

Type of Bulb	Wattage
1. _____	2._____

M10. What types of light bulbs do you have in the other lights in your home? (READ LIST IF NECESSARY.

RECORD ALL MENTIONS.)

1. Regular Incandescent Bulbs (NOTE: Traditional light bulbs that look like an upside down pear. These are no longer being produced.)
2. Halogen (NOTE: Usually found in outside or recessed lighting.)
3. LEDs (NOTE: LEDs last longer than CFLs.)
5. Compact Fluorescent Bulbs or CFLs (NOTE: These look like a spiral or "twisty.")
4. Other (Please Specify)
98. Don't know (DO NOT READ)

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 PS1.]

IS2a. Please tell me the types of additional energy efficient items 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?) (USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.) (ONLY THE FIRST LINE IS REQUIRED. ENTER AS MANY MEASURES AS THE RESPONDENT HAD INSTALLED AND LEAVE THE REST BLANK.)

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

PARTICIPATION and SATISFACTION

Thank you for your time and patience; there are only a few more questions and they relate to your satisfaction with the program.

PS1. How did you first hear about Duke Energy's Multifamily Energy Efficiency Program? (DO NOT READ LIST. RECORD ALL MENTIONS.)

1. Through property manager
2. Duke Energy bill stuffer or mailing
3. Duke Energy website
4. Duke Energy email
10. Social media such as Facebook, Linkedin, etc.
5. Marketing by trade ally, vendor or contactor
6. Through family, friend, or neighbor
7. Participation in other Duke Energy Programs
8. Past Program participants
9. Other (Please Specify)
98. Don't know
99. Refused

PS2. What was the main reason you decided to accept the installation of **[INSERT MEASURE(S)]** through the program? (DO NOT READ LIST. RECORD ONE REASON ONLY. PROBE ONLY IF NECESSARY.)

1. Existing equipment was old

2. Existing equipment was no longer working
3. Existing equipment needed major repairs
4. To save energy
5. To lower energy bill, save money on bills
6. Environmental reasons
7. The installation was free
8. Recommended by a family or friend
9. Contacted by vendor
10. Duke Energy advertising
11. Advertising other than Duke Energy
12. Remodeling
13. Federal tax credit
14. Contractor recommended it
15. Property Manager mandated the installation
16. Other (Please Specify)
98. Don't know
99. Refused

[PS13/PS13A RELOCATED TO AFTER PS12A]

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 new **[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 AT PS4.]

PS5a. **[IF LED_LIGHT_BULBS_1 ≥ 1, ASK. OTHERWISE, SKIP TO PS8.]**
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]**

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

[IF PS7 = 1 ASK PS8, OTHERWISE SKIP TO PS9.]

PS8. How satisfied are you with any savings you noticed on your electric bill since the installation of your new energy efficient items 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

PS9. We understand that the new energy efficient items may have been installed by your property manager, maintenance personnel, or a contractor company. 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. Why aren't you satisfied? (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 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]**

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

[ASK IF PS11 = 0-10]

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]**

[NEW QUESTIONS – PS14-PS20A]

PS14. Do you consider Duke Energy as a resource for energy efficiency information?

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

PS15. Have you heard of 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
8. Other (Please Specify)
9. No **[EXCLUSIVE]**

98. Don't Know
99. Refused

[PS16 REMOVED]

~~PS16. Do you find Duke Energy's solutions or programs helpful in saving energy and money in your apartment?~~

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

[NEW QUESTION]

PS16O. Of the energy efficiency solutions or programs offered by Duke Energy, which ones would be the most useful to you? (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
8. None **[EXCLUSIVE]**

98. Don't Know (DO NOT READ)
99. Refused (DO NOT READ)

[ASK IF PS16O NE 98 OR 99]

PS16a. Why do you say these programs would be useful to you? (RECORD VERBATIM. PROBE FOR CLARIFICATION.)

_____**[OPEN-END]**

PS17. 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 is targeted at property managers of Duke Energy's Multifamily Energy Efficiency Program (MEEP). The goal of property manager surveys includes informing, updating and improving the MEEP Program. This survey guide walks the interviewer through the phone call, which are to be made between 10:00am-8:30pm EST on weekdays, and 10:00am-5:00pm EST on Saturdays. No calls on Sundays. Navigant interviewer will introduce himself/herself and inform the customer about the purpose of the interview.

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

S1. According to our records, your property participated in Duke Energy's Multifamily Energy Efficiency Program this year or during 2017 and received free installation of **lighting and/or water efficiency measures**. Is that correct?
Yes
98. No [Terminate]
99. Don't know
100. Refused

[*FOR TERMINATIONS]*: This study is for people who participated in Duke Energy's Multifamily Energy Efficiency Program this year or during 2017. 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 **lighting and/or water efficiency measures?**
1. Yes [Move to M1]
2. No [Continue]
3. Don't know [Continue]
98. Refused

S2a. I understand that the decision to install the **lighting and/or water efficiency measures** may have been driven by someone other than yourself. However, if you had some involvement in the process of the installation of the measures through the program your input will be helpful. Are you somewhat familiar with the program participation and installation process?
1. Yes [Continue]
2. No [Terminate]
3. Don't know [Terminate]
98. Refused

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

1. Yes [Gather correct contact information]
2. No [Terminate]
3. Don't know [Terminate]
4. Refused [Reassure participant prior to Terminating]

Survey Introduction

My questions are about the **lighting and/or water efficiency measures**[21] installed at [Insert Property] through the Duke Energy Multifamily Energy Efficiency Program this year or in 2017: 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.

PS0. Using a scale from 0 to 10, with 0 being "not at all satisfied" and 10 being "extremely satisfied", how satisfied are you with your overall experience with the program? (INTERVIEWER: 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

PS0a. What is the reason for your rating? (RECORD VERBATIM)

PS1. 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 program enrollment, lead time and communications involved with the program? If this does not apply to you, please say "Does Not Apply" (INTERVIEWER: 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

PS1a. [if PS1 response is 4 or less] What is the reason for your rating? (RECORD VERBATIM)

[21] If respondents participated prior to the introduction of LEDs into the program (October 2016), Navigant will inform the respondent that the questions only pertain to water measures.

PS1b. 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 tenant notification and program materials from the program? (INTERVIEWER: 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

PS1c. [if PS1b response is 4 or less] What is the reason for your rating? (RECORD VERBATIM)

_____

PS2. 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 and water efficiency measures**? (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

PS2a. What is the reason for your rating? *(RECORD VERBATIM)*

_____

PS3. (ASK ONLY IF PARTICIPANT RECEIVED LEDs) The LED lighting equipment that your facility received is a relatively new offering of the program. Can you tell me about any feedback that you have received from your tenants about their experience with the LED lights? (RECORD VERBATIM)

PS4. (ASK ONLY IF PARTICIPANT RECEIVED LEDs) As the property manager, can you explain any differences that you have noticed in the quality of lighting from the LED lamps in the tenant spaces?

PS5. (ASK ONLY IF PARTICIPANT RECEIVED LEDs) As the property manager, can you explain any differences that you have noticed in reactions from prospective tenants to the quality of lighting as they are considering moving into your property?

PS6. 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 program equipment options? (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

PS6a. Why do you say that? (RECORD VERBATIM)

_____

PS7. Are there other equipment options, you think the program should include? (RECORD VERBATIM)

PS8. If you are responsible for any of the energy bills at your facility, have you noticed an increase, decrease or no change in the energy bills at your property since participating in the program?

1. Increase
2. Decrease
3. No Change
98. Don't Know
99. Refused

PS9. How would you rate your satisfaction with the installation team's "quality of work", on a scale of 0 to 10, with 0 meaning "not at all satisfied" and 10 meaning "extremely satisfied"? (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. Why do you say that? (RECORD VERBATIM)

_____

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

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

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

_____

Awareness Questions

The next set of questions relate to your program awareness, prior planning, and decision making.

A1. How did you first learn about the Duke Energy Multifamily Energy Efficiency Program?
[DO NOT READ LIST. RECORD ALL MENTIONS.]

5. Duke Energy bill stuffer
6. Duke Energy mailing
7. Duke Energy website
8. Duke Energy email
9. Duke Energy phone call
10. On-site visit from Duke Energy program staff
11. Marketing by trade ally, vendor or contactor
12. Through family, friend, or neighbor
13. Participation in other Duke Energy Programs
14. Past program participants
15. Other [SPECIFY] _____
98. Don't know
99. Refused

A2. 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
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. Are there any other reasons you decided to install **lighting and water efficiency measures**? [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

Prior Plans

P1. Prior to participating in the Duke Energy program, <u>had you considered installing</u> the **lighting and water efficiency measures** at the property?

3. Yes [Continue]
4. No [Move to IC1]
98. Don't know

P1a. Please describe the plans you had to install the **lighting and water efficiency measures** prior to participating in the Duke Energy program.
[Record PM Response verbatim]:_____

P2. Thinking about before you decided to participate in the Duke Energy 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 measures. (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

Role of Contractor

P3a. Did an equipment vendor or contractor help you with selecting the **lighting and water efficiency measures**?

1. Yes [Move to P3c].
2. No [Continue]

98. Don't Know

P3b. If no, who selected the energy efficient measures?
[Record PM Response verbatim]:_____
[Move to IC1 when finished]

P3c. If yes, on a scale of 0 to 10, where 0 is "not at all important" and 10 is "extremely important," how important was the recommendation from an equipment vendor or contractor in your decision to install the **lighting and water efficiency measures**? (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

Importance: Categories

IC1. On a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important", please tell me how important the Duke Energy program's free installation was in your decision to install the **lighting and water efficiency measures**? (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

IC2. On a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important", please tell me how important the Duke Energy program's advertising and information was in your decision to install the **lighting and water efficiency measures**? (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

Own

O1. Please tell me in your own words how the program influenced your decision to install the **lighting and water efficiency measures**. (RECORD VERATIM)

_____

Likelihood

L1. Given everything you've just told me, what is the likelihood that you would have installed the same **lighting and water efficiency measures** 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 efficiency measures without the Duke Energy program**
2. MAY HAVE installed the same **lighting and water efficiency measures**, even without the Duke Energy program
3. Definitely WOULD have installed the same **lighting and water efficiency measures,** even without the Duke Energy program

98. (DO NOT READ) Don't know

L1a. [If Option 2 was chosen] 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 **measures** without the 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

L2. Thinking about the quantity of measures you installed through the program, what is the likelihood that you would have installed the same quantity of the same **lighting and water efficiency 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 efficiency measures** without the Duke Energy program
2. MAY HAVE installed the same quantity of the same energy efficient **lighting and water efficiency measures**, even without the Duke Energy program
3. Definitely WOULD have installed the same quantity of the same energy efficient **lighting and water efficiency measures**, even without the Duke Energy program

98. (DO NOT READ) Don't know

L2a. [If Option 2 was chosen] You indicated you may have installed the same quantity of the same measures 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 **lighting and water efficiency measures without the 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

L3. [For all participants] Is there a chance you would have had at least some of the work done without the program?

1. Yes [Continue]
2. No [Skip to IS1]

98. Don't know

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 efficiency measures** 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

L4c. You mentioned you might have done some work without the program, please describe what you might have had done. (RECORD VERBATIM)

_____

[Continue to T1]

L5. Without the program, about when would you have installed the **lighting and water efficiency measures**?

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. Sometime after 2 years within the time you did
5. Would have never installed without the program

Spillover

Thank you for your time and patience; the final set of questions relate to your additional improvements made because of the program.

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 [Continue]
2. No [Skip to IS5]
98. Don't know

IS2. 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._____ _____

IS3. 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)

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 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

IS5. Did your company mandate that this property to participate in this program?

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

IS6. 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

IS7. To your knowledge, did your company mandate other owned properties, aside from this property, to participate in this program or install energy efficiency measures?

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

IS8. Is there anything you would suggest to improve 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.

Opinion Dynamics

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Duke Energy Carolinas and Duke Energy Progress

Non-Residential Smart $aver® Prescriptive Program Evaluation Report – Final

July 16, 2020

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1. Evaluation Summary

1.1 Program Summary

The Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) Smart $aver® Program provides incentives for electric commercial and industrial customers to purchase and install high-efficiency lighting products, HVAC systems, pumps and drives, as well as qualifying process, food service, and information technology. Incentives are available for new construction and retrofits and replacements. Prescriptive incentives under the program are limited to 75% or less of the customer cost. The program has three delivery channels:

- The **main channel** for the program is application-based and primarily delivered through trade allies.
- The **midstream channel** allows distributors to provide incentives directly to prequalified customers on applicable equipment and receive reimbursement for those incentives from Duke Energy.
- The **Business Savings Store** on the Duke Energy website offers customers a limited number of qualified products for which they can receive an instant discount.

All three channels offer the same incentive levels. The evaluation period for this program is from March 1, 2017 to December 31, 2018.

1.2 Evaluation Objectives

The majority of ex ante savings were realized through the main channel (50% DEC, 54% DEP) and the midstream channel (48% DEC, 46% DEP). As a result, the focus of this evaluation is on those two channels. While the scope of this evaluation did not include research specific to the Business Savings Store, our deemed savings review considered all measures incented through the program, irrespective of delivery channel. In addition, we applied results from our research for the main channel and the midstream channel to Business Savings Store projects.

Our evaluation addressed the following key objectives:

Gross Impact Evaluation

- Update deemed savings values through review of measure assumptions and calculations.
  - Develop updated per-unit savings values for reviewed measures.
  - Document causes of differences between ex ante and ex post (evaluated) savings estimates.
- Verify program-tracked hours of use (HOU) for a sample of lighting projects through on-site metering.
  - Develop a population-level HOU adjustment factor for key lighting technologies for incorporation into updated deemed-savings values.
- Assess differences, if any, in self-reported lighting HOU between applications completed by customers versus trade allies.
- Verify installed quantities and measure characteristics for a sample of main channel projects through desk reviews.
  - Develop project-specific realization rates.

  - Document causes of differences between tracked and verified information.
  - Develop a population-level quantity adjustment factor by technology.
- Verify installed quantities for a sample of midstream lighting projects through the participant survey.
  - Develop project-specific realization rates.
  - Develop a population-level quantity adjustment factor.
- Estimate verified gross energy and peak demand savings (both summer and winter), by technology, via engineering analysis, based on the deemed savings and quantity adjustment factors.
- Develop overall gross realization rates for each technology.

Net-to-Gross Analysis

- Estimate free-ridership (FR) for main channel and midstream channel projects, including separate estimates for main channel lighting and non-lighting.
- Estimate participant spillover (PSO) for main channel and midstream channel participants.
- Estimate trade ally spillover (TA SO) for the main channel.
- Develop Net-to-Gross Ratios (NTGRs) for lighting and non-lighting projects, providing separate estimates by channel as well as aggregated estimates.

Process Evaluation

- Identify barriers to program participation and how these barriers can be addressed.
- Identify program strengths and opportunities for improvements.
- Assess participant and trade ally satisfaction with program processes.
- Assess trade allies' perception of the status of the lighting market.
- Provide a high-level assessment of remaining opportunities for energy efficiency upgrades of lighting and non-lighting measures.

1.3 Key Findings

During the evaluation period, non-residential customers completed close to 19,000 projects through the DEC Smart $aver® Program and close to 7,000 projects through the DEP Smart $aver® Program. The DEC projects generated approximately 482 GWh of ex post gross energy savings, 86 MW of ex post gross summer peak demand savings, and 84 MW of ex post gross winter peak demand savings. The DEP projects generated approximately 177 GWh of ex post gross energy savings, 31 MW of ex post gross summer peak demand savings, and 30 MW of ex post gross winter peak demand savings.

The main channel accounted for the majority of ex post gross energy savings in both service territories (51% DEC, 54% DEP). The midstream channel gained a lot of traction during the evaluation period and almost equaled the main channel in contribution to savings (48% DEC, 46% DEP). A relatively small share of savings was generated through the Business Savings Store (2% DEC, 1% DEP; see Table 1-1).

In both jurisdictions, lighting accounted for the vast majority of program projects and savings.

Table 1-1. Summary of Ex Post Gross Energy Savings

Delivery Channel	DEC		DEP	
	MWh	Percent [a]	MWh	Percent [a]
Main Channel	243,946	51%	95,034	54%
Midstream Channel	230,286	48%	81,129	46%
Business Savings Store	7,814	2%	967	1%
TOTAL	**482,047**	**100%**	**177,131**	**100%**

[a] Individual values do not sum to totals due to independent rounding.

Gross Impact Findings

Our gross impact analysis found overall gross realization rates (RRs) for energy and demand savings close to 100%, ranging from 96% to 102%, for both DEC and DEP. These results were driven by the following:

- Our deemed savings review made small adjustments to lighting projects and somewhat larger adjustments to projects in the pumps and drives category.
- The light logger study resulted in HOU estimates for LED tube and LED panel measures that are 16% higher than data in the program-tracking database.
- The database comparison of HOU reported by trade allies and customers, respectively, found close alignment between the two sources in the aggregate but variations at the measure-group level.
- Our desk reviews of main channel projects found relatively few data tracking issues with respect to the quantities of installed measures, adjusting the quantities for only 11 of the 136 sampled projects. One food service project had a quantity adjustment that significantly affected the overall RR for that end-use.
- In-service rates for midstream participants were also high, at 99% for DEC and 97% for DEP.

Table 1-2 and Table 1-3 summarize the overall gross energy and demand impacts, respectively, for DEC and DEP.

Table 1-2. Overall Gross Energy Impacts

Technology	DEC			DEP		
	Ex Ante kWh	Realization Rate	Ex Post kWh	Ex Ante kWh	Realization Rate	Ex Post kWh
Lighting	473,196,869	97%	459,722,955	175,849,149	96%	168,509,214
Pumps and Drives	9,621,917	100%	9,604,616	1,468,036	115%	1,694,655
HVAC	8,438,190	100%	8,415,298	4,762,444	100%	4,752,610
Food Service	3,464,138	81%	2,816,818	1,038,041	81%	844,294
Process	1,455,989	100%	1,455,950	143	100%	143
IT	31,499	98%	31,027	1,329,977	100%	1,329,694
TOTAL	**496,208,603**	**97%**	**482,046,663**	**184,447,789**	**96%**	**177,130,609**

Table 1-3. Overall Gross Demand Impacts

Technology	DEC			DEP		
	Ex Ante kW	Realization Rate	Ex Post kW	Ex Ante kW	Realization Rate	Ex Post kW
Summer Demand Impacts						
Lighting	83,501	97%	81,372	29,960	97%	28,977
Pumps and Drives	1,427	100%	1,425	171	136%	232
HVAC	2,447	100%	2,447	1,225	100%	1,225
Food Service	300	72%	216	79	72%	57
Process	260	100%	260	0	N/A	0
IT	0	N/A	0	128	100%	128
TOTAL	**87,934**	**97%**	**85,719**	**31,563**	**97%**	**30,618**
Winter Demand Impacts						
Lighting	79,375	102%	80,656	28,173	102%	28,703
Pumps and Drives	1,481	100%	1,478	151	139%	211
HVAC	1,121	100%	1,120	799	100%	799
Food Service	288	71%	204	77	71%	55
Process	276	100%	276	0	100%	0
IT	0	N/A	0	0	N/A	0
TOTAL	**82,540**	**101%**	**83,734**	**29,201**	**102%**	**29,768**

Net Impact Findings

We estimate the program-level NTGR to be 88.4% for DEC and 79.5% for DEP. For all three analysis groups (main channel lighting, main channel non-lighting, and midstream lighting), the DEC NTGRs are higher than the corresponding DEP NTGRs. For both jurisdictions, the lighting NTGRs (both main channel and midstream) are higher than the non-lighting NTGRs.

Table 1-4 presents the individual net-to-gross (NTG) components (i.e., FR, PSO, and TA SO) and the resulting NTGRs by jurisdiction and channel/technology group (i.e., lighting and non-lighting). The NTGR is calculated as 1 – FR + PSO + TA SO.

Table 1-4. Summary of NTG Results

	Free-Ridership	Participant SO	Trade Ally SO	NTGR [a]
DEC				
Main Channel Lighting	18.1%	0.04%	7.0%	88.9%
Main Channel Non-Lighting	26.7%			80.3%
Midstream Lighting	11.5%	0.10%	-	88.6%
TOTAL DEC	**15.3%**	**0.07%**	**3.6%**	**88.4%**
DEP				
Main Channel Lighting	31.2%	0.04%	7.0%	75.8%
Main Channel Non-Lighting	34.5%			72.5%
Midstream Lighting	15.9%	0.10%	-	84.2%
TOTAL DEP	**24.3%**	**0.06%**	**3.8%**	**79.5%**

[a] NTGR = 1 – FR + PSO + TA SO

Table 1-5 and Table 1-6 summarize ex post gross and net savings for the evaluation period for DEC and DEP, respectively.

Table 1-5. Summary of DEC Ex Post Gross and Net Savings

Technology	Ex Post Gross			NTGR	Ex Post Net		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)		Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Main Channel	**243,946,395**	**44,453**	**42,831**	**0.88**	**215,112,095**	**39,161**	**37,820**
Lighting	*223,443,824*	*40,278*	*39,829*	*0.89*	*198,641,559*	*35,807*	*35,408*
Pumps and Drives	*9,604,616*	*1,425*	*1,478*	*0.80*	*7,715,772*	*1,145*	*1,188*
HVAC	*6,659,752*	*2,278*	*1,050*	*0.80*	*5,350,045*	*1,830*	*844*
Food Service	*2,784,828*	*213*	*202*	*0.80*	*2,237,164*	*171*	*162*
Process	*1,453,375*	*260*	*272*	*0.80*	*1,167,554*	*209*	*218*
IT	-	-	-	*0.80*	-	-	-
Midstream Channel	**230,286,322**	**40,071**	**39,616**	**0.89**	**204,029,075**	**35,502**	**35,099**
Lighting	*230,076,090*	*39,876*	*39,615*	*0.89*	*203,842,814*	*35,329*	*35,098*
Non-Lighting	*210,232*	*196*	*2*	*0.89*	*186,261*	*173*	*1*
Business Savings Store	**7,813,947**	**1,194**	**1,286**	**0.89**	**6,923,001**	**1,058**	**1,140**
TOTAL DEC	**482,046,663**	**85,719**	**83,734**	**0.88**	**426,064,171**	**75,722**	**74,059**

Table 1-6. Summary of DEP Ex Post Gross and Net Savings

Technology	Ex Post Gross			NTGR	Ex Post Net		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)		Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Main Channel	**95,034,465**	**16,442**	**15,678**	**0.76**	**71,780,071**	**12,413**	**11,852**
Lighting	*86,819,822*	*14,852*	*14,628*	*0.76*	*65,821,580*	*11,260*	*11,090*
Pumps and Drives	*1,694,655*	*232*	*211*	*0.73*	*1,229,218*	*168*	*153*
HVAC	*4,366,481*	*1,174*	*785*	*0.73*	*3,167,227*	*851*	*569*
Food Service	*832,522*	*56*	*54*	*0.73*	*603,870*	*41*	*39*
Process	*143*	*-*	*0.3*	*0.73*	*104*	*-*	*0.2*
IT	*1,320,842*	*128*	*-*	*0.73*	*958,073*	*93*	*-*
Midstream Channel	***81,128,776***	**14,066**	**13,956**	**0.84**	***68,303,128***	**11,842**	**11,750**
Lighting	*81,053,594*	*14,003*	*13,955*	*0.84*	*68,239,832*	*11,790*	*11,749*
Non-Lighting	*75,182*	*62*	*1*	*0.84*	*63,296*	*52*	*1*
Business Savings Store	***967,368***	**111**	**134**	**0.84**	***814,437***	**93**	**113**
TOTAL DEP	**177,130,609**	**30,618**	**29,768**	**0.80**	**140,897,636**	**24,348**	**23,714**

Process Findings

The process evaluation for the **main channel** focused on program processes (including the new pre-qualification option), customer and trade ally satisfaction with the program, opportunities for program improvement, the status of the commercial lighting market, and remaining opportunities for lighting and non-lighting upgrades. For the **midstream channel**, the process evaluation was limited to an assessment of participant satisfaction. The following are key findings:

Sources of Information

- Contractors and trade allies continue to be a key source of information for main channel participants. Participants most often first learn about the program from a trade ally or contractor (55% DEC, 53% DEP), and about three-quarters receive equipment selection support from a contractor or vendor. For close to half of participants, the contractor or vendor is the most influential party in identifying the installed equipment.
- Midstream participants are generally aware of the discount at the time they purchase the equipment (91% DEC, 89% DEP), and almost all of them are aware that Duke Energy provided the discount. Participants aware of the discount most often learn about it from their distributor (69% DEC, 74% DEP).

Pre-Qualification Option

- Two-thirds of trade allies (66%) are aware of the pre-qualification option and 36% have used it. Trade allies see the certainty of knowing that the equipment will qualify and what the incentive amount will be as the main benefits of the pre-qualification option. Notably, responses suggest that some trade allies believe that the incentive is “set aside” or “guaranteed.”

- Awareness of the pre-qualification option is significantly lower among participating customers (29% DEC, 35% DEP). In addition to providing certainty about equipment eligibility and incentive levels, the pre-qualification option helps some participants secure internal budget approval.
- The likelihood of future use is higher among participants (91% DEC, 96% DEP) compared to trade allies (75%). The main reason for not planning on using the option is already being familiar with qualifying equipment and incentive levels and therefore not needing to pre-qualify applications.

Satisfaction

- Main channel participants are generally satisfied with their program experience and with most program components. All program components included in the survey received a mean rating of 7.6 or higher (on a scale of 0 to 10 [1]), and the program overall was rated an average of 8.2 and 8.4 by DEC and DEP participants, respectively. DEC participants are least satisfied with the application process and eligible measures, while DEP participants are least satisfied with incentive levels.
- Main channel trade allies are slightly less satisfied with the program than main channel participants, giving mean satisfaction ratings between 7.0 and 8.6. The mean rating for the program overall was 8.0, with 69% of trade allies being "satisfied."[2] Trade allies expressed the lowest satisfaction with incentive levels (mean rating of 7.0), often pointing to decreasing lighting incentives over time, which they believe has had an adverse effect on the number and scope of LED projects.
- Midstream participants have a more streamlined program experience (compared to main channel participants) and are generally very satisfied with it (giving mean ratings ranging from 8.8 to 9.4).

Remaining Opportunities for Energy Efficiency Upgrades

- Smart $aver® lighting projects generally address the majority of interior lighting in participants' facilities (on average 89% DEC, 74% DEP), leaving little opportunity for future upgrades. More than one-third of lighting projects addressed all interior lighting, while only 12% of projects addressed 50% or less.
- Among participants who completed non-lighting projects, linear LEDs (38%) and nonlinear LEDs (34%) are the lighting types most commonly present at their facilities. Only 11% of participants with non-lighting projects have no LEDs or CFLs at their facilities but 59% have at least some inefficient lighting technologies (including incandescent/halogen bulbs, HID lighting, or T8/T10/T12 linear fluorescent lighting), suggesting some remaining opportunities among this group of participants.
- Reduced cost (31%), increased selection (16%), and quality improvements (14%) for LEDs are most often identified by participating trade allies as key developments in the non-residential lighting market. However, many trade allies believe that utility incentives are still needed to support customer adoption of LEDs, noting adverse consequences of recent incentive reductions on their LED sales. Close to half of interviewed trade allies consider the program incentive very influential on LED selection and on project timing.
- Among participating customers, heating, cooling, and information technology are the most common non-lighting types of energy-using equipment, and they are also the most likely to have undergone energy-efficient upgrades in the past five years. Nevertheless, a large share of facilities with these equipment types have not recently made upgrades—or have made standard-efficiency upgrades—and might therefore present opportunities for future program participation.

[1] A rating of 0 means "extremely dissatisfied;" a rating of 10 means "extremely satisfied."
[2] "Satisfied" is defined as a rating of 8 or higher on the 0 to 10 satisfaction scale.

- Trade allies and participants most often identify upfront cost as the key barrier to energy-efficient upgrades to non-lighting equipment. Both groups most commonly identify awareness and knowledge as the key barrier to program participation but also note other barriers, including incentive levels, the equipment eligible for incentives, and the required paperwork.
- Trade allies most commonly identify HVAC equipment and motors/VFDs as types of non-lighting products with the most potential for increased program uptake, matching their areas of expertise.

1.4 Evaluation Recommendations

Based on our impact and process research, we identified the following opportunities for program improvement.

Recommendation 1: Continue to Improve Data Collection and Tracking Processes

Our review and processing of program-tracking data revealed a few issues that, if addressed, would allow program staff to better track program activity and potentially also improve future realization rates. In particular, areas that can be improved include the following:

- **Perform additional quality assurance steps on the data entered into the program-tracking database.** While our impact analysis generally found few data tracking issues, each of the last two evaluations of this program found a major discrepancy in the quantity tracked for one food service project, which significantly impacted the RR for that end-use. While it is impossible to ensure perfect data entry for a program of this size, additional checks could catch these impactful errors. In specific, the program may wish to generate statistics on the incentive amount per unit of quantity for each type of measure to identify outlier values. In addition, single records that account for unusually large shares of savings for non-lighting end-uses can provide useful flags for potential data entry errors. Similarly, a small share of annual HOU values in the program-tracking data (36 of 22,208, or 0.2%) were outside the range of valid values (i.e., above 8,760 hours), in some cases significantly. If used for any analytical purposes, such invalid values could be caught with a simple check on maximum values.
- **Ensure that customer contact information is collected for each project.** This evaluation was the first one for the Smart $aver® Prescriptive Program to use an online survey with program participants. Fielding of the main channel survey was difficult as 10% of projects listed a trade ally or billing service as the primary contact and did not include an email address for the participating customer. To allow for important evaluation activities, including the assessment of FR and PSO, the program should ensure that valid contact information for participating customers is collected.

Recommendation 2: Continue to Promote the Pre-Qualification Option

The pre-qualification option is a popular new feature of the program that is known to a majority of trade allies; however, the feature remains unknown to many customers: Only about a third of participating customers knew of its existence but many of them expressed an interest in taking advantage of it. Featuring information about the pre-qualification option in future marketing to customers could help promote participation and further improve customers' experience with the program. In addition, some trade allies appeared to think that if they used the pre-qualification option, incentives are reserved or guaranteed. The program may wish to more clearly communicate to trade allies that pre-qualification does not mean that incentives are reserved, especially if the program should ever be in a situation of potentially exhausting its incentive budgets.

Recommendation 3: Continue to Develop Tools to Streamline the Application Process

A somewhat cumbersome and sometimes unclear application process continues to be a source of participant and trade ally dissatisfaction. In fact, a few interviewed trade allies noted that they now only use the midstream channel (which has a simpler participation process) or sometimes forgo participation in the program altogether. The program should continue to develop tools to streamline this process, which could include more guidance on required steps (e.g., a workflow sheet) and better functionality of the online portal (e.g., lookup or pre-fill functions).

Recommendation 4: Reduce Uncertainties around Incentive Levels

Trade allies who were less than satisfied with incentive levels often pointed to decreasing lighting incentives over time, which they believe has had an adverse effect on the number and scope of their LED projects. This is due not only to the incentive amount covering less of the incremental cost but also to the uncertainty it introduces for planning projects. While periodic adjustments to incentives are inevitable and needed to optimize program performance, the program may wish to consider approaches that reduce uncertainty among trade allies and customers. For example, the program could establish and circulate a policy of incentive adjustments that occur at specific times, e.g., on January 31st of every year (and avoid, if at all possible, additional unscheduled adjustments). This would allow trade allies and customers to plan for project completion prior to the selected date if they want to be certain of the incentive amount. Another option would be to provide advanced notification of upcoming adjustments to registered trade allies, which would not only reduce uncertainty for this group but might also motivate more contractors to join the trade ally network.

Recommendation 5: Continue Marketing and Education around Non-Lighting Technologies

Both trade allies and participants identified awareness and knowledge as the most significant barrier to increasing the number of non-lighting projects completed through the program. Program staff should continue to provide information on non-lighting technologies and assist trade allies with promoting this part of the program. Recommendations provided by trade allies included more in-person outreach by trade ally representatives to discuss non-lighting opportunities, case studies and other tools to help determine and communicate potential energy savings from non-lighting measures, and incentivized energy audits for customers to showcase ways to save energy besides lighting.

2. Program Description

This section describes key elements of program design, implementation, and performance. The evaluation period addressed in this report is March 1, 2017 to December 31, 2018.

2.1 Program Design

The Duke Energy Carolinas and Duke Energy Progress Smart $aver® Prescriptive Program provides per-unit incentives for electric commercial and industrial customers to purchase and install qualifying high-efficiency equipment in six technology categories: lighting, HVAC equipment, pumps and drives, food service equipment, process equipment, and information technology equipment. Incentives are available for new construction, retrofits of existing equipment, and replacements of failed equipment. Prescriptive incentives under the program cannot exceed 75% of the customer's equipment cost.

The program has three delivery channels:

1. The **main channel** for the program is application-based and primarily delivered through trade allies.
2. The **midstream channel** allows distributors to provide incentives directly to prequalified customers on applicable equipment and receive reimbursement for those incentives from Duke Energy.
3. The **Business Savings Store** on the Duke Energy website offers customers a limited number of qualified products for which they can receive an instant discount.

All three channels offer the same incentive levels.

The program made a few design changes during the evaluation period, including (1) the addition of new measures, including additional LED measures; (2) a reduction in incentive levels for many types of LEDs; (3) the introduction of a new pre-approval option, which allows customers and trade allies to receive confirmation about a product's eligibility and the expected incentive level;[3] and (4) a modification to the program's 90-day "grace period" to no longer allow customers/trade allies to make a new installation after the effective date of new incentives and still claim old incentive levels if inside the 90-day window.

