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9. MEASURE-LEVEL INPUTS FOR DUKE ENERGY ANALYTICS

The SBES program estimates deemed savings on a per-fixture basis that takes into account specific operational characteristics. This approach differs from a more traditional prescriptive approach that applies deemed parameters by measure type and building type only.

For the lighting measures, the EM&V team applied HVAC interactive effects and coincident factors in the analysis that differed from those used by the IC; the values used are shown in Table 9-1 and Table 9-2. Note that for the PY2015 SBES evaluation the EM&V team applied the summer coincidence factors for both summer and winter peak demand reductions, with additional adjustments based on logger data for each of the corresponding peak periods, as in previous years.

Table 9-1. HVAC Interactive Effects[7]

Building Type	Cooling Type	Heating Type	Energy HVAC Interactive Effect	Demand HVAC Interactive Effect
Grocery	Electric	Electric Resistance	1	1.43
Grocery	Electric	Electric HP	1.08	1.43
Grocery	Electric	Not Electric	1.22	1.42
Grocery	No Cooling	Electric Resistance	0.77	1
Grocery	No Cooling	Electric HP	0.86	1
Grocery	No Cooling	Not Electric	1	1
Grocery	DK	DK	1.14	1.36
Lodging	Electric	Electric Resistance	1.11	1.18
Lodging	Electric	Electric HP	1.11	1.18
Lodging	Electric	Not Electric	1.11	1.18
Lodging	No Cooling	Electric Resistance	1.11	1.18
Lodging	No Cooling	Electric HP	1.11	1.18
Lodging	No Cooling	Not Electric	1.11	1.18
Lodging	DK	DK	1.14	1.36
Manufacturing	Electric	Electric Resistance	1.1	1.29
Manufacturing	Electric	Electric HP	1.1	1.29
Manufacturing	Electric	Not Electric	1.1	1.29
Manufacturing	No Cooling	Electric Resistance	1.1	1.29
Manufacturing	No Cooling	Electric HP	1.1	1.29
Manufacturing	No Cooling	Not Electric	1.1	1.29

[7] PY2013 DEP EEB EM&V Report

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Manufacturing	DK	DK	1.14	1.36
Medical	Electric	Electric Resistance	1.05	1.44
Medical	Electric	Electric HP	1.12	1.44
Medical	Electric	Not Electric	1.22	1.43
Medical	No Cooling	Electric Resistance	0.83	1
Medical	No Cooling	Electric HP	0.89	1
Medical	No Cooling	Not Electric	1	1
Medical	DK	DK	1.14	1.36
Office	Electric	Electric Resistance	1.05	1.44
Office	Electric	Electric HP	1.12	1.44
Office	Electric	Not Electric	1.22	1.43
Office	No Cooling	Electric Resistance	0.83	1
Office	No Cooling	Electric HP	0.89	1
Office	No Cooling	Not Electric	1	1
Office	DK	DK	1.14	1.36
Other	Electric	Electric Resistance	1.05	1.44
Other	Electric	Electric HP	1.12	1.44
Other	Electric	Not Electric	1.22	1.43
Other	No Cooling	Electric Resistance	0.83	1
Other	No Cooling	Electric HP	0.89	1
Other	No Cooling	Not Electric	1	1
Other	DK	DK	1.14	1.36
Restaurant	Electric	Electric Resistance	1	1.43
Restaurant	Electric	Electric HP	1.08	1.43
Restaurant	Electric	Not Electric	1.22	1.42
Restaurant	No Cooling	Electric Resistance	0.77	1
Restaurant	No Cooling	Electric HP	0.86	1
Restaurant	No Cooling	Not Electric	1	1
Restaurant	DK	DK	1.14	1.36
Retail	Electric	Electric Resistance	1	1.43
Retail	Electric	Electric HP	1.08	1.43
Retail	Electric	Not Electric	1.22	1.42
Retail	No Cooling	Electric Resistance	0.77	1
Retail	No Cooling	Electric HP	0.86	1
Retail	No Cooling	Not Electric	1	1
Retail	DK	DK	1.14	1.36

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School	Electric	Electric Resistance	1.05	1.44
School	Electric	Electric HP	1.12	1.44
School	Electric	Not Electric	1.22	1.43
School	No Cooling	Electric Resistance	0.83	1
School	No Cooling	Electric HP	0.89	1
School	No Cooling	Not Electric	1	1
School	DK	DK	1.14	1.36
Warehouse	Electric	Electric Resistance	1.1	1.29
Warehouse	Electric	Electric HP	1.1	1.29
Warehouse	Electric	Not Electric	1.1	1.29
Warehouse	No Cooling	Electric Resistance	1.1	1.29
Warehouse	No Cooling	Electric HP	1.1	1.29
Warehouse	No Cooling	Not Electric	1	1
Warehouse	DK	DK	1.14	1.36

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Table 9-2. Coincidence Factors[8]

Building Type	Summer Coincidence Factor
OFFICE	0.81
SCHOOL	0.42
COLLEGE/UNIVERSITY	0.68
RETAIL/SERVICE	0.88
RESTAURANT	0.68
HOTEL/MOTEL	0.67
MEDICAL	0.74
GROCERY	0.81
WAREHOUSE	0.84
LIGHT INDUSTRY	0.99
HEAVY INDUSTRY	0.99
AVERAGE/MISC	0.77
AGRICULTURAL	0.50

[8] PY2013 Savings Basis and Changes, December 10, 2013. EEB Program Documentation.

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10. APPENDICES

One additional spreadsheet document details project level findings, and is embedded below:

- PY2015 DEP SBES Impact Summary.xlsx

PY2015 DEP_DEC
SBES Impact Summa

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Non-Residential Assessments Program Year 2014-2016 Evaluation Report

Submitted to Duke Energy Carolinas
in partnership with Tetra Tech

June 8, 2017

Principal authors:

Patrick Burns, Senior Vice President

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Carrie Koenig, Dan Belknap, Tetra Tech

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1 Executive Summary

1.1 Program Summary

The Non-Residential Assessment Program (NR Assessment Program) helps Duke Energy Carolinas (DEC) non-residential customers in North Carolina and South Carolina find energy saving opportunities within their businesses by subsidizing a portion of the cost of an energy assessment. Energy assessments are professional engineering studies that identify energy conservation measures that, when implemented, can assist in lowering customer energy costs.

The scope of the assessments ranges from whole-facility ASHRAE Level II[1] and Level III Energy Audits[2] (with and without calibrated simulation modeling) to studies targeting specific systems such as compressed air or commercial refrigeration systems. The energy assessments are conducted by pre-approved trade allies. Energy savings are credited to the NR Assessments Program by way of paid incentives through the Duke Smart $aver Custom Program for measures recommended in an NR Assessment report. The Program covers up to 50% of the energy assessment cost.

1.2 Evaluation Objectives and High Level Findings

This report presents the results and findings of evaluation activities for the Duke Energy Carolina's Non-Residential Assessments program conducted by the Evaluation Team, collectively Nexant Inc. and our subcontracting partner, Tetra Tech, for the period of January 2014 through December 2016.

1.2.1 Impact Evaluation

The overarching goals for the NR Assessments impact evaluation were to quantify accurate and supportable energy (kWh) and demand (kW) savings for measures and equipment implemented in customer facilities attributed to the NR Assessments Program. Energy and demand savings estimates were developed for measures implemented with the aid of a financial incentive from the Duke Smart $aver Custom program (herein referred to as "Custom Incentive Participants") and for measures implemented at a customer site without receiving a Duke Custom incentive (herein referred to as "Assessment-Only Participants"). Forward-looking energy and demand savings estimates were also developed for measures reported by participants to be currently in

[1] ASHRAE Level II: Energy Survey and Analysis – This energy audit involves interviews with select facility staff, a review of utility bills or other operating data and a walk through of the facility. Often a Preliminary Energy Use Analysis and Walk-Through Analysis are completed in tandem. The goal is to identify glaring areas of energy waste or inefficiency. The data is compiled and used to complete a preliminary report detailing low-cost/no-cost measures and detailed energy calculations and financial analysis of proposed energy efficiency measures.

2 ASHRAE Level III: This level of engineering analysis involves more detailed field data gathering as well as a more rigorous engineering analysis. It provides detailed project cost and savings calculations with the high level of confidence required for major capital investment decisions. This audit expands on the Level II audit by providing a dynamic model of energy use characteristics of both the existing facility and all energy conservation measures identified. The building model is calibrated using actual utility data to provide a realistic baseline against which to compute operating savings for proposed measures. Existing utility data is supplemented with sub-metering of major energy consuming systems and monitoring of system operating characteristics.

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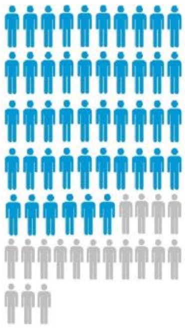
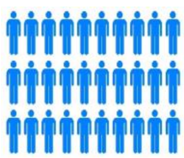
progress or to be implemented by January 1, 2018 (herein referred to as “Pipeline Savings”). Figure 1-1 further defines each participant category referenced within this report and also provides a summary of participation for the evaluation period.

Figure 1-1 NR Assessment Participant Categories and Sample Population Summary

	**"Non-Participants" (gray) -** Customers who showed initial interest in the NR Assessments Program by submitting an assessment application form through the Duke Energy website and may or may not have completed a pre-screening/scoping call with Account Manager, Program Manager, and/or Trade Ally, but ultimately opted out or was determined to be ineligible to participate (**17 Total Non-Participants**). **"Participants" (light blue) -** Customers that opted in and received an energy assessment report through the NR Assessment Program. For the purposes of this report, Participants have been sub-classified based on whether recommended ECMs were implemented and, if so, whether they received an incentive through the Duke Custom Program (**46 Total Participants**).
	**“Assessment-Only Participant w/ No Verified Savings”** - Participant received an energy assessment report through the NR Assessments Program, but did not implement any of the recommended energy conservation measures (ECMs) identified in the energy assessment report (**30 of 46 Participants**.
	**“Assessment-Only Participant w/ Verified Savings (Spillover)”** - Participant received an energy assessment report through the NR Assessments Program and has implemented measures from the assessment report, but did not apply for or receive an incentive through the Duke Custom Program (**9 of 46 Participants**).
	**“Custom Incentive Participant”** – Participant received an energy assessment, implemented energy conservation measures attributed to the NR Assessments Program, and received an incentive through the Duke Custom Program (**7 of 46 Participants**).

Activities included in-depth reviews of all energy assessment reports, on-site verification for a census of Custom Incentive Participant sites as well as some Assessment-Only Participant sites, and in-person or phone interviews with program participants paired with engineering desk analyses to estimate gross savings for all implemented measures attributed to the NR Assessments Program.

1.2.2 Process Evaluation Objectives

The Evaluation Team collected data from a variety of sources to address the researchable questions identified at the beginning of the study. Table 1-1 contains the list of research objectives and the data sources used to investigate each one.

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Table 1-1 Process Evaluation Research Objectives and Data Sources

Preliminary Research Questions	Document Review	Interviews with Key Contacts	Participant Survey	Trade Ally Survey
What non-residential segments are served by the program? How do customer characteristics of participants compare to the segments that are targeted for the program? Are there segments that have high potential and should be reached?		✓	✓	✓
How are customers engaged in the Non-Residential Energy Assessment, and what is the most effective marketing source?		✓	✓	✓
How influential is the program in customers' decisions to install the efficient measure? Is the focus of low and no-cost measures allowing participants to consider additional capital intensive projects with greater energy savings?			✓	✓
What barriers exist for customers who show interest but do not move forward with an audit? Why do customers choose not to move forward with projects after receiving an assessment?			✓	
Does the Non-Residential Assessment Program provide sufficient documentation and information for customers? Is the presentation of the information clear and understandable? What other support should the program provide?	✓	✓	✓	✓
What is the persistence of program engagement with participants? Do they follow up with customers to encourage project completion after audit? How effective is that process?		✓	✓	✓
What percentage of customers install efficiency measures, either within or outside Duke programs? How can that "conversion rate" be increased? What are the barriers to customers' adoption? Are customers making behavioral changes as a result of the information provided in the assessment?	✓		✓	✓
How satisfied are customers with the program and its components?			✓	
What program changes may improve program performance and energy efficiency equipment installation rates?	✓		✓	✓

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Preliminary Research Questions	Document Review	Interviews with Key Contacts	Participant Survey	Trade Ally Survey
Is sufficient data being captured to effectively verify recommendations and savings? How do program participants move between the Non-Residential Assessment Program and other Duke Energy programs?	✓		✓	✓

1.2.3 High Level Findings

1.2.3.1 Gross Impact Evaluation Key Findings

The gross impact evaluation found that the NR Assessments Program realization rate was 84% for energy (kWh) and 85% and 86% for Summer and Winter demand (kW), respectively. An encouraging parameter is the spillover and pipeline energy savings being generated by the energy assessment reports. The combined total of Custom Incentive Participant, Assessment-Only Participant spillover, and pipeline energy savings are projected to be on the order of 42 million kWh. Summaries of program-level gross impact results for energy (kWh) and demand (kW) are provided in Table 1-2 and Table 1-3. Table 1-4 shows the combined energy and demand savings from Custom Incentive Participant projects, verified Spillover, and Pipeline. The combined savings estimates exclude any considerations for energy or demand savings associated with ECMs implemented through the Duke Smart $aver Prescriptive Program. This is due to the fact that these savings are already claimed by the Prescriptive Program.

Table 1-2 Program Reported and Verified Gross Energy and Demand Impacts from Measures Implemented with Aid of Duke Custom Incentive

Measurement	Gross Reported (MWh)	Gross Verified (MWh)	Realization Rate
Energy (MWh)	21,843	18,408	84%
Summer Demand (kW)	2,142	1,833	86%
Winter Demand (kW)	2,132	1,811	85%

Table 1-3 Program Evaluated Spillover and Pipeline Energy and Demand Impacts

Measurement	Gross Energy MWh	Gross Demand kW
Spillover (Assessment-Only Participants)	2,421	301
Pipeline Savings	21,080	1,980

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Table 1-4 Combined Energy and Demand Impacts (Custom Incentive Participants, Spillover, and Pipeline)

Measure Category	Energy Savings (kWh)	Demand Savings (kW)
Custom Participants	18,408,296	1,845
Assessment-Only Participants	2,420,541	300
Pipeline Projects	21,080,199[3]	1,980
Total Savings	**41,909,036**	**4,125**

Some additional high level findings from the impact evaluation are summarized below.

- The average duration of time between the date an energy assessment report is issued and the date a measure is eventually implemented ranges from 6 months to 3 years. The average duration is approximately 2 years (e.g., the majority of the evaluated pipeline energy savings were identified in energy assessment reports finalized in January and May of 2015). This is partially explained by the capital-intensive nature of many of the energy conservation measures being recommended in the energy assessment reports. The NR Assessments Program focuses on identifying high impact measures that result in significant energy and financial savings. Implementation of the recommended energy conservation measures (ECMs) also often requires the involvement of third-party engineers and/or designers and approval from the highest management levels of an organization, which contributes to delayed implementation.
- The Evaluation Team found the energy assessment reports to be very in-depth and often identified energy conservation opportunities that the customer may not have been considering or been made aware of without the program.
- The level of transparency could be improved with regard to energy savings estimates in cases where simple engineering models were used. Sufficient detail is typically provided for projects involving a Duke Smart $aver Custom incentive, but key assumptions from measures not involving an incentive were much less transparent.

Net Impact Evaluation Key Findings

The net-to-gross evaluation found that the program is extremely effective at producing energy savings, resulting in a net-to-gross ratio of 1.06. Customers largely were not planning to complete the energy-efficiency measures prior to interacting with the program, and credited the program with influencing their decisions to complete the projects. In addition, customers completed additional projects without receiving an incentive from Duke Energy, but attributed influence to the program, resulting in spillover savings that outweighed the small amount of freeridership (FR). Table 1-5 presents the evaluated net verified savings and associated net-to-gross ratio for the program.

[3] Pipeline energy savings will occur outside of the evaluation period (2014-2016) The Evaluation Team felt it was beneficial to show Pipeline energy savings because the energy assessment reports were completed during this timeframe.

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Table 1-5 Net-to-Gross Evaluation Results

Measurement	Gross Verified Energy Savings (kWh)	Net Verified Energy Savings (kWh)	Ratio
Net of Freeridership	15,255,745[4]	14,798,073	0.97
Program-influenced Spillover	18,408,296	1,656,746	0.09
Net-to-Gross	**18,408,296**	**19,512,794**	**1.06**

** Net of Freeridership = (1 – 0.03 FR) = 0.97*

Process Evaluation Key Findings

Overall the program is operating as intended and customers are satisfied with their experiences with the program as well as Duke Energy. Both participant and non-participant respondents appreciate Duke Energy's effort in helping customers identify areas for improvements and saving money. Given cost is a major barrier to making improvements, respondents appreciate the rebates and incentives available and the support vendors provide in helping to navigate the rebate and incentive processes. Additional high-level findings include the following:

- The primary source of program awareness is from Duke Energy, specifically the account managers
- Satisfaction with the program overall and its components is high among Participants and Non-Participants
- The need to upgrade equipment and the need to reduce energy costs were the main reasons for participant respondents wanting an assessment as well as the reason non-participant respondents were considering an assessment
- The cost of the assessment was the main reason why non-participant respondents cited for not moving forward with an assessment
- Three-fourths of participant respondents installed equipment based on recommendations
- The tracking database lacked key information for evaluation activities and program/project tracking

[4] This reflects only the energy savings of customers who responded to the net-to-gross survey.

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1.3 Evaluation Conclusions and Recommendations

Based on evaluation findings, the Evaluation Team concluded the following and provides several recommendations for program improvement.

1.3.1 Impact

Conclusion 1: It would be advantageous for the NR Assessments Program to maintain final versions of all ex ante[5] building energy simulation files used by trade allies to develop energy savings estimates.

- **Recommendation 1:** We recommend that trade allies submit final versions of all ex ante energy simulation modeling files whenever a whole building energy simulation approach is used as the primary source for generating project-level energy and demand savings estimates.
- **Recommendation 2:** We recommend that trade allies provide key inputs and assumptions used in engineered savings estimates in order to provide better transparency with regard to key assumptions and improve evaluation effort of the program. .

Conclusion 2: There are several opportunities for improvement for tracking NR Assessment Projects.

- **Recommendation 3:** The Evaluation Team has several recommendations for how to improve assessment project tracking processes.
  - We recommend that the program develop a means for linking NR Assessment projects with subsequent Custom or Prescriptive Smart $aver incentive applications and payments.
  - We recommend updating the project status (incentive offered, incentive paid, report complete, etc.) in the master tracking system on a monthly basis.
  - We recommend that the program track additional project details including the ECMs identified in each assessment report, estimated measure-level energy and demand savings impacts, and incentives paid to the Customer through the Duke Custom or Prescriptive Programs following an assessment.

1.3.2 Process

Conclusion 1: One of the main reasons customers did not follow-through after expressing interest was because of the cost associated with the assessment. Customers are not necessarily aware of the different levels of assessments or the fees associated with them.

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[5] The term “ex ante” represents the forecasted energy and demand savings rather than the actual results.

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Making customers aware of the services Duke Energy provides, both for assessments and rebates, may encourage use of Duke Energy program offerings.

- **Recommendation 1:** Increase program marketing so customers are aware of the different levels of assessments and are aware of the rebate and incentive programs.

Conclusion 2: It is important to continually follow-up with customers who received an assessment to make sure they are aware of the rebates available at the time they decide to move forward with their project. The process for this follow-up needs to be clear and all parties involved, including account managers, should remain updated. Account managers could follow-up with customers who received an assessment to encourage rebate program use.

- **Recommendation 2:** Ensure processes are in place for follow-up once an assessment is complete.

- **Recommendation 3:** Continue to keep Account Managers informed and involved in the assessment process and project status.

Conclusion 3: The program currently tracks savings based on customers who received an assessment and received a rebate through the Smart $aver Custom program. If a customer who received an assessment made an improvement but went through the prescriptive program, the participation is tracked through the prescriptive program. Tracking customers who received prescriptive rebates within the Custom program would allow account managers and others to focus follow-up efforts on customers who have not followed through with any recommendations.

- **Recommendation 4:** Within the Custom program, track customers who receive prescriptive rebates and custom rebates.

- **Recommendation 5:** Assessment report formats varied from trade ally to trade ally. This is to be expected in instances where a study only focuses on a specific building system, but it is recommended that benchmarks be established to ensure that all critical information is included in every report. As an example, all reports should provide savings estimates in units of energy (kWh), demand (kW), and dollars. There were several reports included in the evaluation that only provided financial savings estimates ($).