2.2 Program Implementation

Duke Energy staff implement the Smart $aver® Prescriptive Program with contractor support for specific program components. The program is also offered in other Duke Energy territories, and most program staff share responsibilities across the territories. In the DEC and DEP territories, the program is managed by two program staff, with support from Duke Energy marketing staff, a trade ally outreach team, a team of Business Energy Advisors (BEAs), and operational support for processing applications. In addition, Large Business Account Managers and Local Government and Community Relations staff assist with outreach efforts.

The program is marketed to commercial and industrial customers through targeted outreach and communications by the program. Marketing approaches during the evaluation period primarily included email and online marketing. Additional outreach is conducted by Large Business Account Managers, BEAs, and Local Government and Community Relations staff.

[3] See Section 6.3.2 for a more detailed description of this option.

The trade ally outreach team is specifically tasked with marketing the program to trade allies, who in turn are encouraged to promote the program to their customers. The trade ally outreach team manages existing trade ally relationships, recruits new trade allies, and educates trade allies about the program offerings and changes in the program as they occur. The program also offers a co-marketing campaign for trade allies that provides reimbursement for up to 50% of their marketing costs (up to $2,000).

2.3 Program Performance

Based on the program-tracking database, the program completed 18,908 projects in DEC territory and 6,870 projects in DEP territory.[4] These projects were completed by over 8,800 unique DEC customers and over 3,000 unique DEP customers.[5] They accounted for approximately 482 GWh and 177 GWh of ex post gross savings for DEC and DEP, respectively.

Close to half (49%) of all DEC projects were completed through the midstream channel, compared to 42% through the main channel and 9% through the Business Savings Store. In DEP territory, equal shares (48%) of projects were completed through the main and midstream channels, and 4% went through the Business Savings Store.

Table 2-1 summarizes these results, by jurisdiction.

Table 2-1. Summary of Projects, Customers, and Ex Post Gross Savings

Delivery Channel	Projects		Number of Unique Customers [a]	Ex Post Gross Savings	
	Number	Percent		MWh	Percent
DEC					
Main Channel	7,880	42%	4,124	243,946	51%
Midstream Channel	9,246	49%	4,157	230,286	48%
Business Savings Store	1,782	9%	1,186	7,814	2%
TOTAL DEC	**18,908**	**100%**	**8,852**	482,047	100%
DEP					
Main Channel	3,292	48%	1,548	95,034	54%
Midstream Channel	3,311	48%	1,487	81,129	46%
Business Savings Store	267	4%	211	967	1%
TOTAL DEP	**6,870**	**100%**	**3,058**	177,131	100%

[a] Note that some customers participated in more than one delivery channel. As a result, the sum of unique customers across delivery channels does not add to the DEC and DEP totals.

[4] The program-tracking database tracks measures but not projects. For evaluation purposes, we defined a unique project as one or more measures of the same technology installed by the same customer (based on account number and name), at the same location, at the same time.

[5] Unique customers are defined at the company level, rather than the location level (i.e., a company that participated at more than one locations is only counted once).

3. Overview of Evaluation Activities

To address the objectives outlined in Section 1.2, the evaluation team performed a range of data collection and analytic activities, including:

- Program staff interviews (n=2)
- Program material review
- Program-tracking database review
- Main channel participant survey (n=170)
- Midstream channel participant survey (n=148)
- Trade ally survey (n=146)
- Engineering desk reviews (n=136)
- Deemed savings review of select measures (n=47)
- Lighting logger on-site visits (n=37)

3.1 Program Staff Interviews

We conducted an in-depth interview with the two Smart $aver® Prescriptive Program managers in November 2018. The purpose of the interview was to collect information on the Smart $aver® Prescriptive Program, including changes in program design and implementation since the last evaluation and the program's goals, successes, and challenges during the evaluation period.

3.2 Program Material Review

The evaluation team reviewed the prior evaluation report for the DEC and DEP Non-Residential Prescriptive Program[6] as well as summary documentation describing the program design and implementation approach, application templates, the 2018 marketing plan, and documentation of incentivized technologies. In support of the gross impact evaluation, we also reviewed a number of technical reference manuals (TRMs) and a variety of secondary materials documenting Duke Energy's ex ante deemed savings assumptions. The full list of these materials is included in the Deemed Savings Review Memorandum, provided in the Appendix.

3.3 Program-Tracking Database Review

We received a data extract from the program-tracking database that contained the data needed in support of our evaluation. Our team of energy data scientists and engineers cleaned these data and created two evaluation datasets (one at the measure level and one at the project level) that reflect program activity during the evaluation period and that could be used for the gross impact analysis and for survey sampling. Key data-cleaning activities included verification of installation dates, removal of duplicate and otherwise ineligible records (e.g., zero savings), development of project IDs, development of ex ante savings (by multiplying per-

[6] Duke Energy Carolinas/Duke Energy Progress Non-Residential Prescriptive Program Evaluation Report (March 25, 2018; Opinion Dynamics)

unit savings by measure quantities), and cleaning of customer and trade ally contact information for sampling purposes.

3.4 Main Channel Participant Survey

We fielded an online survey with a stratified random sample of participants in the main channel. The survey was fielded in October and November 2019. The survey was designed to collect information on FR and PSO for main channel projects (in support of the net impact analysis) and on program processes, such as awareness and prior use of the pre-qualification option, as well as barriers to future participation and program satisfaction.

Sample Design

The survey sample was designed to allow for the development of statistically significant FR estimates (targeting 10% relative precision at 90% confidence) by jurisdiction and for lighting and non-lighting projects. We further stratified the sample in all four groups based on project savings. While the sampling unit for this survey was the unique customer contact, the FR questions had to be asked about a specific project completed by that customer. Because many customers had completed more than one project during the evaluation period, our sampling approach prioritized projects in strata with fewer available sample points, i.e., projects with larger savings and non-lighting projects.

We completed a total of 170 interviews with customers who participated in the program's main delivery channel, 103 with DEC participants and 67 with DEP participants. The average length of the interviews was approximately 17 minutes; the response rate was 7.4%. Table 3-1 summarizes the population and number of survey completes, by jurisdiction and technology.

Table 3-1. Sampling Approach for Main Channel Participant Survey

Technology	DEC		DEP	
	# of Projects in Population (Main Channel)	# of Completes	# of Projects in Population (Main Channel)	# of Completes
Lighting	6,745	59	2,667	55
Non-Lighting	1,135	44	625	12
Pumps and Drives	*53*	*4*	*16*	*1*
HVAC	*595*	*33*	*268*	*8*
Food Service	*446*	*3*	*273*	*3*
Process	*41*	*4*	*1*	-
IT	-	-	*67*	-
TOTAL	**7,880**	**103**	**3,292**	**67**

It should be noted that some respondents did not complete the entire survey but completed all questions in the NTG module. These partial respondents were included in the FR and PSO analyses. As such, the NTG analyses are based on a different number of respondents than shown in Table 3-1.

3.5 Midstream Channel Participant Survey

We fielded an online survey with a stratified random sample of participants in the midstream channel. While the midstream channel includes non-lighting measures, the vast majority of midstream savings is associated with lighting measures. As such, our survey only included participants who made lighting purchases.

The objective of this survey was to verify the purchase and installation of the incented lighting products (in support of the gross impact analysis) and to collect information on FR and PSO for midstream channel projects (in support of the net impact analysis). Process questions were limited to participant satisfaction.

Sample Design

The survey sample was designed to allow for the development of statistically significant in-service rate (ISR) and FR estimates (targeting 10% relative precision at 90% confidence) by jurisdiction. We stratified the sample for each jurisdiction based on savings. While the sampling unit for this survey was the unique customer contact, the ISR and FR questions had to be asked about a specific purchase made by that customer. Because many customers had made more than one purchase during the evaluation period, our sampling approach prioritized purchases in strata with fewer available sample points, i.e., purchases with larger savings.

A total of 148 midstream channel participants completed the survey. The average length of the interviews was approximately 21 minutes; the response rate was 10.5%. Table 3-2 summarizes the population and number of midstream channel participant survey completes by jurisdiction.

Table 3-2. Sampling Approach for Midstream Channel Participant Survey

Jurisdiction	Population (Lighting Purchases)	Survey Completes
DEC	9,228	75
DEP	3,298	73
TOTAL	**12,526**	**148**

It should be noted that some respondents did not complete the entire survey but completed all questions in the ISR module and/or the NTG module. These partial respondents were included in the ISR and/or the NTG analyses. As such, the ISR and NTG analyses are based on a different number of respondents than shown in Table 3-2.

3.6 Trade Ally Survey

We conducted an online survey with trade allies who had completed at least one project through the DEC and/or DEP Smart $aver® Prescriptive Program during the evaluation period. The goals of this survey were to support estimation of TA SO attributable to the Smart $aver® Prescriptive Program and to explore various process topics, such as contractor experience, satisfaction with, and awareness of program processes; drivers of the LED market; and barriers to installation of efficient non-lighting equipment.

Sample Design

We sent an email invitation to each company that served as a trade ally for at least one project incentivized by the Smart $aver® Prescriptive Program during the evaluation period, i.e., we attempted a census of participating trade ally companies. As such, our data collection approach was not sample-based, and the

concept of sampling precision does not apply. To promote participation in the survey, we offered an incentive of $50 to every trade ally who completed the survey.

Overall, 146 trade allies completed the survey, including 109 that primarily serve DEC customers, 31 that primarily serve DEP customers, and 6 that supported the same number of projects in both jurisdictions. The response rate was 18.9%.

3.7 Engineering Desk Reviews

To verify measure quantities reported in the program-tracking database, our engineering team performed 136 desk reviews of main channel projects (84 for DEC and 52 for DEP projects), sampling by technology. The desk reviews consisted of a thorough examination of all available program documentation for the projects, including applications, invoices, and specification sheets.

To select projects for desk reviews, we used a stratified random sampling approach, stratifying by technology and project savings (see Table 3-3). We targeted 10% relative precision at 90% confidence for the resulting quantity adjustments, by technology.

Table 3-3. Summary of Desk Reviews

Technology	Number of Projects	
	Population (Main Channel)	Desk Reviews
Lighting	9,412	62
HVAC	863	30
Food Service	719	18
Pumps and Drives	69	12
Process	42	8
IT	67	6
TOTAL	**11,172**	**136**

3.8 Deemed Savings Review

To assess ex ante per-unit savings values, our engineering team performed a deemed savings review of select measures across all delivery channels. Because of the large number of unique measures incented during the evaluation period (a total of 275), we first identified measures that accounted for the largest share of program savings, i.e., measures that individually accounted for at least 0.5% of total ex ante program savings, as well as closely related measures (e.g., the same type of lighting but with a different wattage or number of lamps). Per Duke Energy's request, we then excluded from this list measures that were discontinued in 2019. In total, we reviewed 47 individual measures, which accounted for approximately 86% of total program energy savings.

For each of these 47 measures, we reviewed existing program documents, program-tracking data, assumptions, TRMs, and other resources, as applicable, to determine the appropriateness of the per-unit savings values. In addition, we incorporated results from the lighting HOU logger study into the deemed savings estimates for key lighting measures (see Section 3.9). We then updated the per-unit savings for several measures, based on the review of materials.

3.9 Lighting Hours of Use Logging

To verify program-tracked HOU for incented lighting equipment, Opinion Dynamics conducted on-site metering visits for a sample of lighting projects and developed annual HOU estimates for logged lighting equipment.

Opinion Dynamics conducted on-site metering visits for a sample of 37 lighting projects, a subset of lighting projects sampled for desk reviews. Deployment visits took place between June 24 and June 28, 2019. During these visits, we confirmed the installation of the energy-efficient lighting measures and deployed a total of 157 loggers (between 1 and 12 loggers per site). Between August 5 and August 7, 2019, we retrieved 153 of the 157 deployed loggers.

4. Gross Impact Evaluation

4.1 Methodology

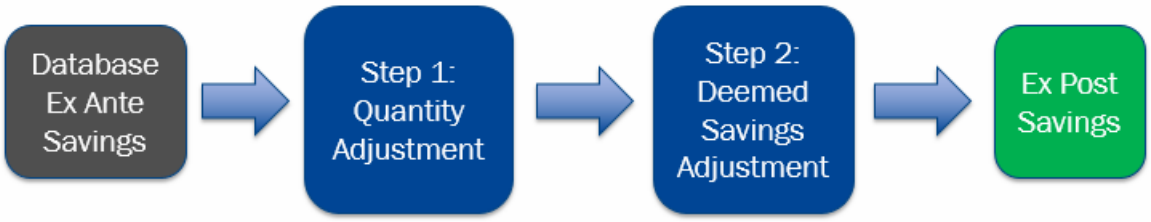
Our gross impact evaluation included five main evaluation activities (1) a program-tracking database review, (2) engineering desk reviews to verify measure quantities for main channel projects, (3) a survey-based ISR analysis to verify measure quantities for midstream channel purchases, (4) a review of Duke Energy's ex ante (deemed) savings assumptions, and (5) a lighting HOU logging study to verify program-tracked lighting HOU values.

The evaluation team used these activities to develop ex post (verified) gross savings and realization rates at the technology level, by delivery channel and jurisdiction. The methodology consisted of two general steps:

- Step 1: Quantity Adjustment
  - For the main channel, the quantity adjustment was based on a sample of 136 engineering desk reviews. We developed technology-specific quantity adjustment factors, which we applied to the main channel measure quantities in the program-tracking database. The sample included both DEC and DEP projects but did not target specific quota for each jurisdiction. We therefore developed quantity adjustments by technology but not by jurisdiction.
  - For the midstream channel and the Business Savings Store, the quantity adjustment was based on responses from the midstream participant survey. We developed ISRs by jurisdiction, but not by technology.
- Step 2: Deemed Savings Adjustment
  - Based on the deemed savings review, we developed updated per-unit savings values for 47 reviewed measures, across all three delivery channels. For measures not part of the deemed savings review, ex post per unit savings were set to equal ex ante savings.
  - The deemed savings review included development of evaluation period-specific lighting HOU values, by key lighting technologies, based on the program-tracking database. For LED tube and panel measures, we further adjusted the program-tracked HOU estimates based on results from the lighting HOU logging study.

To develop ex post gross savings, we applied the quantity adjustments and deemed savings adjustments to ex ante savings. Figure 4-1 depicts this process.

Figure 4-1. Gross Impact Evaluation Approach



The following subsections provide more detail on the gross impact evaluation activities.

4.1.1 Program-Tracking Database Review

The first step in the gross impact evaluation was to perform a review of the program-tracking database. This review consisted of several steps. First, we verified dates of installation, identified duplicate records, and checked for any other parameters that may disqualify measures (e.g., not achieving the minimum efficiency level). Second, we calculated ex ante savings for each database record by multiplying per-unit database savings by measure quantities. Third, we developed unique project identifiers to support sampling.

The database review resulted in a clean dataset that reflects the eligible population of program projects with complete data required to estimate savings, including measure- and project-level ex ante savings. We used this dataset to select measures for the deemed savings review, to select projects for the engineering desk reviews and light logger study, and to develop ex ante gross impacts by technology, delivery channel, and jurisdiction.

4.1.2 Main Channel Quantity Adjustment

The purpose of the desk reviews was to compare measure quantities included in the program-tracking database with those identified in project documentation. We performed desk reviews for a sample of 136 main channel projects, sampling by technology (see Section 3.7). We reviewed all available project documentation for sampled projects, including the project application; any supplied calculations, invoices, specification sheets, and inspection forms; and any other project-specific data made available to our team. For all sampled projects, we compared measure types and quantities listed on project documents with measure types and quantities listed in the program-tracking database to ensure consistency and to check for any errors. If inconsistencies were found, quantities listed on project documents superseded those in the tracking database for use in calculating ex post savings. Based on results from the desk reviews, we developed technology-level quantity adjustment factors to apply to main channel projects.

4.1.3 Midstream and Business Savings Store Quantity Adjustment

As part of the midstream channel participant survey, we asked customers to verify receipt, installation, and continued operation of lighting measures recorded in the program-tracking database. We calculated the quantity adjustment as the number of lamps or fixtures installed and operational at the time of the survey divided by the number of lamps or fixtures in the program-tracking database (by respondent and type of lighting measure). We then aggregated measure-level ISRs to the respondent level, weighting by savings. We further aggregated respondent-level ISRs to the program level, by jurisdiction, applying savings and stratum weights to reflect our sampling strategy (see Section 3.5 above). We used these ISRs as the quantity adjustments for both midstream channel and Business Savings Store purchases.[7]

4.1.4 Deemed Savings Adjustment

The purpose of the deemed savings review was to update per-unit savings assumptions for key measures incented through the Non-Residential Prescriptive Program. Because of the large number of unique measures incented during the evaluation period (a total of 275), we focused our efforts on the measures that accounted

[7] Due to the small contribution of the Business Savings Store to overall program savings, we did not conduct research specific to this delivery channel. We applied ISR results from the midstream channel to Business Savings Store purchases due to similarities in the delivery mechanism: Both channels rely on customer purchases and independent installation, while the main channel is largely contractor-driven.

for the largest share of program savings, including savings from all three delivery channels. The review excluded measures that were discontinued in 2019.

Table 4-1 presents the number of measures incented through the program, as well as those selected for review, by technology. As shown, the deemed savings review included 47 measures that accounted for 86% of total ex ante program savings. For the measures not covered by the deemed savings review (accounting for the remaining 14% of total ex ante savings), we maintained existing per-unit ex ante assumptions.

Table 4-1. Summary of Measures Reviewed

	Total		Included in Deemed Savings Review			
	# Measures	MWh (Ex Ante)	# Measures	% Measures	MWh (Ex Ante)	% MWh
Lighting	117	649,046	46	39%	577,422	89%
Pumps and Drives	14	11,090	1	7%	8,194	74%
HVAC	81	13,201	-	0%	-	0%
Food Service	50	4,502	-	0%	-	0%
Process	11	1,456	-	0%	-	0%
IT	2	1,361	-	0%	-	0%
TOTAL	**275**	**680,656**	**47**	**17%**	**585,616**	**86%**

For the selected measures, we reviewed all program-supplied documentation of ex ante assumptions. We leveraged a variety of TRMs, including the Mid-Atlantic TRM and Michigan Master Measure Database as well as previous program evaluations and research.

For lighting measures, the deemed savings review included development of evaluation period-specific HOU estimates, by lighting category, based on the program-tracking database. In addition, for LED tube and panel measures only, we applied an HOU adjustment based on results from the lighting HOU logger study (described in Section 4.1.5).

The full, measure-level deemed savings review, including the supporting spreadsheet, can be found in the Appendix.

4.1.5 Lighting HOU Verification

HOU are a key input required to estimate the savings from lighting projects. The program collects facility-specific HOU estimates as part of the incentive application and includes these in the program-tracking database. In this evaluation (as well as the prior one), Opinion Dynamics used the program-tracked HOU data to develop weighted average HOU estimates for major categories of lighting equipment and used these estimates to update deemed savings values for relevant lighting measures.

Given the large contribution of lighting measures to overall DEC and DEP Smart $aver® Prescriptive Program savings, North Carolina Public Staff, as part of their review of the last evaluation of this program, recommended that Duke Energy verify program-tracked lighting HOU values through a light logger study. In response to this recommendation, Opinion Dynamics worked with Duke Energy to incorporate such a light logger study into the scope of this evaluation.

In a related activity, to further investigate self-reported HOU in the program-tracking database, Opinion Dynamics compared trade ally-provided HOU values with customer-provided HOU values for lighting categories included in the deemed savings review. The goal of this analysis was to determine if there are systematic

differences between the two sources of this data. The analysis focused on measure categories included in the deemed savings review since the self-reported HOU values for those measures directly impact ex post savings.

It should be noted that for each record, the program-tracking data contains an HOU value reported by either the trade ally or the customer. This analysis therefore compares trade ally and customer reported HOU for different sets of projects (albeit for the same measure groups and therefore for the same functional applications). As such, this analysis does not control for any factors that may systematically differ between trade ally-implemented projects and customer-implemented projects (within the same measure group).

Light Logger Study Methodology

The lighting HOU logging study was conducted between June and August 2019. It included on-site metering visits for a sample of 37 lighting projects, a subset of the desk review projects. Deployment visits took place between June 24 and June 28, 2019. During these visits, we confirmed the installation of the energy-efficient lighting measures and deployed a total of 157 loggers (between 1 and 12 loggers per site). Between August 5 and August 7, 2019, we retrieved 153 of the 157 deployed loggers.

Opinion Dynamics performed a series of data cleaning steps on the retrieved loggers, including (1) identification and removal of corrupted/failed loggers; (2) analysis of unexpected/suspicious usage patterns; (3) logger date "trimming;" and (4) analysis of logger flickering. Based on the cleaning steps, we excluded 41 of the 153 deployed loggers (27%) from further analysis.

We calculated annual HOU by first summing, for each logger, the average time the light was on, per day, during the logging period. We then multiplied the result by 365 days. We paid particular attention to two special cases to ensure that the hours recorded during the logging period could be extrapolated to the full year: (1) different operating hours during the week of July 4th, and (2) seasonality of facility operating schedules.

We developed a program-level HOU realization rate through a series of aggregation and weighting steps (described in detail in the Appendix). Given the number of sample points for different types of lighting technologies, we developed two estimates of the program-level HOU realization rate.

- The first estimate included all lighting technologies that were represented in the light logger study: LED tube lighting, LED panel lighting, LED case lighting, LED downlights, LED highbay lighting, and LED reflector lamps.
- The second estimate included only LED tube lighting and LED panel lighting. We developed this second estimate since most loggers (87 out of 95) and site/measure-level sample points (42 out of 50) were associated with these two lighting technologies.

Opinion Dynamics selected the second estimate for use in this evaluation. We feel that it is a better estimate, given that the vast majority of loggers were associated with these two technologies. The HOU realization rate was applied as an adjustment to annual HOU values for LED tube lighting and LED panel lighting, as part of the deemed savings review.

A detailed description of the methodology and results of the lighting HOU study can be found in the Appendix.

4.2 Gross Impact Results

Table 4-2 summarizes the overall gross energy impacts for DEC and DEP (including savings from all three delivery channels) resulting from the two-step adjustment approach described above. The overall realization

rates are slightly less than 100%, driven by small downward adjustments to both quantities and per-unit savings values for lighting projects. We describe these adjustments in more detail below.

Table 4-2. Overall Gross Energy Impacts

Technology	DEC			DEP		
	Ex Ante kWh	Realization Rate	Ex Post kWh	Ex Ante kWh	Realization Rate	Ex Post kWh
Lighting	473,196,869	97%	459,722,955	175,849,149	96%	168,509,214
Pumps and Drives	9,621,917	100%	9,604,616	1,468,036	115%	1,694,655
HVAC	8,438,190	100%	8,415,298	4,762,444	100%	4,752,610
Food Service[a]	3,464,138	81%	2,816,818	1,038,041	81%	844,294
Process	1,455,989	100%	1,455,950	143	100%	143
IT	31,499	98%	31,027	1,329,977	100%	1,329,694
TOTAL	496,208,603	97%	482,046,663	184,447,789	96%	177,130,609

[a] The realization rates for food service projects were driven by one project with a large quantity adjustment due to a data entry error. The realization rates without this error would have been 100%, which may be a better planning value to use.

Table 4-3 summarizes the overall gross demand impacts for DEC and DEP (including savings from all three delivery channels) resulting from the two-step adjustment approach described above.

- The overall summer demand realization rates are slightly less than 100% for both jurisdictions, with both quantity and deemed savings adjustments contributing to the discrepancy.
- The overall winter demand realization rates, on the other hand, are slightly higher than 100%, mainly due to deemed savings adjustments for lighting measures.

We describe these adjustments in more detail below.

Table 4-3. Overall Gross Demand Impacts

Technology	DEC			DEP		
	Ex Ante kW	Realization Rate	Ex Post kW	Ex Ante kW	Realization Rate	Ex Post kW
Summer Demand Impacts						
Lighting	83,501	97%	81,372	29,960	97%	28,977
Pumps and Drives	1,427	100%	1,425	171	136%	232
HVAC	2,447	100%	2,447	1,225	100%	1,225
Food Service[a]	300	72%	216	79	72%	57
Process	260	100%	260	0	N/A	0
IT	0	N/A	0	128	100%	128
TOTAL	**87,934**	**97%**	**85,719**	**31,563**	**97%**	**30,618**
Winter Demand Impacts						
Lighting	79,375	102%	80,656	28,173	102%	28,703
Pumps and Drives	1,481	100%	1,478	151	139%	211
HVAC	1,121	100%	1,120	799	100%	799
Food Service[a]	288	71%	204	77	71%	55
Process	276	100%	276	0	100%	0
IT	0	N/A	0	0	N/A	0
TOTAL	**82,540**	**101%**	**83,734**	**29,201**	**102%**	**29,768**

[a] The realization rates for food service projects were driven by one project with a large quantity adjustment due to a data entry error. The realization rates without this error would have been 100%, which may be a better planning value to use.

4.2.1 Main Channel Quantity Adjustment

Based on our desk reviews, we adjusted the quantities for 11 of the 136 sampled main channel projects. Of the 11 adjustments, 10 were relatively minor and often resulted from differences due to rounding. One large (based on ex ante savings) food service project, however, had a quantity adjustment that significantly impacted the overall realization rate for that technology. This project had a measure (ECM refrigerated case motors) with a tracked quantity of 130, but project documents showed a quantity of 35 motors with a horsepower (HP) of 0.0323 each. Since the quantity unit for this measure is per horsepower, the ex post quantity was updated to 1.13 HP.

Table 4-4 summarizes the quantity adjustments made for the 11 projects.

Table 4-4. Summary of Main Channel Project with Quantity Adjustments

Sample Project #	Measure	Technology	Unit of Measure	Quantity	
				Database (ex ante)	Desk Review (ex post)
#1	Exterior HID Lighting	Lighting	Fixture	475	4
#2	LED Flood Lighting	Lighting	Fixture	15	5
#3	VFD HVAC Fan	Pumps & Drives	Horsepower	8	7.5
#4	VFD HVAC Fan	Pumps & Drives	Horsepower	8	7.5
	VFD HVAC Fan	Pumps & Drives	Horsepower	8	7.5
#5	VFD HVAC Fan	Pumps & Drives	Horsepower	8	7.5

Sample Project #	Measure	Technology	Unit of Measure	Quantity	
				Database (ex ante)	Desk Review (ex post)
#6	VFD HVAC Fan	Pumps & Drives	Horsepower	1	0.5
	VFD HVAC Fan	Pumps & Drives	Horsepower	1	0.75
	VFD HVAC Fan	Pumps & Drives	Horsepower	8	7.5
#7	HVAC DX AC 65-135kBtuh 12.2 EER (Tier 2)	HVAC	Ton	9	9.4
	HVAC DX AC less than 65kBtuh 15 SEER (Tier 2)	HVAC	Ton	6	6.2
#8	HVAC DX AC 240-760kBtuh 10.8 EER (Tier 2)	HVAC	Ton	115	120
#9	HVAC DX AC 65-135kBtuh 12.2 EER (Tier 2)	HVAC	Ton	8	7.5
#10	Water-Cooled Chiller	HVAC	Ton	164	163.6
#11	ECM Refrigerated Case Motors	Food Service	Horsepower	130	1.129

The quantity adjustments for the 11 projects resulted in realization rates different from 100% for lighting, pumps and drives, HVAC, and food service technologies. We did not make any adjustments to the other technologies because we did not find any discrepancies in our sample for those technologies. Table 4-5 summarizes these results.

We achieved a relative precision, at 90% confidence, of ±3% for lighting projects, better than ±1% for pumps and drives and HVAC projects, and ±9% for food service projects. Because we found no discrepancies for the other technologies, the relative precision is ±0%.

Table 4-5. Main Channel Quantity Adjustments

Technology	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Lighting	98.1%	100.0%	100.0%
Pumps and Drives	99.8%	99.8%	99.8%
HVAC	100.1%	100.1%	100.0%
Food Service	81.2%	71.7%	70.7%
Process	100.0%	100.0%	100.0%
IT	100.0%	100.0%	N/A

4.2.2 Midstream and Business Savings Store Quantity Adjustment

The midstream participant survey found high ISRs for both DEC and DEP respondents (98.5% and 96.9%, respectively). The relative precision of these estimates, at 90% confidence, is 2.3% and 3.7%, respectively. Table 4-6 summarizes these results.

As noted above, these quantity adjustments were applied to the midstream channel as well as the Business Savings Store.

Table 4-6. Midstream and Business Savings Store Quantity Adjustments

Jurisdiction	n	ISR	Relative Precision (90% Confidence)
DEC	77	98.5%	2.3%
DEP	72	96.9%	3.7%

4.2.3 Deemed Savings Adjustment

The deemed savings review resulted in modifications to per-unit savings values for select measures within the lighting and the pumps and drives technology categories.[8] For reviewed measures, we multiplied revised per-unit savings values by ex ante quantities, at the measure-level, to calculate deemed savings-adjusted gross savings. We then developed deemed savings adjustments by dividing these adjusted gross savings by ex ante savings. For all measures that were not included in the deemed savings review, ex post per unit values were set to equal ex ante values.

The deemed savings review resulted in the following adjustments:

- Lighting
  - We incorporated measure-specific weighted average HOU estimates from the program-tracking database.
  - For LED tube and panel measures, an HOU realization of 1.163, based on the lighting HOU logger study (see Section 4.2.4), was applied to the HOU value from the program-tracking database.
  - For lighting measures not included in the prior deemed savings review, we made the following additional adjustments:
    - We applied waste heat and coincidence factors consistent with values used in the previous DEC-DEP deemed savings review.
    - We cross-checked and updated any wattage assumptions to ensure consistency between the previous evaluations for the DEC/DEP, DEI, and DEO Smart $aver® Prescriptive Programs.
- Pumps and drives
  - For the one pumps and drives measure reviewed (VFD HVAC Fan), we made no adjustment to the DEC values. The DEP values were aligned with the DEC values.

Table 4-7 summarizes the results of the deemed savings review, by jurisdiction and technology. The full, measure-level deemed savings review, including the supporting spreadsheet, can be found in the Appendix.

[8] The deemed savings review did not include measures within the HVAC, food service, process, or information technology categories.

Table 4-7. Deemed Savings Adjustments

Technology	DEC			DEP		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Lighting	99%	98%	102%	98%	98%	103%
Pumps and Drives	100%	100%	100%	116%	136%	140%
HVAC	100%	100%	100%	100%	100%	100%
Food Service	100%	100%	100%	100%	100%	100%
Process	100%	100%	100%	100%	N/A	100%
IT	100%	N/A	N/A	100%	100%	N/A
TOTAL	**99%**	**98%**	**102%**	**98%**	**99%**	**104%**

4.2.4 Lighting HOU Verification

The lighting HOU verification resulted in two key findings:

- The light logger study resulted in HOU estimates for LED tube and LED panel measures that are 16% higher than data in the program-tracking database.
- The database comparison of HOU reported by trade allies and customers, respectively, found close alignment between the two sources in the aggregate but variations at the measure-group level.

Results from both analyses are described below.

Light Logger Study

Based on the results of the light logger study, we developed two estimates of the program-level HOU RR:

- The first estimate includes all lighting technologies that were represented in the light logger study: LED tube lighting, LED panel lighting, LED case lighting, LED downlights, LED highbay lighting, and LED reflector lamps.
- The second estimate includes only LED tube lighting and LED panel lighting. We developed this second estimate since most loggers (87 out of 95) and site/measure-level sample points (42 out of 50) were associated with these two lighting technologies.

Table 4-8 summarizes the results and precision estimates for both approaches. Notably, both approaches yielded almost identical results – HOU RRs of 1.147 and 1.163, respectively – as well as fairly similar precision levels.

Table 4-8. HOU Realization Rates and Precision Estimates

	n	HOU RR	Relative Precision at...		
			90%	85%	80%
All Logged Lighting Technologies	50	1.147	0.17	0.15	0.13
LED Tube and Panel Lighting	42	1.163	0.19	0.16	0.15

Opinion Dynamics selected the second estimate – the HOU realization rate of 1.163, based on LED tube and panel lighting only – for application in this evaluation. Despite slightly lower precision levels, we feel that it is

more appropriate to use this estimate, given that the vast majority of loggers were associated with these two technologies.

As described above, the HOU realization rate was applied as an adjustment to annual HOU values as part of the deemed savings review. It should be noted that this adjustment was applied to a subset of lighting measures incented during the evaluation period:

- Given that the HOU realization rate is based on LED tube and LED panel lighting only, it was only applied to these two measure types.
- Since the HOU RR was incorporated into ex post deemed savings values, it was only applied to LED tube and lighting measures that were part of the deemed savings review for this evaluation.[9]

Overall, the HOU RR of 1.16 was applied to 33% of program-incented lighting savings during the evaluation period. If we had used the estimate for all logged lighting technologies (RR of 1.15), we would have applied it to a broader set of lighting measures, accounting for 65% of program lighting savings. The selected approach therefore represents a more conservative assumption, despite the slightly higher RR.

Comparison of Trade Ally and Customer-Reported HOU

The comparison of HOU values reported by trade allies versus those reported by customers showed very close alignment in the aggregate: Across all 10 lighting measure categories included in the deemed savings review (accounting for 94% of total main channel lighting savings), the weighted HOU difference was less than 1%. For each lighting category, however, there were differences:

- For four of the ten measure categories, the average estimates were within 5% of each other.
- For another four categories, trade ally estimates exceeded customer estimates by more than 5%.
- For two categories, customer estimates exceeded trade ally estimates by more than 5%.

Table 4-9 summarizes these results.

[9] Several LED tube measures were discontinued in 2019 and were therefore excluded from the deemed savings review.