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2 Introduction and Program Description

2.1 Program Description

The Non-Residential Assessment Program (herein NR Assessments Program) helps Duke Energy business customers in North Carolina and South Carolina find energy saving opportunities within their organizations by subsidizing a portion of the cost of an energy assessment. Energy assessments are professional engineering studies that identify energy conservation opportunities that, when implemented, will assist in lowering energy costs. The program follows a specific methodology and organizations approved for participation receive the following:

- No charge pre-assessment energy scoping to identify high-level energy savings and areas of opportunity
- An on-site energy assessment performed by an experienced and professional engineering firm
- Up to 50 percent subsidy of assessment costs
- A comprehensive Energy Report with a detailed analysis of utility bills, energy consumption by system type, potential energy conservation measures with savings projections, full financial analysis and estimated utility incentives
- Engineering and application support for Duke Energy's Smart $aver® Incentive Program, that can be utilized to help fund projects
- Assistance with post implementation project verification as needed for the Smart $aver program

Various types of assessments are available that cover most building types as well as specific electrical infrastructure and systems. Specifically, energy assessments are available to the following building types:

- Commercial offices
- Industrial
- Hospitals and health care facilities
- Colleges and universities
- K-12
- Public/government
- Data centers
- Hospitality
- Churches/places of worship

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- Arenas/sports complexes

And the assessments explore energy savings for the following key technologies:

- Lighting and lighting controls
- HVAC equipment and controls
- Building envelope
- Motors
- Compressed air
- Commercial refrigeration
- Load shifting
- Electric hot water fixtures
- Kitchen equipment
- Transformers

2.2 Program Implementation

The NR Assessments Program is implemented by a team of preferred and pre-approved trade allies. There are currently three trade allies serving the program: Chicago Bridge & Iron, CLEAResult, and ThermalTech Engineering. Energy assessment reports developed by former trade allies including the Building Intelligence Group and I&M Industrials were also reviewed as part of the NR Assessments impact evaluation. The Building Intelligence Group's involvement with the program stopped in early 2016. Reports written by I&M Industrials were mostly from Program year 2014.

Customers who are interested in participating must first make a formal request through the Duke Energy website and meet program eligibility requirements. Once eligibility has been confirmed and a customer is pre-approved to participate, the process begins with a no charge pre-assessment energy scoping meeting between the customer, assessment program manager, and a preferred trade ally. Following this initial call, for those who express interest in moving forward with an assessment, the customer then receives a proposal from the trade ally outlining the scope of services and a lump sum cost to complete. A portion of the assessment cost (up to 50%) is covered by the NR Assessments Program.

2.2.1 Participation Summary

For reporting purposes, Non-Participants are customers who engage the program by submitting an assessment request, go through the no charge pre-assessment energy scoping meeting, and/or receive a proposal for an assessment from a trade ally, but opt to not go through with the assessment. All customers who elect to move forward with an energy assessment are identified as participants.

"Assessment-Only Participants" are those who receive an energy assessment report and either choose not to implement any of the recommended ECMs or implement all or a portion of the

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tem without receiving a Duke Custom incentive. Savings attributed to Assessment-Only projects were treated as spillover in the evaluation.

Participants who implement all or a portion of the recommended energy conservation measures and receive a financial incentive from the Duke Custom Smart $aver Program are classified as “Custom Incentive Participants.” A summary of program participation from 2014 through 2016 is provided in Table 2-1.

Table 2-1 DEC NR Assessments Program Participation Summary 2014-2016

NR Assessments Population Summary	Participants/Non-Participants	Unique Premises
Non-Participant (Opted Out / No Report)	17	17
Assessment-Only Participant / No Verified Savings	28	30
Assessment-Only Participant w/ Verified Savings (Spillover)	4	9
Custom Incentive Participant	4	7
Total	**53**	**63**

The Evaluation Team conducted on-site inspections at all seven of the Custom Incentive Participant sites. On-sites were also conducted at six of the Assessment-Only Sites with verified savings. Primary data collection activities for the remaining Assessment-Only sites were accomplished through phone interviews and desk reviews.

Figure 2-1 and Figure 2-2 summarize the distribution of reported energy (kWh) and demand (kW) savings for Custom Incentive Participant projects by measure category.

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Figure 2-1 Distribution of Reported Energy Savings from Custom Incentive Participants

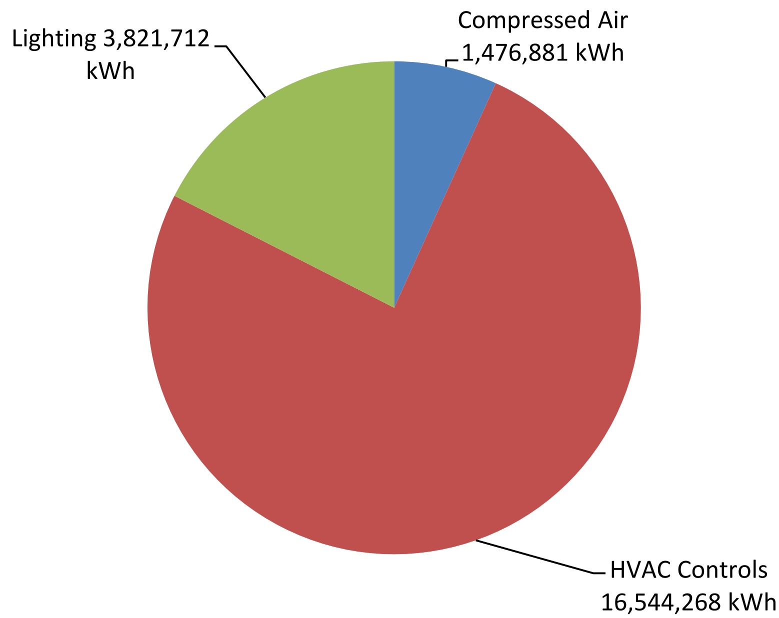

Figure 2-2 Distribution of Reported Demand Savings from Custom Incentive Participants

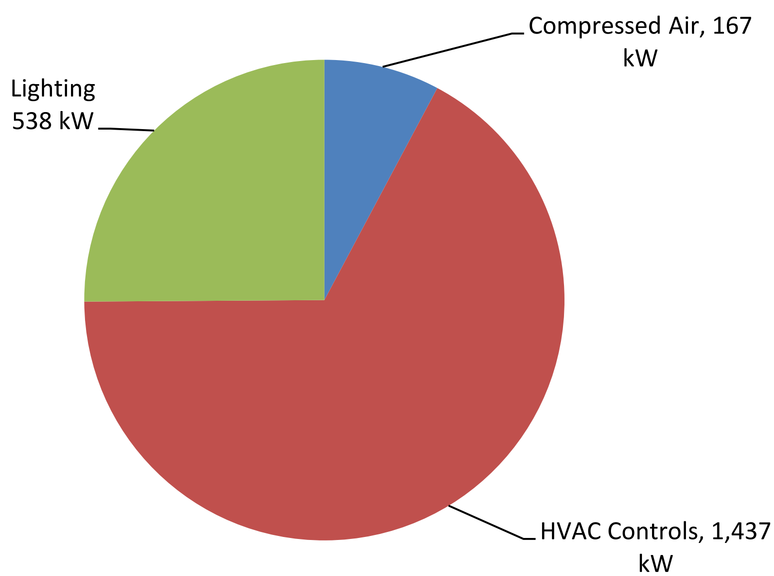

Table 2-2 provides a breakdown of reported energy and demand savings by Program year. It should be noted that the distribution of savings by year are approximations based on a variety of sources including the reported timeframe of measure implementation provided during participant interviews, Smart $aver application dates, and/or the date on which an energy assessment report was issued. Energy savings in 2015 were substantially higher based on major HVAC Control System upgrade projects at four large hospitals that were completed.

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Table 2-2 Reported Energy and Demand Savings by Program Year

Program Year	Reported Energy Savings (kWh)	Reported Summer Demand (kW)	Reported Winter Demand (kW)
2014	1,476,881	167	167
2015	16,743,918	1,528	1,518
2016	3,622,062	447	447

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3 Key Research Objectives

3.1 Gross Impact

The impact evaluation processes followed standard industry protocols and definitions, where applicable, and include the Department of Energy Uniform Methods Protocol[6], as an example. As part of evaluation planning, the Evaluation Team outlined the following activities for this program evaluation:

- Quantify accurate and supportable energy (kWh) and demand (kW) savings for measures and equipment being implemented in customer facilities attributed to the NR Assessments Program;
- Quantify energy (kWh) and demand (kW) savings for measures and equipment being implemented in customer facilities, but for which the customer did not receive a Duke Energy incentive (spillover savings);
- Determine whether deeper savings can be achieved by assessing the depth and veracity of the energy efficiency opportunities identified by the assessment;
- Assess the program market effects and rate of free riders and spillover effects;
- Monitor enrollment process to determine effectiveness (enrollment script, enrollment specialist phone etiquette, etc.);
- Review Non-Residential Rebates and Custom Program applications that identify participants originally brought into the program through energy assessments; and
- Measure and document the level of customer satisfaction with the programs and its processes.

3.2 Net Impact

The goal of net impact evaluation was to estimate the overall energy impact that is attributable to the program. This estimate comprises two components: free-ridership and spillover.

Freeridership is the estimate of what proportion of the program's savings would have happened in the absence of the program. Free ridership takes into account the customers' plans prior to engaging the program and the various influences the program can have on the customer such as the assessment report, incentives, and other interaction with the program.

Spillover estimates additional energy savings for efficiency projects that were completed without receiving a program incentive, but were influenced by the program in some other way.

[6] The DOE's Uniform Methods Project for Determining Energy Efficiency Program Savings can be found at http://www1.eere.energy.gov/office_eere/de_ump.html.

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Net program results expressed through a net-to-gross ratio, which is calculated as follows:

$$\text{Net-to-gross} = (1 - \text{Freeridership \%}) + \text{Spillover \%}$$

3.3 Process

Process evaluations are designed to support continuous program improvement by identifying successful program elements that can be expanded upon as well as underperforming/inefficient processes that could be holding back program performance. The process evaluation for the NR Assessments Program sought to:

- Assess how participant characteristics compare to segments targeted for the program
- Assess the sources of customer engagement and most effective marketing source
- Assess influence the program has on customers' decisions to install EE measures
- Assess barriers for customers who show interest but do not move forward with an audit
- Understand reasons customers choose not to move forward with projects after receiving an assessment
- Assess whether sufficient documentation and information are provided to customers
- Assess persistence of program engagement with participants
- Assess satisfaction with the program and its components including suggestions for program changes
- Understand participant movement between the Assessment program and other Duke programs.

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4 Impact Evaluation

4.1 Approach

The evaluation team's impact analysis focused on the energy and demand savings attributable to the NR Assessments Program for the period of January 2014 through December 2016. The evaluation was divided into two research areas to determine gross and net savings (or impacts). Gross impacts are energy and demand savings estimated at a participant's site that are the direct result of implementing measures identified in an energy assessment report. 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 NR Assessments and Custom Program participant databases
- Completion of on-site verification at all Custom Incentive Participant sites and select Assessment-Only Participant sites
- Telephone and in-person interviews to verify key inputs into savings calculations
- Estimation of gross verified savings using primary data collected
- Comparison of the gross-verified savings to program-evaluated results to determine realization rates
- Application of attribution survey data to estimate net-to-gross ratios and net-verified savings at the program level

4.2 Database Review

Review of the program database and program participation records provided details that informed all evaluation activities. The database review process required multiple rounds of data requests before the Evaluation Team was able to develop a full understanding of program participation. This is due to the fact that not all information was being tracked in a single database for the NR Assessments Program. Many of the details necessary to evaluate gross savings had to come from the Duke Smart $aver Custom Program tracking database in instances where the participant implemented measures with the aid of an incentive from the Duke Custom Program.

The database review began with a preliminary data request for an extract for the NR Assessments Program for program years 2014 through 2016. The first priority of this review was to identify the status of each participant included in the initial extract. There were a total of 63 unique premises identified in the initial extract. Through the review process and based on supplemental feedback from the program manager it was determined that there were a total of 46 program participants for Program Years 2014 through 2016. The Evaluation Team was informed by the program manager that 17 of the customers opted out and did not receive a

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report. Once the participation status of each project was determined, the Evaluation Team requested copies of all energy assessment reports.

All energy assessment reports were then reviewed in detail by the Evaluation Team. Standardized processes for conducting these reviews were established and the Evaluation Team developed a MS Excel-based database for tracking key details from each report including measure category and a brief description of each recommended ECM identified in the report. The aggregated results were then shared with the process team for reference during participant process surveys which also functioned as a means for pre-screening participants for inclusion in the impact evaluation. During each participant interview the process team would inquire as to whether any of the recommended ECMs had been implemented at a customer site. Those who affirmed having implemented measures were then followed up with the Evaluation Team to gather information necessary to calculate savings.

4.3 Targeted and Achieved Sampling

Original sample targets from the Evaluation Plan were based on a first estimate on the level of NR Assessments Program participation, which ended up being too high. The sample targets were adjusted downward once true participation levels were determined. This issue was brought to the attention of Duke Energy early on in the evaluation process.

There were a total of 46 energy assessments conducted between January 2014 and December 2016. Actual achieved sampling for the impact evaluation is shown in Table 4-1.

Table 4-1 Achieved Sampling for NR Assessment Program Impact Evaluation

Jurisdiction	Category	Desk Reviews	On-Site M&V
Duke Energy Carolinas	Projects w/ Program-Tracked Savings	0	7
	Projects w/ Identified Spillover Savings	3	6
	Recent Energy Assessment Projects	2	0
	Total	**2**	**13**

A census of Custom Incentive Participant projects were evaluated; therefore, uncertainty and error bounds for savings estimates provided in this report are not applicable.

4.4 Impact Evaluation Methodology

The gross program energy impacts were evaluated using the data collection and analysis approaches described below. This section of the report also outlines the procedures and equations used to estimate energy and demand savings.

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4.4.1 Data Collection

As outlined in prior sections, the gross impact evaluation process began with a thorough review of each energy assessment report where the evaluation team extracted key details and data and recorded them in a central master tracking database. This information was referenced while conducting phone surveys in order to determine whether any ECMs were implemented as part of pre-screening process. Data collection activities conducted for the impact evaluation were dependent upon a few influencing parameters determined during the data review process:

- Participation Classification: Is the participant a Custom Incentive Participant (Projects w/ Program-Tracked Savings) or Assessment-Only Participant (Projects w/ Identified Spillover Savings):
  - Custom Participant Sites: on-site verification was conducted at 100% of sites
  - Assessment-Only Participant Sites: on-site verification was conducted at 6 of 9 (67%) of the sites
    - Assessment-Only Participant Sites were also assessed based on level of project complexity and savings:
    - Projects with low measure complexity and low reported energy savings were analyzed using information found in the project documentation and through the telephone survey.
    - Projects with high measure complexity and high reported energy savings were identified as on-site verification candidates.

4.4.1.1 On-site Verification Activities

Before any on-site activities could take place, the Evaluation Team developed a site-specific measurement & verification plan (SSMVP) for each unique premise and completed measure. These were developed in order to create a standardized, rigorous process for the verification of project claims while on-site. Each SSMVP was specifically tailored to verify the equipment that was installed and measures were appropriately implemented as proposed in the energy assessment report. The SSMVP also identified baseline assumptions for verification with on-site personnel in order to validate ex ante, forecasted, savings estimates.

Each SSMVP also identified the specific parameters to be gathered in the field for each measure included in the energy assessment report. The plans also identify a preferred and one or two alternate analysis approaches along with the critical data to be gathered for each. Regardless of the method ultimately selected for the savings analysis, field engineers were instructed to gather the data necessary for all methods identified in the SSMVP. Table 4-2 provides a few examples of the data points typically gathered for several of the more commonly-encountered measures.

During on-site verification, field engineers also requested copies of equipment specifications and sequences of operation. Any available historic trend data (when available) was also obtained from existing HVAC control and central plant sequencing control systems. This

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information was particularly useful when developing baseline consumption profiles.

Table 4-2 Key Data Points Gathered for Commonly Encountered ECMs

Measure Name	Baseline or Retrofit
HVAC Controls: Time-of-Day Scheduling	Determine baseline setpoints and schedules through customer interviews Determine post-retrofit setpoints and schedules through central BAS and interviews with customer including the following parameters • Supply air temperature reset strategy and setpoints • Static pressure reset strategy and setpoints • Implemented temperature setbacks Verify economizers have been optimized via customer interview and review of BAS Gather nameplate information from primary heating and cooling systems
HVAC Controls: Operating Room Air Changes & Controls	Determine baseline setpoints and schedules through customer interviews Determine post-retrofit setpoints and schedules through central BAS Verify occupancy schedule of hospital departments Determine baseline terminal unit flow conditions through customer interviews Determine post-retrofit terminal flow conditions through central BAS Determine baseline ACHs from customer interview Determine post- retrofit ACHs through BAS Gather nameplate information from primary heating and cooling systems
HVAC Controls: Chilled Water Plant Upgrades	Determine whether pump head has been reduced through customer interview and any available trend data from BAS Verify system delta T has been increased to 12°F from 8°F through customer interview and BAS Determine whether condenser water reset strategy has been implemented through BAS and verify baseline operations through customer interview
Interior Lighting Upgrades	Quantity of existing fixtures Fixture type of existing fixtures Quantity of retrofit fixtures Fixture type of retrofit fixtures Existing fixture controls, if any New fixture controls, if any Typical schedule and hours of operation Space temperature Type of heating and cooling equipment/specifications

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4.4.2 Peak Period Definition

Demand savings were evaluated based on the definition of the peak period provided by Duke Energy, as summarized in Table 4-3.

Table 4-3 Definition of Peak Demand Periods

	Summer	Winter
Month	July	January
Hour	4pm – 5pm	7am – 8am

4.5 Level of Rigor

A variety of analysis approaches were utilized for the impact evaluation. The approach applied was decided based upon the methods used by the trade ally in generating the ex ante[7] savings estimates, the availability of information, and the extent of interactive effects. An overview of each analysis approach applied is provided in Sections 4.5.1 through 4.5.3.

4.5.1 Enhanced Rigor: Whole Building Simulation with On-Site Verification Only

Consistent with IPMVP Option D[8] (Calibrated Simulation), this analysis approach was only used on projects where the ex ante savings estimates were developed from calibrated energy simulation modeling (typically eQuest) and when the Evaluation Team was able to obtain a final copy of the model used to develop the ex ante savings estimates. This information had to come from the trade ally directly. The Evaluation Team was able to obtain final ex ante models from one of the two trade allies (*CB&I*) that used an Option D approach in an energy assessment report. The Evaluation Team was able to connect with the other trade ally, Building Intelligence Group, but they are no longer in business and could only provide MS Excel-based output files from the ex ante *eQuest* simulation models.

Once the models were obtained from the trade ally the evaluation process began by calibrating the ex ante models to verified post-installation conditions and actual historical weather data coincident with post-retrofit utility bills. Historical weather data was obtained from the National Oceanic and Atmospheric Administration (NOAA). The implemented energy conservation measures (ECMs) were then modified to be consistent with baseline operations and the model was then re-run to determine baseline consumption. The difference between the ex ante and ex post simulated models resulted in the estimated first-year savings. The Evaluation Team leveraged any and all available trend data from on-site Energy Management Systems and/or HVAC control systems in order to better inform and assist in calibrating the ex post models. All simulation modeling adhered to the guidelines set forth in the Department of Energy (DOE)

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[7] The term “ex ante” represents the forecasted energy and demand savings rather than the actual results.

[8] The International Performance Measurement and Verification Protocol (IPMVP) is published by the Efficiency Valuation Organization (EV0) and can be found at: http://evo-world.org/en/

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Uniform Methods Project (UMP)[9] HVAC Controls (DDC/EMS/BAS) Evaluation Protocol and was completed using *eQuest*.

4.5.2 Enhanced Rigor: Billing Analysis with On-Site Verification Only

Consistent with IPMVP Option C (Whole Building), this approach was used for projects involving multiple HVAC control measures with interactive effects and when final ex ante building simulation models could not be obtained from the Trade Ally. This approach entailed a pre- and post-retrofit comparison of weather-normalized whole facility energy consumption. This approach adhered to guidelines set forth in the Department of Energy Uniform Methods Project Protocols for HVAC Controls (Chapter 19) and Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol (Chapter 8).

Our general approach consisted of the following:

1. Fit a premise-level degree-day regression model separately for the pre- and post-periods.

2. For each period (pre- and post-) use the coefficients of the fitted model with normal year degree days to calculate weather-normalized annual consumption (NAC) for that period.

3. Calculate the difference between the pre- and post-period NAC for the site.

This approach was used for four of the Custom Incentive Participant projects. Outlined below is the step-by-step process for this analysis:

<u>Step 1. Fit the Regression Model:</u> The degree-day regression for the site and year (pre or post) are modeled as:

Equation 1: Average Consumption per Day

$$E_m = \mu + \beta_H H_m + \beta_C C_m + \varepsilon_m$$

Where:

E_m = Average consumption per day during interval m

H_m = Specifically, $H_m(T_H)$, average daily heating degree days at the base temperature (T_H) during meter read interval m, based on daily average temperatures on those dates

C_m = Specifically, $C_m(T_C)$, average daily cooling degree days at the base temperature (T_C) during meter read interval m, based on daily average temperatures on those dates

μ = Average daily baseload consumption estimated by the regression

[9] The DOE's Uniform Methods Project for Determining Energy Efficiency Program Savings can be found at http://www1.eere.energy.gov/office_eere/de_ump.html.

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β_H, β_C = Heating and cooling coefficients estimated by the regression

ε_m = Regression residual

Step 2. Applying the Model: To calculate NAC for the pre- and post-installation periods for the given site and timeframe, combine the estimated coefficients μ, β_H, and β_C with the annual normal-year or typical meteorological year (TMY) degree days H_0 and C_0 calculated at the site-specific degree-day base, τ_H and τ_C. The example shown below puts all premises and periods on an annual and normalized basis.