Table 4-9. Comparison of Trade Ally and Customer-Reported HOU

Measure Category	Weighted Average HOU[A]		% Difference
	Trade Allies	Customers	
LED Panel Lighting	4,394	3,526	25%
LED Downlight	4,864	3,936	24%
LED Lamps	4,550	4,117	11%
Occupancy Sensors per Watt	5,711	5,198	10%
LED Canopy Lighting	4,209	4,047	4%
Exterior HID Lighting	4,084	3,956	3%
LED Lowbay Lighting	4,303	4,337	-1%
LED Tube Lighting	4,168	4,373	-5%
Garage HID Lighting	6,439	6,997	-8%
LED Highbay Lighting	3,431	4,177	-18%
TOTAL	**4,080**	**4,108**	**<1%**

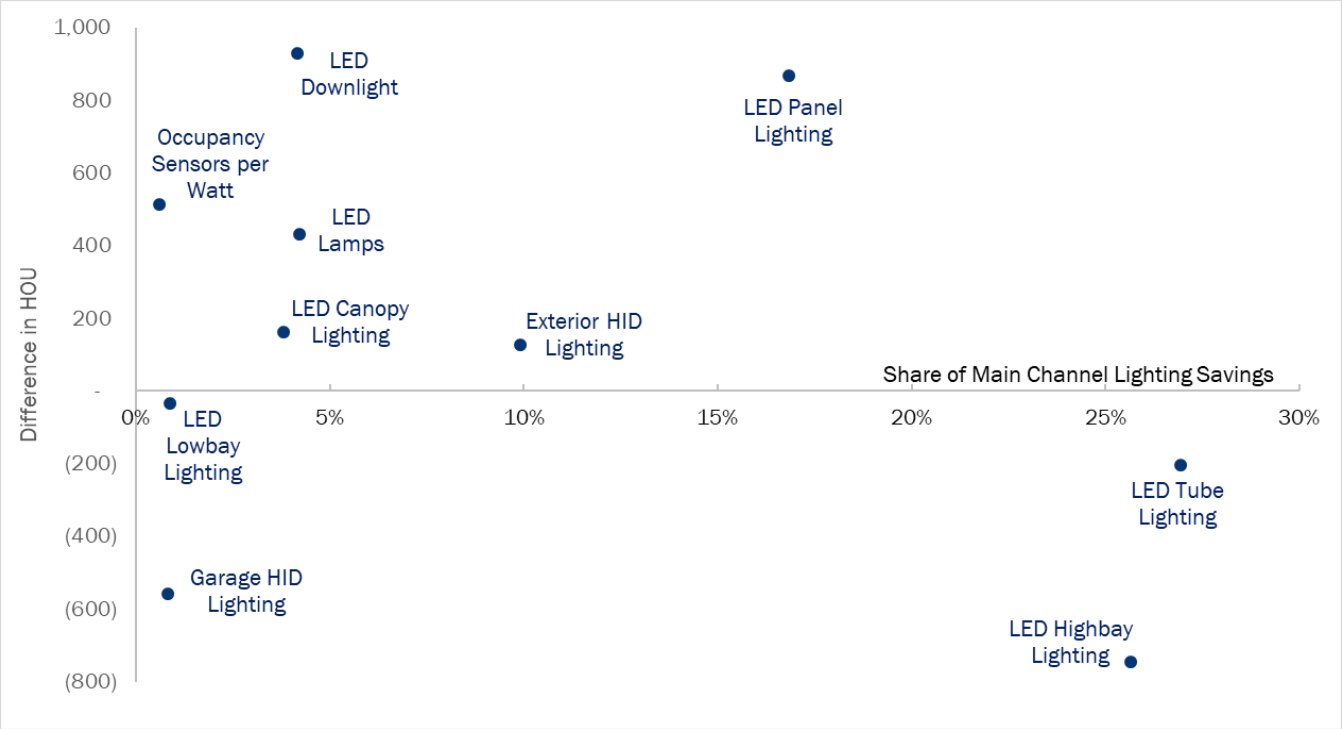
[A] Within each measure category, HOU estimates were weighted by measure quantity; across the categories, the average HOU estimates were weighted by kWh savings.

Figure 4-2 presents these results graphically:

- The y-axis shows the absolute difference (in hours) between trade ally-reported values and customer-reported values: Points above the x-axis reflect measure categories for which trade allies provided a higher estimate than customers; points below the x-axis reflect measure categories with higher customer estimates.
- The x-axis represents the share of main channel lighting savings that each measure category accounts for: The further to the right, the greater the share of savings from that category.

Mapping differences in HOU estimates against the share of savings helps explain the results: Even though trade allies provided higher estimates for the majority of measure categories, the overall HOU estimates closely align because customer-provided values are higher for the two measures with the highest savings: LED tube lighting and LED highbay lighting.

Figure 4-2. Differences in Trade Ally and Customer Provided HOU Estimates Relative to Savings



5. Net-to-Gross Analysis

5.1 Methodology

Our NTG analysis included consideration of FR, PSO, and TA SO. We developed estimates of FR and PSO based on the online surveys with participants in the main and midstream channels and estimates of TA SO based on the online survey with main channel trade allies. The NTGR was calculated as follows, separately for DEC and DEP and for the main channel and the midstream channel:

$$NTGR = 1 - FR + PSO + TA\ SO$$

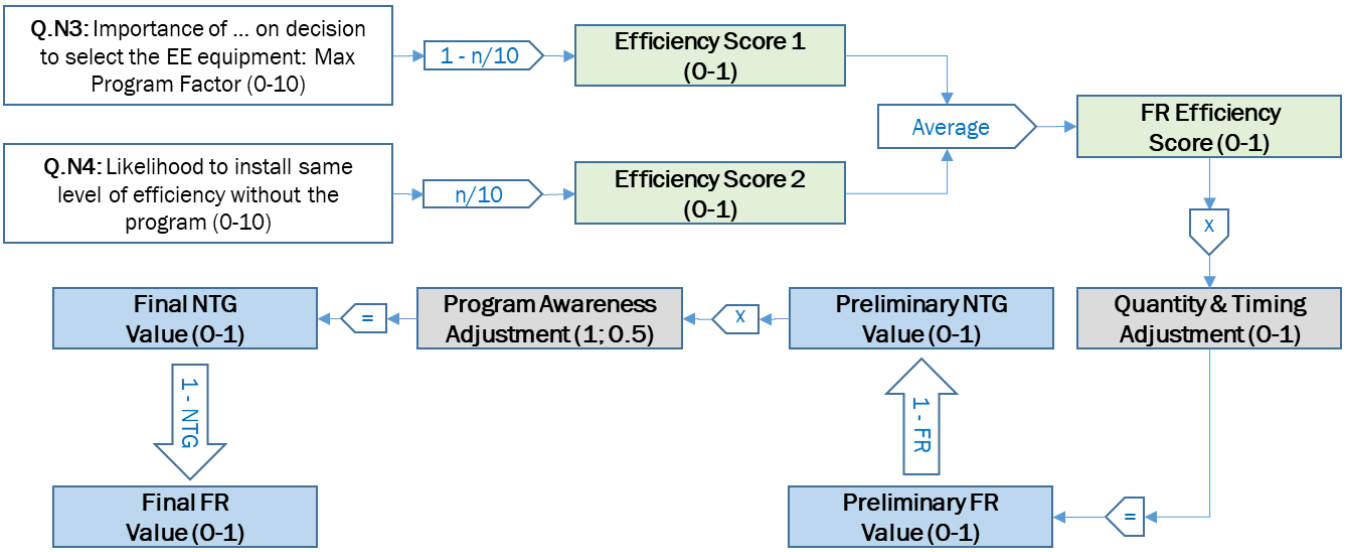
5.1.1 Free-Ridership

Free-riders are program participants who would have completed the same energy efficiency upgrade without the program. FR scores represent the percentage of savings that would have been achieved in the absence of the program. FR scores can range from 0% (not a free-rider; the participant would not have completed the project without the program) to 100% (a full free-rider; the participant would have completed the project without the program). FR scores between 0% and 100% represent partial free-riders, i.e., participants who were to some degree influenced by the program to complete the energy efficiency upgrade.

FR survey questions focused on the importance of various program factors on the decision to install energy-efficient equipment, as well as on the likelihood of making the same upgrades in the absence of the program (the counterfactual). These questions were used to determine program influence on levels of efficiency and on measure quantity (where applicable) and project timing. We developed two measurements of program influence on levels of efficiency and used consistency checks in cases where inconsistent responses were given. Responses about measure quantity and project timing were used to adjust the efficiency-based FR rate, allowing the program to receive credit in cases where the program influenced project size and timing rather than, or in addition to, the level of efficiency. A second adjustment, the Program Awareness Adjustment, was applied in cases where participants reported having learned about the program after they selected the equipment for which they received an incentive. This adjustment was applicable to the main channel only and, if applied, reduced a respondent's program attribution (1 – FR) by 50%.

Figure 5-1 presents a diagram of the FR algorithm used for this evaluation, including references to question numbers. A more detailed description of the algorithm can be found in the Appendix.

Figure 5-1. Overview of Free-Ridership Algorithm



We developed separate FR estimates for six analysis groups: DEC main channel lighting, DEC main channel non-lighting, DEP main channel lighting, DEP main channel non-lighting, DEC midstream lighting, and DEP midstream lighting. We explored the possibility of developing separate FR estimates for the various non-lighting technologies incented through the main channel (i.e., HVAC equipment; process equipment; pumps and drives; food service equipment; and information technology). However, due to the small number of unique customers who completed non-lighting projects, we did not obtain enough responses to develop rigorous FR estimates at the technology level (despite an attempted census of these projects).

We developed FR estimates for the six analysis groups as follows:

- We first developed a FR estimate for each survey respondent, using the algorithm depicted above.
- We then aggregated respondent-level FR estimates to the stratum level, weighting the sampled projects within each stratum by their ex post gross savings. In cases of low numbers of responses within an analysis group, we combined two or more of the size strata.
- For each analysis group, we developed a FR value by applying ex post savings weights to reflect the relative contribution of each stratum to the group's overall savings.

In addition, we rolled up FR results to the channel level (across lighting and non-lighting projects) and to the lighting level (across the two delivery channels), by jurisdiction. We developed these aggregate values by applying ex post savings weights to reflect the relative contribution of each analysis group to the aggregated values.

5.1.2 Participant Spillover

PSO refers to additional energy efficiency upgrades participants made at the time of or after their participation in the Smart $aver® Prescriptive Program that were influenced by the program but for which they did not receive a program incentive. PSO was estimated separately for the main and midstream channels and is expressed as a percentage of delivery channel savings.

To determine if a survey respondent is eligible for PSO savings, we asked a series of questions about additional energy efficiency installations that they made without receiving an incentive and the degree to which the program influenced their decision to install the efficient equipment. The survey included two program influence questions:

SP2a. How much did your experience with the Smart $aver Incentive Program or interactions with Duke Energy staff influence your decision to make efficiency improvements without an incentive?

This question was asked on a scale of 0 to 10, where 0 means "No Influence" and 10 means "Greatly Influenced."

SP2b. If you had NOT participated in the Smart $aver Incentive Program, how likely is it that <COMPANY> would still have made the additional energy efficient improvements?

This question was asked on a scale of 0 to 10, where 0 means "Definitely would not have made improvements" and 10 means "Definitely would have made improvements."

To supplement these numeric responses, we asked open-ended questions about how the program influenced the decision to make the energy efficiency installations and why the participant made the installations without a program incentive. A respondent's additional energy efficiency installations were deemed eligible for PSO if two conditions were met: (1) the Program Influence Factor (see below) was greater than 7.0 and (2) the open-ended responses did not contradict that the installations were eligible for PSO.

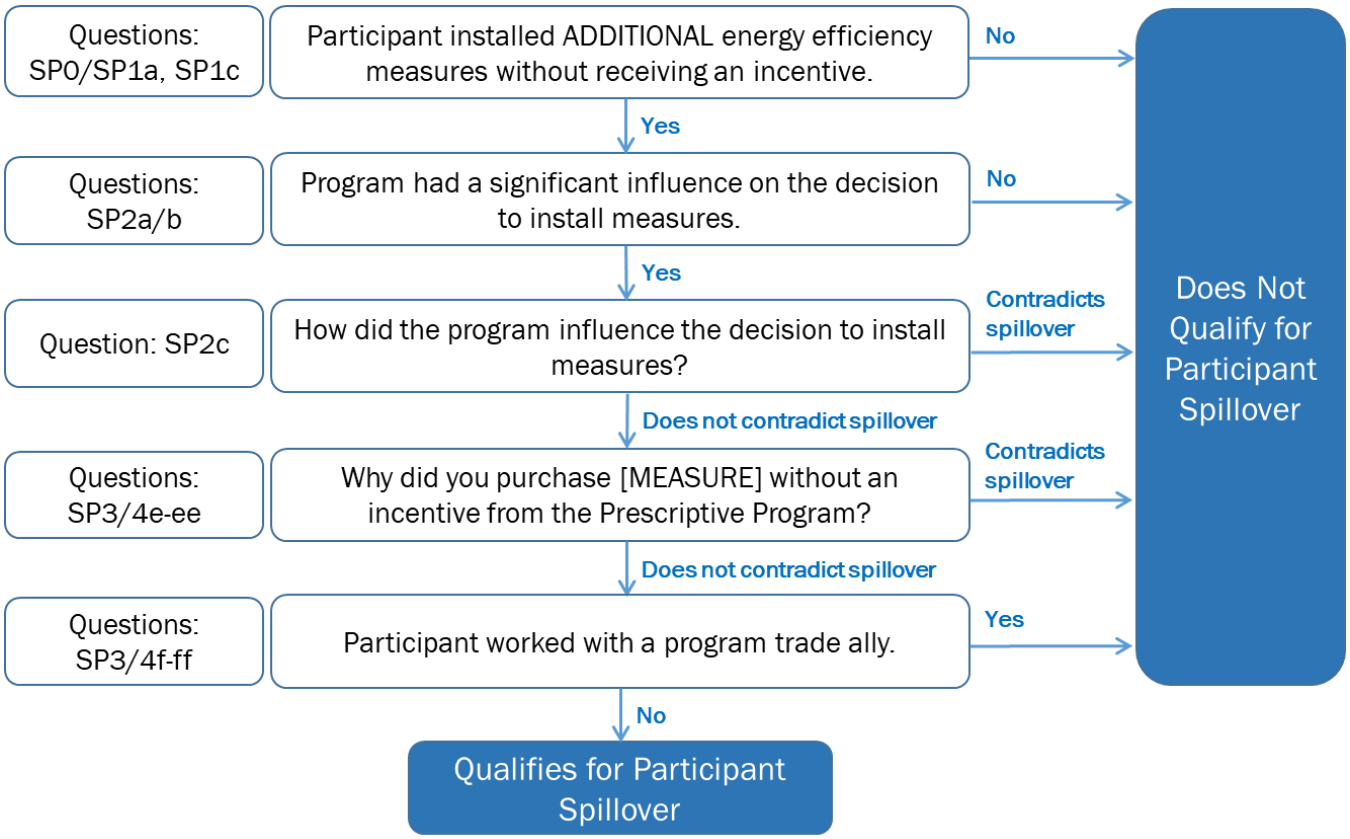
The Program Influence Factor was calculated as follows:

$$\textit{Program Influence Factor} = (\textit{SP2a Response} + (10 - \textit{SP2b Response})) \div 2$$

In addition, we applied a third PSO eligibility condition: that the participant did not work with a participating trade ally. This condition was necessary because this evaluation also estimated TA SO. When estimating spillover (SO) from multiple sources, it is important to avoid double-counting. In the case of this evaluation, double-counting could occur if participants and trade allies report SO from the same projects. We avoided such double-counting by determining if the participant's SO project was completed by a trade ally who is in the sample frame for the TA survey (i.e., the trade ally completed at least one project through the Smart $aver® Prescriptive Program during the evaluation period). If so, the SO reported by the participant was excluded from the PSO estimate as it was captured through the TA SO analysis (see next section).

Figure 5-2 presents a diagram of the PSO eligibility determination methodology used for this evaluation, including references to question numbers.

Figure 5-2. Participant Eligibility for Spillover - Methodology



The survey also included a few follow-up questions about SO-eligible measures, including the type of equipment and, for lighting measures only, information on the quantity of measures installed, whether they were installed in a conditioned space, and the type of lighting they replaced.

For participants with qualifying installations, we conducted follow-up interviews to collect more-detailed information for each additional measure, such as baseline and efficient wattages or the age of the equipment. We then used the program's deemed savings values to develop SO savings for each measure. In two cases, we were not able to reach a participant with qualifying installations for a follow-up interview[10] and were not able to estimate SO savings with the desired degree of confidence. Following discussion with Duke Energy evaluation staff, we made the conservative decision to set SO savings for these two participants to zero.

We developed a "PSO Rate," separately for the main channel and the midstream channel, which is calculated using the following formula:

$$PSO\ Rate = \frac{SO\ in\ Sample}{Ex\ Post\ Gross\ Impacts\ in\ Sample}$$

[10] Our outreach included several attempts via phone and email over a 4-week period. We used contact information available in the program-tracking database, provided in the online survey, as well as additional contact information received from Duke Energy.

5.1.3 Trade Ally Spillover

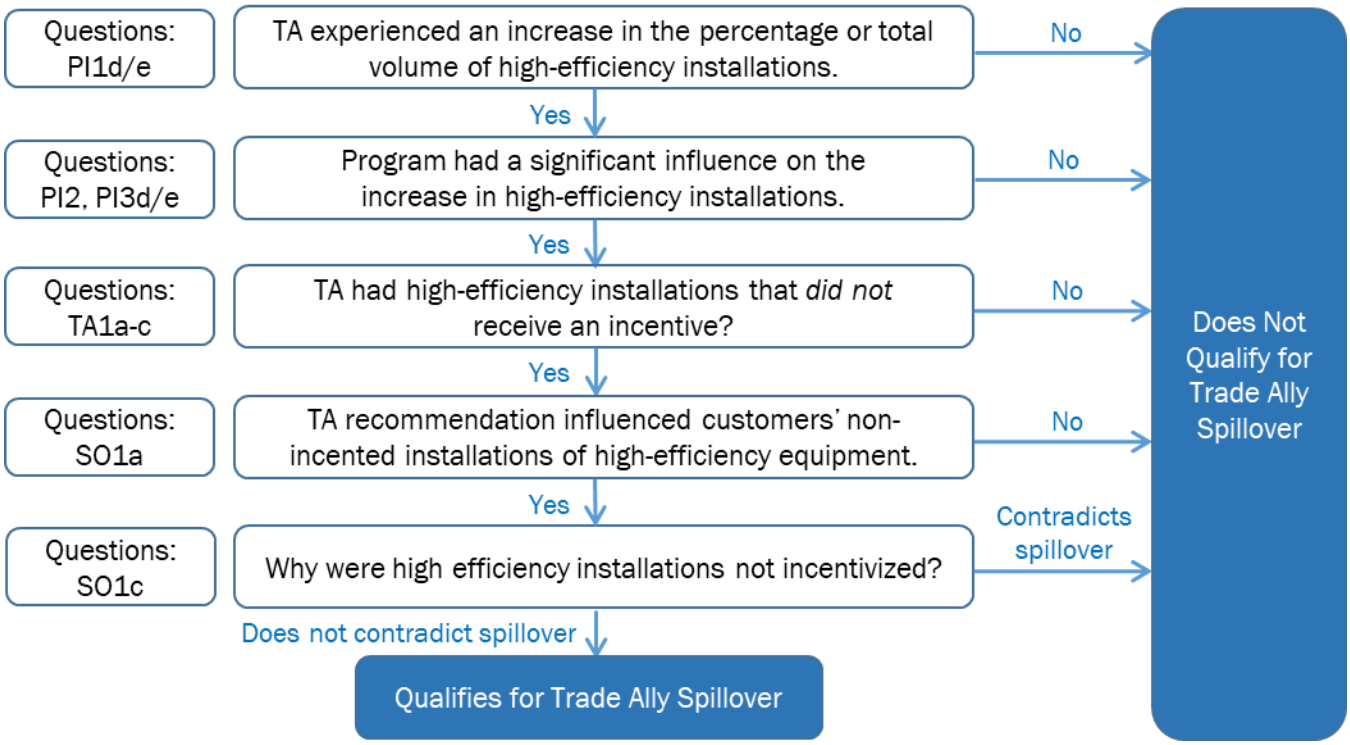
TA SO refers to non-incented energy efficiency upgrades made by customers who were influenced by a participating main channel trade ally who was in turn influenced by the Smart $aver® Prescriptive Program. TA SO is estimated at the program level and is expressed as a percentage of program savings. This section presents a high-level overview of the TA SO methodology.

To determine if a trade ally was eligible for SO savings, the online survey asked a series of SO-related questions. We considered a trade ally eligible for SO if the following conditions were met:

- Since working with the Smart $aver® Prescriptive Program, either the trade ally's percentage of high-efficiency installations increased or the trade ally's total volume of high-efficiency installations increased.
- The trade ally rated the importance of the Smart $aver® Prescriptive Program on at least one of these increases an 8, 9, or 10 (on a scale of 0 to 10).
- The trade ally reported having installed at least some high-efficiency equipment without an incentive from the Smart $aver® Prescriptive Program during the evaluation period.
- The trade ally gave a rating of 8, 9, or 10 (on a scale of 0 to 10) for the importance of their recommendation on installations of high-efficiency equipment that did not receive an incentive from the Smart $aver® Prescriptive Program.
- The trade ally's open-ended response about why customers with high-efficiency installations did not receive an incentive from the program did not contradict that non-incented, high-efficiency installations qualified as SO.

Figure 5-3 presents a diagram of the TA SO eligibility determination methodology used for this evaluation, including references to question numbers.

Figure 5-3. Trade Ally Eligibility for Spillover - Methodology



For each respondent who met these qualifying conditions, we determined SO savings from the non-incented, high-efficiency installations through:

- Survey questions about:
  - The respective shares of the trade ally's total high-efficiency installations that did and did not receive a program incentive;
  - The level of increase in the percentage or total volume of high-efficiency installations, and whether factors other than the program contributed to the increase; and
  - For trade allies who could not report the respective shares of total high-efficiency installations that did and did not receive a program incentive: The size of non-incented, high-efficiency installations relative to those that did receive an incentive (resulting in a "Size Adjustment" factor).
- Program-tracking data on the savings associated with the Smart $aver® Prescriptive Program projects for that respondent.

For respondents who met the five main qualifying conditions outlined above, SO savings were considered to be equal to a portion of the savings of their non-incented, high-efficiency installations. SO for each qualifying trade ally respondent (i) is calculated using the following equation. Data inputs to this formula are further described in the Appendix.

$$\text{TA SO Respondent}_i = \left(\frac{\text{Savings from Program Database}_i}{\text{\% Efficient Installations that Received Incentive}_i} - \text{Savings from Program Database}_i \right) * \text{Attribution Factor}_i * \text{Size Adjustment}_i$$

To extrapolate savings to the program, we developed a "Respondent SO Ratio" by dividing the sum of the estimated SO savings by total program savings associated with all survey respondents. We then applied this Respondent SO Ratio to program savings associated with all trade allies (whether a survey respondent or not) to derive the overall SO estimate (in MWh). Finally, we estimated the "Program-level SO Ratio" by dividing the overall SO estimate (in MWh) by total program ex post savings (in MWh). This final step is necessary to normalize the SO rate to the entire Smart $aver® Prescriptive Program, taking into account that some customers complete projects without a trade ally.

Since many trade allies completed projects in both DEC's and DEP's service territory, we conducted the TA SO analysis across both jurisdictions.

A more detailed description of the TA SO algorithm can be found in the Appendix.

5.2 Net-to-Gross Results

We estimate the program-level NTGR to be 88.4% for DEC and 79.5% for DEP. For all three analysis groups (main channel lighting, main channel non-lighting, and midstream lighting) the DEC NTGRs are higher than the equivalent DEP NTGRs. For both jurisdictions, the lighting NTGRs (for both channels) are higher than the non-lighting NTGRs.

Table 5-1 presents the individual NTG components (i.e., FR, PSO, and TA SO) and the resulting NTGRs by jurisdiction and channel/technology group (i.e., lighting and non-lighting). The NTGR is calculated as 1 – FR + PSO + TA SO.

Table 5-1. Summary of DEC and DEP NTG Results

	Free-Ridership	Participant SO	Trade Ally SO	NTGR [a]
DEC				
Main Channel Lighting	18.1%	0.04%	7.0%	88.9%
Main Channel Non-Lighting	26.7%			80.3%
Midstream Lighting	11.5%	0.10%	-	88.6%
TOTAL DEC	**15.3%**	**0.07%**	**3.6%**	**88.4%**
DEP				
Main Channel Lighting	31.2%	0.04%	7.0%	75.8%
Main Channel Non-Lighting	34.5%			72.5%
Midstream Lighting	15.9%	0.10%	-	84.2%
TOTAL DEP	**24.3%**	**0.06%**	**3.8%**	**79.5%**

[a] NTGR = 1 – FR + PSO + TA SO

In addition to the results presented in Table 5-1, we rolled-up NTG results to the channel level (across lighting and non-lighting projects) and to the lighting level (across the two delivery channels), by jurisdiction. These results are shown in Table 5-2.

Table 5-2. Summary of Channel- and Technology-Level NTG Results

	Free-Ridership	Participant SO	Trade Ally SO	NTGR [a]
DEC				
Main Channel	18.9%	0.04%	7.0%	88.2%
Lighting	14.8%	0.07%	3.5%	88.7%
DEP				
Main Channel	31.5%	0.04%	7.0%	75.5%
Lighting	23.8%	0.07%	3.6%	79.9%

[a] NTGR = 1 – FR + PSO + TA SO

5.2.1 Free-Ridership

A total of 172 main channel participants and 140 midstream participants provided valid responses to the FR questions in the participant surveys and were included in the FR analysis. Using the algorithm summarized in Section 5.1.1, we estimate program-level FR to be 15.3% for DEC and 24.3% for DEP. For all three analysis groups (main channel lighting, main channel non-lighting, and midstream lighting) the DEC FR estimates are lower than the equivalent DEP estimates. For both jurisdictions, the lighting FR estimates (for both channels) are lower than the non-lighting ones.

Relative precision levels for all FR estimates are 6.2% or better at 90% confidence. It should be noted that we attempted a census for main channel non-lighting projects. As such, the concept of relative precision does not apply to these analysis groups.

Table 5-3 summarizes the FR estimates for the six analysis groups as well as DEC and DEP totals, including precision levels.

Table 5-3. Summary of DEC and DEP FR Estimates

Project Type	n	Free-Ridership	NTGR (1-FR)	Relative Precision (90% Conf.)
DEC				
Main Channel Lighting	58	18.1%	81.9%	5.0%
Main Channel Non-Lighting	49	26.7%	73.3%	n/a
Midstream Lighting	75	11.5%	88.5%	2.1%
TOTAL DEC	**182**	**15.3%**	**84.7%**	**2.5%**
DEP				
Main Channel Lighting	52	31.2%	68.8%	6.2%
Main Channel Non-Lighting	13	34.5%	65.5%	n/a
Midstream Lighting	65	15.9%	84.1%	5.1%
TOTAL DEP	**130**	**24.3%**	**75.7%**	**3.8%**

Participants' free-ridership related survey responses show the following:

- **Efficiency:** Interviewed participants generally reported a high degree of program influence on the efficiency level of their projects, resulting in savings-weighted Efficiency FR Scores ranging from 0.19

(DEC midstream) to 0.35 (DEP main channel non-lighting). Program influence on efficiency was higher for:

- DEC participants compared to DEP participants;
- Lighting projects compared to non-lighting projects; and
- The midstream channel compared to the main channel.

- **Quantity:** The program had a significant influence on the scope of many incented projects, in particular lighting projects. Respondents with lighting projects reported that between 43% (DEP midstream and main channel) and 58% (DEC midstream) of the efficient lighting would not have been installed at the same time without the program. Notably, the share of non-lighting measures that would not have been installed at the same time without the program is much smaller than the share of lighting measures (33% DEC; 8% DEP), suggesting that customers have more flexibility in the scope of lighting projects and that the program was successful in encouraging them to make additional upgrades.
- **Timing:** Responses to the timing questions show trends similar to the quantity questions: Participants reported that the program was responsible for a greater acceleration of lighting projects compared to non-lighting projects. The resulting timing adjustment factors, applied to the quantity that participants would not have installed at the same time without the program, range from 0.44 (DEC midstream) to 0.60 (DEP main channel) for lighting projects compared to 0.71 (DEC) to 0.95 (DEP) for non-lighting projects.[11]
- **Quantity and Timing Adjustment:** Combining the responses to the quantity and timing questions resulted in overall Quantity and Timing Adjustments ranging from 0.60 (DEC midstream) to 0.98 (DEP main channel non-lighting), meaning that the program can claim credit for 40% (1 − 0.60 = 0.40) of DEC midstream savings but only 2% (1 – 0.98 = 0.02) of DEP main channel non-lighting savings that would be considered free-rider savings based on efficiency alone.
- **Program Awareness:** Few participants reported having learned about the program *after* they selected the equipment for which they received an incentive. For these participants, we reduced the Preliminary NTGR by 50%, resulting in adjustments of between 0.98 (DEC main channel non-lighting and DEP main channel lighting) and 1.00 (DEC main channel lighting). Note that for the midstream channel, we set the Program Awareness Adjustment to 1.0, i.e., no adjustments, since the concept of program awareness does not apply.

The following two figures summarize FR results for DEC and DEP participants, respectively, using the diagram presented in Figure 5-1.

[11] A higher factor means a lower adjustments, i.e., less program influence on the timing of the project.