Equation 2: Weather-Normalized Annual Consumption

$$NAC = \mu * 365.25 + \beta_H H_0 + \beta_C C_0$$

Step 3. Calculate the Change in NAC: The difference between pre- and post-program NAC values (ΔNAC) represents the change in consumption under normal weather conditions.

4.5.3 Basic Rigor: Simple Engineer Model (SEM) with On-Site Measurement

Consistent with IPMVP Option A (Partially Measured Retrofit Isolation), this approach was used for all lighting and compressed air measures. An overview of the key inputs and algorithms used to develop energy and demand savings estimates for each of these two measure categories is provided in Sections 4.5.3.1 and 4.5.3.2.

4.5.3.1 Lighting Measures

Equations 1 and 2 were used to calculate energy and demand savings for all lighting retrofit measures.

Equation 3: Lighting Demand Savings

$$\Delta kW = (Qty_{BASE} \times Watts_{BASE} - Qty_{EE} \times Watts_{EE}) / 1000 \times WHF_d$$

Equation 4: Lighting Annual Energy Savings

$$\Delta kWh/yr = (Qty_{BASE} \times Watts_{BASE} - Qty_{EE} \times Watts_{EE}) / 1000 \times HoursWk \times Weeks \times WHF_e$$

Where:

Qty_{BASE} = Quantity of baseline fixtures

$Watts_{BASE}$ = Watts of baseline fixture (based on the specified existing fixture type) (Watts)

Qty_{EE} = Quantity of energy efficient fixtures

$Watts_{EE}$ = Watts of energy efficient fixture (based on the specified installed fixture type) (Watts)

HoursWk = Weekly hours of equipment operation (hrs/week)

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Weeks = Weeks per year of equipment operation (weeks/year)

*WHF_d = Waste heat factor for demand to account for cooling savings from efficient lighting**

*WHF_e = Waste heat factor for energy to account for cooling savings from efficient lighting**

1000 = Conversion: 1000 Watts per kW

Fixture Wattages

The pre-existing fixture wattages were quoted from industry standards and commercial literature for the applicable type of fixtures.

The installed light fixture wattages were taken from the manufacturer's cut sheets.

Hours of Use

Nexant verified hours of use assumptions by deploying lighting loggers. The lighting operating hours may exceed the facility's posted hours of business.

4.5.3.2 Compressed Air Measures

Energy use reduction for all compressor projects can be calculated by the difference between the energy consumed in the baseline operation minus the energy consumed in the post-retrofit operation. Generally, information is required for compressor capacity in both the baseline and post-retrofit scenarios. Appropriate adjustments are made to ensure the flow profile is equivalent between pre- and post-retrofit conditions unless demand improvements have been made that result in a change in the flow profile. Compressor power at full load can be calculated using Equations 5 and 6.

Equation 5: Compressor Power at Full Load (No VSD)

$$\text{Full Load kW}_{rated} = \frac{(\text{Compressor hp}) \times LF_{rated} \times (0.746\ \text{kW/hp})}{(\eta_{motor})}$$

Equation 6: Compressor Power at Full Load (w/ VSD)

$$\text{Full Load kW}_{rated} = \frac{(\text{Compressor hp}) \times LF_{rated} \times (0.746\ \text{kW/hp})}{(\eta_{motor}) \times (\eta_{VSD})}$$

Where:

Compressor hp = compressor horsepower, nominal rating of the prime mover (motor)

0.746 = horsepower to kW conversion factor

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η_{moto} = *motor efficiency (%)*

η_{VSD} = *variable-speed drive efficiency (%)*

LF_{rated} = *load factor of compressor at full load (typically 1.0 to 1.2)*

The above methods for determining the instantaneous demand of an air compressor at a given load is then repeated for many bins of hour-CFM operation. This is commonly referred to as a CFM demand profile. A demand profile is developed to provide accurate estimates of annual energy consumption. A demand profile typically consists of a CFM-bin hour table summarizing hours of usage under all common loading conditions throughout a given year.

The annual CFM profile is used to determine base case and proposed case energy use. For both, compressor electricity demand for each CFM-bin is determined from actual metering data, spot power measurements, historical trend data or CFM-to-kW lookup tables.

The difference in energy consumption between an air compressor operating in idling mode and being physically shut down can be significant depending on the base case and post-retrofit case methods of system control. For example, a rotary screw compressor with inlet valve modulation (w/blowdown) controls will draw 26% of full-load power (kW) when operating in idling mode; whereas a VSD-controlled system (w/stopping) has zero load for the same bin-hours. Table 4-4 shows the average percent power versus percent capacity for rotary screw compressors with various control methods.[10]

Table 4-4 Average Percent Power Versus Percent Capacity for Rotary Screw Compressors With Various Control Methods

% Capacity	% Power							
	On/Off Control	Load/Unload (1 gal/CFM)	Load/Unload (10 gal/CFM)	Inlet Valve Modulation (w/o Blowdown)	Inlet Valve Modulation (w/Blowdown)	Variable Displacement	VSD w/Unloading	VSD w/Stopping
0%	0%	27%	27%	71%	26%	25%	12%	0%
10%	10%	32%	35%	74%	40%	34%	20%	12%
20%	20%	63%	42%	76%	54%	44%	28%	24%
30%	30%	74%	52%	79%	62%	52%	36%	33%
40%	40%	81%	60%	82%	82%	61%	45%	41%
50%	50%	87%	68%	86%	86%	63%	53%	53%
60%	60%	92%	76%	88%	88%	69%	60%	60%

[10] Source: Department of Energy Uniform Methods Project: Chapter 22: Compressed Air Evaluation Protocol

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% Power								
% Capacity	On/Off Control	Load/Unload (1 gal/CFM)	Load/Unload (10 gal/CFM)	Inlet Valve Modulation (w/o Blowdown)	Inlet Valve Modulation (w/Blowdown)	Variable Displacement	VSD w/Unloading	VSD w/Stopping
70%	70%	95%	83%	92%	92%	77%	71%	71%
80%	80%	98%	89%	94%	94%	85%	80%	80%
90%	90%	100%	96%	97%	97%	91%	89%	89%
100%	100%	100%	100%	100%	100%	100%	100%	100%

The energy consumption for each CFM-bin is determined from the product of the average compressor demand and the number of hours in each bin (Equation 7). The sum of the kWh bin values gives the annual consumption (Equation 8).

Equation 7: Energy Consumption of CFM-bin

$$\Delta kWh_{bin1} = (Base\ kW_{operating\_bin1} - Post\ kW_{operating\_bin1}) \times CFM\text{-}bin\ 1\ Hours$$

$$\Delta kWh_{binN} = (Base\ kW_{operating\_binN} - Post\ kW_{operating\_binN}) \times CFM\text{-}bin\ N\ Hours$$

Where:

Base $kW_{operating\_bin1}$ = *baseline demand at part-load associated with CFM-bin 1*

Post $kW_{operating\_bin1}$ = *post demand at part-load associated with CFM-bin 1*

Base $kW_{operating\_binN}$ = *baseline demand at part-load associated with CFM-bin N*

Post $kW_{operating\_binN}$ = *post demand at part-load associated with CFM-bin N*

Equation 8: Total Energy Consumption of All CFM-bins

$$Total\ Energy\ Reduction\ (kWh/yr) = \sum_{o\text{-}n} [\ \Delta kWh_{bin1} + \Delta kWh_{bin2} + \ldots + \Delta kWh_{binN}\ ]$$

Where:

ΔkWh_{bin1} = *energy reduction for CFM-bin 1*

ΔkWh_{binN} = *energy reduction for CFM-bin N*

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4.6 Impact Evaluation Analysis and Findings

4.6.1 High Level Findings

The Evaluation Team reviewed the distribution of measure types being recommended in energy assessment reports and the implementation conversion rates. Figure 4-1 shows the distribution of energy conservation measures (by category) taken from all reviewed energy assessment reports.[11] HVAC Controls, HVAC equipment, Lighting, and Compressed Air measures were the most prevalent.

Figure 4-1 Distribution of Energy Conservation Measure Recommendations by Measure Category (All Participants)[12]

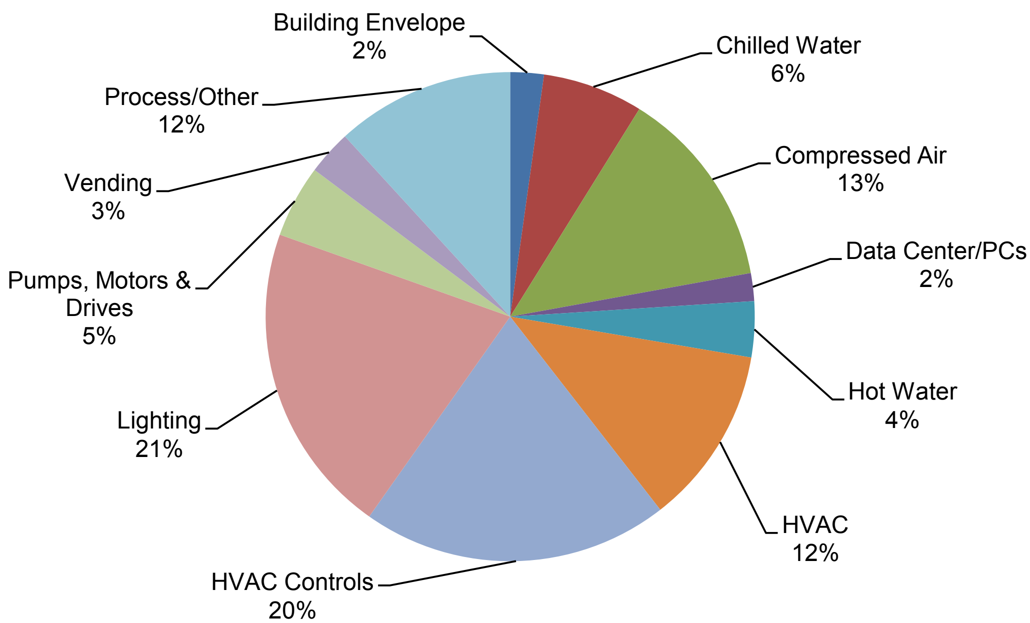

Table 4-5 provides insight into the program-level implementation conversion rate of ECMs identified in the energy assessment reports for the evaluated sample. Participants indicated that measures were implemented through a variety of channels, whether through the Duke $mart Saver Custom Program (12%) or Prescriptive Program (7%) or outside of a DSM program funded fully by the participant ("Spillover", 13%). Several of the surveyed participants also reported that several measures were in the process of being implemented at the time they were surveyed or would be complete by year end 2017 ("Pipeline", 8%). Among the 195 ECMs identified in assessment reports from the evaluation sample, approximately 39% of them have been implemented or will be soon.

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11 Note that the percentages represent the ratio of counted measures assigned to each category in relation to the total number of measures identified collectively in the energy assessment reports. For example, 39 of 195 (20%) of recommended ECMs were HVAC Controls-related.

12 A figure showing the relative contribution of each category to combined potential energy savings could not be developed as this level of granularity was not uniformly provided in each assessment report. Some energy assessment reports only provided financial savings estimates in dollars, which would need to be converted to energy through the application of utility rates for each given customer at the time that the report was originally drafted. There were also several reports for which energy savings were only aggregated at the whole-facility level making it difficult to dissect the savings retroactively down to the measure level.

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Table 4-5 Energy Conservation Measure Report to Implementation Conversion Rate

ECM Category	ECMs	ECM Conversion Rate
Total ECMS Identified in Reports from Evaluation Sample (25 Reports)	195	
Total ECMs Implemented w/ Duke Custom Incentive	23	12%
Total ECMs Implemented w/ Prescriptive Incentive	13	7%
Total ECMs Implemented w/out Incentive (Gross Spillover)	26	13%
Total ECMs In Progress (Pipeline)	15	8%
Total ECMS Implemented	**77**	**39%**

4.6.2 Gross Impacts

The data collected as a result of on-site data measurement and verification activities allowed the Evaluation Team to recalculate energy and demand savings for each sampled project – this is termed “gross verified savings.” The ratio of gross verified savings to the reported savings is the project “realization rate” for each project. For the NR Assessments Program, only those projects involving a Duke Custom Incentive (Custom Incentive Participants) actually have reported energy or demand savings against which verified savings can be compared. Table 4-6 and Table 4-7 summarize the verified savings and realization rates for energy and demand benefits for program years 2014, 2015, and 2016.

Table 4-6 Gross Reported & Verified Energy Savings by Program Year

Program Year	Verified Energy Savings (kWh)	Reported Energy Savings (kWh)	Energy Realization Rate
2014	1,426,881	1,476,881	97%
2015	13,628,164	16,743,918	81%
2016	3,353,765	3,622,062	93%
PY14-PY16	**18,408,296**	**21,842,861**	**84%**

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Table 4-7 Gross Reported & Verified Demand Savings by Program Year

Program Year	Verified Summer Demand Savings (kW)	Reported Summer Demand Savings (kW)	Summer Demand Realization Rate	Verified Winter Demand Savings (kW)	Reported Winter Demand Savings (kW)	Winter Demand Realization Rate
2014	167	167	100%	167	167	100%
2015	1,218	1,528	80%	1,195	1,518	79%
2016	449	447	101%	449	447	101%
PY14-PY16	**1,833**	**2,141**	**86%**	**1,811**	**2,132**	**85%**

The low realization rates for energy and demand benefits for Program Year 2015 are attributable to a single, very large hospital site involving extensive HVAC controls upgrades and enhancements to a chilled water plant that had not yet been fully implemented at the time of this evaluation.

As a part of the impact analysis the Evaluation Team also rolled up verified savings and realization rates by measure category for all Custom Incentive Participants from 2014 to 2016. The results of this analysis are shown in Table 4-8. Once again the low realization rate for HVAC Controls is attributable to the single, very large aforementioned hospital project.

Table 4-8 Gross Verified Energy and Average Demand Savings by Measure Category

Measure Category	Verified EnergySavings (kWh)	Energy Realization Rate	Verified Avg. Demand Savings (kW)	Avg. Demand Realization Rate
Compressed Air	1,426,881	97%	167	100%
HVAC Controls	13,402,650	81%	1,432	78%
Lighting	3,578,765	94%	538	102%

The gross energy and demand impacts from Assessment-Only Participant sites with verified spillover savings are summarized in

Table 4-9. Pipeline energy and demand impacts for projects reported to be “still in progress” are presented in Table 4-10. Finally, the combined energy and demand impacts for all three savings categories are provided in

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Table 4-11.

Table 4-9 Verified Energy and Demand Spillover Savings for Assessment-Only Participants

Measure Category	Spillover Energy Savings (kWh)	Spillover Demand Savings (kW)
Building Envelope	165,611	19
Chilled Water	51,904	6
Compressed Air	1,100,838	126
Hot Water	365,169	42
HVAC	241,847	34
HVAC Controls	288,230	0
Lighting	187,814	73
Pumps, Motors & Drives	5,826	1
Vending	13,300	0
Total	**2,420,541**	**301**

Table 4-10 Estimated Pipeline Energy and Demand Savings for Projects "Still In Progress"

Measure Category	Pipeline Energy Savings (kWh)	Pipeline Demand Savings (kW)
Compressed Air	763,889	388
HVAC	616,562	134
HVAC Controls	19,203,734	1,344
Lighting	496,015	113
Total	**21,080,199**	**1,980**

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Table 4-11 Combined Energy and Demand Impacts (Custom Incentive Participants, Spillover, and Pipeline)

Measure Category	Energy Savings (kWh)	Demand Savings (kW)
Custom Participants	18,408,296	1,845
Assessment-Only Participants	2,420,541	300
Pipeline Projects	21,080,199	1,980
Total Savings	**41,909,036**	**4,125**

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5 Net-to-Gross

5.1 Methodology

The Evaluation Team based the net-to-gross evaluation on customer self-report surveys, as described in the Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices.[13] The survey was designed based on established methodologies outlined in the Pennsylvania Evaluation Framework.[14] The Evaluation Team interviewed 14 of 36 participating customers, and seven of these customers completed projects through the program, representing 83 percent of the program's gross verified energy savings.

Net-to-gross analysis for this program involved two calculations: freeridership and spillover. The results of these calculations are combined to produce the program-level net-to-gross ratio as follows:

Equation 9: Net-to-Gross Equation

$$NTG = (1 - FR) + SO$$

Where:

NTG = the program-level net-to-gross ratio

FR = the program-level freeridership ratio

SO = the program-level spillover ratio.

The program net verified energy savings are calculated by multiplying the program net-to-gross ratio by the gross verified energy savings resulting from the impact evaluation described in Section 4.

Equation 10: Net Verified Energy Savings

$$kWh_{nv} = kWh_{gv} \times NTG$$

The calculations of the program-level freeridership and spillover ratios are detailed in the following sections.

13 https://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf, Section 3.2.

14 http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework082516.pdf, Appendix B.

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5.1.1 Free Ridership

The evaluation calculated freeridership for each survey respondent based on their answers to a series of questions. These questions collected information on the customers' *intention* prior to interacting with the program and the *influence* of the program on changing those intentions.

Survey respondents were asked how the project would have changed if the assessment and incentive were not available. Responses were scored on a scale from 0 to 50 as shown in Table 5-1. If the respondent indicated they would do a smaller or less efficient project, they are prompted to categorize it as a small, moderate, or large reduction in scope.

Table 5-1 Net-to-Gross Intention Score Methodology

Response	Intention Score
Done nothing	0
Canceled or postponed the project	0
Done a smaller or less efficient project	Small = 37.5 Moderate = 25 Large = 12.5 Don't know = 25
Done exactly the same project	50

To recognize the direct points of influence that the program has on customers' decisions, the survey asked respondents to rate the influence of several aspects of the program. The highest rating for each customer was scored, again on a scale of 0 to 50. The rationale is that if any aspect of the program is highly influential on a customer's decision, then the program overall was equally influential (see Table 5-2).

Table 5-2 Net-to-Gross Influence Score Methodology

<table>
<tr><th>Program Aspect</th><th>Max Rating →
Influence Score</th></tr>
<tr><td>Incentive provided by Duke Energy</td><td rowspan="6">0-1 → 50
2 → 43.75
3 → 37.5
4 → 31.25
5 → 25
6 → 18.75
7 → 12.5
8 → 6.25
9-10 → 0</td></tr>
<tr><td>Interactions with Duke Energy</td></tr>
<tr><td>Duke Energy marketing materials</td></tr>
<tr><td>Previous experience with Duke Energy programs</td></tr>
<tr><td>Contractor or vendor recommendation</td></tr>
<tr><td>Information provided from the Duke Energy assessment</td></tr>
</table>

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The intention and influence scores are added together to produce each respondent's freeridership ratio.

Equation 11: Freeridership Ratio

$$FR_i = \frac{Intention + Influence}{100}$$

The ratio is multiplied by that respondent's verified gross savings to result in free-rider savings, or savings that would have occurred without the program. The program freeridership ratio is the sum of free-rider savings divided by the sum of verified gross savings.

Equation 12: Freeridership Energy Savings

$$FR_p = \frac{\sum(FR_i \times kWh_{gv})}{\sum kWh_{gv}}$$

5.1.2 Spillover

Spillover is an estimate of savings resulting from the installation of energy efficient projects that were completed without a program incentive but that still were influenced by the program. There are two components to arriving at program-attributable savings.

First, the survey collects information on the type of energy-efficiency equipment that was installed but for which an incentive was not received. This is used to estimate energy savings using established calculation methodologies, often a technical reference manual.

Second, the survey asks the respondent to rate the influence of the program on their decision to implement the project despite not receiving an incentive. That score is used to prorate the total project savings, recognizing that the program may not have been the only influence in the completion of the project. The result of this calculation is program-attributable spillover, shown in the following equation:

Equation 13: Program-Attributable Spillover

$$kWh_{aso} = kWh_{gso} \times Influence$$

Where:

kWh_{aso} is the program-attributable spillover savings

kWh_{gso} is the gross spillover savings

Influence is the influence value based on the respondent's rating of the program influence, as shown Table 5-3.

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Table 5-3 Participant Spillover Program Influence Values

Reported HEIP Influence	Influence Value
0	0.0
1	0.1
2	0.2
3	0.3
4	0.4
5	0.5
6	0.6
7	0.7
8	0.8
9	0.9
10	1.0
Don't know / Refused	Sector-level measure average

This number is divided by the total verified gross energy savings for the program to produce a program spillover ratio.

Equation 14: Program Spillover Ratio

$$Program\ SO\ Ratio = \frac{\sum kWh_{aso}}{kWh_{gv}}$$

5.2 Net-to-Gross Analysis and Findings

Through self-report surveys implemented with 14 of 36 participating customers, the Evaluation Team found that most customers said they would have done either a smaller project, put off the project, or not done the project at all. Two customers indicated they were planning a similar project within a year. The distribution of responses are shown in Table 5-4. Only 7 of the 14 surveyed customers had completed a project through the program, and 2 of these respondents provided separate answers to this question for different projects they completed. The customers who did not complete a project through the program are not included in the analysis since they do not contribute any savings to the program.

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Table 5-4 What Would You Have Done Had You Not Received an Incentive?

Response	Respondents
Done nothing	1
Canceled or postponed the project	1
Done a smaller or less efficient project	5 Large reduction (2) Moderate reduction (3)
Done exactly the same project	2

When asked to rate the influence of the program on their decision to complete the energy-efficiency project, all respondents rated at least one program aspect an 8 or higher on a 0 to 10 scale, where 0 means "not at all influential" and 10 means "extremely influential." Interactions with Duke Energy, the incentive amount, and information in the assessment report were all rated highly.

The resulting freeridership, spillover, and net savings are shown in the table below. These results indicate that the program is extremely effective in encouraging customers to complete projects they would not otherwise do, and even influenced customers to complete projects based on program information but without providing an incentive.

Table 5-5 Net-to-Gross Results

Savings Category	Gross Verified Energy Savings (kWh)	Net Verified Energy Savings (kWh)	Ratio
Net of Free-ridership	15,255,745	14,798,073	0.97
Program-influenced Spillover	18,408,296	1,656,746	0.09
Net-to-Gross	18,408,296	19,512,794	1.06

** Net of Freeridership = (1 – 0.03 FR) = 0.97*

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6 Process Evaluation

6.1 Summary of Data Collection Activities

Process evaluation activities are designed to support continuous program improvement by identifying successful program elements that can be expanded or built upon as well as underperforming or inefficient program processes that could be holding back program performance. The data collection activities for the process evaluation of the NR Assessments Program included a database review, and interviews with key contacts involved in program operations, participating customers, and contractors and trade allies that identify project opportunities.

6.1.1 Program Staff and Database Review

An interview was conducted with Duke Energy program staff to improve the Evaluation Team's understanding of the program and to get background information on program design and implementation practices that assisted in the design of the interview guides and surveys for on-site evaluators and customers. The program staff provided valuable feedback on how the program operates and changes that have been made or will be made to the program.

In addition to the program staff interview, the Evaluation Team reviewed the program tracking database. The database review was used to ensure the necessary data and information was being collected to track program progress.

6.1.2 Trade Allies

Interviews were completed with all four implementation vendors. These vendors are responsible for conducting the onsite assessments and providing customers with an assessment report outlining energy saving opportunities. Discussion topics included program awareness among customers, program guidelines and processes, interactions with customers, and suggestions for improving the program.

6.1.3 Participants

The Evaluation Team conducted in-depth interviews with program participants. Program participants were defined as customers who received an assessment through Duke Energy's NR Assessment Program. Interviews were conducted with program participants in January and February 2017. Interviews focused on customers' experience with the program, sources of awareness, satisfaction with various aspects of the program, energy efficiency recommendations they have implemented, and any additional actions they have taken since the assessment. Interviews were completed with 14 of 36 program participants who received an assessment from 2014 to 2016. Table 6-1outlines the participant response for the evaluation.

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Table 6-1 Participant Response Rate

Participant Response	Qty Participants
Starting Sample	36
Does not recall participating	1
New owners	1
No one knowledgeable	2
Opted out	3
Refusal	0
Attempted, but not completed	15
Completes	**14**
Response Rate (Complete/Starting Sample)	**39%**

6.1.4 Non-Participants

Telephone surveys were conducted with customers who expressed interest in having an assessment done at their facility, but ultimately did not have a Duke Energy assessment. These customers are defined as being Non-Participants. Telephone surveys were conducted between January, 2017 and February, 2017. Survey questions focused on their interactions with program staff, sources of awareness, satisfaction with various aspects of the program they experienced, energy efficiency improvements implemented, and reasons for not having an assessment completed. Surveys were completed with six of the 17 non-participating customers identified as expressing interest in the program but not having an assessment completed from 2014 to 2016 (see Table 6-2).

Table 6-2 Non-Participant Telephone Survey Response Rate

Non-Participant Response	Non-Participant
Starting Sample	17
Does not recall participating	0
New owners	0
No one knowledgeable	2
Opted out	0
Refusal	3
Attempted, but not completed	6

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Non-Participant Response	Non-Participant
Completes	**6**
Response Rate (Complete/Starting Sample)	**35%**

6.2 Process Evaluation Findings

6.2.1 Program Staff and Database Review

The program staff interview was extremely useful in helping the Evaluation Team understand how the program operates. Information from the staff interview has been used throughout the findings section to add context around respondent answers.

An additional part of the evaluation activities included reviewing the program database to ensure the necessary information needed to track the program and conduct evaluation activities existed. Program staff use the tracking database to document customers who expressed interest in the program as well as customers who received an assessment and any projects that were completed and received a Smart $aver Custom incentive.

The Evaluation Team utilized this same database to pull the sample for the impact and process evaluation activities. When pulling information for evaluation purposes, the staff was knowledgeable about the information included in the file although some areas were not electronically documented. Specifically, the status of projects was not always kept up to date, making evaluation efforts difficult in understanding which customers had reached out to Duke Energy but were deemed ineligible, which customers received an assessment, and which customers had received a Smart $aver Custom incentive. Understanding which customers received a Custom incentive is critical in understanding how the program is doing when compared to program goals. Furthermore, understanding which customers went on to receive a prescriptive rebate would be useful to track within the NR Assessment program. Knowing which customers have made improvements based on the assessment report could be useful to account managers and vendors who conduct follow-up discussions with customers.

In conducting the impact evaluation, the tracking database excluded the raw claimed project-level savings (pre-realization rate gross savings without losses). This information is necessary to understand the project-level savings to be able to verify savings figures. The tracking system also did not identify the measures that were incentivized through the program. This information was only available by reviewing project calculations.

In conducting the process evaluation telephone efforts, there were times the contact information associated with some participants was out of date. Given the evaluation activities went back to 2014, some level of personnel turnover at companies is expected, resulting in having contact information for someone who is no longer with the company. That said, for the participant interview effort, the Evaluation Team found two cases where there was Duke Energy contact

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information associated with the customer. Ensuring contact information is kept up to date will support follow-up efforts for either scheduling assessments or following up once an assessment has been completed.

6.2.2 Trade Allies

As part of the process evaluation, the Evaluation Team interviewed the four vendors involved in conducting assessments at customer's businesses. The time these vendors have been involved in the program vary from two to eight years, with one vendor being involved from the predecessor program (Smart Building Advantage).

6.2.2.1 Communication

Staff with each vendor talked about having open lines of communication with staff from Duke Energy. Regular bi-weekly conference calls occur for the program, which have been working well with Duke Energy staff being responsive to any questions. These meetings focus on the status of individual projects, any additional projects in the pipeline and status of incentives. Additional communications are had as needed and are typically via email or telephone calls. Large account managers are also included in conversations when it applies to the customers they oversee.

Duke typically makes changes to their program once per year, generally in January. These changes are typically provided to the vendors, although at least one mentioned they would like the changes discussed with the vendors so they are proactively made aware of the changes and rationale for the change. Another vendor talked about having to check the Duke Energy website for program changes rather than hearing about the changes directly from Duke Energy.

6.2.2.2 Customer Interaction

Interaction with the customer has typically been initiated by Duke Energy. Only recently (in 2016) has the program begun to be marketed with some vendors doing their own outreach to bring customers to the program. Once a customer has been identified there is typically an initial conversation, either in person or via conference call. Part of the initial discussion is to understand the goals the customer has as well as their building operations and use. An onsite visit is then performed, focusing on the customer's goals for the assessment. This could be focused on specific equipment or parts of the building or the entire building operations. Once the assessment is completed, the vendor produces a report, which documents the energy savings opportunities and recommendations. The report is provided to the customers either in person or remotely. All vendors indicated they prefer to meet in person after the report is generated to discuss the results. As part of the in-person meetings, the vendors discuss the Smart $aver Custom program and the process to receive rebates, if that has not already been discussed. The most important part of these discussions is having both the decision makers as well as the operations staff in the room as the recommendations and incentives are being discussed. Both vendors and Duke Energy program staff recommend having the decision makers hear the recommendations as well as the potential savings as a way of getting energy efficient projects scheduled quicker.

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Once the assessment report has been delivered, vendor activity varies. Two vendors indicated everything beyond the assessment report is not through the Duke Energy program while another vendor indicated they assist the customer in completing any rebate paperwork. This follow-up is important in keeping customers engaged and utilizing the Duke Energy programs. Ensuring follow-up is being done and communicated to the parties involved will help convert assessments into projects. This communication needs to reach all levels of the customer organizations, since senior management as well as more technical contacts are both involved in implementing projects, whether allocating budget and approvals or specifying equipment needs.

Similar to customer feedback, vendors agree that budget and available capital are the main reasons customers do not follow through with recommendations. One vendor also went on to say the time the customer has available to pursue projects was another big issue. While this was mentioned by one vendor, at least two mentioned how they work with customers if they have questions about the rebates and incentives available from Duke Energy. With both custom incentives and prescriptive rebates available, some customers are confused about the requirements of each and the timeline associated with the custom incentives. Shortening the timeline for custom incentives was recommended by one vendor to help with this process. Including Duke Energy account managers can also help reach additional contacts in customer organizations.

6.2.2.3 Future Opportunities

As mentioned by both Duke Energy staff and the vendors, one of the biggest challenges for the program is keeping projects in the pipeline. One suggestion vendors had was to increase the marketing of the program. Keeping customers aware of the program and its value will encourage uptake in the program. With marketing campaigns fully starting in 2016, the program may see additional leads being generated.

6.2.3 Participants

Interviews were conducted with program participants, customers who completed an energy assessment through the Duke Energy Non-residential Assessment Program. This section provides the detailed findings from the 14 completed interviews.

6.2.3.1 Marketing Practices

Prior to 2016, the program largely focused on account managers as the primary source of program promotion. In 2016, a marketing campaign was put together which included direct mailings. Additional promotional activities have also occurred, such as including the program in newsletters. When asked how they heard about the program, most participant respondents (ten out of 14) listed their account representative or another contact at Duke Energy as the primary source of awareness of the NR Assessments Program, which is consistent with how the program was marketed. Figure 6-1 shows the awareness sources for all 14 respondents.

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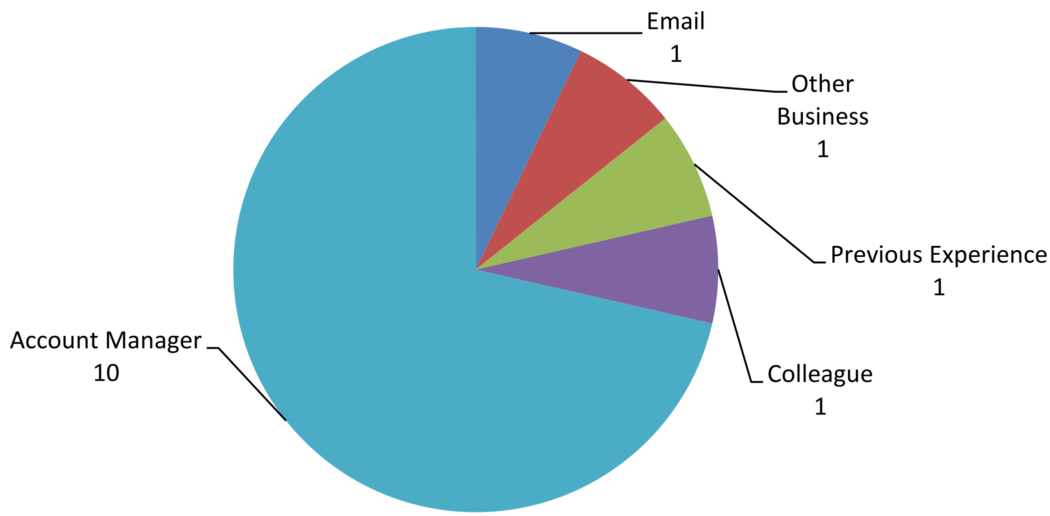
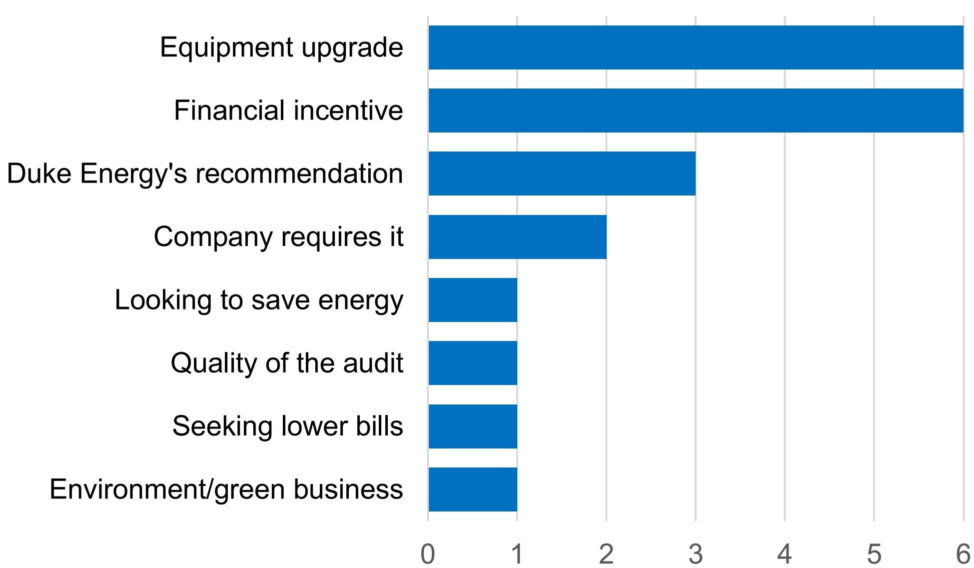
Figure 6-1 Participant Source of Program Awareness



Program marketing materials note that the NR Assessments program gives customers "the power to take control of your building's energy consumption. Whether you need to drive down operational costs, increase efficiency, meet corporate sustainability goals or address aging infrastructure, Duke Energy's assessments will help identify areas for improvement. " When respondents were asked what made them decide to have an assessment through the NR Assessments Program, most of these items were mentioned. The top reasons cited included the need to upgrade equipment at the facility (six respondents), the financial incentive offered (six respondents), and Duke Energy's recommendation (four respondents). Other reasons are included in Figure 6-2.

Figure 6-2 Reasons Respondents Cited for Participating in Non-Residential Assessment Program



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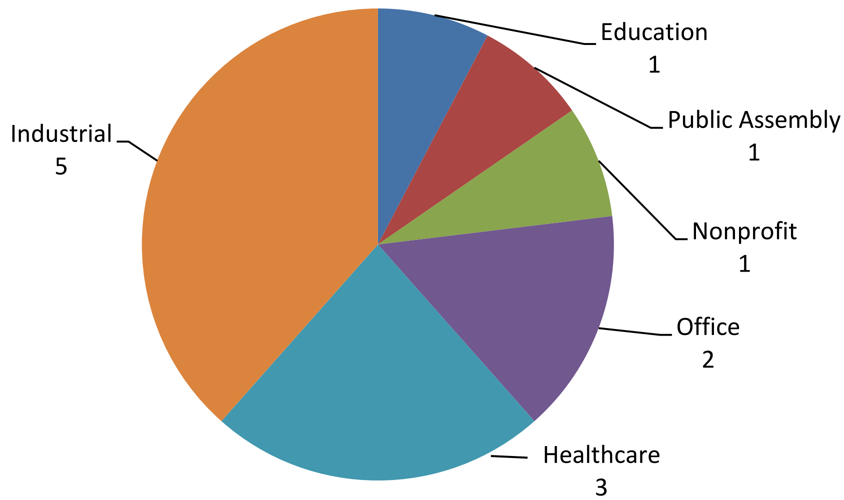
6.2.3.2 Participating Customer Characteristics

Of the 14 participant respondents, the majority of the respondent facilities were industrial (five respondents). Other common facility types included healthcare (three respondents) and office (two respondents). Figure 6-3 shows the distribution of industries covered by the respondent facilities. These facility types are consistent with how the program was marketed, which initially targeted larger industrial customers.

Figure 6-3 Non-Residential Assessment Program Participant Industries



Participants were asked how their companies make budget decisions and whether they were decided locally, regionally, nationally, worldwide or something else. Most respondents (nine) reported that decisions are made either locally or regionally. One reported that decisions are made nationally, and two reported decisions are made on a global level. Two respondents said it would depend on the project.

Participants were also asked how far into the future their companies plan when creating budgets and financial plans. Over half of respondents (eight) stated that they plan five years into the future. Two respondents said they planned one year and three said they planned more than five years into the future. In addition, one respondent said they budgeted one year into the future, but had financial plans out to five years.

Twelve of the fourteen respondents said that their business production schedule or business cycle affects when they can implement energy efficiency projects. When asked for more details, two said capital projects are started at the beginning of their budget year, one said their business was largely dependent on the market, one said projects are typically seasonal, and another said they had to plan shut-down times for any new projects.

When asked what simple payback period their business would need to achieve in order to undertake an energy efficiency project, eight respondents provided answers between two and four years, and three said it would depend on the project or the client. Three respondents did

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not report a payback period.

6.2.3.3 Recommendation Status

As Figure 6-4 shows, 11 of the 14 participant respondents completed at least one recommendation made through the assessment. All 11 respondents mentioned they completed the project because it was recommended from the assessment report. Seven of these applied for incentives through Duke Energy and six reported receiving a Duke Energy incentive (custom or prescriptive incentive). One applicant was deemed ineligible to receive an incentive due to the fact that the installed equipment was not new, but had been refurbished. Four of the incentive recipients said they also have plans to complete at least one additional project in the future. Two of these respondents plan to apply for incentives through Duke Energy for those projects as well.

Figure 6-4 Number of Respondents Who Completed Assessment Recommendations

Participants who made improvements based on assessment recommendations but did not apply for Duke Energy incentives cited various reasons. Two participant respondents mentioned the time it takes to apply for custom incentives with one mentioning they looked at the prescriptive rebates but did not find any that would work. One respondent lacked the awareness of incentives for the recommended measures. The last respondent indicated the program rider fee was larger than the incentive they would have received making it more costly to apply for the rebate.

For customers who still have recommendations to follow-through on, respondents cited several reasons for not completing the improvements. Typical responses included the following:

- Financial incentives were not adequate (two)
- Internal delays (two)
- Concern over business impacts of recommendations (one)
- Concern over environmental impacts of recommendations (one)
- Equipment limitations (one)

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- Preference for other equipment (one)
- Recommendations were too numerous and complex to implement all (one)

For the three participants who did not complete any recommendations, one said they were still in the review process and developing a plan to implement a recommendation, but they have yet to determine if the return on investment will be good enough to proceed with the project. Another Participant indicated they have been focusing their efforts on another facility so they have not moved forward with anything yet. The third respondent indicated their building is currently up for sale so any improvements are in a holding pattern.

When asked what Duke Energy could do to encourage them to complete additional recommendations, two respondents stated that savings would have to be high enough to justify any additional expense. In total, three respondents noted that they only opt-in to the program rider when they have an improvement planned.

6.2.3.4 Program Satisfaction

Overall, program participants were highly satisfied with the Non-Residential Assessment program. Respondents were asked to rate their overall experience with the program and different program components on a scale of 0 to 10, where 0 is “very dissatisfied” and 10 is “very satisfied.” All program aspects were rated an average of 8.0 or higher. Additionally, respondents rated their overall satisfaction with the program highly overall (9.0 out of 10.0) and rated Duke Energy highly as their service provider (8.8 out of 10.0) (see Table 6-3).

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Table 6-3 Non-Residential Assessment Program Participant Satisfaction

Program Aspect	Mean Satisfaction
Overall satisfaction with the program	9.0
Satisfaction with Duke Energy	8.8
The services performed by the auditor	9.3
The level of detail provided in the assessment report	9.2
The equipment and building systems review	9.1
Interactions with Duke Energy staff	9.1
The overall process of receiving the assessment from Duke Energy	9.1
The recommendations provided	8.7
The staff time it took to submit the application and necessary paperwork	8.6
The cost of the assessment	8.5
The application process	8.0

As another gauge of satisfaction, customers were asked if they have recommended the program to others. As shown in Figure 6-5, six participants reported that they had recommended the program. If provided the opportunity, another six respondents said they would recommend the program. Of the two who would not recommend the program, one respondent said it was not his responsibility to make recommendations and the other did not elaborate as to why.

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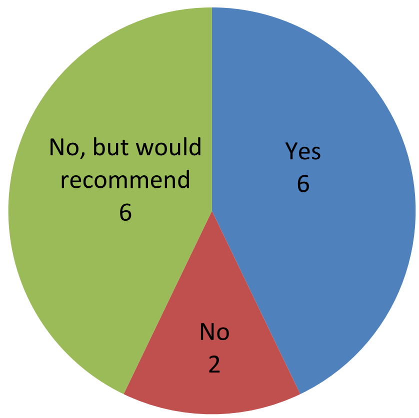
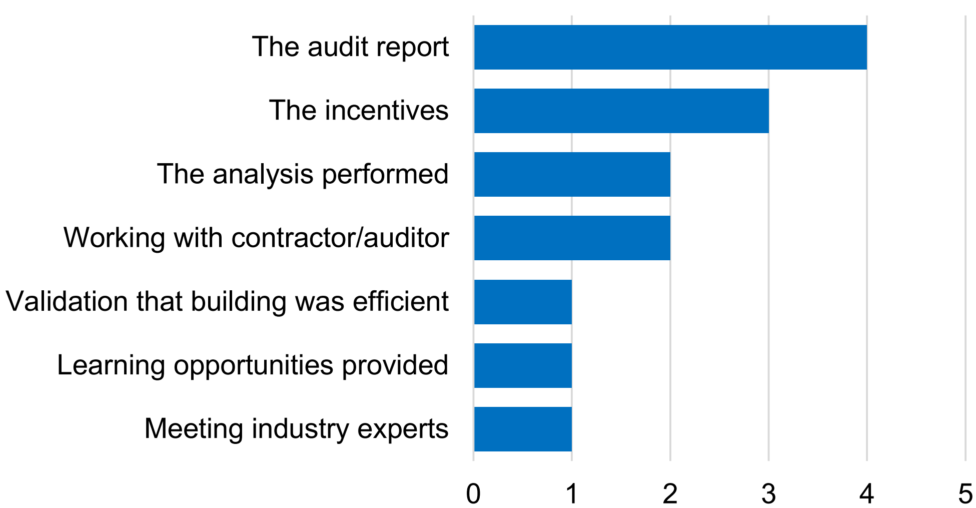
Figure 6-5 Have You Recommended the Program to Others?