Figure 5-4. Free-Ridership Results – DEC

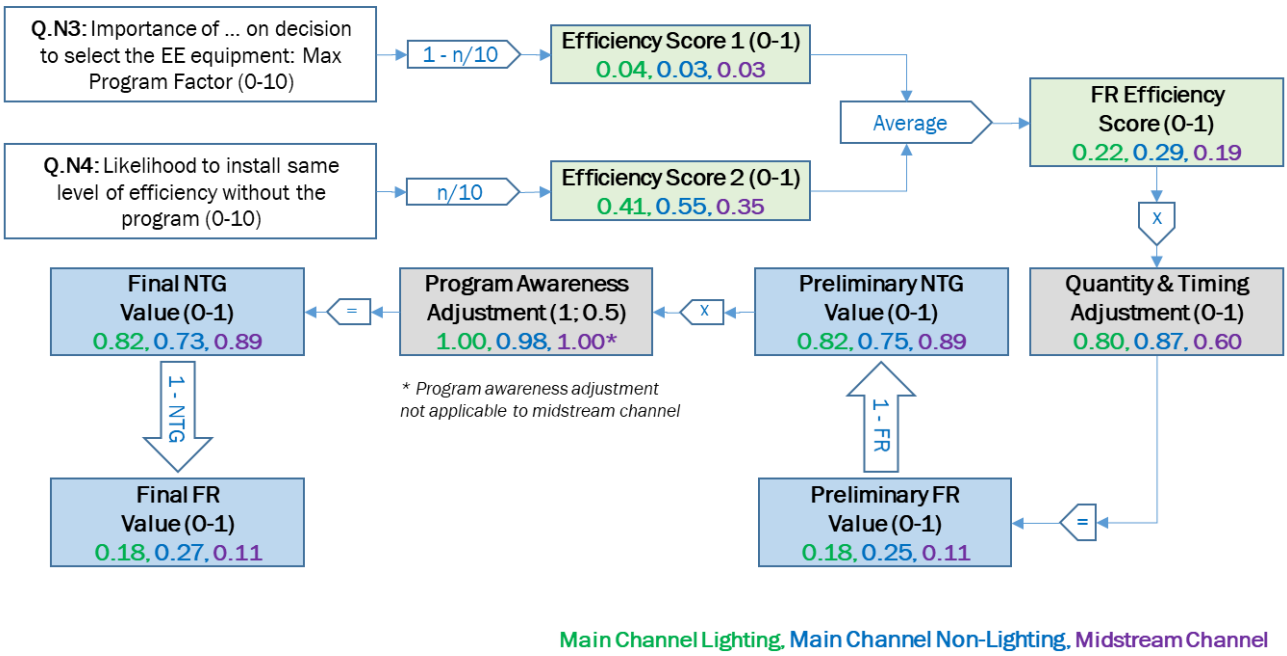
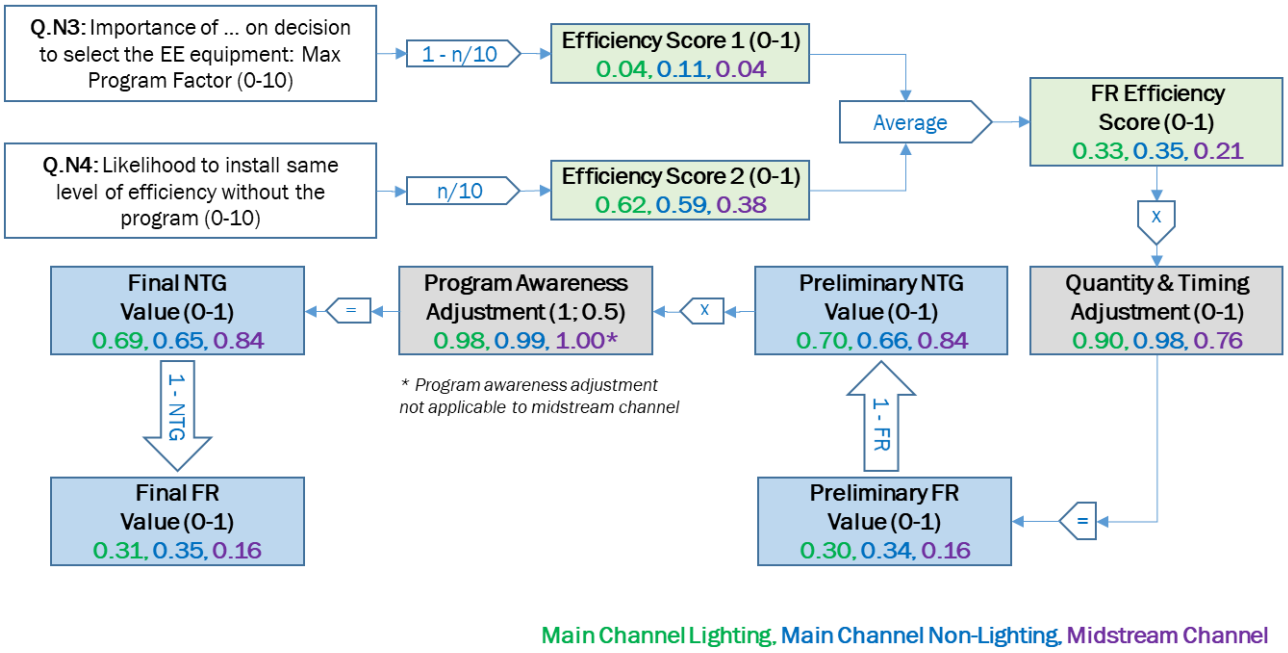


Figure 5-5. Free-Ridership Results – DEP

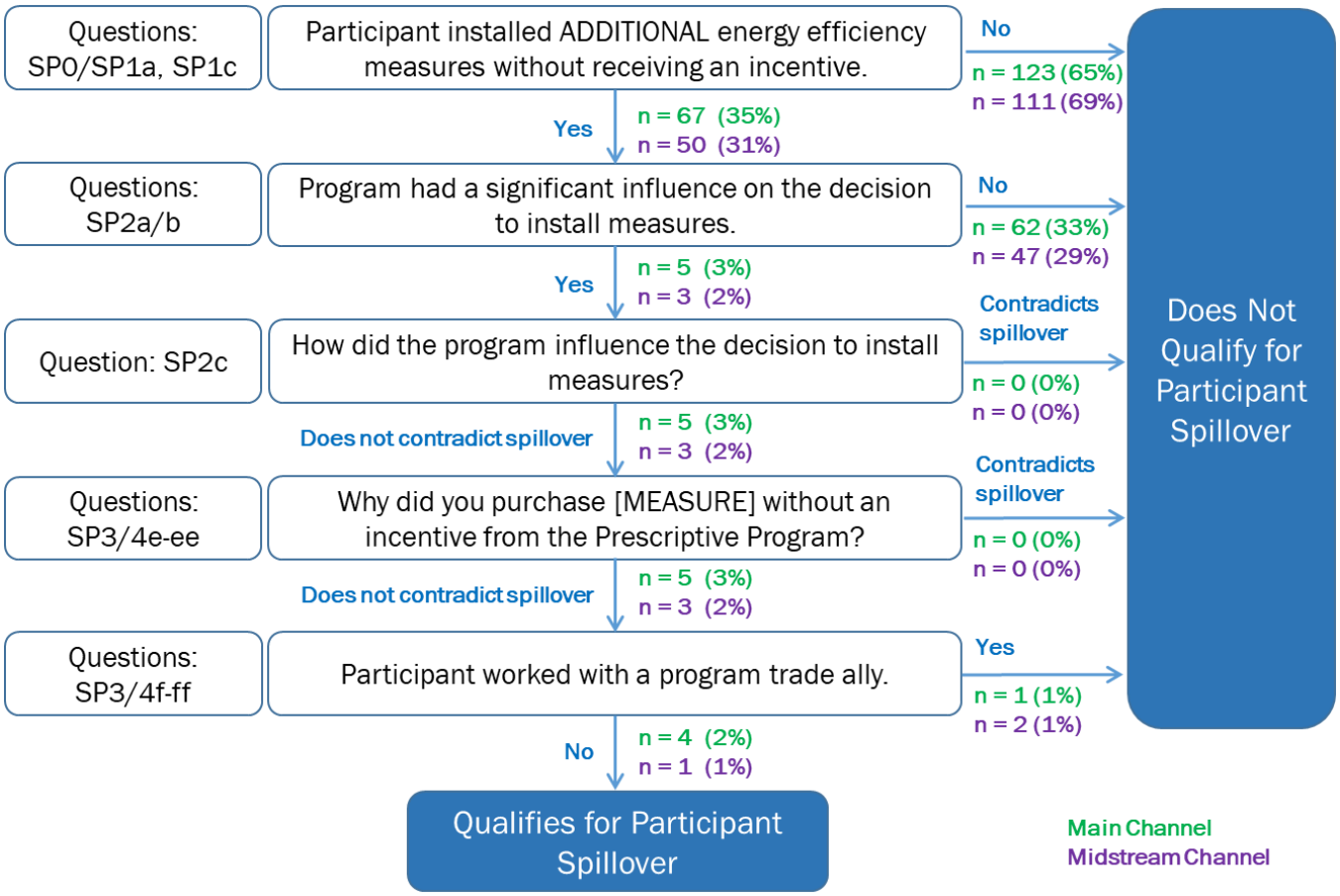


5.2.2 Participant Spillover

A total of 190 main channel participants and 161 midstream participants completed the SO questions in the participant surveys and were included in the PSO analysis. Most of these participants did not install any additional energy efficiency measures without receiving an incentive (65% main channel and 69% midstream channel) or did install additional measures but were not influenced by the program (33% main channel and 29% midstream channel). Four main channel respondents (2%) and one midstream channel survey respondent (1%) qualified for PSO.

Figure 5-6 summarizes the analysis of PSO eligibility, using the diagram presented in Figure 5-2.

Figure 5-6. Participant Eligibility for Spillover - Results



Of the four main channel respondents with PSO, two did not provide sufficient information in the survey to quantify PSO and could not be reached for a follow-up interview. Following discussion with Duke Energy evaluation staff, we made the conservative decision to set PSO savings for these two participants to zero. The other two main channel respondents and the one midstream channel respondent who qualified for PSO installed the lighting measures summarized in Table 5-4. We used the measure types and quantities reported by the respondents and the program's ex post deemed savings values for these measures to determine PSO savings.

Table 5-4. Summary of Measure-Level Participant Spillover

Participant	Measure	Quantity	Analysis Summary	kWh Per-unit	Total kWh
Main Channel					
#1	Linear LEDs	16	Deemed savings value for 4ft 1-LED tube replacing T8	77	1,233
#2	LEDs	16	Deemed savings value for 4ft 1-LED tube replacing T8	77	1,233
	Outside Lights	4	Deemed savings value for exterior HID replacement (up to 175W retrofit)	347	1,389
#3	LEDs	Unknown	Could not reach respondent for follow-up questions. Made conservative assumption of zero PSO savings.	n/a	0
#4	Unknown Process Equipment	Unknown	Could not reach respondent for follow-up questions. Made conservative assumption of zero PSO savings.	n/a	0
TOTAL MAIN CHANNEL					3,855
Midstream Channel					
#1	LEDs	15	Deemed savings value for 2x4 LED panels replacing T8	219	3,288
	Occupancy sensors	9	Deemed savings value for occupancy sensor per watt (@40 watts)	1.436	517
	Linear LEDs	24	Deemed savings value for 4ft 1-LED tube replacing T8	77	1,849
TOTAL MIDSTREAM CHANNEL					5,654

To determine the PSO Rate for each channel, we divided the channel's PSO savings by the total ex post gross savings of the sampled projects completed by the survey respondents. This calculation yielded a PSO rate of 0.04% for the main channel and of 0.10% for the midstream channel.

$$\text{PSO Rate–Main Channel} = \frac{\text{PSO in Main Channel Sample}}{\text{Ex Post Gross Impacts in Main Channel Sample}} = \frac{3{,}855\ kWh}{10{,}553{,}552\ kWh} = 0.04\%$$

$$\text{PSO Rate–Midstream Channel} = \frac{\text{PSO in Midstream Channel Sample}}{\text{Ex Post Gross Impacts in Midstream Channel Sample}} = \frac{5{,}654\ kWh}{5{,}935{,}688\ kWh} = 0.10\%$$

5.2.3 Trade Ally Spillover

A total of 146 main channel trade allies completed the SO section of the online survey. Three-quarters of responding trade allies (75%) reported increases in either the percentage or the total volume of their high-

efficiency installations and two-fifths (40%) attribute these increases to the program.[12] Trade allies most often credit the program incentive for the increases in energy-efficient installations, pointing specifically to reduced upfront costs and payback periods and a better return on investment (ROI). However, trade allies also pointed to market factors unrelated to the program that contributed to increases in high-efficiency sales, such as longer term energy savings and product quality and performance.

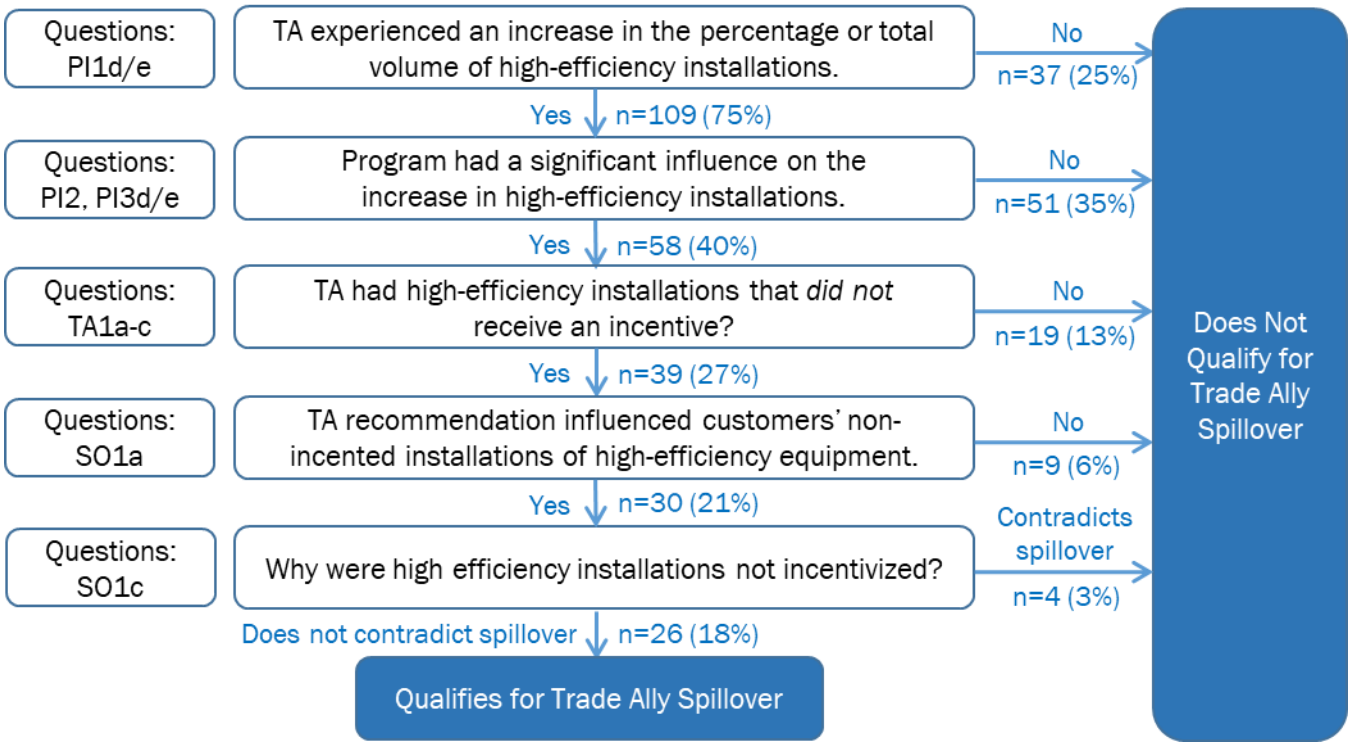
Close to three-quarters of trade allies (72%) reported having had at least one high-efficiency project that did not receive a program incentive during the evaluation period. On average, trade allies reported that 15% of their installations during the evaluation period were standard efficiency, while 64% were high efficiency and received an incentive and 21% were high efficiency and did not receive an incentive. On average, trade allies estimated that non-incented, high-efficiency installations were smaller, about 66% the size of those that received an incentive from the Smart $aver® Prescriptive Program.

Trade allies also reported that it was not too common for projects that receive an incentive from Duke Energy to also include high efficiency equipment that is not included in the incentive application (37% slightly common and 30% not at all common). When this does happen, the most common reason is that the non-incented products are not eligible for incentives through the Smart $aver® Prescriptive Program.

Overall, 18% of responding trade allies qualified for TA SO. Those who did not qualify experienced no increase in their energy-efficient installations (25%); were not influenced by the program (35%); did not have any non-incented, high-efficiency installations (13%); did not think that their recommendations influenced their customers' choice of non-incented, high-efficiency equipment (6%); or provided an open-ended response that contradicted the presence of SO (3%). Figure 5-7 summarizes these TA SO eligibility results.

[12] The Appendix contains additional details on trade ally responses to survey questions about changes to their business practices since becoming a trade ally and the program's influence on these changes.

Figure 5-7. Trade Ally Eligibility for Spillover – Results



Trade allies who qualified for SO most often indicated that the high-efficiency installations were completed without an incentive because the equipment did not qualify for program incentives, because the projects were too small to justify the paperwork, or because the customer had opted out of Duke Energy's energy efficiency programs. Non-incented high-efficiency equipment includes various types of LED lighting (sometimes not eligible for incentives or only eligible in a different category). A few trade allies also mentioned non-lighting equipment, such as solar, EC motor upgrades, compressors, and valves.

We estimated SO savings for each of the trade allies who qualified for SO (26 respondents, or 18%) using the trade ally's program savings from the program-tracking database as well as their survey responses on (1) the share of high-efficiency installations that received a program incentive; (2) the level of increase in the percentage or total volume of high-efficiency installations, and whether factors other than the program contributed to the increase; and (3) the relative size of incented and non-incented projects (for trade allies who could not report the respective shares of total high-efficiency installations that did and did not receive a program incentive). Respondent-level TA SO savings ranged from 272 kWh to just under 3,000 MWh.

Table 5-5 summarizes the results of the respondent-level TA SO savings.

Table 5-5. Summary of Respondent-Level Trade Ally Spillover

Trade Ally	Ex-Post Gross Program Savings (kWh)	Percent of High-Efficiency Installations That Received Incentive	Attribution Factor	Estimated SO Savings (kWh)
#1	2,977,872	50%	100%	2,977,872
#2	9,774,528	65%	25%	1,315,802
#3	696,053	65%	100%	374,798

Trade Ally	Ex-Post Gross Program Savings (kWh)	Percent of High-Efficiency Installations That Received Incentive	Attribution Factor	Estimated SO Savings (kWh)
#4	1,087,942	66%	50%	276,877
#5	65,795	10%	50%	296,076
#6	1,370,610	83%	100%	274,122
#7	84,348	13%	50%	274,131
#8	2,126,611	95%	100%	111,927
#9	605,824	75%	50%	100,971
#10	713,567	83%	50%	71,357
#11	520,023	89%	100%	65,003
#12	202,640	80%	100%	50,660
#13	212,224	67%	50%	53,056
#14	342,483	85%	50%	30,219
#15	630,999	95%	100%	33,210
#16	1,082,303	98%	100%	22,088
#17	234,180	93%	100%	18,014
#18	549,580	95%	50%	14,463
#19	70,455	66%	25%	8,965
#20	154,335	89%	25%	4,823
#21	8,822	66%	100%	4,490
#22	23,697	80%	50%	2,962
#23	9,676	74%	100%	3,456
#24	7,148	89%	100%	893
#25	22,063	93%	50%	788
#26	3,342	75%	25%	272
Total				**6,387,294**

The SO savings from these trade allies (accounting for 6,387 MWh) were used to extrapolate SO savings for the population of participating trade allies. Using the methodology described in Section 5.1.3, we estimated a Respondent SO Ratio of 7.7% and a Program-level SO Ratio of 7.0%.

5.3 Net Impact Results

Table 5-6 and Table 5-7 present the ex post net impacts for DEC and DEP, respectively, that result from applying the evaluation NTGRs to ex post gross savings.

The DEC program realized net energy savings of approximately 426 GWh during the evaluation period. The main channel contributed 215 GWh to this total while the midstream channel contributed 204 GWh and the Business Savings Store contributed 7 GWh.

Table 5-6. Summary of DEC Net Program Savings

Technology	Ex Post Gross			NTGR	Ex Post Net		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)		Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Main Channel	**243,946,395**	**44,453**	**42,831**	**0.88**	**215,112,095**	**39,161**	**37,820**
Lighting	*223,443,824*	*40,278*	*39,829*	*0.89*	*198,641,559*	*35,807*	*35,408*
Pumps and Drives	*9,604,616*	*1,425*	*1,478*	*0.80*	*7,715,772*	*1,145*	*1,188*
HVAC	*6,659,752*	*2,278*	*1,050*	*0.80*	*5,350,045*	*1,830*	*844*
Food Service	*2,784,828*	*213*	*202*	*0.80*	*2,237,164*	*171*	*162*
Process	*1,453,375*	*260*	*272*	*0.80*	*1,167,554*	*209*	*218*
IT	-	-	-	*0.80*	-	-	-
Midstream Channel	**230,286,322**	**40,071**	**39,616**	**0.89**	**204,029,075**	**35,502**	**35,099**
Lighting	*230,076,090*	*39,876*	*39,615*	*0.89*	*203,842,814*	*35,329*	*35,098*
Non-Lighting	*210,232*	*196*	*2*	*0.89*	*186,261*	*173*	*1*
Business Savings Store	**7,813,947**	**1,194**	**1,286**	**0.89**	**6,923,001**	**1,058**	**1,140**
TOTAL DEC	**482,046,663**	**85,719**	**83,734**	**0.88**	**426,064,171**	**75,722**	**74,059**

The DEP program realized net energy savings of approximately 141 GWh during the evaluation period. The main channel contributed 72 GWh to this total while the midstream channel contributed 68 GWh and the Business Savings Store contributed less than 1 GWh.

Table 5-7. Summary of DEP Net Program Savings

Technology	Ex Post Gross			NTGR	Ex Post Net		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)		Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Main Channel	**95,034,465**	**16,442**	**15,678**	**0.76**	**71,780,071**	**12,413**	**11,852**
Lighting	*86,819,822*	*14,852*	*14,628*	*0.76*	*65,821,580*	*11,260*	*11,090*
Pumps and Drives	*1,694,655*	*232*	*211*	*0.73*	*1,229,218*	*168*	*153*
HVAC	*4,366,481*	*1,174*	*785*	*0.73*	*3,167,227*	*851*	*569*
Food Service	*832,522*	*56*	*54*	*0.73*	*603,870*	*41*	*39*
Process	*143*	-	*0.3*	*0.73*	*104*	-	*0.2*
IT	*1,320,842*	*128*	-	*0.73*	*958,073*	*93*	-
Midstream Channel	**81,128,776**	**14,066**	**13,956**	**0.84**	**68,303,128**	**11,842**	**11,750**
Lighting	*81,053,594*	*14,003*	*13,955*	*0.84*	*68,239,832*	*11,790*	*11,749*
Non-Lighting	*75,182*	*62*	*1*	*0.84*	*63,296*	*52*	*1*
Business Savings Store	**967,368**	**111**	**134**	**0.84**	**814,437**	**93**	**113**
TOTAL DEP	**177,130,609**	**30,618**	**29,768**	**0.80**	**140,897,636**	**24,348**	**23,714**

6. Process Evaluation

The process evaluation for the **main channel** focused on program processes, customer and trade ally satisfaction with the program, program strengths and weaknesses, and opportunities for program improvement. Our research focused on areas of change, e.g., the new pre-approval process, as well as areas of interest identified by program staff, e.g., the status of the commercial lighting market and remaining opportunities for lighting and non-lighting upgrades.

For the **midstream channel**, the process evaluation was limited to an assessment of participant satisfaction.

6.1 Researchable Questions

The process evaluation explored the following questions:

- How effective are the program implementation practices?
- Are participants and trade allies satisfied with their program experiences?
- What is the level of awareness and interest in the new pre-qualification option? How satisfied are customers and trade allies with this process? Is it effective in increasing the reach of the program?
- What are the strengths, weaknesses, and opportunities for program improvement?
- What are key barriers to the installation of energy-efficient equipment and program participation? How can the program increase the share of savings from non-lighting measures?
- What is the status of the non-residential lighting market (from the point of view of participating trade allies)?
- What are remaining opportunities for energy efficiency upgrades for lighting and non-lighting measures?

6.2 Methodology

The process evaluation relied primarily on an analysis of responses to the surveys with main channel participants, midstream participants, and participating main channel trade allies. These survey efforts are described in more detail in Section 3, including sample design, the number of completed interviews, and response rates. To support the process evaluation, we also developed participant survey weights, developed cross-tabulations of survey responses, and conducted significance testing for all three surveys, as described below.

Participant Survey Weights

The sample designs of both participant surveys were based on the needs of the impact analysis and oversampled projects with larger savings and, for the main channel survey only, projects with non-lighting technologies. To ensure that aggregated responses to process questions are representative of the population, we developed process weights, which reflect each stratum's percentage of projects in the population divided by its percentage of projects in the sample.

Table 6-1 summarizes the process weights for the main channel participant survey.

Table 6-1. Main Channel Participant Survey Process Weights

Stratum	Population (n=11,172)	Survey Completes (n=170)	Weight
DEC Lighting Large	2%	8%	0.24
DEC Lighting Medium	20%	12%	1.73
DEC Lighting Small	38%	15%	2.50
DEC Non-Lighting Large	<1%	1%	0.21
DEC Non-Lighting Medium	1%	7%	0.19
DEC Non-Lighting Small	9%	18%	0.49
DEP Lighting Large	1%	4%	0.30
DEP Lighting Medium	8%	12%	0.66
DEP Lighting Small	15%	16%	0.94
DEP Non-Lighting Large	<1%	3%	0.10
DEP Non-Lighting Medium	1%	2%	0.50
DEP Non-Lighting Small	4%	3%	1.46

Table 6-2 summarizes the process weights for the midstream participant survey.

Table 6-2. Midstream Channel Participant Survey Process Weights

Stratum	Population (n=12,526)	Survey Completes (n=147)	Weight
DEC Lighting Large	1%	4%	0.35
DEC Lighting Medium	18%	25%	0.73
DEC Lighting Small	54%	22%	2.48
DEP Lighting Large	1%	2%	0.40
DEP Lighting Medium	6%	16%	0.39
DEP Lighting Small	19%	31%	0.62

Cross-Tabulation of Survey Results

For each of the three surveys, we developed detailed survey results tables showing weighted response frequencies for all process-related survey questions and cross-tabulations of responses for subgroups of interest. These survey results can be found in the Appendix.

We used the following subgroups for cross-tabulations:

Main Channel Participant Survey:

- Jurisdiction: DEC participants versus DEP participants
- Type of project: Lighting projects versus non-lighting projects
- Size of projects: Small projects versus medium/large projects

Midstream Participant Survey:

- Jurisdiction: DEC participants versus DEP participants
- Size of company: Fewer than 50 employees versus 50 or more employees
- Size of projects: Small projects versus medium/large projects

Trade Ally Survey:

- Type of projects: Only lighting projects versus one or more non-lighting projects
- Number of projects: Fewer than 5 projects versus 5 or more projects completed during the evaluation period
- Jurisdiction: Predominantly DEC versus predominantly DEP
- Company's geographic reach: Local companies versus regional/national companies

It should be noted that the survey results tables included in the Appendix include both valid and non-valid responses (generally "unsure" responses). In contrast, most of the process analyses presented in this report consider only valid responses. As a result, percentages shown in the survey tables may not always align with the results presented in the subsections below. In addition, all results shown in the results tables for the participant surveys, including the number of respondents, are weighted. While process results in this report are weighted as well, the underlying number of responses ("n") is on an unweighted basis, so again may not match numbers in the survey results tables.

Significance Testing

We conducted significance testing to determine if differences in responses between the subgroups included in the cross-tabulations are statistically significant. We compared (1) percentages, using the Independent Z-Test for Percentages; and (2) means, using the Independent T-Test for Means (unequal variances). Throughout this section, we report differences in responses only if they are statistically significant at a 90% confidence level. The detailed survey results in the Appendix identify statistically significant differences between all subgroups and for all questions.

6.3 Key Findings – Main Channel

Below, we present key findings related to this evaluation's researchable questions.

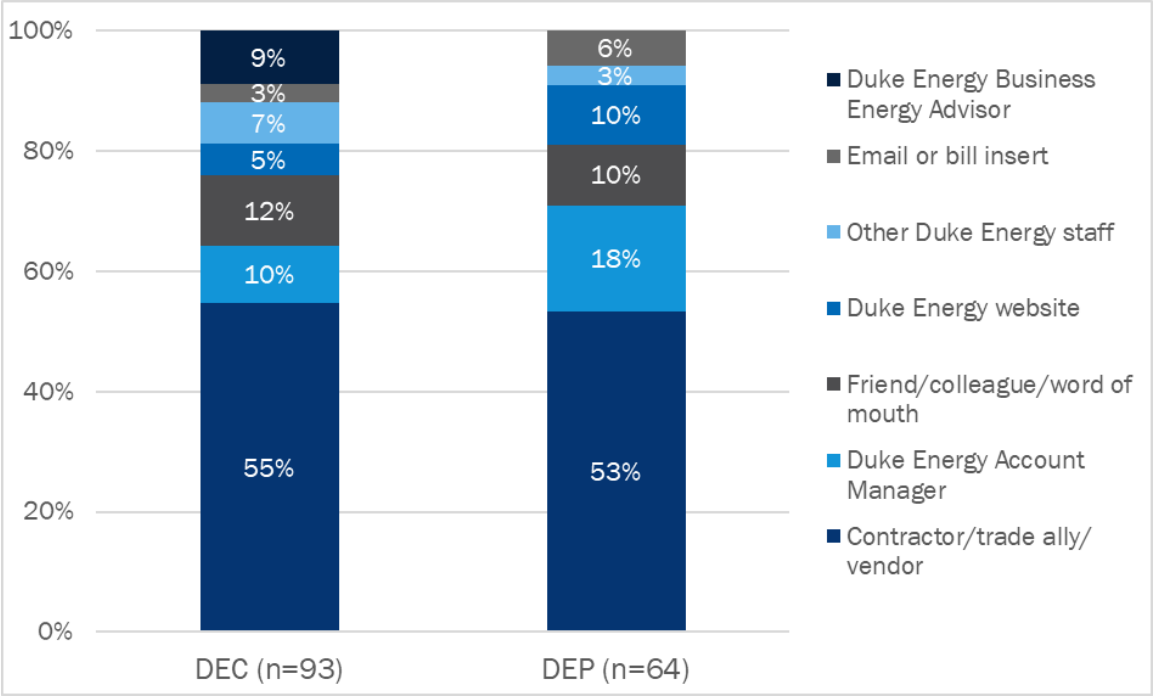
6.3.1 Sources of Program Information

The Smart $aver® Prescriptive Program relies on Duke Energy staff—including program staff, BEAs, and Large Business Account Managers—and trade allies working together to drive customer awareness and participation in the program. Main channel trade allies play a particularly important role in promoting the program as they are in direct contact with customers at the time of equipment replacement/installation.

The main channel participant survey included questions about program awareness and sources of program information, and responses confirmed the importance of trade allies in driving program awareness: Over half of respondents (55% DEC, 53% DEP) first heard about the program from a contractor, trade ally, or vendor. Other important sources of program awareness were Duke Energy staff (including Account Managers, BEAs,

and other staff; 25% DEC , 21% DEP), word of mouth (12% DEC, 10% DEP), and the Duke Energy website (5% DEC, 10% DEP). Figure 6-1 summarizes these results.

Figure 6-1. Participant Sources of Program Information



Most respondents also reported working with a contractor or vendor to assist with the selection of equipment (79% DEC, 75% DEP). Almost half (44% DEC, 49% DEP) of respondents said the contractor or vendor was the most influential in identifying the installed equipment, followed by the respondents themselves (40% DEC, 35% DEP).

6.3.2 Pre-Qualification Option

During the evaluation period, the Smart $aver® Prescriptive Program introduced an option for trade allies and customers to pre-qualify their incentive applications. Under this option, trade allies or customers can submit an incentive application for review by program staff to (1) ensure that the product they plan to install is eligible and (2) receive documentation of the incentive level. If approved, the application is pre-qualified for 90 days.[13]

To explore customer and trade ally views of this new pre-qualification option, the main channel participant and trade ally surveys included short modules on this topic, including questions about awareness and prior use, benefits and satisfaction, and the likelihood of future use.

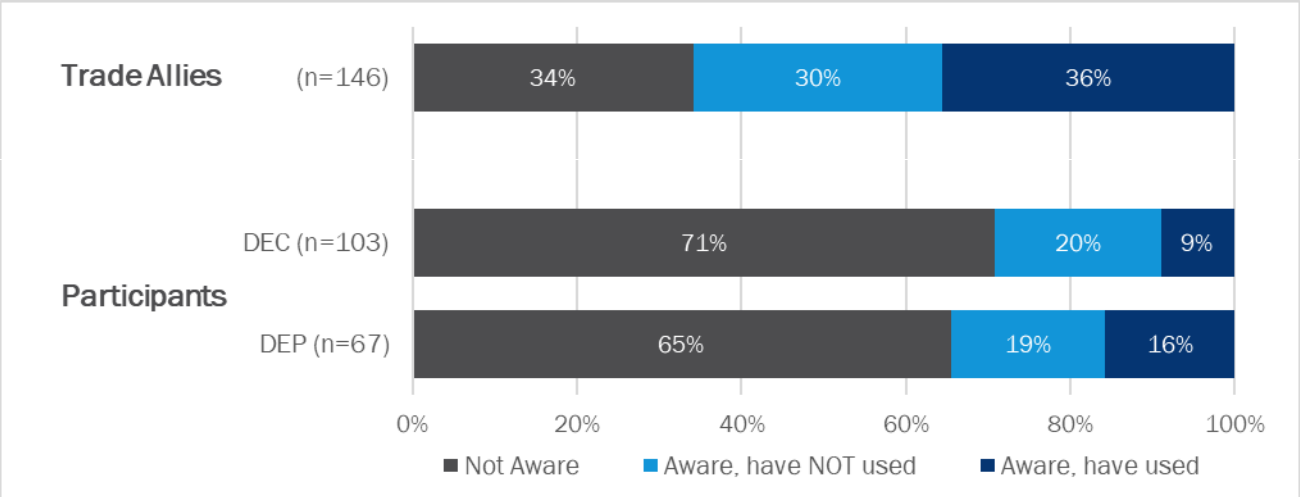
Awareness and Prior Use

Not surprisingly, awareness of the pre-qualification option is higher among trade allies (66%) than among participating customers (29% DEC, 35% DEP). Trade allies are also more likely to have taken advantage of the

[13] Unlike in the Midwest, the pre-qualification in DEC and DEP service territory does not include a "reservation" (or guarantee) of incentive funds.

pre-qualification option than customers. Figure 6-2 shows trade ally and customer awareness and prior use of the pre-qualification offering.

Figure 6-2. Awareness and Prior Use of the Pre-Qualification Option



Benefits and Satisfaction

Among trade allies who have used the pre-qualification option, 54% reported that it had an impact on the *number* of projects completed, while 37% reported that it had an impact on the *type* of projects completed. Trade allies see the certainty of knowing that the equipment will qualify and what the incentive amount will be as the main benefits of the pre-qualification option. Several interviewed trade allies also noted that the pre-qualification option saves time and speeds up the application and rebate process. Notably, several responses suggest that trade allies believe that the incentive is "set aside" or "guaranteed." The program may wish to more clearly communicate to trade allies that pre-qualification does not mean that incentives are reserved, especially if the program should ever be in a situation of potentially exhausting its incentive budgets.

Trade ally satisfaction with the pre-qualification option is high, with a mean rating of 8.2 on a scale of 0 to 10 (where 0 means "extremely dissatisfied" and 10 means "extremely satisfied"). Only 8% of trade allies who have used the pre-qualification option reported having experienced an issue with it. The only issue noted by more than one interviewed trade ally was related to having to provide the customer's account number:

> *"Hard to find customers using their address. Not the biggest deal as you can just ask for their account number. Would make life easier if the search functionality was more intuitive."*

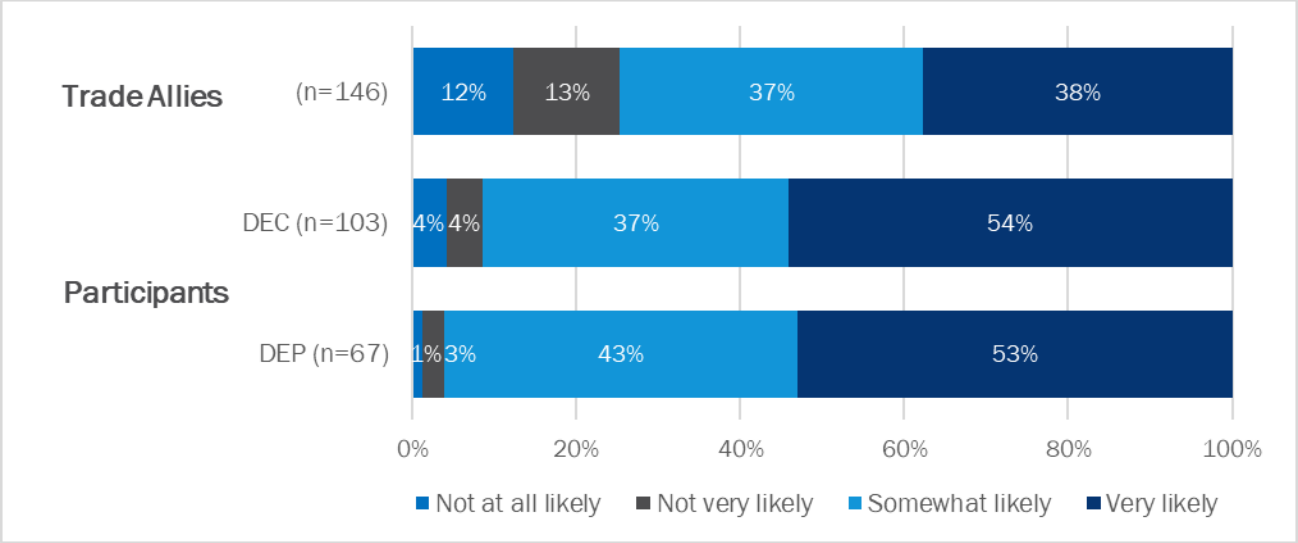
Among participants who have used the pre-qualifying option, 81% reported an impact on the type of equipment installed, 52% on the quantity of equipment installed, and 39% on the ability to complete the project. Similar to trade allies, participants see the certainty of knowing that the equipment will qualify and what the incentive amount will be as the main benefits of the pre-qualification option. Several interviewed participants noted that this can be helpful to secure budget approval for their projects.