When asked about the aspect of the program they liked best, respondents' top rated aspect of the program included the audit report (four respondents). The incentives were the second most cited aspect mentioned by three respondents. Other important factors included the analysis performed by the auditor and working with the contractor or auditor (two respondents each). Other responses are listed in Figure 6-6.

Figure 6-6 What Part of the Non-Residential Assessment Program Did You Like Best?



When asked what they would change about the NR Assessments Program, two participants asked for larger incentives, which is a common response to energy efficiency programs. Other responses included requests for an incentive approval timeline and more recommendations (one respondent each). The respondent who wanted more recommendations said they were somewhat disappointment by the lack of savings opportunities identified and that it would have been helpful to verify opportunities prior to conducting a full assessment.

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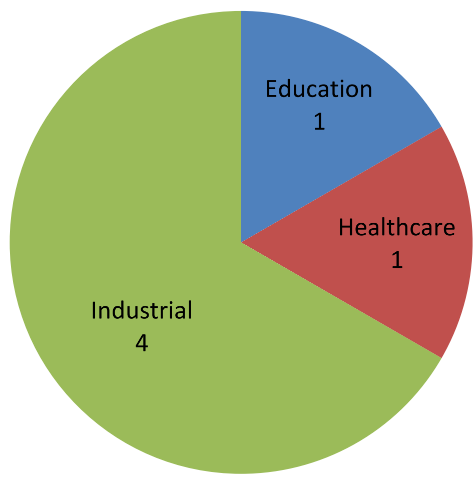
6.2.4 Non-Participants

The Evaluation Team completed six interviews with Non-Participants who had initiated contact with the Non-Residential Assessment Program, but had not completed an assessment. Questions for non-participant respondents focused on reasons for not having an assessment and their satisfaction with the aspects of the program they were involved in.

6.2.4.1 Non-Participant Customer Characteristics

Similar to the participants, a large portion of respondents (four) represented industrial facilities. Again, this is consistent with how the program was initially marketed, which was through account managers. Other facility types are shown in Figure 6-7.

Figure 6-7 Non-Residential Assessment Program Non-Participant Industries



Non-Participants were asked how their companies make budget decisions and whether they were decided locally, regionally, nationally, worldwide or something else. Half of the respondents (three) reported that decisions are made locally. One said decisions are made regionally, one said decisions are made nationally, and one said it would depend on the budget of the project.

Participants were also asked how far into the future their companies plan when creating budgets and financial plans. Half of the respondents (three) stated that they plan one year into the future. One respondent said they planned four years and two said they planned five years into the future.

Five of the six respondents said that their business production schedule or business cycle affects when they can implement energy efficiency projects. When asked for more details, two respondents said their work was seasonal, while three said they have to schedule any equipment shut-downs in advance due to a busy manufacturing cycle.

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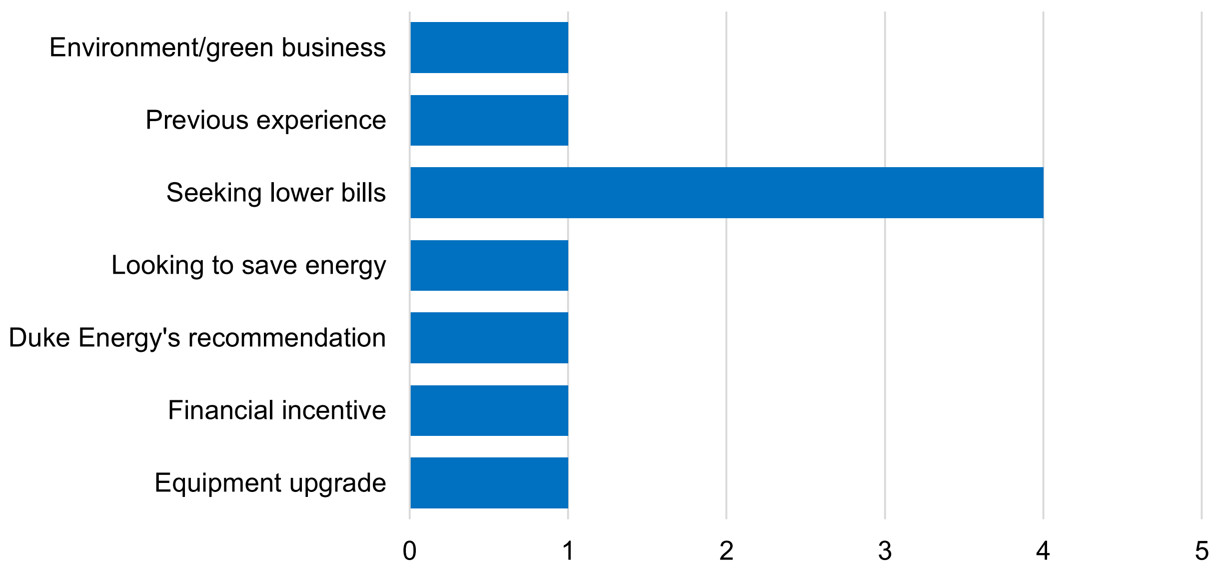
When asked what simple payback period their business would need to achieve in order to undertake an energy efficiency project, three respondents reported a one-year payback, one reported a two-year payback, one reported a three-year payback, and one reported a ten-year payback.

6.2.4.2 Marketing Practices

Similar to Participants, Non-Participants were asked to name the source of program awareness, with two of them naming a colleague, one naming a conference they attended, and three naming a Duke Energy staff member or an account representative.

Non-Participants were also asked why they considered having an assessment through Duke Energy's NR Assessments Program. Similar reasons were identified with over half (four respondents) mentioning they had been seeking to lower their utility bills. Additional reasons were also mentioned such as previous experience with Duke Energy and the financial incentive. All reasons provided by Non-Participants are listed in Figure 6-8.

Figure 6-8 What Made You Consider Having an Assessment Through Duke Energy's Non-Residential Assessment Program?



Non-Participants, as defined in the process evaluation, were customers who ultimately did not have an assessment complete. When asked why they chose not to participate in the Non-residential Assessment Program, the most common response was that the cost of the assessment and program rider was not worth the expense to their business (five respondents). In addition, two respondents made arrangements with Clemson University's audit program, as there was no fee involved in that specific audit program. Another noted the time requirement was burdensome and they had conflicting priorities.

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6.2.4.3 Program Satisfaction

Non-participant respondents were asked about the steps they had completed through the program and their satisfaction with each of those that they had completed. Table 6-4 shows the average satisfaction of Non-Participants on a scale of 0 to 10, where 0 is "very dissatisfied" and 10 is "very satisfied."

Table 6-4 Non-Participant Program Steps Completed and Mean Satisfaction Rates

Program Step Completed	Respondents	Mean Satisfaction
Initial call with program staff	4	7.3
Completed the online applications	1	6.0
Received a proposal letter	5	6.6
Preliminary walkthrough	3	8.0
Kickoff call with Duke	2	7.0
Schedule the onsite assessment	1	8.0

Non-Participants were asked what Duke Energy could have done differently so that they would have completed an assessment. Responses included the following:

- More affordable assessment pricing (three respondents)
- More involvement from Duke Energy/account representative (two respondents)
- Ability to break down cost over multiple billing cycles (one respondent)
- In-person meetings rather than conference calls (one respondent)

All six Non-Participants had made energy efficiency improvements on their own in the last two years. Energy efficiency projects included lighting (four respondents), chillers (two respondents), variable frequency drives (two respondents), air compressors (1 respondent), and roofing (one respondent). Furthermore, five of the non-participant respondents planned to make energy efficiency improvements during the next two years. These future projects are likely to include lighting (three respondents), HVAC (one respondent), exhaust systems (one respondent), process equipment (one respondent), chillers (one respondent). Three of the Non-Participants said they planned to participate in a Duke Energy program to complete the improvements.

Overall, Non-Participants were split on their satisfaction with Duke Energy as their service provider, ranking the company a 6.8 on a scale of 0 to 10, with where 0 is "very dissatisfied" and 10 is "very satisfied." Three stated they were satisfied and with Duke and included the following praise:

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They have bent over backwards to cut the price [of the assessment].

We have relatively reliable power.

Two Non-Participants discussed some issues they had with Duke Energy as reasons for dissatisfaction. One noted that the price of opting in to the program was high, while another said they have had issues getting rebates issued in the past.

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7 Conclusions and Recommendations

7.1 Impact Evaluation

Conclusion 1: Trade allies had to be approached directly by the Evaluation Team in order to obtain final versions of any ex ante building energy simulation models used to develop energy savings estimates as part of the energy assessment. Our team was able to retrieve this information from one of two trade allies, but it would have been advantageous for the NR Assessments Program to have copies of this information readily available for the evaluator.

- **Recommendation 1:** We recommend that trade allies provide final versions of all modeling files whenever a whole building energy simulation approach is used as the primary source for generating project-level energy and demand savings estimates. This practice would improve evaluation efforts of the program.

Conclusion 2: Assessment report formats varied from trade ally to trade ally. Some variability in reporting format is to be expected, especially in instances where a study only focuses on a specific building system, but improvements can be made with regard to benchmarking reporting content. As an example, all reports should provide savings estimates in units of energy (kWh), demand (kW), and dollars. There were several reports that only included estimated financial energy savings ($). It should also be noted that there were four Custom Incentive Participants that didn't actually receive a comprehensive energy assessment report. Instead they were provided with the results from energy simulation models developed by the *Building Intelligence Group* along with a two-page description of the recommended ECMs. This made the evaluation of reported savings more challenging.

- **Recommendation 2:** Develop standardized reporting template(s) or a benchmark document identifying required content to be included in each energy assessment report.

- **Recommendation 3:** We recommend that trade allies are encouraged to provide key inputs and assumptions used in engineering calculations used to estimate measure-level savings.

Conclusion 3: There are several opportunities for improvement for tracking NR Assessment Projects.

- **Recommendation 3:** The Evaluation Team has several recommendations for how to improve assessment project tracking processes.
  - We recommend that the program develop a means for linking NR Assessment projects with subsequent Custom or Prescriptive Smart $aver incentive applications and payments. This would eliminate the need to cross-reference participant databases for the NR Assessments, Custom, and Prescriptive

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Programs. There were two instances during the evaluation when the Evaluation Team discovered that a participant had received a financial incentive from the Duke Custom Program, but had not been identified by the program management as a Custom Incentive Participant.

- We recommend updating project status (incentive offered, incentive paid, report complete, etc.) in the master tracking system on a more frequent (monthly) basis. The true participation status of each customer in the tracking database was not fully-understood until the Program Manager provided updated information via a follow-up data request.

- We recommend that the Program track additional project details including the ECMs identified in each assessment report, estimated measure-level energy and demand savings impacts, and incentives paid to the Customer through the Duke Custom or Prescriptive Programs following an assessment. Adopting these practices would make the process of tracking projects more efficient.

7.2 Process Evaluation

Conclusion 1: One of the main reasons customers did not follow-through after expressing interest was because of the fee associated with the assessment. Customers are not necessarily aware of the different levels of assessments or the fees associated with them. As a result, they go to other sources (i.e., a local university) to have a study done. Making customers aware of the services Duke Energy provides, both for assessments and rebates, may encourage use of Duke Energy program offerings.

- **Recommendation 1:** Increase program marketing so customers are aware of the different levels of assessments and are aware of the rebate and incentive programs.

Conclusion 2: One of the key aspects to an evaluation program is customer follow-through once an assessment is completed. This process could take up to a few years if customers need budget approval to move forward. Given this, it is important to continually follow-up with customers who received an assessment to make sure they are aware of the rebates available at the time they decide to move forward with their project. The process for this follow-up needs to be clear and all parties involved, including account managers, should remain updated. Although not specifically identified as one of their goals, account managers could follow-up with customers who received an assessment to encourage rebate program use. While a portion of vendor compensation is tied to implementation, one vendor specifically mentioned how there is no program requirements once an assessment report is delivered and a second indicated they do not do any follow-up.

- **Recommendation 2:** Ensure processes are in place for follow-up once an assessment is complete. This includes having account managers follow-up on accounts that received an assessment to answer any questions and to encourage and assist in project

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completion.

- **Recommendation 3:** Continue to keep Account Managers informed and involved in the assessment process and project status.

Conclusion 3: The program currently tracks savings based on customers who received an assessment and received a rebate through the Smart $aver Custom program. If a customer who received an assessment made an improvement but went through the prescriptive program, the participation is tracked through the prescriptive program. Tracking customers who received prescriptive rebates within the Custom program would allow account managers and others to focus follow-up efforts on customers who have not followed through with any recommendations.

- **Recommendation 4:** Within the Custom program, track customers who receive prescriptive rebates and custom rebates.

Conclusion 4: It is not uncommon for program staff to make program changes throughout the program's lifecycle. These changes typically occur at the start of each program year, although changes can occur at any time. When changes are made to the program, it is important to notify vendors of the changes (ideally before the changes are made) so they are providing customers with accurate information.

- **Recommendation 5:** Proactively communicate program changes with vendors.

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Appendix A - Summary Form

Appendix B - Per Energy Assessment Impact Results

Appendix C - Participant IDI Guide

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Appendix A Summary Form

Smart $aver Program

Completed EMV Fact Sheet

Description of program

The Non-Residential Assessment Program helps Duke Energy commercial customers in North Carolina and South Carolina find energy saving opportunities within their businesses by subsidizing a portion of the cost of an energy assessment. Energy assessments are that identify energy conservation opportunities, that – when implemented – can assist in lowering energy costs.

Date	April 15, 2017
Region(s)	North Carolina South Carolina
Evaluation Period	January 1, 2014 – December 31, 2016
Total kWh Savings	18,408,296 kWh
Per Participant kWh Savings	2,629,756/assessment
Coincident kW Impact - Summer	1,833 kW
Coincident kW Impact - Winter	1,811 kW
Net-to-Gross Ratio	106%
Process Evaluation	Yes
Previous Evaluation(s)	N/A

Evaluation Methodology

Impact Evaluation Activities

- *13 on-site verifications*
- *3 desk reviews*
- *Analysis of 32 unique measures*

Impact Evaluation Findings

- *Realization rate = 84% for energy impacts; 86% for summer demand impacts; 85% for winter demand impacts*
- *Net-to-gross ratio = 1.06*

Process Evaluation Activities

- *Trade Allies; 4 telephone surveys*
- *Participants; 14 telephone surveys*
- *Non-participants; 6 telephone surveys*

Process Evaluation Findings

- *Satisfaction with the program overall is high among participants and nonparticipants*
- *Cost is the main reason participant and non-participant respondents wanted an assessment*
- *Cost was the main reason why nonparticipant respondents cited for not moving forward with an assessment*
- *The primary source of program awareness is from Duke Energy, specifically the account managers*
- *The transition to the online portal has been challenging for trade allies.*

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Appendix B Per Energy Assessment Impact Results

Table A-1 Program Years 2014 – 2016 Verified Impacts by Program Year

Program Year	Gross Energy Savings per EA Report (kWh)	Gross Summer Coincident Demand per EA Report (kW)	Gross Winter Coincident Demand per EA Report (kW)	Free Ridership	Spillover	Net to Gross Ratio
2014	1,426,881	167	167	0.97	0.09	1.06
2015	2,725,633	244	239	0.97	0.09	1.06
2016	3,353,765	449	449	0.97	0.09	1.06

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Appendix C Duke Energy Non-Residential Assessment Program Customer Survey Guide

Sample Variables

CONTACT NAME Primary customer contact name

MEASURE Summary of project measure implemented

YEAR The year the measure was completed and paid

ADDRESS The address of the site where the measure was installed

INCENTIVE The amount of the incentive paid for the measure

CONTRACTOR Flag that customer worked with external contractor
1 Worked with contractor
0 Implemented within company

TYPE Type of customer
1 Assessment and installation
2 Assessment only
3 Expressed interest but no assessment

Introduction and Screening
Hello, my name is [NAME], and I am calling on behalf of Duke Energy. May I speak with [CONTACT NAME]?

I'm calling from Tetra Tech, an independent research firm. We were hired by Duke Energy to talk with some of their customers about their participation in the Non-residential Assessment Program.

Our records indicate that in [YEAR] you participated in Duke Energy's Non-residential Assessment Program. An engineering firm came to your business at [ADDRESS] and conducted an energy assessment of your facility and provided you with a report recommending energy efficiency measures. Is this correct?

Yes
No (what is not correct? If did not receive an assessment (type = 3), terminate)

If needed:
Is it possible that someone else in your organization would be more familiar with the program or the assessment that was completed?

Were you involved in the decision to complete the assessment?

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Great, thank you. I'd like to assure you that I'm not selling anything, I would just like to ask your opinion about this program. Your responses will be kept confidential and your name will not be revealed to anyone. For quality and training purposes, this call will be recorded.

Program Awareness and Marketing

Q1 How did you first hear about Duke Energy's Non-residential Assessment Program? (Select one)

1 Account representative
2 Business Energy Advisor
3 Contractor / Vendor [CONTRACTOR = 1]
4 Email from Duke Energy
5 Mail from Duke Energy
6 Colleague/Another business
7 Conference/Trade Show/Expo
8 Duke Energy website
9 Other (specify)

Assessment Details

Q10 What made you decide to have an assessment done through Duke Energy's Non-residential Assessment Program?

Q11 Did you complete any of the recommendations on your assessment report?

If yes

Did you complete the energy efficiency projects because it was recommended by the Duke Energy assessment?
What projects have you done that were recommended in the report?
Did you apply for an incentive from Duke Energy for the recommendation?

If yes: Did you receive an incentive from Duke Energy for this project?
Do you have plans to complete any additional improvements based on the recommendations from the assessment report?
If no: What factors influenced your decision not to apply? What could the program do to encourage you to apply for incentives from Duke Energy's Smart Saver custom and prescriptive programs?

If no

Do you have plans to complete any improvements based on the recommendations from the assessment report in the future?

If yes: What could Duke Energy do to encourage you to complete the recommendation through a Duke Energy program?
If no: What could Duke Energy do to encourage you to complete the recommendation through a Duke Energy program?

Q12 Are there any recommendations you have not completed?

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If yes
Do you have plans to move forward with the others?
Do you plan to apply for an incentive through Duke Energy's Smart Saver custom and prescriptive programs? (if no, why not?)
What could Duke Energy do to encourage you to complete additional projects?
Why did you move forward with some recommendations but not others?

Q13 Using a scale from 0 to 10, where 0 is not at all valuable and 10 is very valuable, how valuable was the *assessment report* you received from Duke Energy?

Q14 How could the assessment report be improved to be more valuable?

Q15 Using a scale of 0 to 10, where 0 is "very dissatisfied" and 10 is "very satisfied", how satisfied are you with the following aspects of the assessment? [ROTATE a-h]

a. The level of detail provided in the assessment report?
b. The recommendations provided?
c. The equipment and building systems reviewed?
d. Interactions with Duke Energy staff?
e. The application process?
f. The services performed by the auditor?
g. The staff time it took to submit the application and necessary paperwork?
h. The cost of the assessment?
i. The overall process of receiving the assessment from Duke Energy?

Q16 [IF any in Q15<=3] Is there anything the program could do to improve the assessment process?

Net-to-Gross
(TYPE = 1, receive Duke Energy prescriptive/custom rebate)

[if TYPE = 2] SKIP TO SAT1

FINTRO Now I would like to ask you some questions about the [MEASURE] project you completed following your assessment.

F1 Would your business have completed a similar assessment on your own if you had not received the assistance from Duke Energy?

1 Yes
2 No

F2 Which of the following is most likely what would have happened if you had not received the assessment and incentive from Duke Energy for the [MEASURE]?

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1 Done nothing
2 Canceled or postponed the project at least one year
3 Done a smaller or less efficient project within a year (By how much would you have reduced the size, scope, or efficiency of the project? Would you say a small amount, moderate amount or large amount?)
4 Done exactly the same project within a year (Would your business have paid the additional [INCENTIVE AMOUNT] to complete the project on your own?)
5 Don't know

F3 On a scale of 0 to 10, with 0 being "not at all influential" and 10 being "extremely influential", how would you rate the influence of the following factors on your decision to have an assessment and complete the project? [randomize list]

a. The incentive provided by Duke Energy
b. The interaction with Duke Energy program representatives
c. Information from Duke Energy's marketing materials
d. Previous experience with a Duke Energy program
e. Your contractor or vendor's recommendation
f. The information provided from the assessment from Duke Energy

F4 Were there other factors we have not discussed that were influential in your decision to have an assessment and complete the recommended improvements?

1 Yes (What were those other factors?)
2 No

SP1 Since your participation in the Non-residential Assessment Program, did you complete any additional energy efficiency projects at this facility or another facility served by Duke Energy that did not receive an incentive through a Duke Energy program? This includes projects that you did on your own as well as projects that were recommended by the assessment.

1 Yes
2 No
3 Don't know
4 Refused

SP2 What type of energy efficient products, equipment, or improvements did you install or implement? (Select all that apply)

1 Lighting
2 Heating/Cooling systems
3 Hot Water
4 Appliances/Office Equipment
5 Insulation
6 Motor/Variable Frequency Drives (VFDs)
7 Compressed Air
8 Refrigeration

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9 Something else
10 Don't know

[ASK SP3-SP5 FOR EACH MENTIONED IN SP2]

SP3 Can you describe the [SP2] equipment?

[FOR EXAMPLE: What was the brand or model? Efficiency rating? Dimensions? Capacity? Quantity?]

SP4 [IF SP2 <> 5, "How many" or IF SP2=5, "How much"] [SP2] did you install?

SP5 Was the [SP2] project recommended by the assessment?

1 Yes
2 No

SP6 On a scale of 0 to 10, with 0 meaning "not at all influential" and 10 meaning "extremely influential", how influential was your participation in the Non-residential Assessment Program on your decision to complete the additional energy efficiency project(s)?

Customer Satisfaction

SAT1 What part of the Non-residential Assessment Program did you like best?

SAT2 What would you change about the Non-residential Assessment Program, if anything?

SAT3 Have you recommended the Non-residential Assessment Program to anyone?

1 Yes
2 No (If you had the chance, would you recommend the Non-residential Assessment Program to anyone?)
3 Don't know (If you had the chance, would you recommend the Non-residential Assessment Program to anyone?)

X1 Considering all aspects of the program, using a scale of 0 to 10, where 0 is "very dissatisfied" and 10 is "very satisfied", how would you rate your overall satisfaction with the Non-residential Assessment Program?

X2 [IF x1<=3] Why do you say that?

X3 Using a scale of 0 to 10, where 0 is "very dissatisfied" and 10 is "very satisfied", how satisfied are you overall with Duke Energy as your service provider?

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X4 Why do you say that?

Customer Characteristics

C1 What is the main business activity at [ADDRESS]?

1 Office/Professional
2 Warehouse or distribution center
3 Food sales
4 Food service
5 Retail (other than mall)
6 Mercantile (enclosed or strip malls)
7 Education
8 Religious worship
9 Public assembly
10 Health care
11 Lodging
12 Public order and safety
13 Industrial/manufacturing (DESCRIBE)
14 Agricultural (DESCRIBE)
15 Vacant (majority of floor space is unused)
16 Other (DESCRIBE)
17 Don’t know

C2 Are your company’s budget decisions made locally, regionally, nationally, worldwide, or something else?

1 Locally
2 Regionally
3 Nationally
4 Worldwide
5 Other (specify)
6 Don’t know

C3 When creating budgets and financial plans, how far into the future does your company plan?

0 Less than 1 year
1 One year
2 Two years
3 Three years
4 Four years
5 Five years
6 More than 5 years
7 Other (specify)
8 Don’t know

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C4 Does your business' production schedule or business cycle affect when you can implement energy efficiency projects?

[PROBE: A business cycle refers to time periods when your business' activities might be significantly different. For example, a school might have to wait until summer to implement projects, while a manufacturing facility might wait until production is lower."]

C5 What simple payback period would your business need to achieve in order to undertake an energy efficiency project?

[PROBE: The payback period is the amount of time to recover the cost of the investment.]

C6 Would you like someone from Duke Energy to contact you directly to provide more information or answer any questions you might have about their energy efficiency programs?

We will not share your responses to this survey, only pass along your contact information.

C7 [IF C6=1] To confirm, where is the best number to reach you at?

C8 And who should they get in touch with? [Can you spell your name?]

C9 As part of the study, we may have follow-up questions regarding specific projects implemented at your business and will be conducting onsite visits with a sample of customers. Who should we contact regarding these items?

[RECORD VERBATIM]

C9a And what is their role or position?

C10 Those are all the questions I have. I'd like to thank you for your help with this survey. Do you have any comments you would like to share with Duke Energy?

1 Yes (specify)
2 No

END That completes the survey, thank you very much for your time.

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A.1 Non-Participant survey instrument

Duke Energy Non-residential Assessment Program
Non-Participant Customer Survey

Sample Variables

CASEID	Unique case identifier
FACILITY_NAM	Name of the facility
ACCOUNT_NAM	Name of the account
CONTACT NAME	Primary customer contact name
YEAR	The year the customer contacted Duke Energy about an assessment
ADDRESS	The address of the site where the assessment would have occurred

Introduction and Screening

INT01 Hello, my name is [NAME], and I am calling on behalf of Duke Energy. May I speak with [CONTACT NAME]?

1 Yes
2 Respondent not knowledgeable [SKIP TO OTHER_R]
3 No [DISPO CASE OUT]

PREAMBLE I'm calling from Tetra Tech, an independent research firm. We were hired by Duke Energy to talk with some of their customers about their interest in the Non-residential Assessment Program.

Our records indicate that in [YEAR] you discussed with Duke Energy the possibility of participating in the Non-residential Assessment Program but did not complete the assessment. This is a program that performs professional engineering studies in order to recommend energy efficiency projects. Are you able to answer questions about your company's interest in this program?

1 Yes, I'm able to answer [SKIP TO SCREEN2]
2 Yes, but information isn't quite right
3 No, I'm not able to answer [SKIP TO OTHER_R]
4 We have not participated [SKIP TO OTHER_R]

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99 Refusal [TERMINATE 91]

SCREEN1 What is not correct?

1 Received an assessment but did not install any equipment [TERMINATE 82]
2 Received an assessment and installed equipment [TERMINATE 82]
3 Year is off [SKIP TO SCREEN2]
4 Something else [SPECIFY] [SKIP TO SCREEN2]

OTHER_R Is it possible that someone else in your organization would be more familiar with the program or the assessment that was considered?

1 Yes
2 No [TERMINATE 81]
99 Refused [TERMINATE 91]

AVAILABLE_R May I please speak with that person?

1 Yes [SKIP TO INT01]
2 No [SET UP CALLBACK (When would be a good time to call back?)]
88 Don't know [TERMINATE 81]
99 Refused TERMINATE 91]

SCREEN2 Were you involved in the decision whether or not to complete the assessment?

1 Yes
2 No [SKIP TO OTHER_R]
99 Refused [TERMINATE 91]

PREAMBLE2 Great, thank you. I'd like to assure you that I'm not selling anything, I would just like to ask your opinion about this program. Your responses will be kept confidential and your name will not be revealed to anyone. For quality and training purposes, this call will be recorded.

1 Continue

Program Awareness and Marketing (all)

Q1 How did you first hear about Duke Energy's Non-residential Assessment Program? (Select one)

1 Account representative
2 Business Energy Advisor
3 Contractor / Vendor
4 Email from Duke Energy

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5 Mail from Duke Energy
6 Colleague/Another business
7 Conference/Trade Show/Expo
8 Duke Energy website
9 Other (specify)
10 Don't know

Assessment Details

Q10 Why did you consider having an assessment done through Duke Energy's Non-residential Assessment Program?

[RECORD VERBATIM]

Q11 Participating in the program involves several steps. Which of the following steps did you complete? [READ LIST, SELECT ALL THAT APPLY]

Q11C01 Did you have an initial call with program staff to discuss the facility characteristics and the focus of the assessment?
Q11C02 Did you complete the online application form?
Q11C03 Did you receive a proposal letter with scope and pricing for the assessment?
Q11C04 Did a program representative come to your facility to do a preliminary walk-through?
Q11C05 Did you have a kickoff call for Duke to collect facility and equipment details?
Q11C06 Did you schedule the onsite assessment?
Q11C07 [DO NOT READ] None selected [SKIP TO Q14]

Q12 On a 0 to 10 scale where 0 is "very dissatisfied" and 10 is "very satisfied", how satisfied were you with (each of) the following step(s) in program participation.

For Q12A through Q12F
__ Record satisfaction [0-10]
88 Don't know
99 Refused

Q12A [ASK IF Q11C01=1] The initial call with program staff to discuss the facility characteristics and the focus of the assessment?
Q12B [ASK IF Q11C02=1] Completing the online application form?
Q12C [ASK IF Q11C03=1] The proposal letter with scope and pricing for the assessment?
Q12D [ASK IF Q11C04=1] The program representative coming to your facility to do a preliminary walk-through?
Q12E [ASK IF Q11C05=1] The kickoff call for Duke to collect facility and equipment details?
Q12F [ASK IF Q11C06=1] The scheduling of the onsite assessment?

Q13 [ask for each if Q12 < 3] What could Duke Energy do to improve your satisfaction with [item from Q12]?

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For Q13A through Q13F
[RECORD VERBATIM]

Q13A [ASK IF Q12A<3] The initial call with program staff to discuss the facility characteristics and the focus of the assessment?
Q13B [ASK IF Q12B<3] Completing the online application form?
Q13C [ASK IF Q12C<3] The proposal letter with scope and pricing for the assessment?
Q13D [ASK IF Q12D<3] The program representative coming to your facility to do a preliminary walk-through?
Q13E [ASK IF Q12E<3] The kickoff call for Duke to collect facility and equipment details?
Q13F [ASK IF Q12F<3] The scheduling of the onsite assessment?

Q14 Why did you choose not to have an assessment through Duke Energy?

[RECORD VERBATIM]

Q15 What could Duke Energy have done differently so that you would have an assessment completed?

[RECORD VERBATIM]

Q16 Have you made any energy efficiency improvements in the **last** 2 years?

1 Yes [SPECIFY: What improvements have you made?]
2 No
88 Don't know
99 Refused

Q17 Do you have any plans to make energy efficiency improvements in the **next** 2 years?

1 Yes What improvements do you have planned?
2 No
88 Don't know
99 Refused

Q18 [ASK IF Q17=1] Do you plan to participate in a Duke Energy program as part of these energy efficiency improvements?

1 Yes
2 No
88 Don't know
99 Refused

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Customer Satisfaction

SAT13 Using a scale of 0 to 10, where 0 is "very dissatisfied" and 10 is "very satisfied", how satisfied are you overall with Duke Energy as your service provider?

___ [RECORD RESPONSE]
88 Don't know
99 Refused

SAT14 Why do you say that?

[RECORD VERBATIM]

Customer Characteristics

C1 What is the **main** business activity at [ADDRESS]?

1 Office/Professional
2 Warehouse or distribution center
3 Food sales
4 Food service
5 Retail (other than mall)
6 Mercantile (enclosed or strip malls)
7 Education
8 Religious worship
9 Public assembly
10 Health care
11 Lodging
12 Public order and safety
13 Industrial/manufacturing (DESCRIBE)
14 Agricultural (DESCRIBE)
15 Vacant (majority of floor space is unused)
16 Other (DESCRIBE)
88 Don't know
99 Refused

C2 Are your company's budget decisions made locally, regionally, nationally, worldwide, or something else?

1 Locally
2 Regionally
3 Nationally
4 Worldwide

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5 Other (specify)
88 Don't know
99 Refused

C3 When creating budgets and financial plans, how far into the future does your company plan?

0 Less than 1 year
1 One year
2 Two years
3 Three years
4 Four years
5 Five years
6 More than 5 years
7 Other (specify)
88 Don't know
99 Refused

C4 Does your business' production schedule or business cycle affect when you can implement energy efficiency projects?

[PROBE: A business cycle refers to time periods when your business' activities might be significantly different. For example, a school might have to wait until summer to implement projects, while a manufacturing facility might wait until production is lower."]

1 Yes (Please describe that schedule or cycle)
2 No
88 Don't know
99 Refused

C5 What simple payback period would your business need to achieve in order to undertake an energy efficiency project?

[PROBE: The payback period is the amount of time to recover the cost of the investment.]

1 [RECORD VERBATIM]
88 Don't know
99 Refused

C7 Would you like someone from Duke Energy to contact you directly to provide more information or answer any questions you might have about their energy efficiency programs?

We will not share your responses to this survey, only pass along your contact information.

1 Yes
2 No SKIP TO C9

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C8_phone [IF C6=1] To confirm, what's the best number to reach you at?

[RECORD PHONE NUMBER]

C8_name And who should they get in touch with? [Can you spell your name?]

[RECORD NAME]

C9 Those are all the questions I have. I'd like to thank you for your help with this survey. Do you have any comments you would like to share with Duke Energy?

1 Yes [SPECIFY]
2 No

INT99 That completes the survey, thank you very much for your time.

A.2 Trade ally interview guide

Duke Energy Carolinas Non-residential Assessment Program
Trade Ally In-depth Interview Guide

This document serves as a guide for interviews with the companies providing assessment services to Duke Energy's Non-residential Assessment Program.

Background for respondent: We are working with Duke Energy to evaluate their Non-residential Assessment Program in the Carolinas. As part of this evaluation, we are speaking with Duke Energy staff, customers, and contractors such as yourself. We will be asking questions about your experience with the program in the past and improvements you would suggest for the future.

I would like to record this call so I can review it later and make sure I capture your responses accurately. Is that OK?

Trade Ally Background

1 What is your role at <company>? What is your role within the Non-Residential Assessment s program?

2 How long has <company> been providing services to the Non-Residential Assessment s program? Have you been involved the whole time?

Program Interaction

3 Who do you interact with at Duke Energy in connection with the Non-Residential Assessment s program? Can you describe your interaction with them? (e.g., method and frequency of communication) Do you have any suggestions for improving

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communication?

4 What information or training did/does Duke provide as part of the Non-Residential Assessment s program? Is the information or training sufficient? Is there anything additional Duke could provide (either technical or regarding program operation)?

Customer Interaction

5 How do you initiate interaction with a customer? What are the steps that your company completes with the customer? (e.g., How involved are you in the application process?) Do you feel that this process works well, or are there areas that could be streamlined?

6 What types of materials or information do you provide to customers during different phases of a project? (start-up and planning, execution, wrap-up) Have you received any feedback, positive or negative, on any of these materials or information?

7 What challenges do you face when planning an assessment? Conducting an assessment (types of equipment, types of buildings)? Reporting?

8 How do you present the assessment results to the customer? Do customers tend to anticipate what is coming? How often do customers already know about issues that are confirmed by the assessment?

9 Do you think there are certain types of recommendations that customers are more likely to follow through? Are there recommendations where customers don't seem to follow through? (What are they?)

10 Why do customers *not* follow through with recommendations? (if money/budget, what other reasons?) What could the program do to address this? Are these issues that could be anticipated before the assessment?

11 Do customers respond well to the incentive estimates? Are there recommendations where incentives are not sufficient?

12 What do you do to connect customers with contractors who can complete the work? Have you encountered any issues with that hand-off?

Wrap-up

13 What challenges does your company face in supporting Duke's Non-residential Assessment Program? What could be done to address these challenges?

14 What do you think are the strengths of the Non-residential Assessment Program? What aspects of the program work well for your company? For customers?

15 Is there anything Duke Energy could do better to support your participation in the Non-residential Assessment Program?

16 Do you have anything else to add that we haven't already discussed?

Those are all the questions I have today. Thank you for your time.

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Duke Energy Carolinas and Progress

EnergyWise for Business Programs
Evaluation Report – Final

June 12, 2017

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Mar 07 2018

Opinion Dynamics

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1. Evaluation Summary

1.1 Program Summary

The Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) EnergyWise for Business Program is a demand response (DR) and energy efficiency (EE) program that provides small businesses with the opportunity to participate in DR events, earn incentives, and realize additional energy efficiency (EE) benefits. The program was introduced in 2016 and offers participants either a programmable, two-way WiFi Smart Thermostat or a Load Control Switch. Participants can select one of three levels of DR participation—30% cycling, 50% cycling, and 75% cycling—with varying levels of earned incentives based on the selected cycling strategy. Smart thermostat participants who have a heat pump with electric resistance heat strips are also offered the option of participating in winter DR events and can earn additional incentives per season. Customers who opt for the smart thermostat have the ability to manage their thermostat remotely with presets that help them potentially realize energy savings. Duke Energy contracted with Comverge to implement this program.

The program targets small businesses with a qualifying central air conditioning system and a minimum usage of 1,000 kWh per month during the billing months of May through September. By the end of 2016, the program had enrolled a total of 606 customers and 1,202 devices. The program called three summer but no winter DR events in 2016.

1.2 Evaluation Objectives

The 2016 evaluation included a deemed savings review and an engineering-based gross impact analysis to answer the following key research questions:

1. What were the estimated gross demand response impacts from the program in 2016?
2. What were the estimated gross energy efficiency impacts from the program in 2016?

It should be noted that this evaluation did not include a regression-based modeling approach, which is the industry-standard approach to estimating impacts from DR events. As such, the results of this evaluation should be interpreted as directional. The upcoming evaluation of the 2017 EnergyWise for Business Program will include a regression-based model approach to estimating both DR and EE impacts.

1.3 High-Level Findings

Based on our engineering-based impact analysis, the EnergyWise for Business Program fell short of planned savings in 2016, realizing between one-quarter (DEP) and one-third (DEC) of planned DR savings and just above 40% of planned EE savings.

Table 1-1 presents the results of our DR and EE analyses, including ex ante and ex post values for the number of devices, per device savings, and overall impacts, by jurisdiction. The table also presents the resulting realization rates.

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Table 1-1.Summary of Gross Impact Analysis

Estimate	DEC			DEP		
	Ex Ante	Ex Post	Realization Rate	Ex Ante	Ex Post	Realization Rate
Demand Response Impacts						
Average # of Participating Devices[A]	625	442	71%	355	262	74%
Average Per Device kW Savings	3.59	1.54	43%	3.59	1.25	35%
Total Demand Response Savings	**2,244**	**682**	**30%**	**1,274**	**329**	**26%**
Energy Efficiency Impacts						
Number of Enrolled Thermostats[B]	750	692	92%	426	447	105%
Average Per Thermostat kWh Savings	1,450	641	44%	1,450	562	39%
Total Energy Efficiency Savings	**1,087,500**	**443,344**	**41%**	**617,700**	**251,433**	**41%**

[A] Ex post values represent the average number of devices (across the three 2016 DR events) that were enrolled during the event and did not opt out. These are the devices that achieved demand reductions during the 2016 events.
[B] Ex ante and ex post values represent thermostats enrolled at the end of 2016.

Two factors contributed to the shortfall in savings:

1. **Per-unit savings assumptions:** Our deemed savings review found that ex ante per-unit savings were too high, mostly due to an overestimate of the size (tonnage) of the controlled air conditioning units. Since equipment size is directly correlated with savings, the smaller than expected controlled units significantly affected realized EE and DR savings. On the DR side, other contributors to lower than expected per unit savings were a higher than planned adoption of thermostats (which in 2016 were estimated to achieve lower DR savings than switches) and a slight under-enrollment in the more aggressive cycling strategies for DEP.

2. **Enrollment:** By the end of 2016, the program had almost met its planned number of enrolled devices: Enrollment for DEC was 92% of projections while enrollment for DEP exceeded projections (105%). As a result, enrollment assumptions did not significantly contribute to the shortfall in EE savings. Device enrollment did affect DR impacts, however, as some of the devices were not installed until after the summer DR events. As a result, participation levels in the DR events were just short of three-quarters of planned participation.

1.4 Evaluation Recommendations

Because this evaluation was limited to an engineering-based analysis, there is uncertainty about the program impacts achieved in 2016. However, based on our comparison of planning and verified assumptions, we provide the following recommendations for future program planning.

Adopt More Conservative HVAC Average Tonnage Values

The tonnage values tracked in the program participation database suggest that Duke Energy's current planning values are too high. Pending results from the 2017 evaluation, the program may wish to lower its planning values as smaller units, everything else being equal, will achieve lower savings compared to larger units. As a result, an erroneous tonnage assumption might result in the program not achieving its savings goals.

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Increase Promotion of Higher Cycling Strategies among Program Enrollees

Participants in DEP seemed to shy away from enrolling in the 75% cycling strategy and opted for strategies that result in lower savings. As such, we encourage Duke Energy to put additional emphasis on 75% cycling when recruiting participants, as it will lead to greater savings. Another alternative would be for Duke Energy to adjust its ex ante assumptions regarding cycling strategies. While this would not increase savings, it would provide more realistic planning assumptions and improve realization rates.

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2. Program Description

2.1 Program Design

The Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) EnergyWise for Business program is a demand response (DR) and energy efficiency (EE) program that provides small businesses with the opportunity to participate in DR events, earn incentives, and realize additional EE benefits. The program was introduced in 2016 and offers participants either a programmable, two-way WiFi Smart Thermostat or a Load Control Switch. Participants can select one of three levels of DR participation—30% cycling, 50% cycling, and 75% cycling—with varying levels of earned incentives based on the selected cycling strategy. Smart Thermostat participants who have a heat pump with electric resistance heat strips are also offered the option of participating in winter DR events and can earn additional incentives per season. Customers who opt for the smart thermostat have the ability to manage their thermostat remotely with presets that help them potentially realize energy savings. Duke Energy contracted with Comverge to implement this program.

The program targets small businesses with a qualifying central air conditioning system and a minimum usage of 1,000 kWh per month during the billing months of May through September.

The program was first implemented by Comverge in the DEC and DEP territories in 2016. The evaluation period considered in this report is January 1, 2016 to December 31, 2016.