Participant satisfaction with the pre-qualification option is very high, with a mean rating of 9.0 on a scale of 0 to 10, and only 4% of participants who have used the pre-qualification option reported having experienced an issue with it.

Likelihood of Future Use

Once aware of the pre-qualification option's availability, most interviewed participants (91% DEC, 96% DEP) reported being somewhat or very likely to use it in the future (see Figure 6-3). While still high, the likelihood among trade allies to use the option in the future is somewhat lower compared to customers (75%). Those not likely to use the option going forward most often noted that they are familiar with qualifying equipment and incentive levels and therefore do not find it necessary to pre-qualify their applications. Others noted that going through the pre-approval process can delay project timelines.

Figure 6-3. Likelihood of Using the Pre-Qualification Option for Future Projects



6.3.3 Program Satisfaction

The participant and trade ally surveys explored satisfaction with the Smart $aver® Prescriptive Program overall, as well as with individual program components. All satisfaction questions asked respondents to rate their satisfaction on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied." Consistent with Duke Energy's practices, we categorized numeric responses as follows:

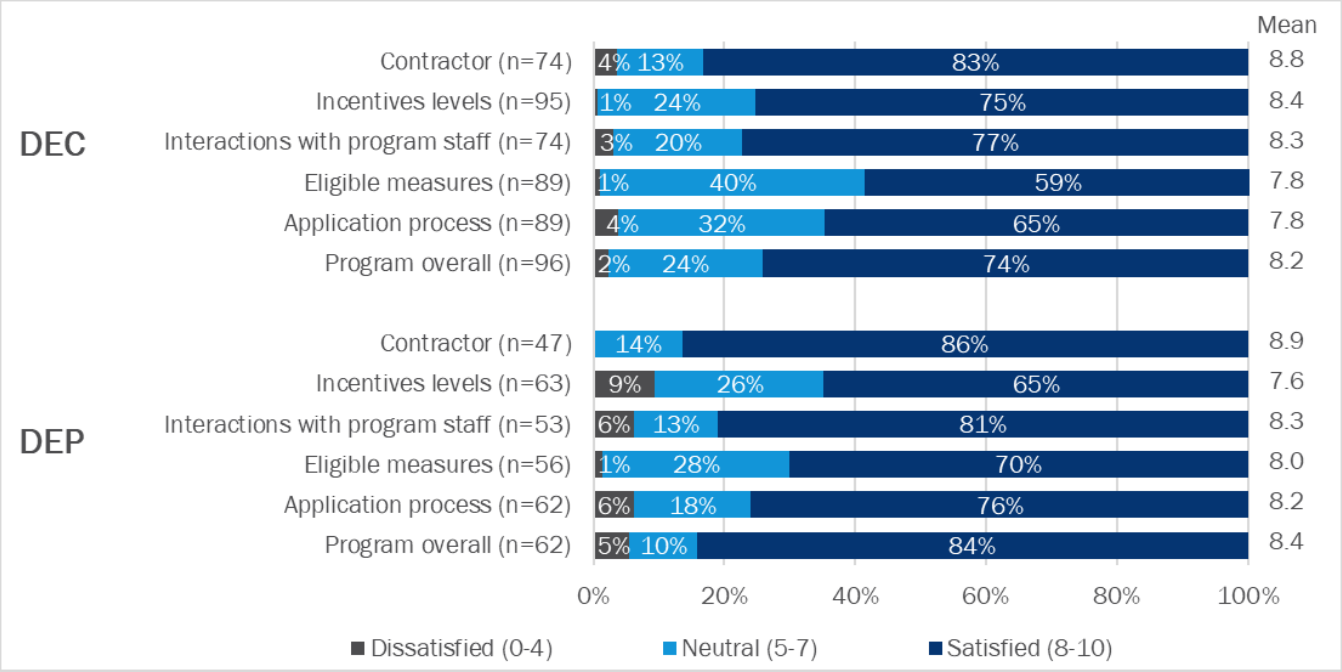
- 0 to 4 = "Dissatisfied"
- 5 to 7 = "Neutral"
- 8 to 10 = "Satisfied"

Participant Satisfaction

Participants in the main channel are generally very satisfied with their program experience and with most program components. All program components included in the survey received a mean rating of 7.6 or higher, and the program overall was rated an average of 8.2 by DEC participants and 8.4 by DEP participants. Both DEC and DEP participants are most satisfied with contractors who installed the equipment (mean satisfaction rating of 8.8 DEC and 8.9 DEP). DEC participants are least satisfied with the application process and eligible measures (mean rating of 7.8), while DEP participants are least satisfied with incentive levels (mean rating of 7.6).

Figure 6-4 summarizes main channel participant responses to the satisfaction questions.

Figure 6-4. Main Channel Participant Satisfaction with Program Components



Additional findings related to main channel participant satisfaction include:

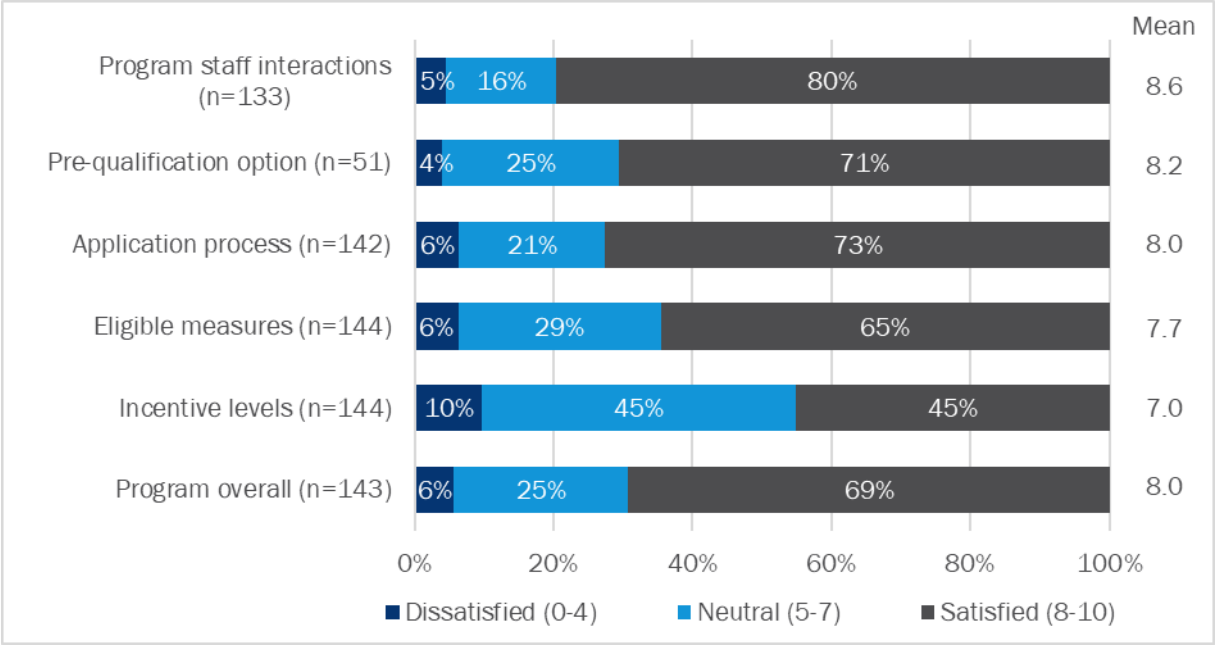
- **Application process:** The main source of reduced satisfaction was that the application process is complicated and tedious and requires a lot of detailed information. Several respondents noted a lack of clarity of what was required, and one suggested that a workflow sheet might be helpful.
- **Eligible measures:** The most common suggestion among less-than-satisfied participants was that the list of eligible measures is too specific and therefore too limited. In addition, a few respondents offered measure categories they felt could benefit from additional eligible measures, including new construction, exterior lighting, and HVAC.
- **Incentive levels:** Most participants who were less than satisfied with incentive levels did not name specific measures for which they would like to see higher incentive levels. One interviewed participant suggested a more direct correlation between efficiency levels and incentive levels, while another noted that incentives sometimes are not enough to cover the cost of the vendor to complete the application.

Trade Ally Satisfaction

In general, trade allies are satisfied with the program but gave satisfaction ratings slightly lower than those given by main channel participants. Mean trade ally satisfaction ratings for program components range from 7.0 to 8.6, with trade allies expressing particularly high satisfaction with program staff interactions. Trade allies expressed lower satisfaction with incentive levels (mean rating of 7.0). The mean rating for the program overall was 8.0, with 69% of trade allies providing a "satisfied" rating.

Figure 6-5 summarizes responses to the trade ally satisfaction questions.

Figure 6-5. Trade Ally Satisfaction with Program Components



Additional findings related to trade ally satisfaction include:

- **Application process:** Similar to participants, the main complaint voiced by less-than-satisfied trade allies is that the application process can be time consuming, lengthy, and difficult to navigate and that better educational materials would be helpful. Several interviewed trade allies noted that as a result of this process, they now go through the midstream channel or sometimes skip the program altogether. A few trade allies also noted that due to confusions in the process, their customers missed out on some rebates or the trade ally had to absorb the cost.
- **Eligible measures:** There was no consensus among less-than-satisfied trade allies as to what additional measures the program should offer, suggesting that there are no obvious gaps in the program. A few specific recommendations included options for 8-foot fixtures, a wider range of DLC-approved fixtures, and more clarity on what lights are eligible, e.g., basing eligibility on wattages rather than listing specific makes and models.
- **Incentive levels:** Trade allies who were less than satisfied with incentive levels often pointed to decreasing lighting incentive levels over time, which they believe has had an adverse effect on the number and scope of LED projects. This is due not only to the incentive amount covering less of the incremental cost (they believe the reduction in incentives has outpaced the reduction in LED prices)

but also to the uncertainty it introduces for longer-term planning. Some trade allies also suggested better alignment of incentive levels with energy savings, e.g., higher incentives for DLC premium fixtures.

- **Program staff interactions:** While program staff interactions received generally high satisfaction ratings, several trade allies mentioned that program staff can be hard to reach and that responses are sometimes delayed. A few trade allies mentioned the need of a more direct line and/or assigned program representatives, which they thought would help in getting better and more consistent information.

6.3.4 Remaining Opportunities for Energy Efficiency Upgrades

As part of this evaluation, Duke Energy was interested in exploring remaining opportunities for energy efficiency upgrades among their customers. While a rigorous examination of remaining opportunities was outside the scope of this study, Opinion Dynamics added to the main channel participant and trade ally surveys questions to explore this topic. The subsections below present the results of this investigation for lighting and non-lighting equipment, respectively.

It should be noted that the results in this section represent a high-level and somewhat limited view of broader program opportunities. Customers often struggle to accurately self-report details about their energy-using equipment, such as efficiency levels. In addition, the surveys only included *participating* customers and trade allies, who may not be representative of their respective populations in terms of their equipment and their views on energy efficiency. The results in this section should be interpreted with these limitations in mind. To obtain a more rigorous picture of remaining opportunities, Duke Energy should consider conducting baseline research with the general population of customers and trade allies (rather than just participants) that also includes on-site visits (to collect reliable information on equipment characteristics).

Lighting Opportunities

Over the past few years, lighting projects have dominated the DEC and DEP Smart $aver® Prescriptive Program. As the lighting market evolves and LED lighting becomes more commonplace, Duke Energy seeks to better understand trends in the lighting market, the role of the Smart $aver® Program in customer decision-making, and remaining opportunities. To explore these topics, the main channel participant and trade ally surveys included questions about the following:

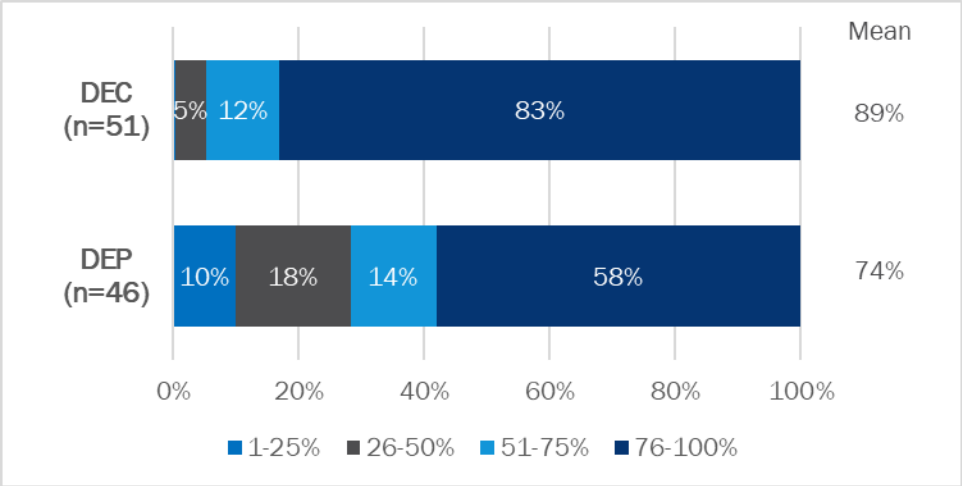
- Share of facility's lighting equipment updated through Smart $aver® lighting projects and type of lighting equipment not replaced (asked of main channel participants with lighting projects);
- Lighting equipment present at facilities (asked of main channel participants with non-lighting projects); and
- Lighting Market Trends and Drivers of LED Sales (asked of main channel trade allies who identified lighting as an area of expertise).

Scope of Lighting Projects and Equipment Not Replaced

On average, lighting projects completed through the program addressed 85% of interior lighting in participants' facilities (89% DEC, 74% DEP). More than one-third of lighting projects addressed 100% of interior lighting

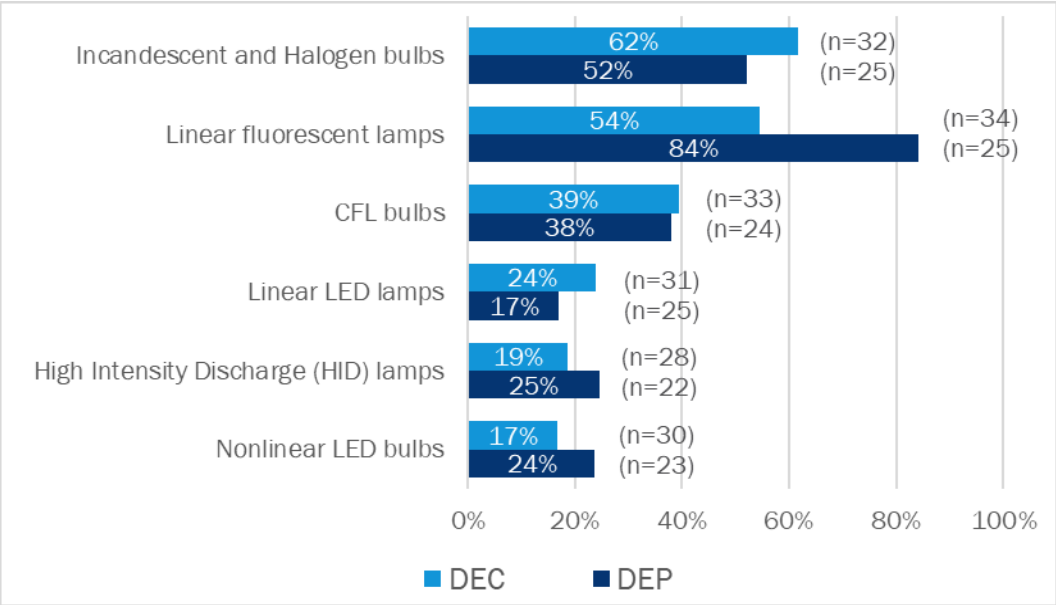
(36% DEC, 38% DEP), while only 12% of projects addressed 50% or less of interior lighting (5% DEC, 28% DEP).[14] Figure 6-6 summarizes these results.

Figure 6-6. Share of Interior Lighting Updated through Program



Most participants who did not update all of their interior lighting equipment through the program still have incandescent/halogen bulbs (62% DEC, 52% DEP) and linear fluorescents lamps (54% DEC, 84% DEP) present at their facilities. Of participants with remaining linear fluorescent lamps, most have T8 lamps (70% DEC, 63% DEP) and about half have T12 lamps (49% DEC, 46% DEP). It should be noted that some of the equipment that was not updated as part of the Smart $aver® project is already efficient equipment (linear and non-linear LEDs and CFLs). Figure 6 7 summarizes these results.

Figure 6-7. Percentage of Projects Where Lighting Not Updated by Type



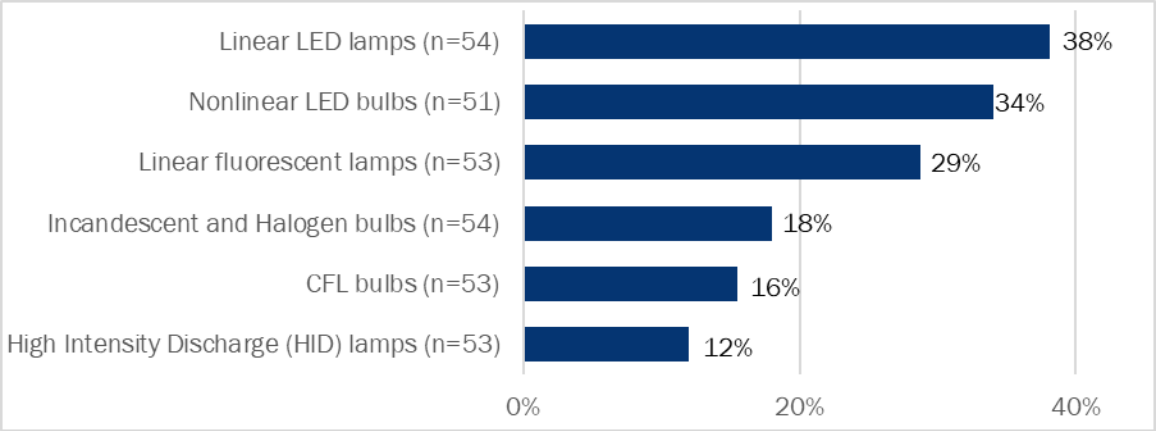
[14] Note that these results exclude lighting projects that only included exterior lighting measures.

Combined, these results suggest limited remaining opportunities for additional interior lighting projects among these participants.

Lighting Equipment Present at Facilities with Non-Lighting Projects

Among participants who completed non-lighting projects, linear LEDs (38%) and nonlinear LEDs (34%) are the bulb types most commonly present at their facilities. In contrast, less efficient technologies are present less frequently, incandescent and halogen bulbs at 18% of facilities and HID lamps at 12% of facilities (see Figure 6-8). Overall, only 11% of participants with non-lighting projects have no LEDs or CFLs at their facilities but 59% have at least some inefficient lighting technologies, including incandescent/halogen bulbs, HID lighting, or T8/T10/T12 linear fluorescent lighting, suggesting some remaining opportunities among this group of participants.

Figure 6-8. Penetration of Lighting Equipment Among Non-Lighting Participant Facilities



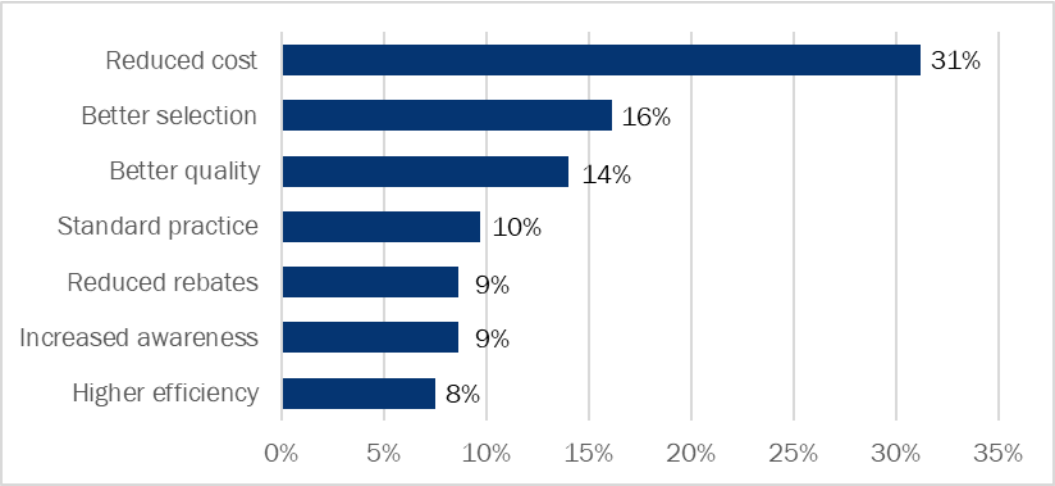
Lighting Market Trends and Drivers of LED Sales

To further explore remaining lighting opportunities, our trade ally survey included a series of questions about recent changes in the lighting market as well as the influence of the Smart $aver® Program on LED sales.

Trade allies most frequently identified reduced cost as the most important change in the lighting market over the past year (31%). In addition, increased selection (16%) – including greater varieties of styles, colors, and fixture sizes, and the integration of controls – and improvements in quality (14%) were frequently mentioned market changes. Interestingly, a number of interviewed trade allies mentioned reduced utility rebates as a recent change in the lighting market, and some noted adverse consequences on their sales. In the words of one interviewed trade ally:

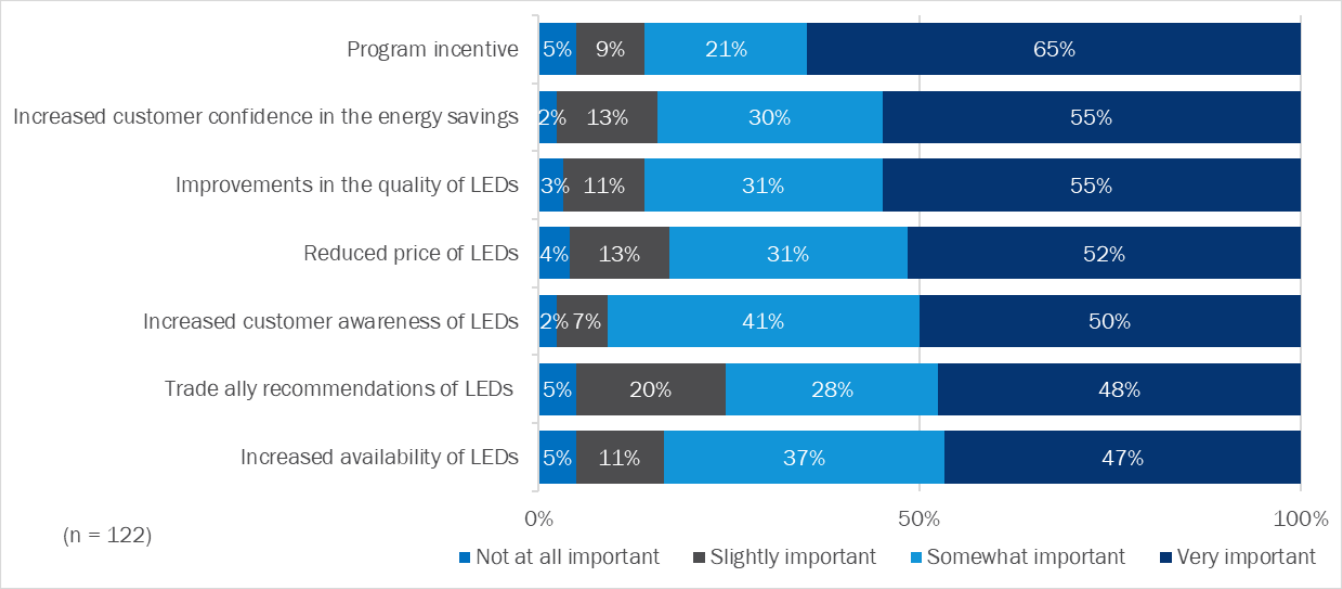
"Lots of utilities are starting to no longer reward LEDs stating that they are now the baseline for most projects but I don't agree with this action. A significant majority of the commercial market has still not converted to LEDs and many that were the early takers of LEDs 10 years ago are already looking to replace the fixtures because of the huge advances in LED drivers and optics."

Figure 6-9. Recent Changes in Lighting Market



When asked about factors contributing to the significant increase in the number of LEDs incented through the Smart $aver® Prescriptive Program, trade allies stressed the importance of the program incentive, with 65% considering it very important. However, trade allies also attributed high importance to other, market-based factors, including increased customer confidence in energy savings (55%), quality improvements (55%), price reductions (52%), and increases in customer awareness (50%; see Figure 6-10).

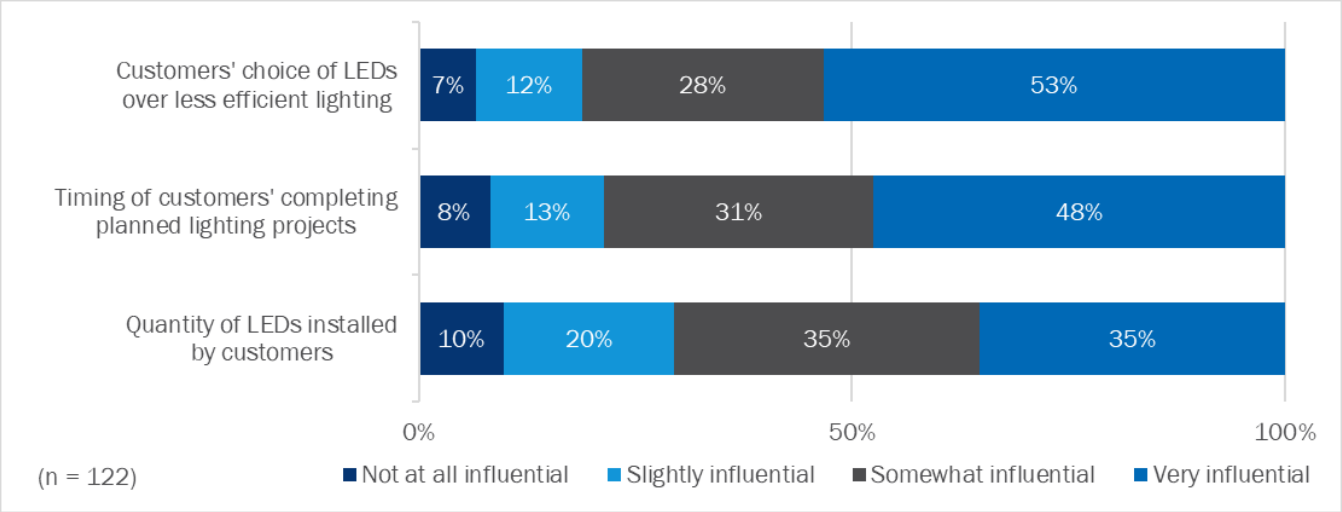
Figure 6-10. Key Factors Contributing to the Increase in LEDs Incented through the Smart $aver® Program



Trade allies also provided their perception of the influence of program LED incentives on customer projects in terms of the selected equipment as well as the timing and quantity of their lighting projects. Overall, trade allies believe that the program incentive has the highest influence on equipment selection, i.e., many customers would not select LEDs in the absence of the incentive (53% consider it very influential), followed by project timing, i.e., the incentive accelerates projects (48%). Trade allies attribute less of an influence on the size of LED projects (35%; see Figure 6-11).

These findings are consistent with free-ridership results based on participant self-report (see Section 5.2.1), which show a high program influence on lighting savings with equipment selection and project timing being key drivers of program attribution.

Figure 6-11. Influence of Program Incentives on Customer Projects



Non-Lighting Opportunities

Given the heavy reliance of the DEC and DEP Smart $aver® Prescriptive Program on savings from lighting projects, Duke Energy is interested in exploring opportunities to increase the contribution of non-lighting equipment to program savings. This evaluation included investigation of two related topics:

- Energy-using non-lighting equipment present at participants' facilities, including recent replacements/upgrades to this equipment and the efficiency level of those upgrades (asked of main channel participants); and
- Barriers to making energy-efficient improvements and participation in the Smart $aver® Program (asked of main channel participants and trade allies who identified at least one non-lighting technology as an area of expertise).

Energy-Using Non-Lighting Equipment and Recent Upgrades

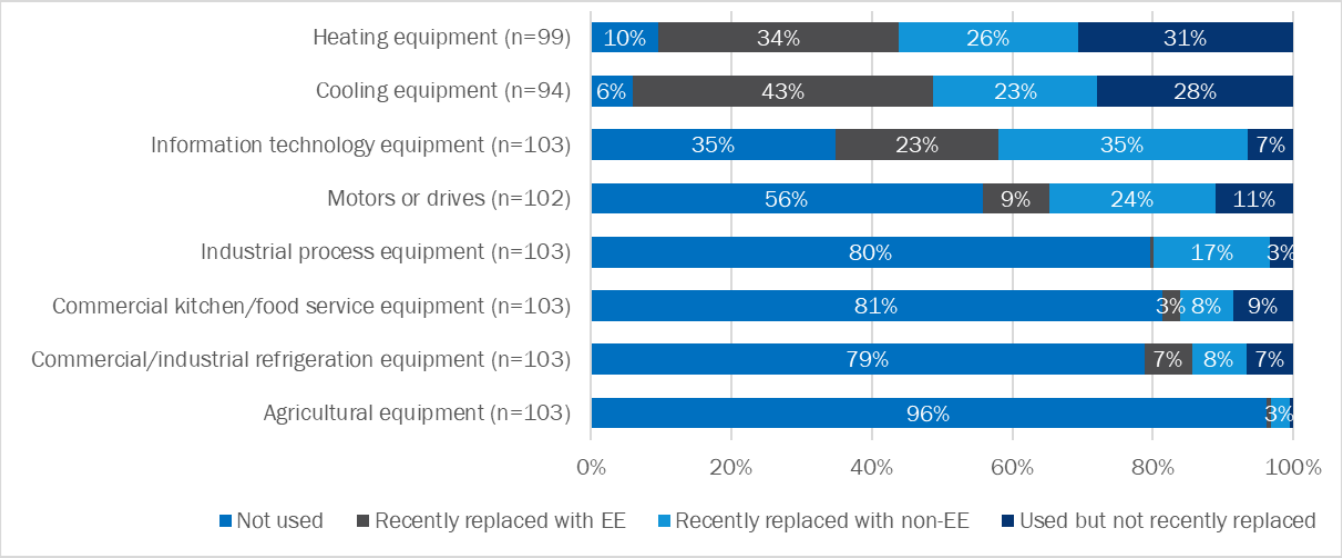
The most commonly used energy-using equipment at participating customers' facilities (other than lighting) includes heating (90% DEC, 77% DEP), cooling (94% DEC, 82% DEP), and information technology (65% DEC, 56% DEP). These three equipment types are also the most likely to have undergone energy-efficient upgrades

in the past five years.[15] Nevertheless, a large share of facilities with these equipment types have not recently made upgrades—or have made upgrades, but with standard-efficiency equipment—and might therefore present opportunities for future program participation.

While opportunities for other types of equipment appear more limited, it is difficult to draw definite conclusions from these results. As noted above, this analysis was limited to program participants (albeit for a different end-use) who may not be representative of other, non-participating customers in their equipment usage and replacement behaviors. For some equipment types, e.g., process equipment, it is also impossible to ascertain, based on a self-report survey, if existing equipment could be replaced or upgraded with program-eligible options. And finally, there is uncertainty about actual efficiency levels of recently replaced equipment, as customers often compare efficiency levels of their new equipment to that of their replaced equipment, which can lead to over-reporting of efficiency levels.

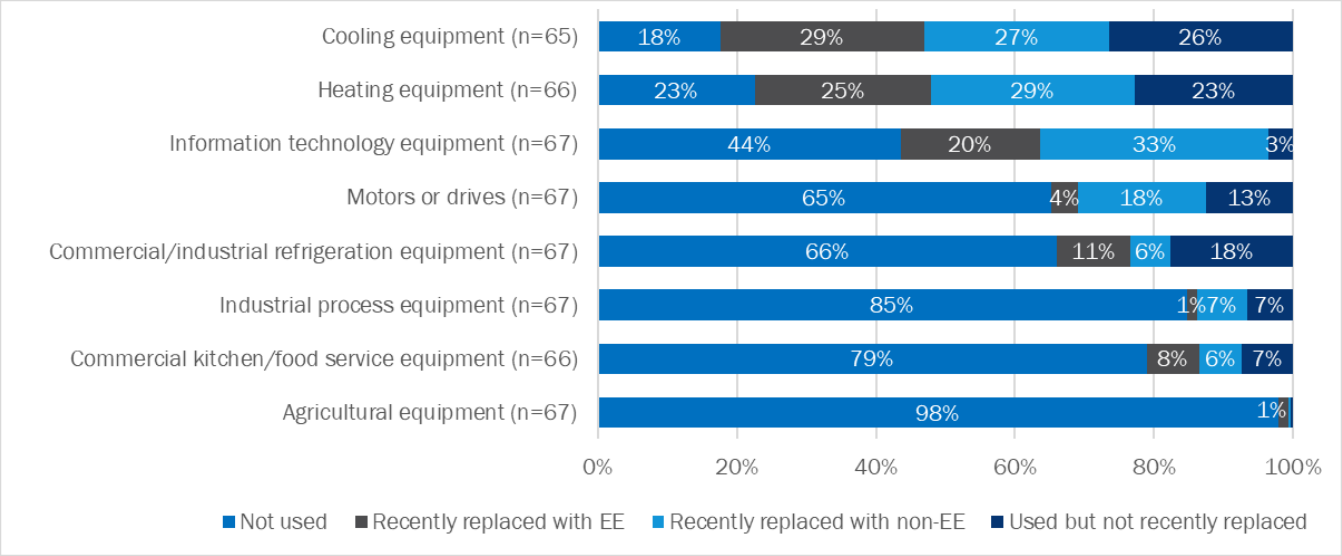
Figure 6-12 and Figure 6-13 summarize these results for DEC and DEP participants, respectively.