2.2 Program Implementation

Duke Energy contracted with Comverge in 2016 to implement the EnergyWise for Business program. Once a customer enrolls in the program, a representative visits the site to install the devices and to show participants how to program their devices and access the web portal. Events are called on weekdays when average temperature criteria are met and a high system peak is projected. Each time an event is scheduled, participants are notified via email and through the web portal. During the event, the devices display a message that an event is in progress. Participants are able to opt out of events at any time before or during the event.

2.3 Program Participation

Based on the program-tracking database, the program distributed 1,202 devices in 2016, associated with 606 unique customer accounts. Customers overwhelmingly opted for Smart Thermostats (95%) over Load Control Switches (5%). The 30% cycling strategy was the most popular among customers, with 63% of devices enrolled into that cycling level. Only 23% of devices were enrolled in the 50% cycling strategy and 14% in the 75% cycling strategy. Table 2-1 provides the distribution of device types and cycling strategies.

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Table 2-1. Counts of Enrolled Devices, Device Jurisdiction, Type, and Cycling Strategy

Jurisdiction and Cycling Strategy	Number of Devices			Percentage of Total Devices in Jurisdiction		
	Thermostat	Switch	Total	Thermostat	Switch	Total
DEC						
30%	393	12	405	54%	2%	56%
50%	169	16	185	23%	2%	25%
75%	130	9	139	18%	1%	19%
Jurisdiction Total	692	37	729	95%	5%	100%
DEP						
30%	289	19	308	61%	4%	65%
50%	113	5	118	24%	1%	25%
75%	45	2	47	10%	<1%	10%
Jurisdiction Total	447	26	473	95%	5%	100%
Overall Total	**1,139**	**63**	**1,202**	**95%**	**5%**	**100%**

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3. Overview of Evaluation Activities

To address the research objectives for this evaluation, Opinion Dynamics performed a range of data collection and analytic activities. These activities are summarized in this section.

3.1 Program Staff Interviews

We conducted an in-depth interview with the Duke Energy EnergyWise for Business program manager. This interview took place in January 2016. The purpose of this interview was to understand the program's current design and implementation, and to determine the priorities for the impact evaluation.

3.2 Program Materials Review

To inform the subsequent analyses, Opinion Dynamics reviewed program materials, including program design and implementation materials, relevant research reports, and most notably the program-tracking database.

3.3 Engineering-Based Impact Analysis to Determine Ex-Post Savings and Realization Rate

To determine program impacts, the evaluation team used a three-step process: (1) we conducted a deemed savings review; (2) we performed an analysis of the program participation database; and (3) we estimated ex post savings and calculated realization rates.

Step 1: Deemed Savings Review. Opinion Dynamics reviewed inputs and algorithms provided by Duke Energy to document existing (ex ante) assumptions and claimed EE and DR savings. We then performed an engineering analysis using various Technical Reference Manuals (TRMs) and secondary sources to develop verified (ex post) per-unit savings estimates for Smart Thermostats and Load Control Switches. As part of this analysis, we looked up cooling equipment characteristics, based on model numbers, for a sample of 54 participants to update program assumptions about equipment efficiency. We then updated the ex ante savings values based on our engineering analysis and the customer data we received. The deemed savings review, including references to all sources used, is presented in Appendix A.

Step 2: Participation Analysis. The evaluation team reviewed program-tracking data to assess program participation during the evaluation period. This effort included:

- A review of the program participation database to determine the total number of devices and participants, the type of devices installed, and the cycling strategies employed, as well as device installation dates.
- A review of thermostat and switch reports to identify opt-outs.

Step 3: Estimation of Ex Post Savings and Realization Rates. To estimate ex post savings, we applied the ex post per-unit savings values from the deemed savings review (Step 1) with participation counts from the participation analysis (Step 2). We then calculated realization rates for both energy and demand impacts by dividing ex post (evaluated) savings by ex ante (claimed) savings.

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4. Gross Impact Evaluation

Our gross impact evaluation included three main analytic steps: (1) a deemed savings review, (2) a participation analysis, and (3) estimation of ex post savings analysis and realization rates for the demand response and energy efficiency components of the program. Figure 4-1 depicts this process.

Figure 4-1. Gross Impact Evaluation Approach

The following subsections describe our approach and the results for each of the three steps.

4.1 Deemed Savings Review

The goal of the deemed savings review was to examine existing program savings values and assumptions and to develop new estimates that the program can use going forward. Our review consisted of several activities:

- We reviewed inputs and algorithms provided by Duke Energy. We also reviewed source documents and program filings to determine existing assumptions about per-device DR and EE savings.
- We reviewed the TRMs for Arkansas, Illinois, Indiana, and the Mid-Atlantic, as well as secondary sources to establish an algorithm for EE savings and to inform assumptions for new per-unit savings estimates for Smart Thermostats and Load Control Switches.
- We used tonnage information from the program-tracking database to update default program assumptions.
- We conducted a look-up of 54 equipment model numbers to develop an estimate of the average efficiency (expressed as the Seasonal Energy Efficiency Ratio [SEER]) of participants' cooling equipment.

Based on the results of these activities, we developed new per-device savings values.

Below, we summarize the inputs for estimating both DR and EE impacts and present the results of the analysis. The full deemed savings review is included in Appendix A.

4.1.1 Demand Response Load Impacts

Our evaluation of the 2016 EnergyWise for Business Program did not include a model-based analysis of DR events.[1] However, one of the key determinants of summer DR event savings is the size (tonnage) of the

[1] Note that a full, model-based DR impact analysis will be performed as part of our 2017 program evaluation.

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controlled cooling equipment. Our comparison of program tonnage assumptions with actual tonnage information in the program-tracking database found that the size of participants' cooling equipment is substantially smaller than the program assumption. Everything else being equal, smaller equipment size would lead to smaller per-device DR event savings. To provide updated per device-DR savings, we therefore developed a ratio of actual to assumed equipment size (i.e., average ex post tonnage/average ex ante tonnage). We applied this ratio to the program's ex ante per-device savings assumptions (by device type and cycling strategy), using the following formula:

*Per-Device kW Event Savings = Ex Ante kW * Ex Post Tons/Ex Ante Tons*

Table 4-1 provides the ex ante and ex post tonnage assumptions, by device type and jurisdiction, and the resulting tonnage ratios. Tonnage ratios range from 0.36 for equipment controlled by DEP load control switches to 0.46 for equipment controlled by DEC smart thermostats.

Table 4-1. Tonnage Assumptions for Estimating DR Event Impacts

	Smart Thermostat			Load Control Switch		
		Ex Post			Ex Post	
Parameter	Ex Ante	DEC	DEP	Ex Ante	DEC	DEP
Tonnage	9.62	4.41	4.08	9.62	4.02	3.48
Tonnage Ratio		0.46	0.42		0.42	0.36

[A] In instances where tonnage values were missing from the program participation database (n = 65 devices), the average tonnage for that device and jurisdiction value was imputed.

Table 4-2 shows the program's ex ante per-device savings assumptions for thermostats and switches, by cycling strategy, and the ex post values that result from applying the tonnage ratios to the ex ante values. Given the relatively low tonnage ratios, estimated ex post kW savings are less than half of ex ante savings, across both jurisdictions and device types.

Table 4-2. Assumptions for Estimating Per Device DR Event Savings (kW)

	Smart Thermostat			Load Control Switch		
		Ex Post kW			Ex Post kW	
Cycling Strategy	Ex Ante kW	DEC	DEP	Ex Ante	DEC	DEP
30% Cycling	2.02	0.93	0.86	2.50	1.04	0.90
50% Cycling	3.77	1.73	1.60	4.25	1.78	1.54
75% Cycling	6.27	2.88	2.66	6.75	2.82	2.44

4.1.2 Energy Efficiency Impacts

The program's energy efficiency impacts are associated with smart thermostats only. Duke Energy provided tonnage assumptions as well as per device ex ante savings, but did not provide the algorithm used to develop these savings. We compared the ex ante tonnage assumption with actual tonnages from the program tracking databases and calculated per thermostat ex post savings using the following equation, which is common to most TRMs for thermostat measures:

*kWh savings per thermostat = Tonnage * 12/SEER * EFLHcool * ESF*

Table 4-3 summarizes the ex ante tonnage and per device savings assumptions (provided by Duke Energy) and provides the ex post inputs into the EE savings formula. These inputs include the average equipment

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tonnage, the average equipment efficiency (SEER), Equivalent Full Load Cooling Hours (EFLHcool), and the Energy Savings Factor (ESF). The deemed savings review memo (Appendix A) provides more detail about these inputs, including the sources of information.

Table 4-3. Assumptions for Estimating EE kWh Impacts

Parameter	Ex Ante Value		Ex Post Value	
	DEC	DEP	DEC	DEP
Tonnage	9.62	9.62	4.41	4.08
SEER	Unknown		11.2	11.8
EFLHcool	Unknown		1,355	1,355
ESF	Unknown		10%	10%
Savings per Thermostat (kWh)	1,450	1,450	641	563

Similar to the per device DR impacts, the greater ex ante tonnage assumption was largely responsible for the difference between ex ante and ex post per-thermostat EE savings. While we do not have ex ante values for SEER, EFLHcool, and ESF, nor the algorithm used, we calculate per-thermostat EE savings of 1,397 kWh (DEC) and 1,326 kWh (DEP) when using the ex post energy savings equation and assumptions but substituting in the ex ante tonnage assumptions. These values are very close to the ex ante EE savings value of 1,450 kWh, so differences in assumptions other than tonnage would be minor.

4.2 Participation Analysis

The second step in the gross impact analysis consisted of an analysis of program enrollment and event participation, based on program tracking data and customer opt out reports. Both are described in this section.

4.2.1 Program Enrollment

According to information provided by Duke Energy, anticipated participation in the program was 1,250 devices for DEC and 710 devices for DEP. The program further assumed that 60% of devices would be thermostats and 40% would be load control switches.

Review of the program tracking data showed a total 2016 enrollment of 729 thermostats and switches in the DEC service territory and 473 thermostats and switches in the DEP service territory, just over half of what was anticipated in the program filings. It should be noted that approximately 34% of these devices were installed after the 2016 summer event season, and therefore were not able to participate in these events. The tracking data also showed a different mix of thermostats and switches from what was anticipated, with fewer customers choosing to install switches than projected.

Table 4-4 provides ex ante and ex post enrollment numbers, by device type and jurisdictionTable 4-4. Projected and Actual Program Enrollment.

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Table 4-4. Projected and Actual Program Enrollment (Number of Devices)

Jurisdiction	Device Type	Demand Response			Energy Efficiency		
		# Projected	# Achieved	% Achieved	# Projected	# Achieved	% Achieved
DEC	Thermostat	750	692	92%	750	692	92%
	Switch	500	37	7%	0	0	n/a
	Overall	**1,250**	**729**	**58%**	**750**	**692**	**92%**
DEP	Thermostat	426	447	105%	426	447	105%
	Switch	284	26	9%	0	0	n/a
	Overall	**710**	**473**	**67%**	**426**	**447**	**105%**

To develop expected savings from DR events, the program also projected the share of customers that would select the different cycling strategies. The program projected 50% of enrollment in the 30% cycling strategy, 30% of enrollment in the 50% cycling strategy, and 20% of enrollment in the 75% cycling strategy. These projections were fairly accurate for DEC customers, but DEP customers showed a stronger preference for the 30% cycling strategy at the expense of the 75% cycling strategy. Everything else being equal, a lower cycling percentage will generate lower DR savings. To realize expected savings, the program may therefore need to more strongly promote the higher cycling strategies, particularly among DEP customers.

Table 4-5 provides the projected and actual distributions of enrollment in the three cycling strategies.

Table 4-5. Ex Ante and Ex Post Distribution of Cycling Strategies by Jurisdiction

Jurisdiction	Projected[A]	Actual
30% Cycling Strategy		
DEC	50%	55.6%
DEP		65.1%
50% Cycling Strategy		
DEC	30%	25.4%
DEP		24.9%
75% Cycling Strategy		
DEC	20%	19.1%
DEP		9.9%

[A]Based on 9/19/2014 PowerPoint presentation, entitled “Small Business Demand Response – Evaluation Gate Presentation”

4.2.2 Participation in Demand Response Events

In 2016, the program called three summer DR events, on July 8th, July 14th, and July 27th. The average peak temperature on these three event days was 96 °F.[2] There were no winter events called in 2016.

To assess participation in the three summer DR events, Opinion Dynamics reviewed override reports to assess the number of event opt-outs. These data were then merged with the program tracking data to determine opt-out rates by jurisdiction. As shown in Table 4-6, opt-out rates for events were low, and review of the data does not suggest that opt-outs vary as a function of cycling strategy. It is worth noting that as of the third event on July 28th, only 797 devices had been installed (66% of the total enrolled devices in 2016).

[2] Average peak temperature is based on weather information for Charlotte and Raleigh, NC.

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Thus, about a third of 2016 participants were not able to participate in any of the 2016 DR events as they had not yet had their devices installed.

Table 4-6. Device Participation by Event and Jurisdiction

Event Date & Jurisdiction	Enrolled Devices	Device Opt-Outs	Part. Devices	Device Part. Rate
7/8/2016				
DEC	424	1	423	99.8%
DEP	235	1	234	99.6%
Total	659	2	657	99.7%
7/14/2016				
DEC	443	16	427	96.4%
DEP	258	8	250	96.9%
Total	701	24	677	96.6%
7/27/2016				
DEC	495	20	475	96.0%
DEP	302	1	301	99.7%
Total	797	21	776	97.4%

4.3 Estimation of Ex Post Savings

The third step in our gross impact evaluation was to estimate program DR and EE savings using the ex post deemed savings values and information from the program participation database developed in the previous steps. Below, we describe the inputs and algorithms used for the DR and EE ex post savings analyses and present the results.

4.3.1 Demand Response Impacts

For each summer DR event, we estimated kW impacts by multiplying the per-device ex post savings (shown in Table 4-2) by the number of participating devices. Since per unit ex post savings estimates vary by jurisdiction, device type, and cycling strategy, we developed 6 different ex post savings values for each jurisdiction and each event (2 device types x 3 cycling strategies). We then summed over these values to estimate the total event savings by jurisdiction.

Table 4-7 provides the number of participating devices per event, average per device savings (i.e., the weighted average across the three cycling strategies), and overall kW savings. Across both DEC and DEP, both participating devices and savings increased with each event, as a result of the program enrolling new customers as the event season progressed. On average, in DEC savings were 682 kW per event and in DEP savings were 329 kW per event, including savings from both thermostats and switches.

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Table 4-7. DR kW Savings by Event

Event Date	DEC		DEP	
	Therm.	Switch	Therm.	Switch
7/8/2016				
Number of Participating Devices	401	22	226	8
Average Per-Device kW Savings	1.52	1.86	1.28	1.18
Total Event kW Savings	**609**	**41**	**288**	**9**
7/14/2016				
Number of Participating Devices	403	24	242	8
Average Per-Device kW Savings	1.54	1.79	1.29	1.18
Total Event kW Savings	**619**	**43**	**312**	**9**
7/27/2016				
Number of Participating Devices	450	25	288	13
Average Per-Device kW Savings	1.53	1.83	1.22	1.07
Total Event kW Savings	**687**	**46**	**352**	**14**
Overall Average				
Number of Participating Devices	418	24	252	10
Weighted Average Per-Device kW Savings	1.53	1.83	1.26	1.13
Total Event kW Savings	**638**	**44**	**317**	**11**

Error! Reference source not found. shows the average ex post summer DR event impacts, by jurisdiction, relative to the ex ante values taken from program filings. Overall, the program achieved just under one-quarter of its anticipated DR savings. This shortfall is driven by two key factors: (1) the lower than projected size of participating air conditioning units and (2) the lower than expected enrollment at the time of the 2016 summer events.

The lower per-unit savings realization rate for DEP, compared to DEC, results from the relative under-enrollment in the 75% cycling strategy in that jurisdiction as well as a slightly greater tonnage adjustment compared to DEC.

Table 4-8. Program DR Impacts

Estimate	DEC			DEP		
	Ex Ante	Ex Post	Realization Rate	Ex Ante	Ex Post	Realization Rate
Average # of Participating Devices	625	442	71%	355	262	74%
Average Per Device kW Savings[A]	3.59	1.54	43%	3.59	1.25	35%
Total Program Savings	**2,244**	**682**	**30%**	**1,274**	**329**	**26%**

[A]Ex post kW values represent the weighted average of thermostats and switches.

4.3.2 Energy Efficiency Impacts

To estimate EE savings, we multiplied the per thermostat savings (shown in Table 4-3. Assumptions for Estimating EE kWh ImpactsTable 4-3), by the number of enrolled thermostats (shown in Table 2-1). Table 4-9

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summarizes ex ante and ex post thermostat counts and per unit savings values and shows the resulting realization rates.

Table 4-9. Program Energy Efficiency Impacts

Estimate	DEC			DEP		
	Ex Ante	Ex Post	Realization Rate	Ex Ante	Ex Post	Realization Rate
Number of Enrolled Thermostats[A]	750	692	92%	426	447	105%
Average Per Thermostat kWh Savings	1,450	641	44%	1,450	562	39%
Total Energy Efficiency Savings	**1,087,500**	**443,344**	**41%**	**617,700**	**251,433**	**41%**

[A] Ex ante and ex post values represent thermostats enrolled at the end of 2016.

Duke Energy achieved just over 40% of its anticipated EE kWh savings. The discrepancy between the ex ante and ex post savings is mainly due to the shortfall in per thermostat savings resulting from the lower than expected size (tonnage) of the controlled air conditioning units.

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5. Conclusions and Recommendations

5.1 Conclusions

Based on our engineering-based impact analysis, the EnergyWise for Business Program fell short of planned savings in 2016, realizing between one-quarter (DEP) and one-third (DEC) of planned DR savings and just above 40% of planned EE savings.

Table 5-1 presents the results of our DR and EE analyses, including ex ante and ex post values for the number of devices, per device savings, and overall impacts, by jurisdiction. The table also presents the resulting realization rates.

Table 5-1.Summary of Gross Impact Analysis

Estimate	DEC			DEP		
	Ex Ante	Ex Post	Realization Rate	Ex Ante	Ex Post	Realization Rate
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Energy Efficiency Impacts						
Number of Enrolled Thermostats[B]	750	692	92%	426	447	105%
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[A] Ex post values represent the average number of devices (across the three 2016 DR events) that were enrolled during the event and did not opt out. These are the devices that achieved demand reductions during the 2016 events.
[B] Ex ante and ex post values represent thermostats enrolled at the end of 2016.

Two factors contributed to the shortfall in savings:

1. **Per-unit savings assumptions:** Our deemed savings review found that ex ante per-unit savings were too high, mostly due to an overestimate of the size (tonnage) of the controlled air conditioning units. Since equipment size is directly correlated with savings, the smaller than expected controlled units significantly affected realized EE and DR savings. On the DR side, other contributors to lower than expected per unit savings were a higher than planned adoption of thermostats (which in 2016 were estimated to achieve lower DR savings than switches) and a slight under-enrollment in the more aggressive cycling strategies for DEP.

2. **Enrollment:** By the end of 2016, the program had almost met its planned number of enrolled devices: Enrollment for DEC was 92% of projections while enrollment for DEP exceeded projections (105%). As a result, enrollment assumptions did not significantly contribute to the shortfall in EE savings. Device enrollment did affect DR impacts, however, as some of the devices were not installed until after the summer DR events. As a result, participation levels in the DR events were just short of three-quarters of planned participation.

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5.2 Recommendations

Because this evaluation was limited to an engineering-based analysis, there is uncertainty about the program impacts achieved in 2016. However, based on our comparison of planning and verified assumptions, we provide the following recommendations for future program planning.

Adopt More Conservative HVAC Average Tonnage Values

The tonnage values tracked in the program participation database suggest that Duke Energy's current planning values are too high. Pending results from the 2017 evaluation, the program may wish to lower its planning values as smaller units, everything else being equal, will achieve lower savings compared to larger units. As a result, an erroneous tonnage assumption might result in the program not achieving its savings goals.

Increase Promotion of Higher Cycling Strategies among Program Enrollees

Participants in DEP seemed to shy away from enrolling in the 75% cycling strategy and opted for strategies that result in lower savings. As such, we encourage Duke Energy to put additional emphasis on 75% cycling when recruiting participants, as it will lead to greater savings. Another alternative would be for Duke Energy to adjust its ex ante assumptions regarding cycling strategies. While this would not increase savings, it would provide more realistic planning assumptions and improve realization rates.

6. Summary Form

Duke Energy Carolinas and Progress EnergyWise for Business Program

Completed EMV Fact Sheet

Duke Energy Progress' and Carolinas' EnergyWise for Business Program is a demand response program that provides small businesses with the opportunity to participate in DR events, earn incentives, and realize additional EE benefits. The program offers either a programmable, two-way WiFi Smart Thermostat or a Load Control Switch to customers. Customers can select one of three levels of DR participation: 30% cycling, 50% cycling, and 75% cycling with varying levels of earned incentives based upon the selected cycling strategy. Thermostat participants having a heat pump with electric resistance heat strips are also offered the option of participating in winter DR, and can earn additional incentives per season.