Figure 6-12. Opportunities for Non-Lighting Improvements – DEC



[15] In order to reduce potential biases, the numbers presented for each end-use *exclude* participants who received a program incentive for that end-use. For example, participants who received an incentive for cooling equipment are not included in the results for the cooling end-use as they, by definition, recently made energy-efficient upgrades.

Figure 6-13. Opportunities for Non-Lighting Improvements – DEP



Barriers to Energy Efficiency and Program Participation

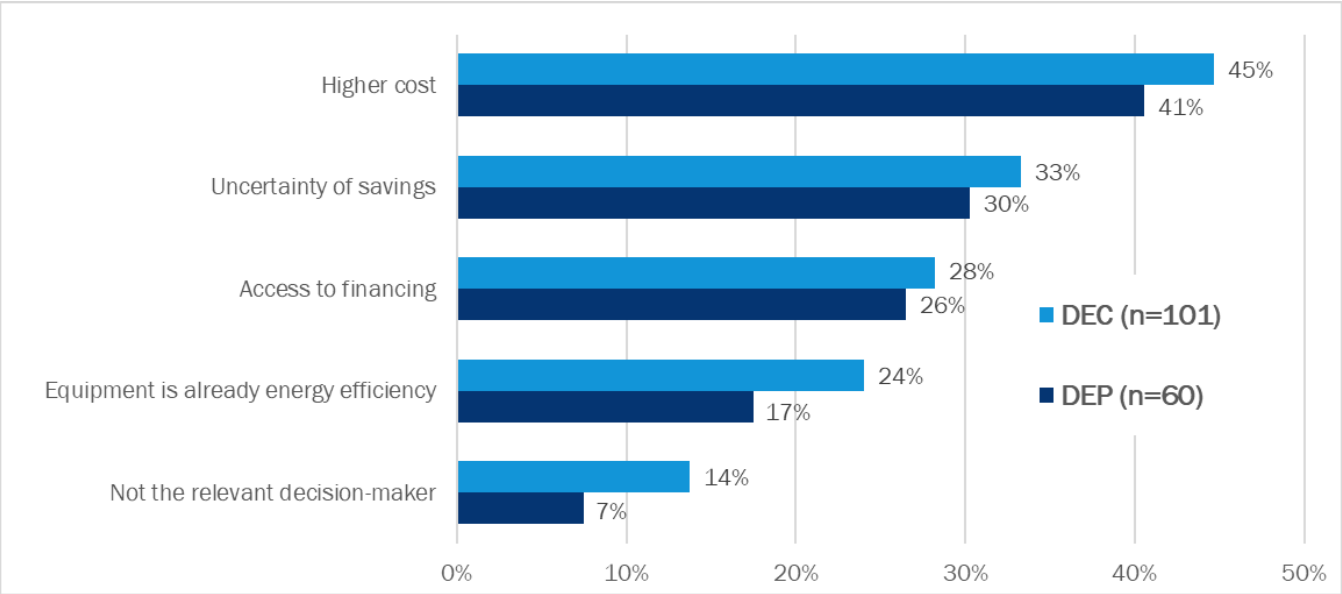
To further explore opportunities to increase non-lighting program participation, the main channel participant and trade ally surveys solicited feedback on barriers to customer adoption of energy-efficient non-lighting equipment, barriers to program participation, and actions Duke Energy could take to reduce those barriers. In addition, the trade ally survey asked trade allies to identify non-lighting measures that they believe have the most potential for increased program uptake.

Not surprisingly, both participants (45% DEC, 41% DEP) and trade allies (51%) pointed to upfront costs as a leading factor preventing the installation of energy-efficient non-lighting equipment. Uncertainty about likely energy savings and access to financing also ranked high for participants, while smaller shares of trade allies pointed to the complexity of some energy-efficient technologies, e.g., HVAC equipment, and lack of knowledge. Close to one-third of trade allies (32%) but smaller shares of participants (17% DEC, 11% DEP) did not see any barriers to installing energy-efficient non-lighting equipment.[16]

Figure 6-14 summarizes the top 5 barriers reported by main channel participants.

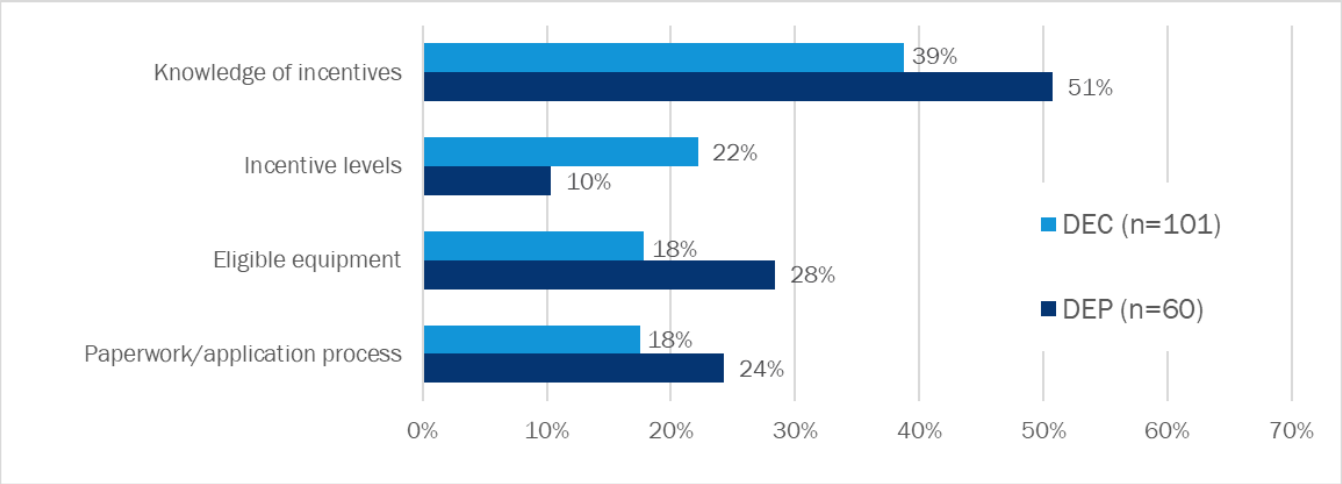
[16] Note that questions about barriers were prompted for participants but unprompted for trade allies.

Figure 6-14. Top 5 Customer Barriers to Making Energy-Efficient Non-Lighting Improvements



Trade allies and participants also agreed that awareness/knowledge of the program and available incentives is the most significant barrier to program participation (51% DEP participants, 39% DEC participants, and 16% trade allies). Smaller shares of participants also mentioned incentive levels, the equipment eligible for incentives, and the required paperwork as barriers (see Figure 6-15). Similarly, the program's application requirements (13%) and equipment cost (10%; suggesting that the incentive is not high enough to overcome the incremental cost barrier) were barriers noted by trade allies. Notably, 43% of interviewed trade allies with a non-lighting area of expertise did not see any barriers to non-lighting program participation, compared to 37% of DEC participants and 25% of DEP participants.[17]

Figure 6-15. Customer Barriers to Program Participation



[17] Note that questions about barriers were prompted for participants but unprompted for trade allies.

Consistent with the barriers identified by both trade allies and participants, the most common recommendations for increasing the uptake of energy-efficient non-lighting equipment were to increase both awareness and knowledge through more marketing and education, to provide higher incentives, and to simplify the application process. More specific suggestions provided by trade allies and participants included:

Trade Allies

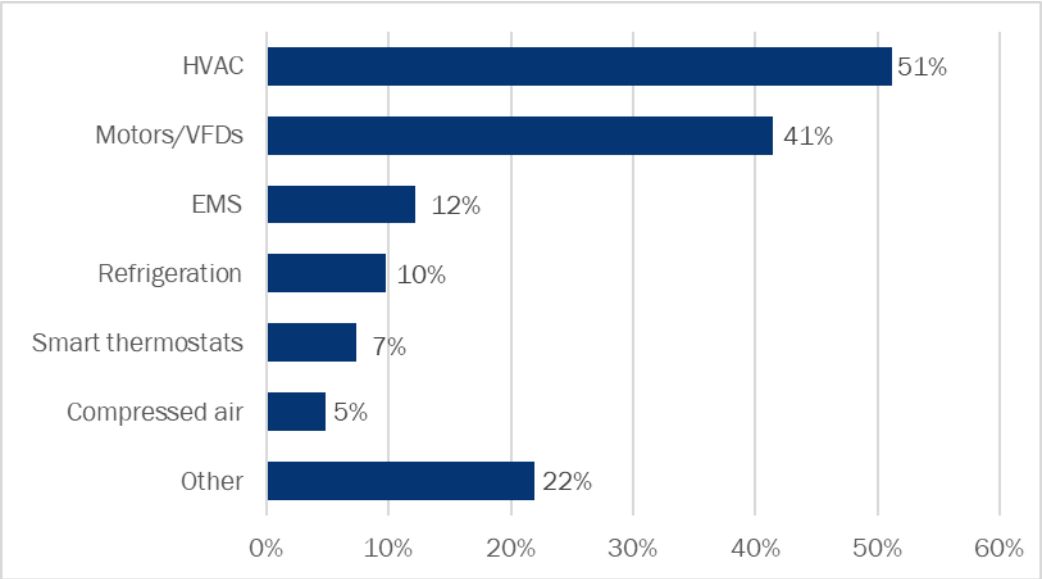
- *"I think if we had not just an email yearly but if a rep came by to discuss what we can key in on with our customers we would be more intuned to the opportunities and more likely to push them hard during the year."*
- *"Provide more education and training to trade allies. Provide case studies and best use cases of new products. Incentivize detailed energy audits for customers to showcase other ways to save energy besides lighting."*
- *"Make a simple but comprehensive list of 'if you did this, you could save this, and it would cost you this.'"*
- *"Provide calculation tools that make the determination of energy savings easier."*
- *"Review and re-publish new efficiency tiers to more accurately reflect actual higher-efficiency equipment capabilities."*

Participants

- *"We have done 4 lighting projects in which the contractors assisted with the Smart Saver, but have not used it for anything else, mostly because of the limited equipment and limited knowledge. Duke should really work on improving connections with smaller manufacturers and communicating the information more frequently, more effectively (newsletter, mailed materials, etc.)."*
- *"Assist in finding information on the different equipment that qualifies. Where do I go to find detailed info? How do compare an HVAC unit from a vendor quote to a unit that has a rebate?"*
- *"Work closely with a wide variety of companies to have a true understanding of their required equipment."*
- *"Have Duke Energy account manager reach out to City Staff on a more regular basis AND/OR have Duke Energy host bi-annual lunch & learns with select City Staff to present more info on Smart Saver Incentives. The latter will be a huge help."*
- *"Contact all businesses with newly approved building permits to ensure they are aware of the programs."*
- *"Keep all landlords informed. Create incentives for landlords to collaborate with leasing companies like ours and share the investment and savings."*

Finally, when asked about the types of non-lighting products with the most potential for increased uptake through the Smart $aver® Prescriptive Program, trade allies most often mentioned HVAC equipment (51%, including rooftop units and chillers) and motors/VFDs (41%; see Figure 6-16). Not surprisingly, these responses are correlated with the trade allies' self-reported equipment areas of expertise (61% HVAC, 48% motors/pumps/VFDs).

Figure 6-16. Non-Lighting Equipment with Potential for Increased Program Uptake



One interviewed trade ally noted the following about the potential for more HVAC projects:

"If HVAC incentives were higher, they might actually encourage the selection of very efficient units. Even if the timing of HVAC projects is generally non-discretionary, their effectiveness could be. Unfortunately, $30/ton is not going to push efficiency very hard in the right direction."

6.4 Key Findings – Midstream Channel

The midstream channel is a relatively new addition to the Smart $aver® Prescriptive Program. It launched in the DEC and DEP service territories in 2015 but was initially slow to gain traction. As such, it accounted for a relatively small fraction of program savings at the time of the last evaluation of this program (covering the period of August 2015 to February 2017 for DEC and March 2016 to February 2017 for DEP) and was not specifically targeted by evaluation activities. However, in 2017 and 2018, the midstream channel began gaining in popularity and started to see significant increases in participation. During the current evaluation period, the midstream channel accounted for 48% of DEC and 46% of DEP ex post gross energy savings. Given this significant contribution, this evaluation included a midstream participant survey to assess free-ridership, participant spillover, and limited process topics, including participant satisfaction.

6.4.1 Midstream Participation

During 2017 and 2018, the midstream channel focused heavily on lighting equipment. A total of 81 unique distributors participated in the program during the evaluation period, 74 selling discounted lighting equipment and 8 selling discounted non-lighting equipment (including HVAC and food service products). Many of these distributors were active in both service territories.

Overall, the 81 distributors accounted for over 12,500 "projects" – defined as one or more measures of the same technology purchased by the same customer (based on account number and name), at the same time, for the same location. Of these projects, 99.8% involved lighting equipment. Notably, the five most active distributors accounted for 44% of all midstream projects during the evaluation period.

Table 6-3 summarizes participation in the midstream channel during the evaluation period.

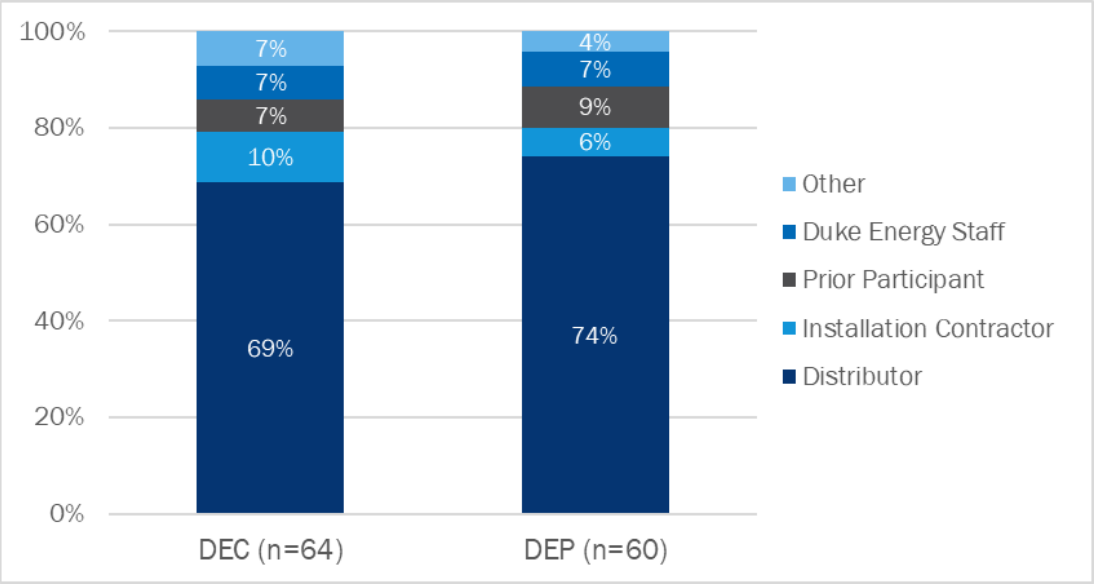
Table 6-3. Participation in the Midstream Channel

	TOTAL	DEC	DEP
Total Distributors	**81**	**75**	**58**
Lighting	*74*	*69*	*55*
Non-Lighting	*8*	*7*	*4*
Total Projects	**12,557**	**9,246**	**3,311**
Lighting	*12,526*	*9,228*	*3,298*
Non-Lighting	*31*	*18*	*13*

6.4.2 Participant Awareness and Equipment Selection

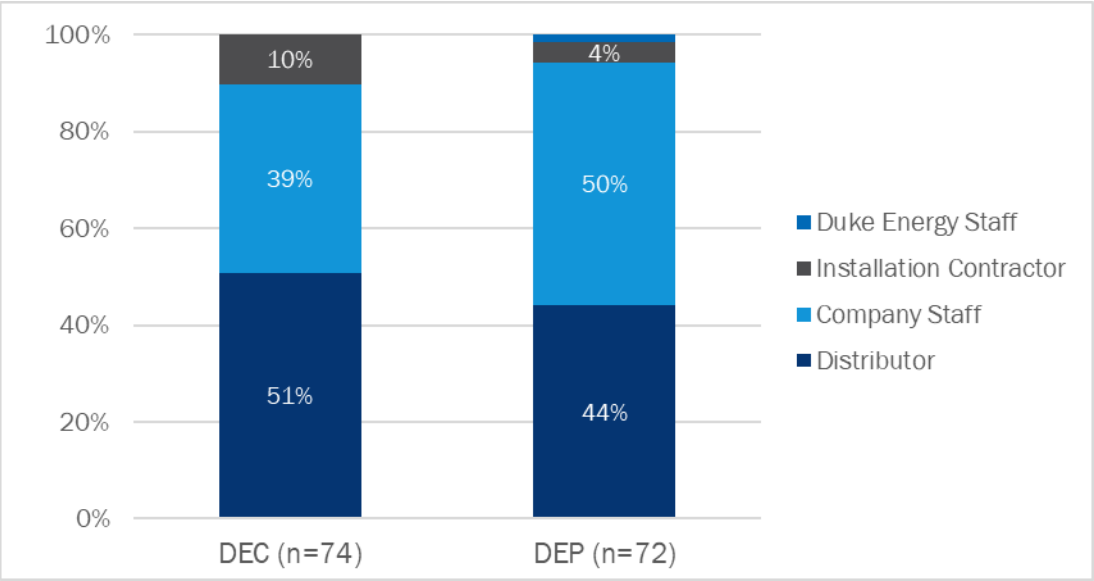
The vast majority of both DEC and DEP midstream respondents was aware of the discount at the time they purchased the equipment (91% DEC, 89% DEP), and almost all of them (97% DEC, 98% DEP) were aware that Duke Energy provided the discount. Participants aware of the discount most often learned about it from their distributor (69% DEC, 74% DEP; see Figure 6-17).

Figure 6-17. Participant Sources of Information about Discount



In addition to informing customers about the discount, distributors also play a key role in the equipment selection process. Based on survey responses, distributors helped most participants (92% DEC, 89% DEP) with the selection of their equipment. Distributors were the most influential party in the selection of the specific types of purchased equipment for 51% of DEC participants and 44% of DEP participants (see Figure 6-18).

Figure 6-18. Most Influential in Equipment Selection

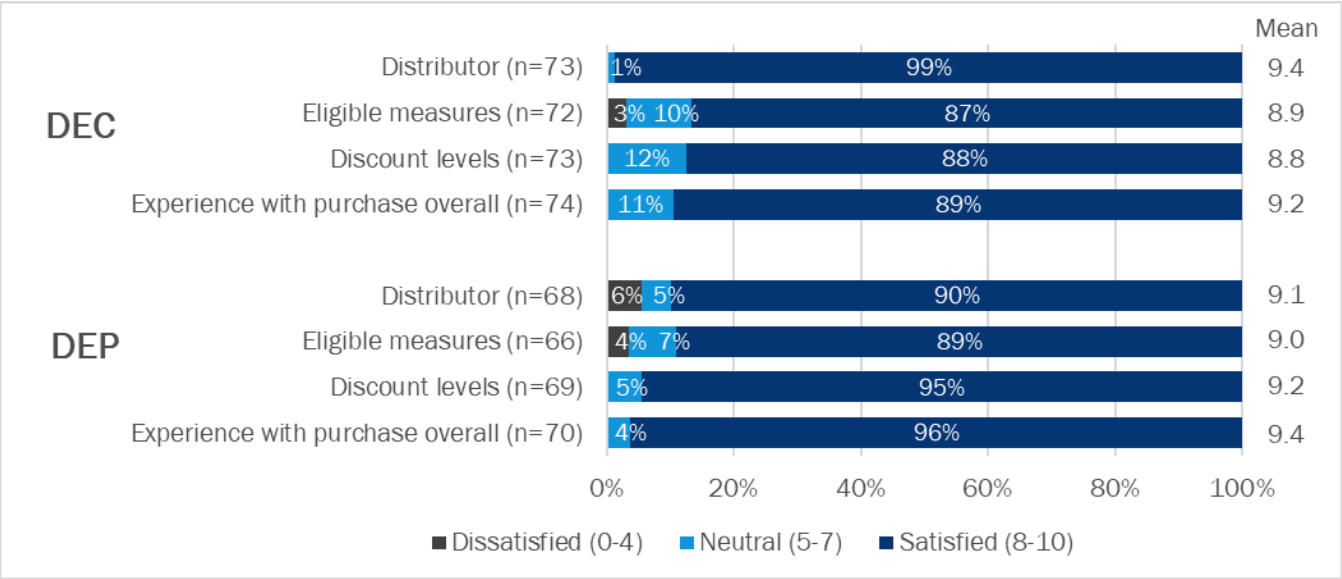


6.4.3 Participant Satisfaction

Midstream channel participants have a more limited exposure to the program and are subject to fewer program processes compared to main channel participants. Survey questions about participant satisfaction therefore focused on those program components applicable to this delivery channel. Similar to the main channel surveys, satisfaction questions in the midstream participant survey were asked on a scale of 0 to 10, where 0 means “extremely dissatisfied” and 10 means “extremely satisfied.”

Overwhelmingly, both DEC and DEP midstream participants expressed high satisfaction levels, giving mean ratings ranging from 8.8 to 9.4 (see Figure 6-19).

Figure 6-19. Midstream Participant Satisfaction with Program Components



While satisfaction by midstream participants was generally high, many respondents noted a general desire for more eligible measures and higher discounts. In addition, some respondents provided more specific comments and suggestions for improvement:

- Several respondents noted that more continuity in eligible measures and incentive levels would be helpful as frequent changes introduce uncertainty.
- Recommendations around eligible lighting measures included discounts for new equipment, not just the retrofit of existing fixtures, as well as offering a discount on all lamp lengths, including 8-foot lamps.
- A few respondents were unaware of the requirement to recycle the old lamps, noting that this introduced unexpected costs and hassle.

7. Summary Form

Duke Energy Carolinas/Duke Energy Progress Non-Residential Smart $aver® Prescriptive Program

Completed EM&V Fact Sheet

Program Description

The Duke Energy Carolinas/Progress Non-Residential Smart $aver® Prescriptive Program provides incentives to commercial and industrial customers for a range of measures, including lighting, HVAC systems, pumps and drives, process equipment, food service products, and information technology equipment. The program works with trade allies to promote the program and drive participation. The program also offers two alternative channels where customers can purchase a subset of products offered through the main channel at comparable incentive levels either directly from distributors as part of the midstream channel or through the online Business Savings Store.

Date	July 16, 2020
Region(s)	Duke Energy Carolinas (DEC) Duke Energy Progress (DEP)
Evaluation Period	March 1, 2017– December 31, 2018
Annual kWh Savings (ex post net)	DEC: 426,064 MWh DEP: 140,898 MWh
Coincident kW Impact (ex post net)	DEC: 75.7 MW (Summer), 74.1 MW (Winter) DEP: 24.3 MW (Summer), 23.7 MW (Winter)
Measure Life	Not Evaluated
Net-to-Gross Ratio	DEC: 88.4% DEP: 79.5%
Process Evaluation	Yes
Previous Evaluation(s)	DEC/DEP Smart $aver® Prescriptive Program, March 25, 2018

Evaluation Methodology

In support of the **gross impact evaluation**, we first reviewed program-tracking data and developed a comprehensive database of program measures and ex ante savings. We then reviewed and adjusted, where warranted, ex ante per-unit "deemed" savings for a sample of measures. The deemed savings updates incorporated results from a light logger study to verify the hours of operation for key lighting measures. To verify measure installations, we conducted desk reviews for main channel projects and a survey with midstream channel participants. Finally, we estimated ex post gross energy and demand savings, by delivery channel and technology, based on the quantity and per-unit deemed savings adjustments.

The **net impact evaluation** relied on participant and trade ally surveys to quantify free-ridership, participant spillover, and trade ally spillover. We estimated overall net-to-gross ratios for the two jurisdictions, as well as by delivery channel and for lighting and non-lighting projects. These net-to-gross ratios were multiplied by the ex post gross savings to determine net program impacts.

We also conducted a **process evaluation** that focused on program processes, customer and trade ally satisfaction with the program, program strengths and weaknesses, and opportunities for program improvement. It also included areas of interest identified by program staff, e.g., the status of the commercial lighting market and remaining opportunities for lighting and non-lighting upgrades.

8. DSMore Table

The Excel spreadsheet containing measure-level inputs for Duke Energy Analytics is provided below. Per-measure savings values in the spreadsheet are based on the gross and net impact analyses reported above. The evaluation scope did not include updates to measure life assumptions.

[Provided as a separate file]

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2020 EM&V Interim Report for the EnergyWise Business Program

February 5, 2021

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Evaluation Summary

Guidehouse conducted an impact evaluation to estimate energy impacts contributed by participants that received the thermostat between January 2018 and February 2019, using monthly energy consumption data. This report contains only the results of the energy impact analysis. Upon completion of the Summer 2021 DR season, Guidehouse will estimate demand response impacts on event days, using participant and non-participant advanced metering infrastructure (AMI) interval data.

Table 1 summarizes the estimated annual energy impacts for participants who installed a thermostat. Guidehouse found that on average, DEC participants saved 1,026 kWh per thermostat and DEP participants saved 423 kWh per thermostat.

Table 1: Per Device and Program Total Energy Impacts

Energy Provider	Devices	Impact per Device (kWh / Device)	Program Impact (MWh)	Margin of Error (90% CI)
DEC	5,304	1,026	5,440	±1,488
DEP	2,653	423	1,122	±724

Source: Guidehouse analysis. Values subject to rounding.

The EnergyWise® Business ("EnergyWise Business") program in the Duke Energy Progress (DEP) and Duke Energy Carolinas (DEC) territories, provides small and medium business customers that consume an average of at least 1,000 kWh per month and have one or more central air conditioning or heat pump units at their facility, with an opportunity to earn bill credits by allowing DEP and DEC to periodically cycle their HVAC equipment during conservation periods (i.e. curtailment or demand response – DR – events).

In the summer, participating devices may be controlled by DEP and DEC from May through September for up to four hours per event. Events typically occur between 1pm and 7pm on non-holiday weekdays. During the curtailment events, the HVAC compressors are typically cycled in 30-minute intervals for the duration of the event. Participants may opt out of up to two events per season. Additional opt-outs may result in the forfeiture of the annual bill credit. Participants who have electric heat pumps with electric resistance auxiliary heat strips can also participate in the winter DR season for an additional $25 bill credit. For the winter 2020/2021 season, events are expected to occur in the morning from 6:30am to 8:30am, around the peak demand hour of 7-8am.

Participants may elect to have curtailment dispatched via thermostat or switch. Participants equipped with the thermostat (the majority) can access the EnergyWise Business portal using a smartphone, tablet, or computer. The portal allows users to monitor and modify their facility HVAC runtimes, change the temperature setpoints, and program customized cooling and heating schedules. The purpose of the portal is to facilitate the adoption of energy efficiency behaviors by participants, specifically the practice of adjusting HVAC setpoints to reduce space heating and cooling energy consumption. The portal includes tips to help participants optimize energy use, including tutorials and preset features for energy efficiency, away times, and vacations.

Evaluation Methods

Guidehouse's impact evaluation approach for this report focuses on energy impacts. Demand impacts will be established after the summer 2021 DR season.

Energy Efficiency Impact Evaluation Approach

Guidehouse assessed the suitability of using a matched comparison group (MCG) to estimate savings, but concluded that such an approach was unsuitable for this evaluation due to evidence of divergent energy consumption behavior after the time period used to select the MCG. As a result, Guidehouse proceeded by using a within-subjects regression approach, using participants only.

Guidehouse estimated annual per participant savings by applying a regression analysis to participant consumption data observed in the period from March 1, 2019 through February 29, 2020 (the "Post-Install Period"). Only participants that enrolled in the period from January 1, 2018 through February 28, 2019 (the "Install Period" or the evaluation sample period) were included in the estimation data. Program impacts were calculated by multiplying estimated annual per participant impacts by the number of participants that enrolled during the Install Period. The impacts per thermostat were calculated by dividing the per participant results by the average number of thermostats at each participant site.

Findings and Conclusions

The principal EM&V findings and conclusions regarding the estimated energy impacts are as follows:

- **Participants are estimated to have reduced an average of 1,026 kWh per device in DEC and 423 kWh per device in DEP for the post-installation period.** The post-installation period was March 2019 through February 2020, and applies to the evaluation sample of participants who enrolled between January 2018 through February 2019. More savings were realized in summer months compared with winter, which reflects the fact that only some participants use electric heating (approximately 20%). Guidehouse has developed hypotheses for the difference in savings between DEC and DEP participants, which may be used to guide future evaluation and program implementation.

- **Guidehouse concluded that selecting a suitable non-participant comparison group was not possible with the data available for estimating energy impacts.** Guidehouse observed evidence of differing evolution of consumption patterns between participants and selected matches from the pre- to post-installation periods, which suggests that the consumption behavior of selected matches may not evolve in similar ways as participants as would be assumed when using a comparison group. This result suggests that an MCG comprised of non-participants is unsuitable for estimating energy efficiency impacts for small and medium-sized businesses in this program.

Based on the impact findings above, Guidehouse recommends that Duke Energy consider the following recommendations:

- **Consider customer targeting or outreach activities to increase energy savings.** Targeting more customers with electric heat could increase winter energy savings. Guidehouse understands that future program data will have more accurate tracking of HVAC equipment types, which would facilitate such targeting efforts. Duke Energy may wish to consider increasing outreach encouraging participants to adopt more energy efficient setpoints. Although program technicians assist participants with initial thermostat setup, it is unclear how the settings persist over time. Following up with participants to encourage them to optimize these settings may increase the amount of energy savings achieved in the program.

- **Consider using future process evaluations to better understand differences in savings estimated in DEP and DEC service territories.** Consistent with the findings of the prior evaluation conducted by another evaluator, Guidehouse estimated that average savings per participant were lower for DEP participants than for DEC participants. Participants interviews or surveys may be used to better understand the factors that cause DEP participants to exhibit lower savings. For example, surveying DEC and DEP participants may show differences in willingness to use temperature setbacks or capability of reducing HVAC consumption based on business operation considerations.

1. Introduction

The EnergyWise® Business ("EnergyWise Business") program in the Duke Energy Progress (DEP) and Duke Energy Carolinas (DEC) territories, provides small and medium business customers that consume an average of at least 1,000 kWh per month and have one or more central air conditioning or heat pump units at their facility, with an opportunity to earn bill credits by allowing DEP and DEC to periodically cycle their HVAC equipment during conservation periods (i.e. curtailment or demand response events).

Upon enrollment, eligible participants select to receive either a "smart" Wi-Fi communicating thermostat[1] capable of remote set-point adjustment, or a switch device to allow DEP and DEC to cycle the participant's HVAC during DR events. The switch device may be either Wi-Fi connected or cellular. Participants may select one of three options for participating:

- 30% Cycling - Participants receive an annual bill credit of $50 per device controlled for the summer season.
- 50% Cycling - Participants receive an annual bill credit of $85 per device controlled for the summer season.
- 75% Cycling - Participants receive an annual bill credit of $135 per device controlled for the summer season.

In the summer, participating devices may be controlled by DEP and DEC from May through September, for up to four hours per event. Events typically occur between 1pm and 7pm on non-holiday weekdays. During the curtailment events, the HVAC compressors are cycled in 30-minute intervals for the duration of the event. Participants may opt out of up to two events per season Additional opt-outs may result in the forfeiture of the annual bill credit. Participants with electric heat pumps or electric resistance heating can also participate in the winter DR season for an additional $25 bill credit. For the winter 2020/2021 season, events are expected to occur in the morning from 6:30am to 8:30am, around the peak demand hour of 7-8am.

Participants with the thermostat can access the EnergyWise Business portal using a smartphone, tablet, or computer. The portal allows users to monitor and modify their facility HVAC runtimes, change the temperature setpoints, and program customized cooling and heating schedules. The purpose of the portal is to facilitate the adoption of energy efficiency behaviors by participants, specifically the practice of adjusting HVAC setpoints to reduce space heating and cooling energy consumption. The portal includes tips to help participants optimize energy use, including tutorials and preset features for energy efficiency, away times, and vacations.

[1] Note that this is not an "adaptive" thermostat.

1.1 Objectives of the Evaluation

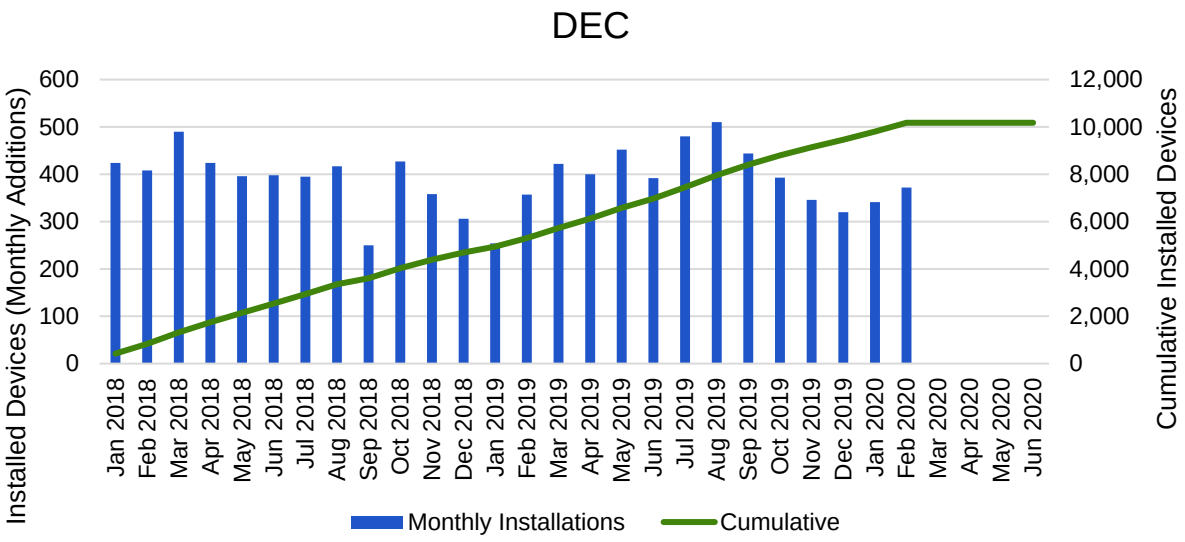
The key objectives for the impact analysis conducted as part of this evaluation, as identified in Guidehouse's evaluation plan, include:

- **Energy Efficiency Impacts:** estimate the annual energy efficiency impacts for participants who have a thermostat and enrolled in the program between January 2018 and February 2019.

1.2 Reported Program Participation

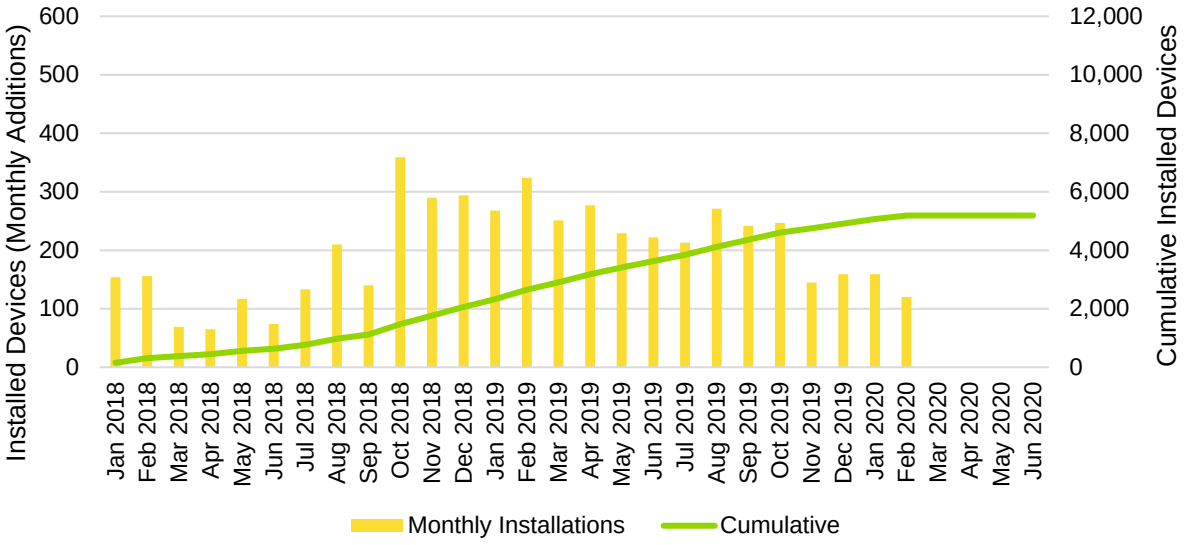
Figure 1-1 and Figure 1-2 illustrate installations between January 2018 and February 2020 for DEC and DEP, to show trends in participation over time outside of the evaluation sample period. In this time period, Duke Energy installed 10,176 and 5,188 devices in DEC and DEP territories respectively. From this population, the energy impacts in the report include a sample of participants who enrolled between January 2018 and February 2019, to allow sufficient post-installation consumption data to accrue for analysis.

Figure 1-1: Installations between January 2018 and February 2020 – DEC



Source: Guidehouse analysis

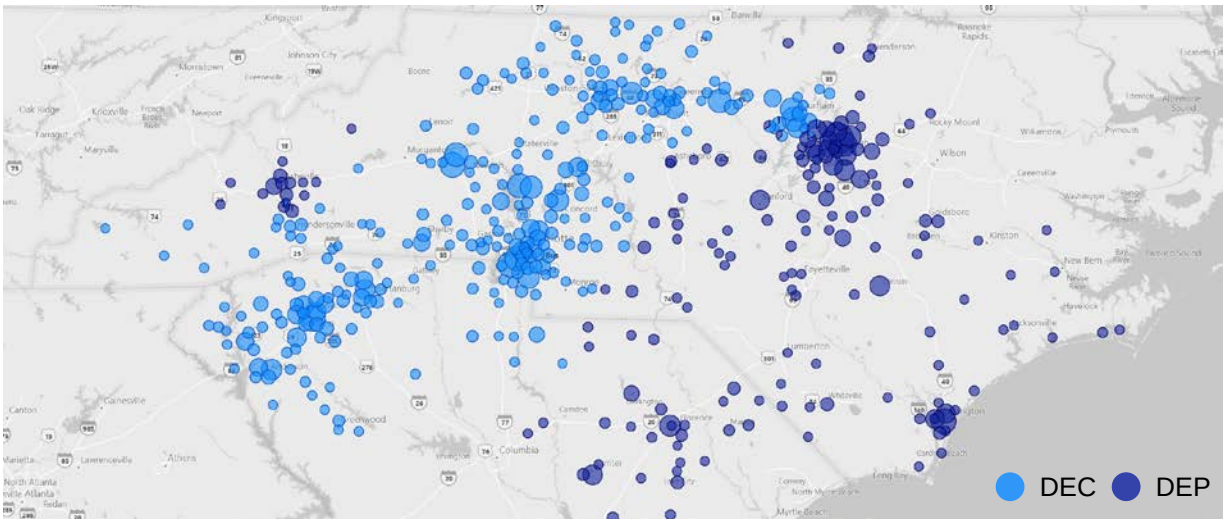
Figure 1-2: Installations between January 2018 and February 2020 – DEP



Source: Guidehouse analysis

Figure 1-3 shows the geographic distribution of participants. Most installations occurred around cities including Charlotte and Raleigh, although participation was achieved throughout the service territories.

Figure 1-3. Geographic Distribution of Participants



Source: Guidehouse Analysis
Size of Circle is Proportional to the Number of Installations

2. Evaluation Methods

This chapter of the evaluation report provides a description of the approaches used to conduct the evaluation. Additional technical details related to the impact approaches may be found in Appendix A.

2.1 Energy Efficiency Impact Methodology

Guidehouse estimated thermostat energy savings impacts using a within-subjects regression analysis applied to participant monthly consumption data, weather data, and data flags identifying the period after which each participant's thermostat was installed. This analysis also controlled for participation in other Duke Energy programs during the same time period, effectively netting out the impacts from other energy efficiency programs such as the Small Business Energy Saver.

A "within-subjects" regression approach is one which includes only participants and implicitly uses observed participant consumption prior to program enrollment to develop an estimate of participant baseline consumption in the program period and the estimated impact of the program on participant consumption in the post-installation period. A detailed description of the regression model specification is included in Appendix A.2.

Guidehouse also performed an experimental analysis comparing participant consumption patterns with those of a large pool of non-participants in pre-program period to select an MCG (non-participants with consumption patterns very similar to those of participants). As discussed below in Section 2.1.3, and in greater detail in Appendix A, Guidehouse's exploratory analysis identified that such an approach appears to be inappropriate for an evaluation of energy efficiency impacts for the small to medium businesses in this program.

2.1.1 Data Sources

For the energy efficiency evaluation, Guidehouse used the following data provided by Duke Energy:

- Monthly consumption data, for DEC and DEP participants and non-participants:
    - DEC: Calendarized monthly billing data for the period of January 2016 through February 2020 for 5,850 participants and 97,571 eligible non-participants[2]
    - DEP: Calendarized monthly billing data for the period of March 2017 through February 2020 for 2,898 participants and 66,899 non-participants. DEP billing consumption data was not available prior to March 2017.
- Customer cross-sectional data, including -

[2] Non-participant data were used only in exploratory analysis. All impacts reported in this evaluation are estimated based only on participant consumption data.

- Standard Industry Classification (SIC) Code
- HVAC equipment type (participants only)
- HVAC system capacity in tons of refrigeration (participants only)
- Program device type – switch or thermostat (participants only)
- Participant enrollment and drop-out dates

- List of participants that participated in other DEP or DEC EE programs, including measures and installation dates.

Guidehouse collected hourly dry-bulb temperature data for the period of January 2016 through February 2020 from twelve weather stations across the Carolinas and developed a weighted average hourly time series for the analysis based on the number of participants closest to each station. This single time series was then used in subsequent modeling to estimate energy efficiency impacts. The stations and corresponding weights are listed in Table 2-1.

Table 2-1. Weather Stations and Weighting Used for Analysis

Weather Station	Weight
Raleigh-Durham Airport	27.4%
Charlotte/Douglas Airport	22.3%
Piedmont Triad Airport	9.1%
Hickory Regional Airport	8.6%
Greenville Downtown Airport	8.3%
Florence Regional Airport	7.0%
Greenville-Spartanburg Airport	4.8%
Asheville Regional Airport	4.1%
Occonee County Airport	3.4%
Anderson Regional Airport	3.1%
Wilmington International Airport	1.7%
Craven County Airport	0.2%

Source; Guidehouse Analysis

2.1.2 Analysis Period, Participant Sample, and Data Cleaning

Guidehouse has divided the participant consumption data into three different periods for analysis:

- **Pre-Install Period (January – December 2017):** the year prior to thermostats being installed for all participants in the estimation sample. No participant included in the analysis had enrolled in the program during this period.
- **Install Period (January 2018 – February 2019):** the year during which participants in the estimation sample installed thermostats. All participants included in the analysis enrolled in the program during this period.
- **Post-Install Period (March 2019 – February 2020):** the year during which all participants in the estimation sample have a thermostat installed. All participants included in the analysis had enrolled in the program prior to this period.

Guidehouse performed data cleaning on the provided monthly consumption data, including checking for:

- Very large consumption (>2,500 kWh per day in a month)
- Negative consumption
- At least 8 months of data in the pre- and post-install periods. This requirement was chosen to balance data completeness while maximizing the number of participants that could be included in analysis, and is consistent with other Guidehouse evaluations.

Table 2-2 summarizes the number of participant accounts that were able to be included in the analysis after the data cleaning process.

Table 2-2. Summary of Accounts Included in Data Cleaning Process

Description	Accounts (DEC)	Accounts (DEP)
All accounts that installed thermostats between January 2018 and February 2019	3,080	1,519
Accounts with any billing data	3,033	1,498
Accounts in the sample after cleaning (i.e. had at least 8 months of billing data in both the pre- and post-periods)*	1,929	1,019
Remaining accounts after removing customers that changed consumption from pre- to post-period by more than 100%**	1,893	1,008

Source: Guidehouse Analysis
** Essentially all (>99%) accounts dropped in data cleaning were due to a lack of sufficient data in either the pre- or post-period.*
*** Guidehouse investigated trimming the sample of customers that exhibited very large changes in energy usage to mitigate potential bias, as discussed in Appendix A.1.*

2.1.3 Assessment of a Matched Comparison Group

Guidehouse assessed the suitability of estimating impacts using a lagged dependent variable (LDV) approach[3] supported by an MCG developed from eligible non-participants. In this process, each participant is assigned a "match." This is the non-participant whose pre-installation period consumption most closely resembles the given participant. In general, this approach is also commonly referred to as quasi-experimental design and is generally the preferred evaluation method in absence of true experimental design (e.g. a randomized control trial, or RCT).

The purpose of selecting an MCG is to find a group of customers for whom energy usage patterns would be expected to follow a parallel trend over time to that of the participants in absence of the program treatment. The treatment in this case is the installation of a thermostat.

The key assumption of selecting an MCG is that the relative difference between participant and MCG consumption is consistent over time in absence of the treatment, conditional on the independent variables included in the regression equation. In the residential sector, this assumption is generally regarded as unproblematic due to the homogenous nature of residential consumption patterns. However, the heterogeneity of small businesses means that the key assumption that underlies this approach may be too restrictive and not reflect the realities of small business. In other words, two businesses that exhibit similar usage patterns in the period in which they are matched may not evolve in similar ways over time. This may be due to differences in business types or to administrative details related to the data themselves. For example, if the electricity account holder is a landlord, the business may change entirely between the pre-program and the program period without any indication.

To assess the suitability of an MCG approach for this evaluation, Guidehouse selected matches for both DEC and DEP participants. Each participant was assigned the non-participant from the same SIC division[4] that had the most similar monthly consumption pattern during the pre-installation period. Guidehouse's exploratory analysis found that participant and comparison group consumption patterns outside of the pre-program matching period diverged materially from each other in a manner inconsistent with what might typically be expected of the program treatment.

Specifically, when using an MCG, savings estimates changed substantially in response to the incremental removal of participants and matches from the estimation set. Conversely, estimated savings using participants only (a within-subjects approach) were robust to the same sub-setting – the regression parameter values were insensitive to the sample used. This result suggests the presence of some non-program effect impacting the relative difference between participant and match consumption over time. Absent any observable data to control for this effect, it will result in omitted variable bias in the model, and inaccurate estimates of savings.

Therefore, Guidehouse concluded that an MCG was not appropriate for this analysis using the data available. Guidehouse proceeded with the analysis using a within-subject approach which considers participants only and compares consumption before and after installation of the

[3] The LDV approach is a special case of the difference-in-differences approach.

[4] Standard industry classification division denotes the broad industry category the small business belongs to. See https://www.naics.com/sic-codes-counts-division/.

thermostat. For a more detailed description of the methods used for selecting and assessing the suitability of a matched control group, see Appendix A.1

2.1.4 Estimating Ex-Post Impacts

Guidehouse employed a within-subject regression analysis to estimate impacts. This approach uses a model that implicitly compares the energy consumption of participants before and after installation of the program thermostat. This type of model is also known as a “pre-post” model. The model estimated for this analysis controls for the effects of weather (cooling and heating degree days), month of year, and participation in other DEP or DEC EE programs (such as Small Business Energy Saver). The treatment effect was modeled to be weather-dependent, on both cooling and heating degree days – savings, that is, are assumed to be a function of temperature.

In this model, any changes in consumption over time that are not explicitly controlled for by the independent variables are attributed to the treatment. As described in Section 2.1.3, Guidehouse employs within-subject models only in the absence of true experimental design (e.g., an RCT) and when matched controls are either not available or inappropriate.

The regression model provides ex-post (i.e., historical) impact estimates for the post-installation period described in Section 2.1.2, March 2019 through February 2020. These are obtained by applying the estimated treatment parameters to the observed weather in this period. For additional details regarding the regression model used for this analysis, see Appendix A.2.

3. Impact Findings

This chapter provides a detailed summary of the impact findings, and is divided into three sections:

- **Energy Efficiency Impacts.** This section summarizes the estimated energy efficiency impacts.
- **Differences in Savings between DEC and DEP.** This section discusses the differences in estimated savings for the two service territories.
- **Net-to-Gross.** This section describes the assumptions informing the net-to-gross ratio applied in this evaluation.

3.1 Energy Efficiency Impacts

Table 3-1 shows the ex-post energy efficiency impacts for the period from March 2019 through February 2020 for those participants who enrolled between January 2018 and February 2019. The program achieved an estimated 5,440 MWh and 1,122 MWh of savings for DEC and DEP participants respectively over the post-install period.

Table 3-1. Ex-Post EE Impacts – Program Total Mar 2019 through Feb 2020

Energy Provider	Devices	Program Impact (MWh)	Margin of Error (90% CI)	Relative Precision (+/-)
DEC	5,304	5,440	±1,488	±27%
DEP	2,653	1,122	±724	±65%

Source: Guidehouse analysis of DEC and DEP data, values subject to rounding.

Figure 3-1 and Table 3-2 show per participant EE savings in each season of the post-install period. Overall, the program delivered 1,743 kWh (DEC) and 724 kWh (DEP) of energy savings per participant over the entire post-install period. This amounts to about 3.9% of facility consumption in DEC and 1.8% in DEP. Statistically significant savings were estimated in both summer and winter seasons, but more savings accrued in the summer – 1,094 kWh (DEC) and 455 kWh (DEP) per participant. The higher savings during the summer months is consistent with Guidehouse's analysis of program tracking data that indicates that approximately 20% of participants have heat pumps installed.

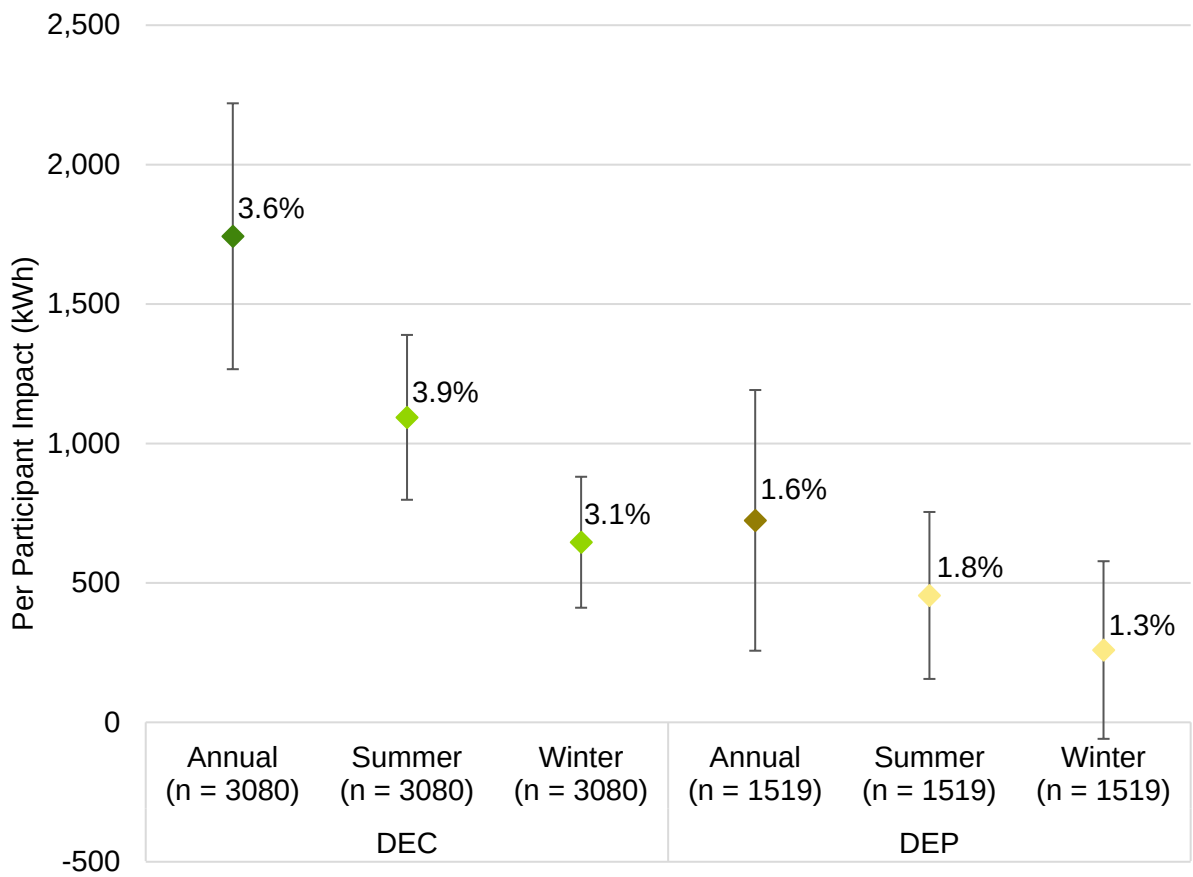
Table 3-2. Ex-Post EE Impacts – per Participant by Season

Energy Provider	Season	Impact (kWh / Participant)	Margin of Error (90% CI)	Savings (% Facility)
DEC	Summer	1,094	±296	3.9%
	Winter	646	±235	3.1%
	Annual	**1,743**	**±477**	**3.6%**
DEP	Summer	455	±299	1.8%
	Winter	259	±319	1.3%
	Annual	**724**	**±468**	**1.6%**

* Summer (May – Oct) and Winter (Nov – Apr) may not add up exactly to Annual impacts due to rounding and the fact that they are estimated separately from annual impacts.

Source: Guidehouse analysis of DEC and DEP data, values subject to rounding.

Figure 3-1. Ex-Post EE Impacts – Per Participant by Season



**percentages indicate savings as a percent of total facility consumption, and bars indicate margin of error.*
Source: Guidehouse analysis of DEC and DEP data.

Similarly, Table 3-3 and Figure 3-2 show per device energy savings in each season of the post-install period. Overall, the program delivered 1,026 kWh (DEC) and 423 kWh (DEP) of energy savings per device over the entire post-install period. Savings were observed for both summer and winter seasons, but more savings accrued in the summer – 644 kWh (DEC) and 266 kWh (DEP) per device.

Table 3-3. Ex-Post EE Impacts – per Device by Season

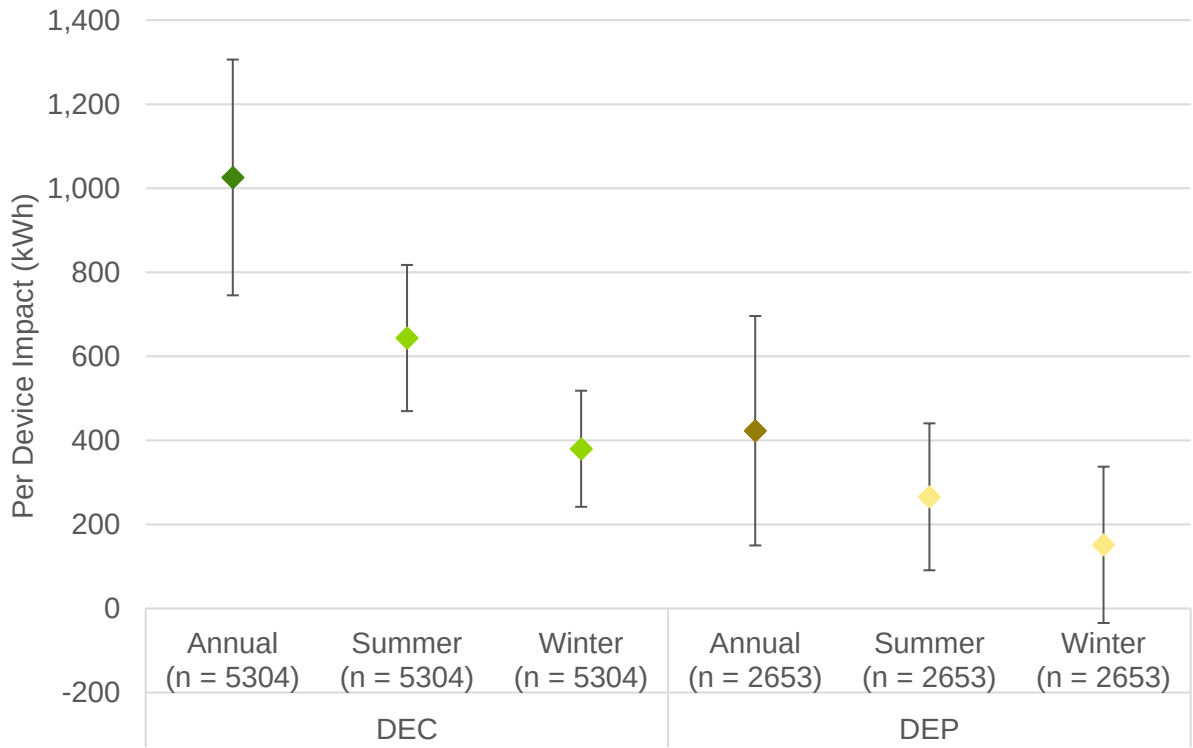
Energy Provider	Season	Impact (kWh / Device**)	Margin of Error (90% CI)
DEC	Summer	644	±174
	Winter	380	±138
	Annual	1,026	±281
DEP	Summer	266	±175
	Winter	152	±186
	Annual	423	±273

* Summer (May – Oct) and Winter (Nov – Apr) may not add up exactly to Annual impacts due to rounding and the fact that they are estimated separately from annual impacts.

*** Per device impacts are based on an average of 1.71 devices per participant (DEC) and 1.75 devices per participant (DEP).*

Source: Guidehouse analysis of DEC and DEP data, values subject to rounding.

Figure 3-2. Ex-Post EE Impacts – Per Device by Season



**Bars indicate margin of error.*
Source: Guidehouse analysis of DEC and DEP data.

3.2 Differences in Savings between DEC and DEP

Guidehouse estimated materially higher savings for DEC participants (1,026 kWh / device) than DEP participants (423 kWh / device). This difference (603 kWh / device) is consistent with the findings of the prior evaluation completed by another evaluator, which found DEC impacts to be 503 kWh higher per device in DEC than DEP. Guidehouse has developed and explored several hypotheses that may explain the difference in achieved savings:

- **Different Participant Setpoint Behavior**: Duke Energy provided Guidehouse with thermostat setpoint schedule data for participants,[5] which provided some insight into how participants in DEC and DEP use the setback features of their thermostats. Setbacks are defined as the temperature setpoint programmed by a participant when a building is likely to be unoccupied, and more aggressive setbacks generally lead to energy savings. Guidehouse found that a greater percentage of DEC participants use setbacks for both heating and cooling seasons as compared to DEP participants. About 60% of DEC participants used heating setbacks as compared to about 40% of DEP participants, and about 40% of DEC participants used cooling setbacks as compared to

[5] Available setpoint schedule data was primarily for participants who installed a device after February 2019 and spanned the period of March 2019 through January 2020. Nevertheless, the data provided some insight into differing behavior among DEP and DEC participants.

about 30% for DEP. These differences between unoccupied and occupied setpoints suggest that DEC participants are more likely to exhibit energy efficient behavior than DEP participants, supporting Guidehouse's finding of greater kWh savings for DEC. This analysis is discussed in further detail in Appendix A.3. Further investigation of participant behavior before and after installation of the smart thermostat may provide additional insight into this phenomenon.

- **Use of Air Conditioning (AC) in Response to Temperature**: Higher AC usage for DEC participants for a given increase in temperature suggests a higher potential for savings. Guidehouse's regression modeling indicates for each incremental cooling degree day experienced, DEC participants increase their electricity demand by more than DEP participants. This modeling result indicates that when DEC and DEP participants are exposed to the same temperature, DEC participants on average use more electricity, suggesting that DEC participants tend to use their AC units more than DEP participants. The total cooling load over the summer season may still be higher for DEP customers, as it is generally warmer in DEP territory.

- **Differences in AC Size**: Larger AC units also suggests a higher potential for energy savings. Guidehouse found that the average size of AC units for DEC thermostats (4.3 tons, average over all thermostats) was slightly higher than DEP thermostats (4 tons, average over all thermostats). Depending on the efficiency of installed equipment, this difference may indicate differences in energy consumption between DEC and DEP participants.

- **Different Participant Business Types**: Differences in business types or operations between the territories may lead to variation in the flexibility to achieve energy savings. Based on SIC code, Guidehouse found that DEC participants include a larger share of Manufacturing and Retail participants, while DEP participants include a larger share of Finance and Services participants. In the manufacturing sector, DEC participants exhibited higher consumption (339 kWh / day) than DEP participants (152 kWh / day). While this difference does not completely account for the differences in savings achieved, it does illustrate that businesses have different consumption patterns and therefore may have a different capability of reducing HVAC usage via the thermostat.

These hypotheses can be used to direct future efforts in evaluation and program design. Potential activities to investigate these hypotheses include:

- **AC Size and Usage**: Further investigate available thermostat telemetry data and any additional available HVAC equipment characteristics (i.e. capacity, SEER/EER) that can be collected for DEC and DEP participants and directly compare the runtime and energy consumption of connected equipment on hot weather days. Alternatively, AMI data for summer 2021 (to be collected for the DR evaluation) may be used to compare whole facility energy consumption directly on hot weather days. In the future, existing thermostat type and temperature setpoints could be collected at the time of installation of the new device, to enable future investigation.

- **Participant Business Types and Behavior:** Future evaluations could include, for example, participant surveys to assess business capacity for saving energy (e.g., ability to curtail AC use during business hours) and willingness and ability to save energy via

the thermostat (e.g., preferences for setpoints before and after installing the device). Participant surveys can also be used to understand how customers in each territory are engaging with the online portal.

3.3 Net-to-Gross

Evaluations of demand-side management programs typically estimate both net and gross savings, and often present a net-to-gross (NTG) ratio based on the evaluated percentage of energy reductions that may be ascribed either to free ridership (which decreases the NTG ratio) or to program spillover (which increases the NTG ratio).

Free ridership is typically defined as the percentage of savings that would have occurred absent the presence of the program. Spillover is typically defined as incremental savings actions undertaken by a program's participants not directly incented by the program.

All savings presented in this report should be considered net.

3.3.1 Energy Efficiency Impacts

The energy efficiency impacts of this program are net of any free ridership. This is because most of the key program elements that drive savings are not available in the consumer market. Furthermore, the program is designed primarily as a demand response program and it is unlikely that energy impacts driven by free ridership occur because participants enroll in demand response.

A participant is considered a free rider when it can be demonstrated that even absent the program the participant would have purchased the efficient equipment and adopted the efficient behavior promoted by that program.

In the case of this program, the energy efficiency equipment being deployed requires educated action on the part of the participant to achieve energy savings. This action requires information feedback provided by program-specific tools. Simply purchasing a Wi-Fi enabled thermostat would not yield any savings. Savings are delivered by the participants taking appropriate and impactful actions that the education, information feedback via the portal, and program-specific thermostat pre-sets empower them to do. It is the combined effect of these elements, packaged in a single offering, that results in the savings estimated in this evaluation.

Key program elements that customers could not acquire in the open market, elements that are essential for achieving the energy efficiency savings include:

- **Multi-Source Information.** Although some Wi-Fi-enabled thermostats for commercial enterprises allow the user to observe thermostat run-times (real-time and historical) the EnergyWise Business online portal allows users to observe things like thermostat run-times and set-points alongside consumption values. This more clearly identifies potential bill savings to participants than commercially available products.

  The portal doesn't just display HVAC usage and run-time characteristics, but combines both sets of information to deliver customized participant business-specific

benchmarking, identifying for the participant (at portal login) periods of high usage and opportunities for bill savings.

- **Education and Tech Support.** When participants enroll, the thermostat is installed *and set up* by industry professionals in consultation with the key business decision-maker. This means that initial thermostat settings for all businesses will be calibrated to deliver savings without impinging on the core business. Additionally, the installer ensures that the participant can access all portal and thermostat functionality while they are on site. The program therefore delivers both a nearly universal adoption of initial energy saving settings and ensures that the business owner understands and can access and use the tools provided.

  In addition to the significant assistance provided at enrollment and installation, Duke Energy maintains a call center for participant technical support, specially trained for supporting this program, the thermostat and portal.

- **Maintenance and Energy-Saving Prompts.** In addition to the standard battery of energy efficiency tips and maintenance prompts, a key feature of the Duke Energy portal not otherwise available in the consumer market is its automated analysis of equipment condition – for example monitoring the relationship between run-time and temperature – and alerting the user when monitored metrics suggest maintenance could deliver cost-effective bill savings. This targeted advice effectively provides users with a customized maintenance schedule and reminders and is a program-specific feature, rather than a thermostat capability that could be obtained through the consumer market.

These elements are all major factors that drive savings and are all specific to the programmatic context of the technology deployed. Given that these elements are available only through participation in the program, Guidehouse believes the energy savings found in this evaluation are net savings.

4. Findings, Conclusions, and Recommendations

The principal EM&V findings and conclusions regarding the estimated energy impacts are as follows:

- **Participants are estimated to have reduced an average of 1,026 kWh per device in DEC and 423 kWh per device in DEP for the period of March 2019 through February 2020.** More savings were realized in summer months compared with winter, which reflects the fact that only some participants use electric heating. Guidehouse has developed hypotheses for the difference in savings between DEC and DEP participants, which may be used to guide future evaluation and program implementation.

- **Guidehouse concluded that selecting a suitable non-participant comparison group was not possible with the data available for estimating energy impacts.** Guidehouse observed evidence of differing evolution of consumption patterns between participants and selected matches from the pre- to post-installation periods, which suggests that the consumption behavior of selected matches may not evolve in similar ways as participants as would be assumed when using a comparison group. This result suggests that an MCG comprised of non-participants is unsuitable for estimating energy efficiency impacts for small and medium-sized businesses in this program.

Based on the impact findings above, Guidehouse recommends that Duke Energy consider the following recommendations:

- **Consider customer targeting or outreach activities to increase energy savings.** Targeting more customers with electric heat could increase winter energy savings. Guidehouse understands that future program data will have more accurate tracking of HVAC equipment types, which would facilitate such targeting efforts. Duke Energy may wish to consider increasing outreach encouraging participants to adopt more energy efficient setpoints. Although program technicians assist participants with initial thermostat setup, it is unclear how the settings persist over time. Following up with participants to encourage them to optimize these settings may increase the amount of energy savings achieved in the program.

- **Consider using future process evaluations to better understand differences in savings estimated in DEP and DEC service territories.** Consistent with the findings of the prior evaluation conducted by another evaluator, Guidehouse estimated that average savings per participant were lower for DEP participants than for DEC participants. Participant interviews or surveys may be used to better understand the factors that cause DEP participants to exhibit lower savings. For example, surveying DEC and DEP participants may show differences in willingness to use temperature setbacks or capability of reducing HVAC consumption based on business operation considerations.

5. Summary Form

EnergyWise Business
2019-2020
Completed EMV Fact Sheet

Description of Program

EnergyWise Business is a commercial HVAC load control program that targets small and medium businesses. At the time of enrollment participants are provided either with a thermostat or a load switch, with most customers having a thermostat. Participants must have a password-protected wireless network in order to qualify for a thermostat.

Participants may elect to be controlled using one of three cycling strategies: 30%, 50%, or 75%. Incentive for participation increases commensurate with the increased aggressiveness of the cycling strategy selected.

Impact Evaluation Methods

Guidehouse estimated energy impacts via a regression analysis of monthly consumption data for the estimation period of March 2019 through February 2020, for participants who installed a thermostat between January 2018 and February 2019.

Impact Evaluation Details

- **The program generated 5,440 MWh (DEC) and 1,122 MWh (DEP) of savings from March 2019 through February 2020.**
- **Participants are estimated to have reduced an average of 1,026 kWh / device (DEC) and 423 kWh / device (DEP) for the period of March 2019 through February 2020.** More savings were realized in summer months compared with winter, which reflects the fact that only some participants use electric heating. Guidehouse has developed hypotheses for the difference in savings between DEC and DEP participants, which may be used to guide future evaluation and program implementation.

Date:	2021-01-22
Region:	DEC and DEP
Evaluation Period	EE: 2019 – 2020
DR Event Program Impact (MW)	
EE Program Impact (MWh)	
Program total for participants with thermostats (Mar 2019 – Feb 2020	DEC: 5,440 MWh DEP: 1,122 MWh
Net-to-Gross Ratio	1

6. Program Impacts for Duke Energy Analytics

DSMore table - DEC-DEP SBDR Therm

Appendix A. Detailed Energy Efficiency Impact Methodology

This appendix includes a more detailed description of Guidehouse's methodology for estimating energy efficiency impacts and ruling out the suitability of an MCG, resulting in a within-subject regression analysis.

A.1 Assessment of Matched Comparison Group

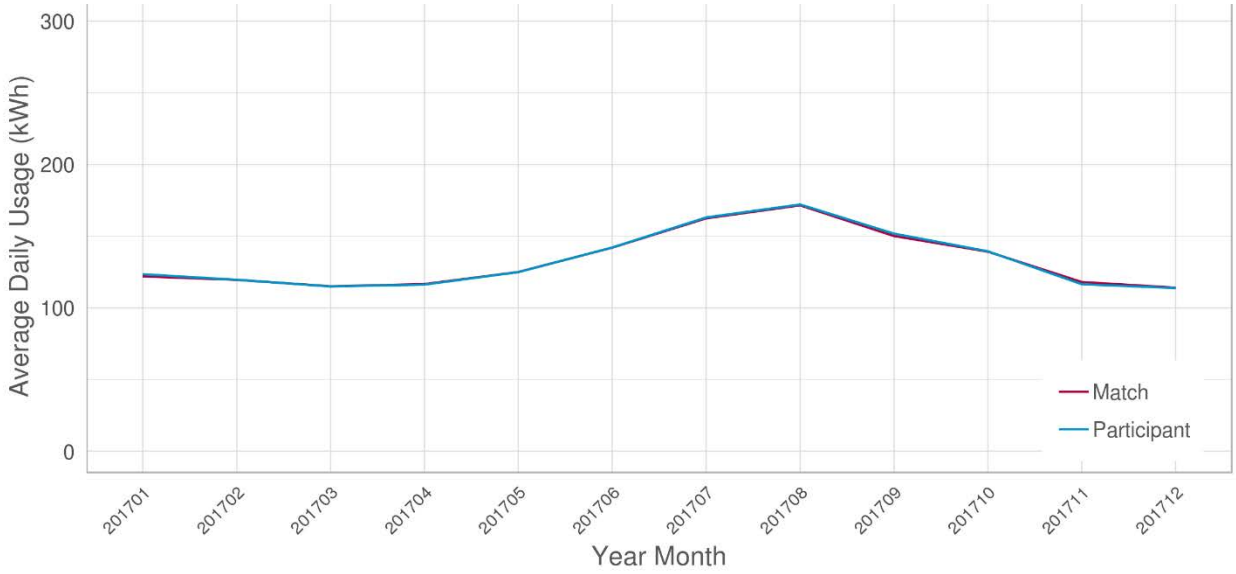
In absence of true experimental design (e.g., a randomized control trial), using an MCG is generally the preferred evaluation method for estimating energy savings for a program like EnergyWise Business. An MCG generally allows evaluators to control for unobserved trends in energy use that are unrelated to the installation of the program thermostat but consistent in effect across both participants and non-participants such as changes in energy use associated with macroeconomic factors. This approach is also commonly referred to as quasi-experimental and reduces the likelihood of specification bias.[6] Within-subject models that do not use a comparison group tend to be much more sensitive to model specification than models with a comparison group, which rely more heavily on contemporaneous observations of non-participant consumption to estimate participant baseline consumption.

Guidehouse developed an MCG where each participant was assigned a "match", which is the non-participant within the same SIC division (first two digits of the SIC Code) that has the most similar consumption patterns in the matching period (e.g., January to December 2017).[7] Figure A-1 and Figure A-2 compare average daily usage by month during the matching period between participants and matches for DEC and DEP, respectively. In general, the selected matches for both DEC and DEP, on average, exhibited similar behavior in the matching period, before any participants have installed the thermostat. DEP participants and matches showed large differences in the matching period. The underlying assumption of using an MCG is that the relative difference between participant and MCG consumption is consistent over time in absence of the treatment, conditional on the independent variables included in the regression equation, such that subsequent differences after installation of the thermostat can be attributed to energy savings.

[6] An LDV approach using an MCG, conditional on the assumption that the two groups' consumption will (absent the treatment) trend in a similar fashion, will tend to be less sensitive to what variables are included (or left out) of the model specification.

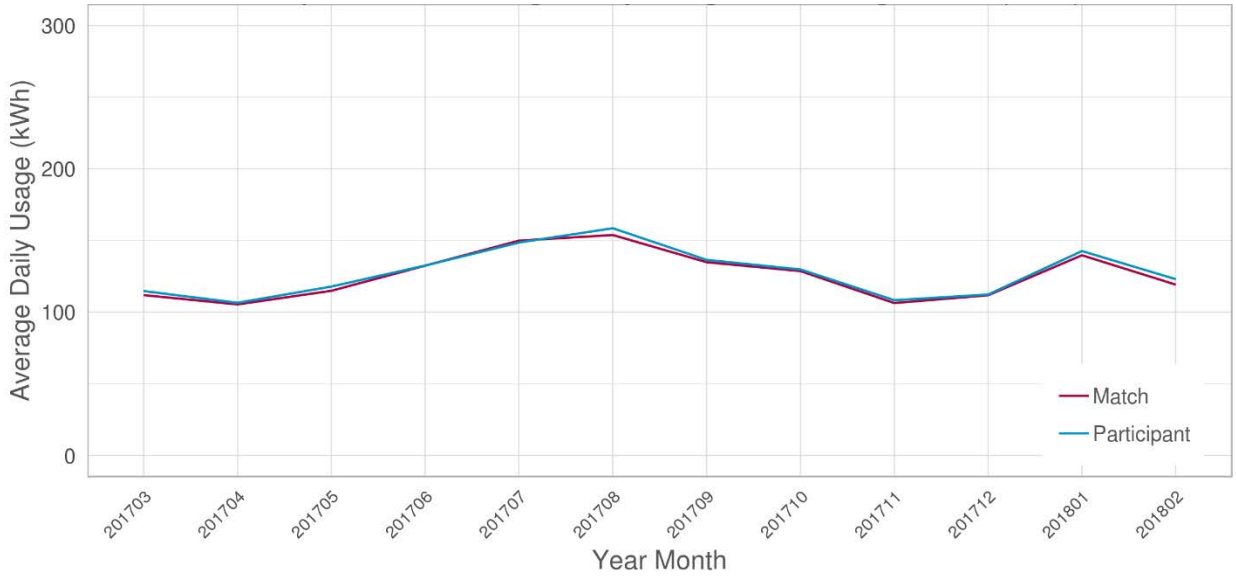
[7] For a small number of DEP customers who installed in January or February of 2018, data was only available for March 2017 onwards. Therefore, for DEP customers who installed in January 2018, the matching period was defined as March through December 2017. For DEP customers who installed in February 2018, the matching period was defined as March 2017 through January 2018. For all other DEP customers, the matching period was defined as March 2017 through February 2018.

Figure A-1. Comparison of Average Daily Usage – Matching Period (DEC)



Source: Guidehouse analysis of DEC and DEP data

Figure A-2. Comparison of Average Daily Usage – Matching Period (DEP)



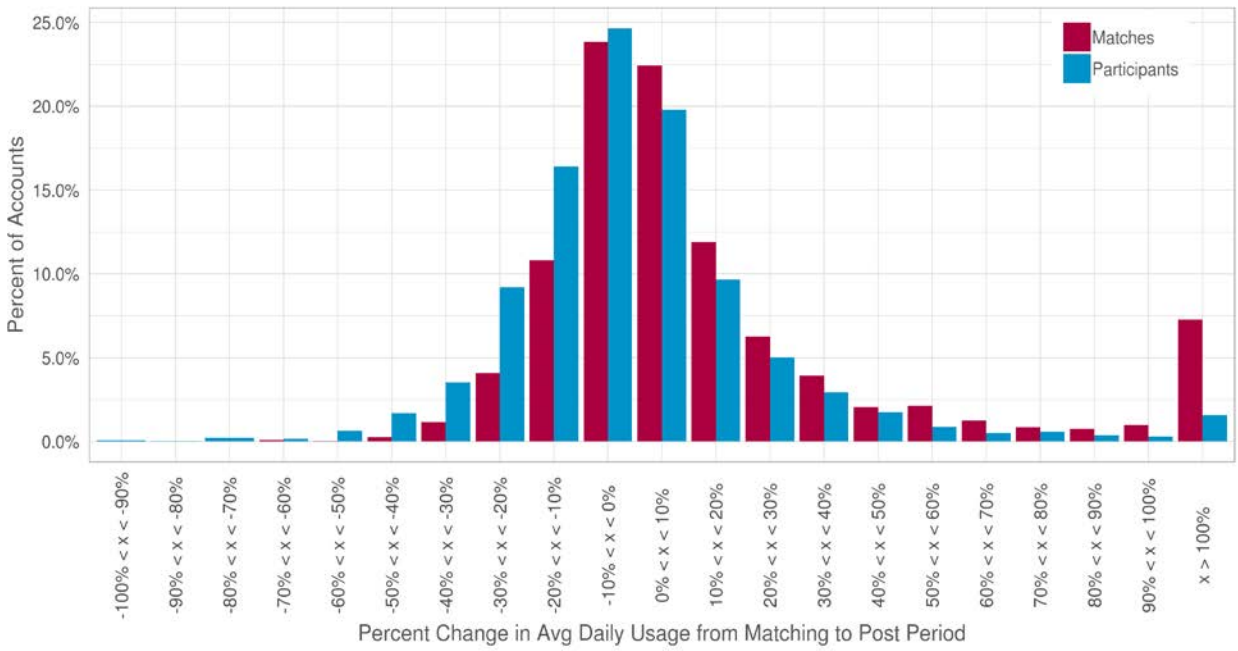
Source: Guidehouse analysis of DEC and DEP data

However, Guidehouse observed some large differences in the post-installation period, particularly for DEC participants and corresponding matches where changes in winter consumption would be unexpected as a result of installing a thermostat. As a result, Guidehouse further investigated match quality. Guidehouse observed that many participants changed their consumption significantly between the pre- and post-installation period (2017 to 2019). This phenomenon may be expected for small businesses, where changes in operations or tenancy may occur. However, these swings in usage may bias impacts if they either:

- Are not experienced similarly by participants and matches, e.g., if matches exhibit large swings in usage that participants do not;
- Are asymmetric, e.g., if swings are more likely to be increases than decreases, then large swing upwards will not 'cancel out' with large swings downward.

Figure A-3 shows the distribution of such changes for both participants and matches. In the middle of the distribution, (i.e. changes in consumption of ±10%), some differences are expected since the participants have installed a thermostat. However, higher levels of change such as increasing consumption by +100% are unexpected and not plausibly related to the installation of a thermostat. The selected matches showed a much higher proportion of customers that increased consumption by more than 100%, which suggests that the selected matches may have evolved differently over time, despite exhibiting similar consumption in the pre-installation (i.e., matching) period.

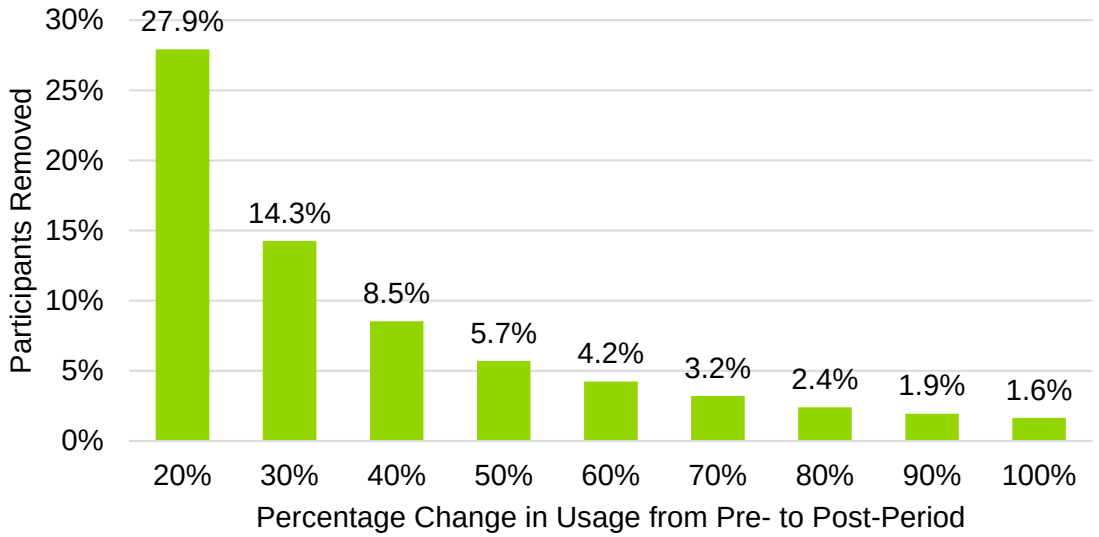
Figure A-3. Distribution of Change in Average Usage, Participants vs Matches



Source: Guidehouse analysis of DEC and DEP data

To test the sensitivity of savings estimates, Guidehouse investigated "trimming" the participant sample to remove customers that exhibited changes in average consumption larger than a certain percentage. Figure A-4 shows the percent of participants (for DEC and DEP combined) that would be removed at different thresholds, from ±20% to no trimming of the sample. For example, if the condition is set that customers whose consumption either doubles or falls to zero (±100% change) should be removed, 1.6% of customers must be "trimmed" from the estimation set.

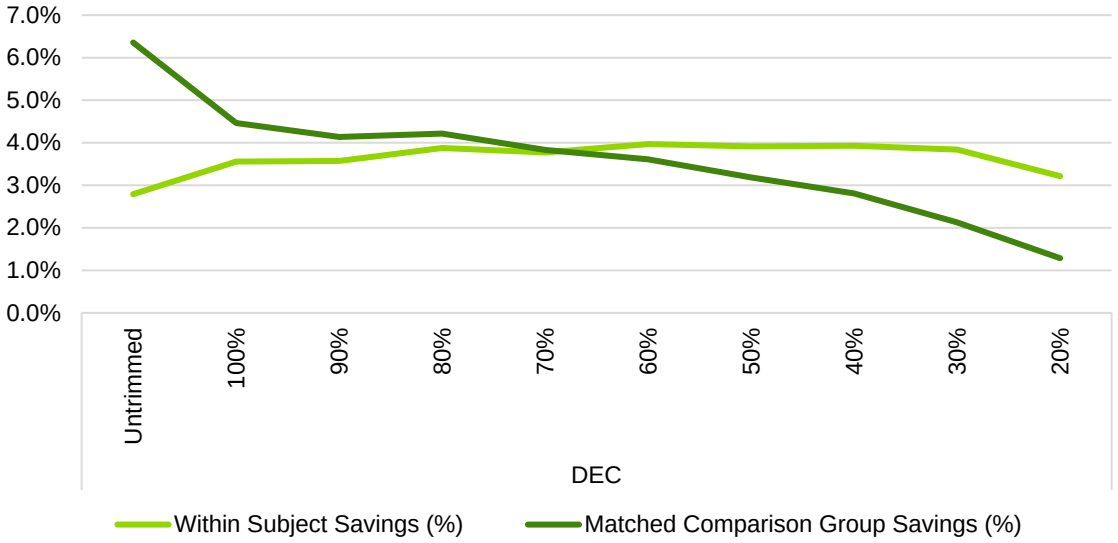
Figure A-4. Comparison of Average Daily Usage – Post Period



Source: Guidehouse analysis of DEC and DEP data

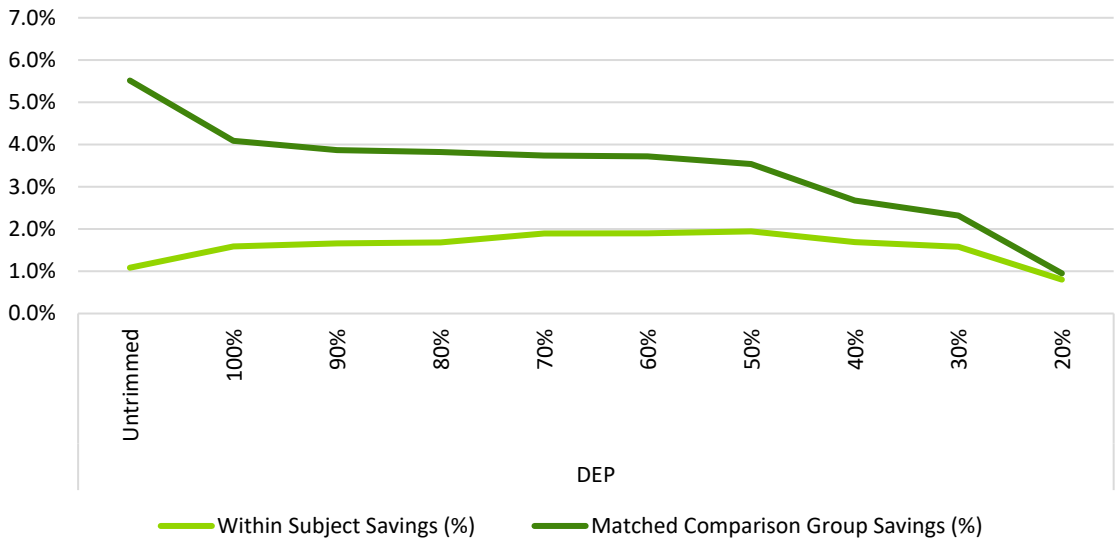
Guidehouse then explored the sensitivity of estimated savings at each level of trim, with the selected MCG and using the within-subjects approach. Guidehouse found that the savings estimates generated using an MCG varied substantially between different trim levels. In contrast, savings estimates estimated without an MCG were much less sensitive, as shown in Figure A-5 and Figure A-6. For both DEC and DEP, aside from the untrimmed and ±20% thresholds, savings estimates are relatively consistent as shown by the flatter profile of the within-subjects' lines.

Figure A-5. Comparison of Percent Savings Estimates at Different Trim Thresholds - DEC



Source: Guidehouse analysis of DEC and DEP data.

Figure A-6. Comparison of Percent Savings Estimates at Different Trim Thresholds - DEP



Source: Guidehouse analysis of DEC and DEP data.

The sensitivity of estimated savings to trim when using the selected MCG suggests that trimming the sample affects the group of participants differently than the selected matches, and therefore suggests that the selected matches may have evolved differently in terms of energy consumption behavior than participants for reasons unrelated to the EnergyWise for Business program.

Based on this investigation, Guidehouse concluded that an LDV approach with MCG is inappropriate for evaluating the impacts of energy efficiency for small businesses in the DEP and DEC territories.[8] Additionally, Guidehouse imposed a restriction on participants for the sample to have a change in average consumption of less than 100% between the pre- and post-installation periods. Guidehouse selected this threshold for the following reasons:

- this threshold removes approximately 2% of participants that could be considered outliers who increased their consumption by more than double their 2017 amount;
- the resulting sample of participants exhibits changes in usage that are more symmetric (i.e. between -100% and 100% of 2017 consumption); and
- estimated savings results were not sensitive to further trim levels.

Guidehouse proceeded with the analysis using a within-subject approach which considers participants only and compares consumption before and after installation of the thermostat.

[8] This finding should be understood to be specific to this program and set of jurisdictions, and caution should be used in generalizing this result to other jurisdictions, or even to other programs within this same jurisdiction.

A.2 Regression Model Specification

DEC and DEP participants were modeled separately. Equation A-1 shows the within-subjects model regression equation used for both models. These models estimate participant average daily usage in a given bill period as a function of month of year, cooling and heating degree days, and participation in Duke Energy's other energy efficiency programs. Only participant data is included in the models for the period from January 2016 through February 2020 (for DEC) and March 2017 through February 2020 (for DEP).

Equation A-1. Within-Subjects Regression Model

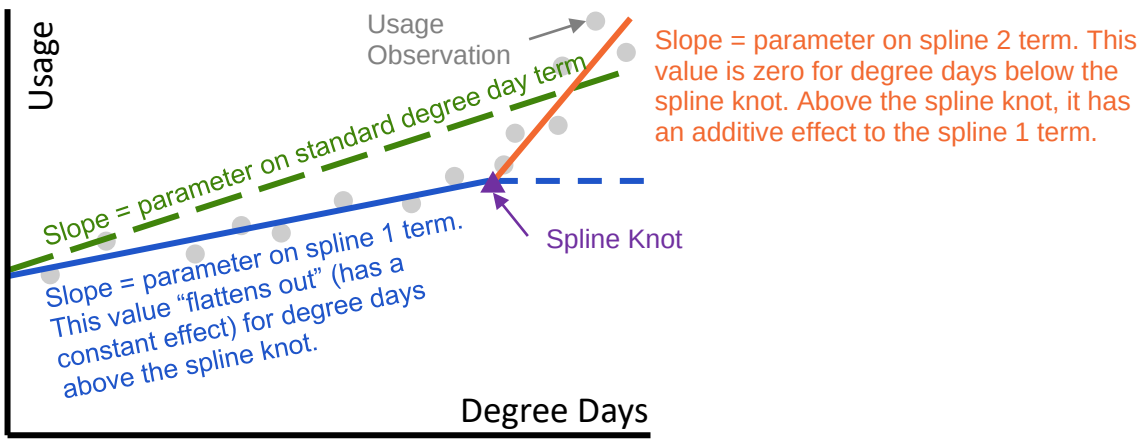
$$ADU_{it} = \alpha_i + \sum_J \beta_{1j} Month_{jt} + \beta_2 CDD_{it} + \beta_3 spline_1 HDD_{it} + \beta_4 spline_2 HDD_{it} + \beta_5 CrossPart_{it}$$
$$+ \beta_6 Treatment_i \cdot CDD_{it} + \beta_7 Treatment_i \cdot spline_1 HDD_{it} + \beta_8 Treatment_i \cdot spline_2 HDD_{it} + \varepsilon_{it}$$

Where,

i	= The subscript identifying the customer.
t	= The subscript identifying the month of sample.
α_i	= The customer-specific fixed effect.
ADU_{it}	= Average daily consumption of kWh by customer *i* in month of sample *t*.
$Month_{jt}$	= A set of binary variables taking a value of 1 when *j* = *t* and 0 otherwise; *j* indexes months 1-12.
CDD_{it}	= average cooling degree days (base 65°F) in month of sample *t*.
$spline_1 HDD_{it}$, $spline_2 HDD_{it}$	= a set of variables acting as a temperature spline for the average heating degree days (base 65°F) in month t experienced by customer I, with a spline knot of 19. As illustrated in Figure A-7, the spline models temperature dependent consumption with a different relationship at lower temperatures below the spline knot. The higher temperature component of the spline accounts for increased electricity usage at very cold temperatures, where auxiliary heating may be used for heat pumps.
$CrossPart_{it}$	= A dummy variable equal to 1 if customer *i* participated in a related small business energy efficiency program (e.g. Small Business Energy Saver, etc.) during, or in any of the months prior to, month of sample *t*; and 0 otherwise.
$Treatment_{it}$	= A dummy variable equal to 1 if customer *i* installed their smart thermostat during, or in any of the months prior to the month of sample *t*; 0 otherwise.
ε_{it}	= The error for customer *i* during month of sample *t*. Standard errors are estimated from model residuals and are cluster-robust to account for any heteroskedasticity or serial correlation at the business level.

β = Parameter estimates. These values are the estimated relationship between demand and the variable for which the beta represents. β_7, β_8 are used to estimate average daily energy savings due to the program.

Figure A-7. Illustration of a Temperature Spline



A.3 Participant Setpoint Analysis

Guidehouse performed analysis of available thermostat setpoint telemetry data for participants in the program, to provide insight into the differences in estimated energy savings between DEP and DEC participants. Duke Energy provided a set of thermostat telemetry data for participants in both DEC and DEP territories. The data contained a log of participant thermostat setpoint schedules spanning the time period of March 2019 through January 2020, where entries appear every time a schedule is created. Customers can create a setpoint schedule in different ways: by day of week, by weekday and weekend, or by occupied and unoccupied. 95% of participants chose to set an unoccupied vs occupied schedule. Only 15% chose to set a daily schedule (10% of customers chose to use both types of schedules at different times). No DEP participants used a daily setpoint schedule, i.e. they only used an occupied vs unoccupied schedule.

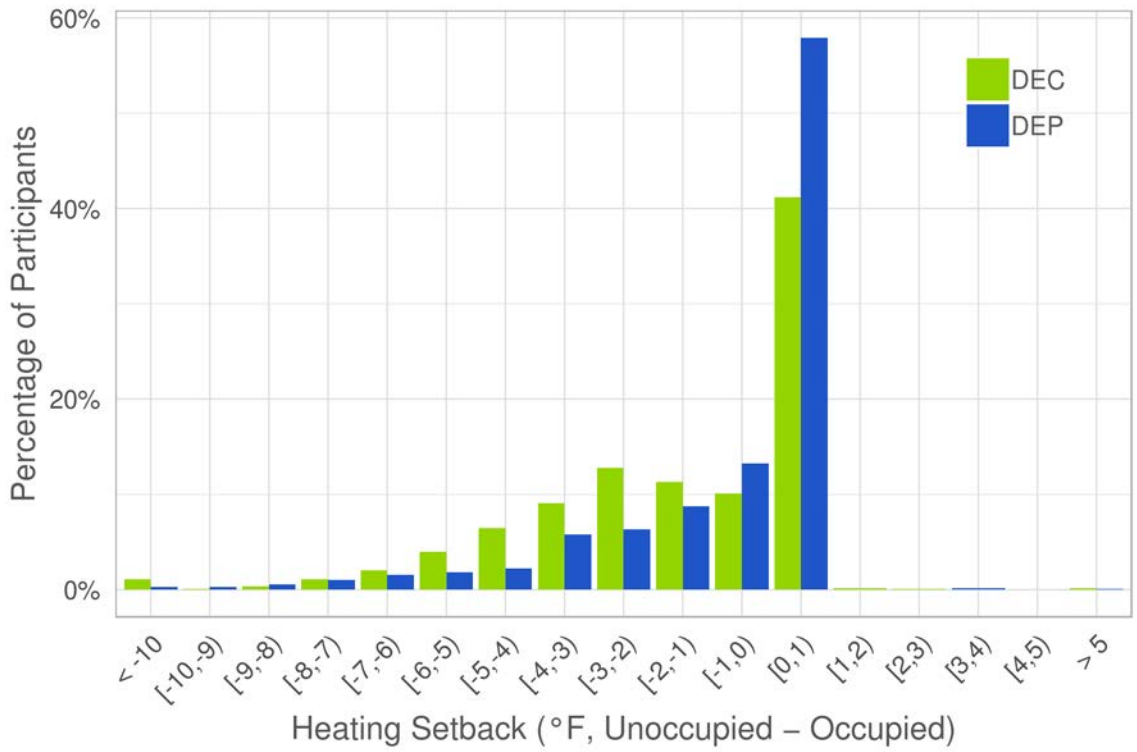
The data contained schedules for participants who installed a device between January 2019 through February 2020; however, there was little overlap with the evaluation sample of those who installed between January 2018 and February 2020, as 98% of devices in the available data were installed after February 2019. Nevertheless, the data still provides insight into DEP and DEC participants, so Guidehouse analyzed the data to discover any trends that may explain differences in observed energy savings.

Since no DEP participants used a daily schedule, Guidehouse focused on comparing unoccupied and occupied setpoints to understand the extent to which customers in each territory use temperature setbacks, or a more energy efficient setpoint, when their business is unoccupied. In the summer, a setback corresponds to a higher setpoint, while in the winter a

setback corresponds to a lower setpoint. A larger setback indicates more energy efficient behavior.

Figure A-8 compares the distribution of observed heating setbacks between DEC and DEP participants. Almost 60% of DEP participants with telemetry data do not appear to use any heating setback, compared with about 40% of DEC participants (indicated by the tall bars on the right of the distribution). Furthermore, setbacks for DEC participants are generally more aggressive than DEP, as indicated by the higher green bars for various setback levels. This suggests that DEC participants are exhibiting more efficient behavior on average than DEP participants during the heating season.

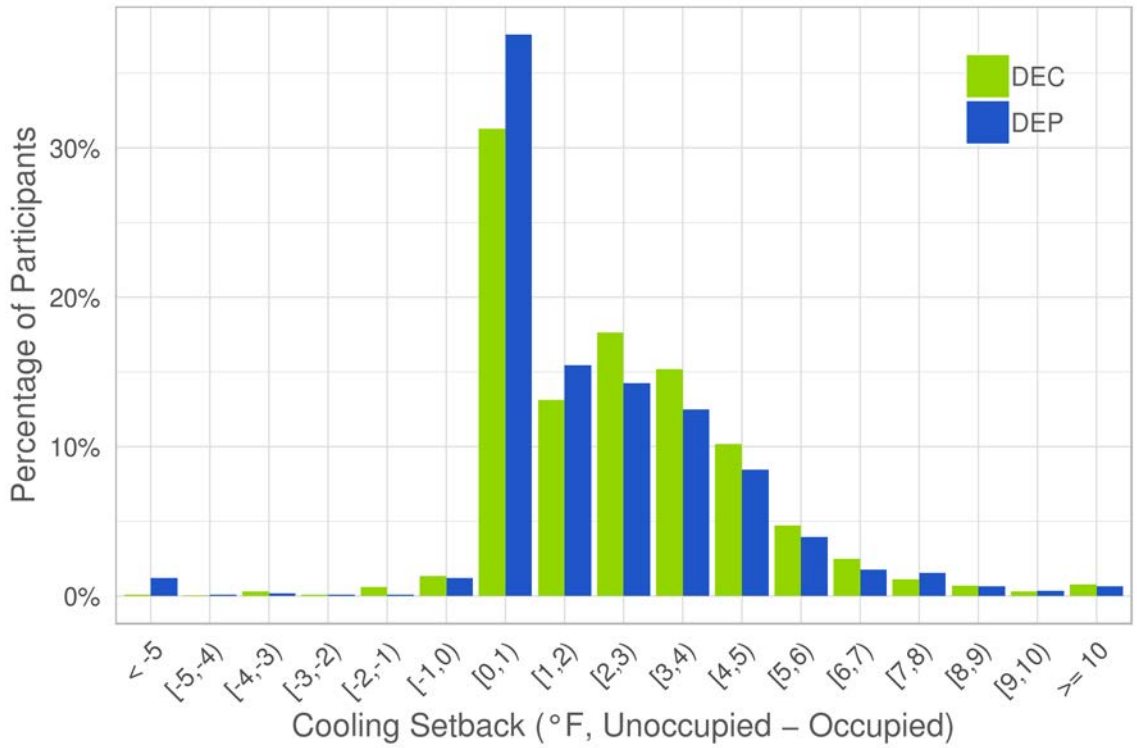
Figure A-8. Distribution of Observed Heating Setbacks



Source: Guidehouse Analysis

Similarly, Figure A-9 compares the distribution of observed cooling setbacks between DEC and DEP participants. Almost 40% of DEP participants with telemetry data do not appear to use any cooling setback, compared with about 30% of DEC participants. Furthermore, setbacks for DEC participants are generally more aggressive than DEP, as indicated by the higher green bars for various setback levels. This suggests that DEC participants are exhibiting more efficient behavior on average than DEP participants for the cooling season.

Figure A-9. Distribution of Observed Cooling Setbacks



Source: Guidehouse Analysis

Across both heating and cooling, occupied and unoccupied setpoints suggest that DEC participants exhibit more energy efficient behavior on average than DEP participants. Almost 60% of DEP participants do not use any heating setback, and almost 40% do not use a cooling setback. Comparatively for DEC participants, ~40% do not use a heating setback and ~30% do not use a cooling setback.

The differences in setback behavior may explain some of the differences in the estimated kWh savings between DEP and DEC. Note that this analysis was based on a more recent sample of participants than those used for estimating kWh savings. Nevertheless, the data provided some insight into differing behavior among DEP and DEC participants. Guidehouse also did not have data on behavior prior to installation of the thermostat; however, since a large portion of participants appear to not use any setback, we may assume that these customers did not use one before installing the new thermostat either.