Date	June 12, 2017
Region(s)	Duke Energy Carolinas & Progress
Evaluation Period	1/1/16 through 12/31/16
Total kWh Savings	DEC: 641 kWh DEP: 563 kWh
Coincident kW Impact	DEC : 681 kW DEP : 328 kW
Measure Life	Not evaluated
Net-to-Gross Ratio	Not evaluated
Process Evaluation	No
Previous Evaluation(s)	None

To determine program impacts, the evaluation team used a three-step process: (1) we conducted a deemed savings review; (2) we performed an analysis of the program participation database; and (3) we estimated ex post savings and calculated realization rates.

Step 1: Deemed Savings Review. The evaluation team reviewed the inputs and algorithms used by Duke Energy to estimate ex ante savings. The team adjusted these values based on information from program-tracking data and secondary sources. The full deemed savings review is provided in Appendix A.

Step 2: Participation Analysis. The evaluation team reviewed program-tracking data to assess program participation during the evaluation period. This effort included:

- A review of the program participation database to determine the total number of devices and participants, the type of devices installed, and the cycling strategies employed, as well as device installation dates.
- A review of thermostat and switch log data to determine device operability rates and to identify opt-outs.

Step 3: Estimation of Ex Post Savings and Realization Rates. To estimate ex post savings, we applied the ex post per-unit savings values from the deemed savings review (Step 1) with participation counts from the participation analysis (Step 2). We then calculated realization rates for both energy and demand impacts by dividing ex post (evaluated) savings by ex ante (claimed) savings.

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7. DSMore Table

The embedded Excel spreadsheets below contains measure-level inputs for Duke Energy Analytics. Per-measure savings values in the spreadsheet are based on the gross and net impact analysis reported above. Measure life estimates have not been updated as part of this evaluation since it was not part of the evaluation scope.

[DSMore Tables provided in separate files]

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Appendix A. Deemed Savings Review

[Deemed Savings Review provided in a separate file]

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

Prepared for:

Duke Energy Progress, Duke Energy Carolinas

DUKE ENERGY®

October 4, 2016
Revised June 27, 2017

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

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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:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

For this evaluation cycle, Navigant assessed the following:

Duke Energy Progress: lighting and water measures installed between 1/1/15 and 2/29/16
Duke Energy Carolinas: lighting measures installed between 1/1/14 and 2/29/16[1]

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. Duke Energy informed Navigant that most customers choose the direct install route by Franklin Energy. 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 Duke Energy Progress (DEP) and Duke Energy Carolinas (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
- **Process evaluation:** To assess program delivery and customer satisfaction

By performing both components of the EM&V effort, Navigant is able to provide 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.

[1] Navigant completed an evaluation report in November of 2015 for water measures in DEC.

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Overall, Navigant found that the Multifamily Energy Efficiency Program is being delivered effectively, customer satisfaction is generally favorable, and the reported measure installations are accurate.

For the evaluation period covered by this report, there were a total of 26,492 housing units at 262 participating properties managed by 85 different property management companies in the DEP jurisdiction. There were 21,937 housing units at 210 properties managed by 99 different property management companies 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 94 percent, meaning that total verified gross energy savings were found to be lower than claimed in the tracking database provided by Duke Energy. For DEC, the realization rate for gross energy savings was 66 percent. Navigant found the net-to-gross (NTG) ratio to be 0.94, meaning that for every 100 kWh of reported energy savings, 94 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)	21,133	19,939	94%
DEC Gross Energy Impacts (MWh)	7,299	4,807	66%

Source: Navigant analysis, totals subject to rounding.

Table 2. Program Claimed and Evaluated Gross Peak Demand Impacts

	Claimed	Evaluated	Realization Rate
DEP Gross Summer Peak Demand Impacts (MW)	1.99	2.35	118%
DEP Gross Winter Peak Demand Impacts (MW)	3.32	3.97	120%
DEC Gross Summer Peak Demand Impacts (MW)	0.68	0.71	104%
DEC Gross Winter Peak Demand Impacts (MW)	0.68	0.90	132%

Source: Navigant analysis, totals subject to rounding.

Table 3. Program Net Energy Impacts

	MWh
DEP Net Energy Impacts	18,836
DEC Net Energy Impacts	4,541

Source: Navigant analysis, totals subject to rounding.

Table 4. Program Net Peak Demand Impacts

	MW
DEP Net Summer Peak Demand Impacts	2.22
DEP Net Winter Peak Demand Impacts	3.75
DEC Net Summer Peak Demand Impacts	0.67

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DEC Net Winter Peak Demand Impacts	0.85

Source: Navigant analysis, totals subject to rounding.

1.3 Evaluation Parameters and Sample Period

To accomplish the evaluation objectives, Navigant performed an engineering review of measure savings algorithms, field verification to assess installed quantities and characteristics, as well as surveys with tenants and property managers to assess satisfaction and decision-making processes. 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 percent.

Table 5. Evaluated Parameters

Evaluated Parameter	Description	Details
Efficiency Characteristics	Inputs and assumptions used to estimate energy and demand savings	1. CFL wattage 2. CFL 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. CFL, 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	

This evaluation covers program participation from January 1, 2015 through February 29, 2016 in DEP, and from January 1, 2014 through February 29, 2016 in DEC. Table 6 shows the start and end dates of Navigant's sample period for evaluation activities.

Table 6. Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification	April 4, 2016	April 15, 2016
Tenant Phone Surveys	April 21, 2016	April 30, 2016
Property Manager Interviews	April 30, 2016	May 18, 2016

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1.4 Evaluation 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 (with the possible exception of making an appropriate adjustment for the lighting measure baseline as discussed in Section 4 of this report).
2. Navigant recommends that no more than the first three feet of cold water inlet pipes be insulated for the water heater pipe wrap measure.
3. Duke Energy should consider adding LEDs to the program.

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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 participation may be realized by the tenant whereas the incremental costs of participating in the program are absorbed by the owner.

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:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **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[2] 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 also an opportunity 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 eventually entered into a tracking database.

When energy efficient program measures are installed, Franklin Energy removes the existing or baseline equipment and generally disposes of it onsite. If the property management previously requested to keep the existing equipment, Franklin Energy will package it up and leave it behind with property management or maintenance personnel. In general, Franklin Energy does not record specific information about the

[2] 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.

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efficiency characteristics of the equipment being removed, although Franklin Energy indicated they are experimenting with the idea of doing so.[3]

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 indicated 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] During the property assessment phase, Franklin Energy determines that housing units selected for participation contain lower efficiency light bulbs (incandescents) and standard aerators and showerheads.

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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 evaluation covers both lighting and water measures in DEP, and lighting measures only in DEC.

The primary purpose of the evaluation, measurement, and verification (EM&V) assessment is to estimate net annual energy and demand impacts associated with participation from January 1, 2015 through February 29, 2016 in DEP, and January 1, 2014 through February 29, 2016 for DEC. 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.

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4. IMPACT EVALUATION

4.1 Impact Results

Figure 1 shows the program-level results for gross energy savings. 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 0.94. The NTG methodology and results are discussed in detail in Section 5 of this report.

Figure 1. Reported and Verified Program-Level Impacts

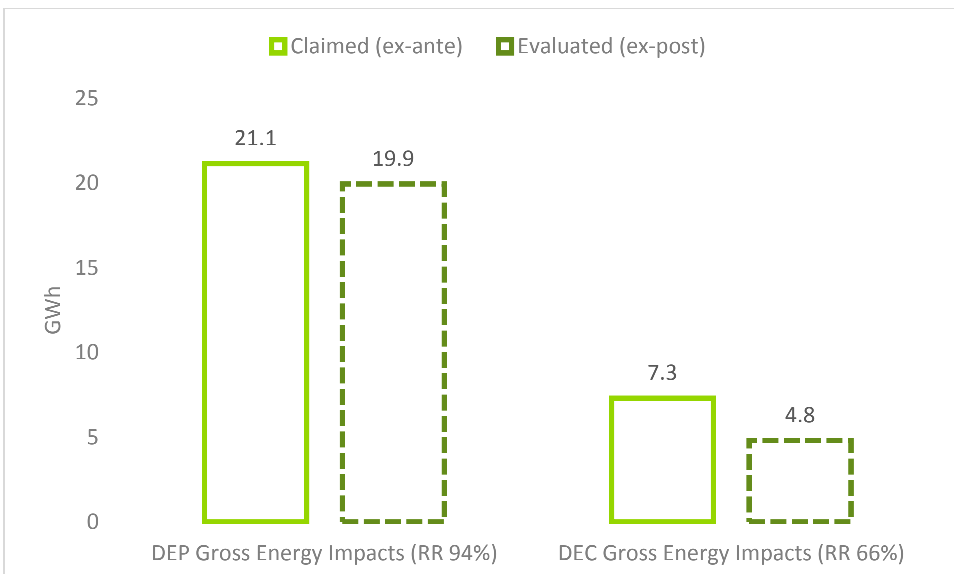

Table 7. Summary of Program Impacts

	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
DEP Verified Gross Impacts	19,939	2.35	3.97
DEP Verified Net Impacts	18,836	2.22	3.75
DEC Verified Gross Impacts	4,807	0.71	0.90
DEC Verified Net Impacts	4,541	0.67	0.85

Source: Navigant analysis

A summary of each measure's contribution to program savings and realization rate between reported savings and verified savings is shown in Table 8 for DEP, and Table 9 for DEC. Compact Fluorescent Light (CFL) bulbs account for just under half of the energy savings for DEP. By dividing the total verified

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savings by the total reported savings in the tracking data in Table 8, Navigant calculates a gross realization rate of 94 percent for energy savings at the program level for DEP. The corresponding realization rate for DEC is 66 percent, as shown in Table 9.

Table 8. Distribution of Program 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
CFLs	238,783	9,718	46%	6,400	66%
Bathroom Faucet Aerators	28,710	1,239	6%	1,135	92%
Kitchen Faucet Aerators	18,862	1,715	8%	1,630	95%
Showerheads	24,743	5,741	27%	5,859	102%
Pipe Wrap (ft)	73,338	2,720	13%	4,916	181%
Total	384,436	21,133	100%	19,939	94%

Source: Navigant analysis

Table 9. Distribution of Program 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
CFLs	179,338	7,299	100%	4,807	66%

Source: Navigant analysis

The realization rate for summer coincident demand is 118 percent at the program level for DEP, as shown in Table 10. The realization rate for summer coincident demand is 104 percent at the program level for DEC, as shown in Table 11. The realization rate for winter coincident demand is 120 percent for DEP and 132 percent for DEC, as shown in Table 12 and Table 13, respectively. These realization rates include adjustments to the estimated savings for each measure which will be discussed during the remainder of this report. On a measure level, the largest adjustments were made to the energy savings for bathroom faucet aerators due to the in-service rates found during field verification.

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

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.907	46%	0.941	104%
Bathroom Faucet Aerators	0.163	8%	0.149	92%
Kitchen Faucet Aerators	0.226	11%	0.214	95%
Showerheads	0.472	24%	0.481	102%
Pipe Wrap (ft)	0.217	11%	0.561	258%
Total	1.99	100%	2.35	118%

Source: Navigant analysis

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

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.681	100%	0.707	104%

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

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.907	27%	1.199	132%
Bathroom Faucet Aerators	0.143	4%	0.131	92%
Kitchen Faucet Aerators	0.197	6%	0.187	95%
Showerheads	1.856	56%	1.893	102%
Pipe Wrap (ft)	0.217	7%	0.561	258%
Total	3.32	100%	3.97	120%

Source: Navigant analysis

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

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.681	100%	0.901	132%

Source: Navigant analysis

4.2 Impact Evaluation Methodology

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

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

4.2.1 Detailed Review of Ex Ante Deemed Savings

Navigant reviewed the ex-ante savings and supporting documentation used to estimate ex ante program impacts. For the compact fluorescent lighting measure in both DEP and DEC, Navigant believes the

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deemed savings are well-documented in the previous EM&V report and that the algorithms and assumptions used to estimate savings are reasonable.[4]

The deemed savings for the 13 watt CFLs are shown in Table 14 below. The baseline lamp is assumed to be a 60 watt incandescent.

Table 14. Ex Ante Savings and Parameters for CFLs

Program measure	kWh savings	Non-coincident kW savings	Coincident kW savings	Coincidence factor	Average baseline wattage	EE wattage	Average daily hours of use
13 watt CFL	40.7	0.0469	0.0038	0.081	55.33	13	2.89

Navigant was able to trace all of these findings to the previous EM&V report provided by Duke Energy. The impacts were calculated using the following algorithms:

Equation 1. Energy Savings Algorithm for CFLs

$$kWh\ savings = ISR\ x \left[\frac{(Watts_{base}\ x\ HOU_{base}) - (Watts_{EE}\ x\ HOU_{EE})}{1000}\right] x\ 365\ x\ HVAC_C$$

Equation 2. Coincident Demand Savings Algorithm for CFLs

$$kW\ savings^5 = ISR\ x \left[\frac{Watts_{base} - Watts_{EE}}{1000}\right] x\ CF\ x\ (1 + HVAC_d)$$

Where the parameters are defined as:

- ISR = in-service rate
- $Watts_{base}$ = wattage of baseline lamp removed
- $Watts_{EE}$ = wattage of CFL lamp installed
- HOU_{base} = daily operating hours of baseline lamp removed
- $HOUs_{EE}$ = daily operating hours of CFL lamp installed
- $HVAC_C$ = HVAC interaction factor for energy
- $HVAC_D$ = HVAC interaction factor for demand
- CF = coincidence factor

[4] *Process and Impact Evaluation of Duke Energy's Residential Smart $aver: Property Manager CFLs in the Carolinas*, TecMarket Works, 2013.

[5] To calculate winter coincident demand savings, the HVAC interaction factor, $HVAC_d$, is subtracted instead of added. This conservative assumption accounts for a mix participants who will have electric heat pumps for heating, as well as those who may use auxiliary electric heating to supplement gas during winter coincident peak periods.

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For water measures, the deemed savings for DEP were based on Navigant's recent EM&V of water measures in the DEC, so little review was needed.[6]

4.2.2 Onsite Field Verification

Navigant performed onsite field verification at 123 housing units across 16 properties. 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 15 shows a summary of the parameters assessed by Navigant during field verification, and Table 16 shows the field verification sample.

Table 15. Parameters Evaluated During Field Verification

	CFLs	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 16. Field Verification Sample

Program Measure	Number of Housing Units in Sample[a]	Number of Measures Reported in Sample
CFLs	123	1,181
Bathroom Faucet Aerators	73	97
Kitchen Faucet Aerators	76	76
Showerheads	76	91
Pipe Wrap	31	162 ft

a. Totals exceed 123 because many sites had multiple measures

Source: Navigant analysis

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

[6] Please refer to Navigant's report, titled "Multifamily Energy Efficiency Program, Evaluation, Measurement, and Verification for Duke Energy Carolinas", dated 11-3-15 for more information.

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4.2.3 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 Compact Fluorescent Light Bulbs

Table 17 shows a summary of Navigant's ex-post, verified findings for CFLs. The energy savings per bulb decreased from the 40.7 kWh provided in the deemed savings to 26.8 kWh. To calculate verified energy and demand impacts, Navigant assessed the parameters that were used in the algorithms to estimate ex-ante savings. Table 18 lists all parameters used to calculate ex-post savings.

Table 17. Summary of CFL findings

	Ex-Post	Ex-Ante
In-Service Rate[1]	84.6%	94.7%
Daily Operating Hours	1.93	2.89
Gross Energy Savings Per Bulb (kWh)	26.8	40.7
Gross Summer Coincident Demand Savings Per Bulb (kW)	0.0039	0.0038
Gross Winter Coincident Demand Savings Per Bulb (kW)	0.0050	N/A

1. *Navigant did not account for vacant housing units, so the actual number of CFLs in use may be lower.*
Source: Navigant analysis

Table 18. Calculation parameters for ex post CFL impacts

Program measure	ISR	Average baseline wattage	EE wattage	Average daily hours of use for baseline lamps[a]	Average daily hours of use for CFLs[a]	Summer coincidence factor	Winter coincidence factor	Energy HVAC interaction factor[b]	Demand HVAC interaction factor[b,c]
13 watt CFL	84.6%	60	13	1.93	1.93	0.082	0.32[d]	0.96	0.21

a. Includes self-report bias correction factor from TecMarket Works and Building Metrics. "Duke Energy Residential Smart $aver® CFL Program in North Carolina and South Carolina". February 15, 2011. Pg. 35.
b. Sourced from 2016 Mid-Atlantic TRM
c. The demand HVAC interaction factor is added for summer coincident demand impacts, and subtracted for winter. Navigant also adjusted the interaction factor for winter demand to account for 50% of participants having gas heating per the 2013 Duke Energy Residential Appliance Saturation Survey.
d. Source: *Coincidence Factor Study, Residential and Commercial & Industrial Lighting Measures*, prepared for: New England State Program Working Group

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4.3.1.1 In-Service Rate

At the 123 housing units inspected by Navigant that had CFLs, there were a total of 1,181 reported program CFLs in the tracking database. During the inspections, Navigant found 844 CFLs. Additionally, during phone surveys with tenants, Navigant interviewed customers representing an additional 1,186 CFLs. Thirteen of the phone survey respondents indicated they had removed a total of 41 CFLs. The predominant reason for removing CFLs was burnout. Navigant used a weighted average to combine the ISR from field verification with the ISR from phone surveys to calculate a final ISR.[7]

4.3.1.2 Wattage

Navigant assessed the wattage of CFLs inspected during the onsite verification and found them to be 13 watts as reported. However, there is potential uncertainty in the wattages of lamps removed during the retrofit process, or at least whether that wattage should be the baseline going forward. The time period covered by this evaluation is January of 2014 through February of 2016. The Energy Independence and Security Act (EISA) of 2007 established that as of January 1st, 2014, 60 watt incandescent bulbs could no longer be manufactured or imported. The new, EISA compliant wattage was 43. However, Navigant's experience has shown that there was considerable lag between the EISA compliance schedule and actual market activity, and potential back stocking of incandescents by multifamily maintenance staff. Because Duke Energy's Multifamily Energy Efficiency Program is a retrofit program (rather than replace on burnout), it is important to consider the actual characteristics of the lamps removed because they likely had remaining useful life. Franklin Energy has indicated that they only remove incandescent lamps during the retrofit process.

Figure 2 shows the results of customer self-reporting from tenant phone surveys with regards to the wattage of lamps removed during participation in the program. It can be seen that a large number of respondents were not sure, but more than half (51 percent) of respondents indicated that the lamps were 60 watts or higher. Additionally, during Navigant's field verification efforts, seven tenants were able to recall the lamps removed, and all seven indicated they were 60 watt incandescents. High rates of tenant turnover at multifamily housing units could explain why so many customers did not know what type of lamps were removed.

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[7] The weighted results reflect a total of 1,989 verified CFLs out of a sample of 2,367. Navigant used the same approach to calculate ISRs during our 2015 evaluation of this program in DEC. We believe that combining the results from field and phone verification effectively increases the sample size, and helps to control for the extended time period covered by this evaluation by incorporating participant input and field observations.

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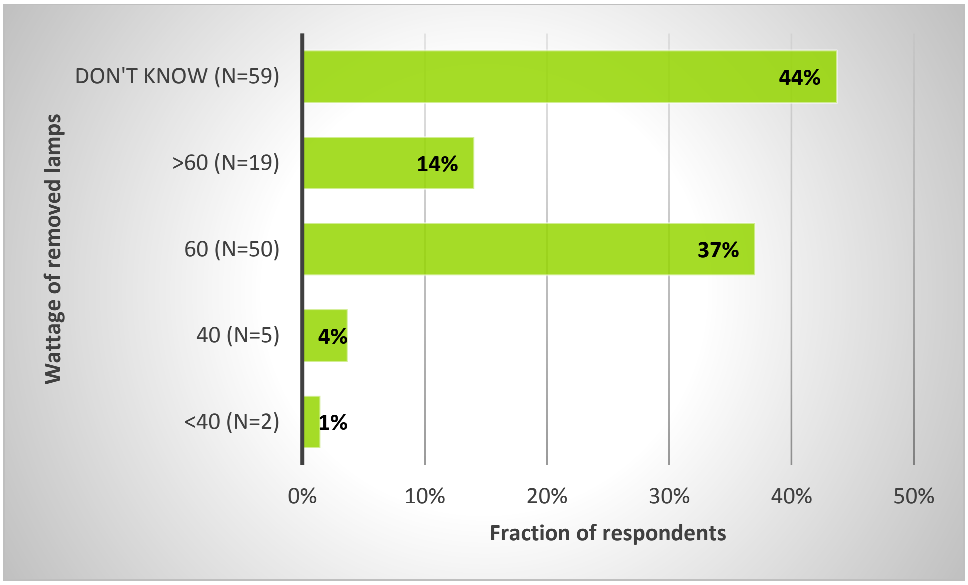
Figure 2. Customer self-reporting of wattage of lamps removed



Given that the period of time covered by this evaluation coincides with important EISA compliance dates that may have experienced a lag in market uptake, along with the results shown in Figure 2, Navigant believes that a baseline wattage assumption of 60 watts was appropriate for this evaluation cycle. However, as will be discussed later in this report, Navigant suggests further research be conducted to understand the lighting baseline for future evaluation cycles.

4.3.1.3 HVAC Interaction and Coincidence Factors

Navigant reviewed the ex-ante assumptions for HVAC interaction factors and summer coincidence factors and chose to replace them with updated values from the 2016 Mid-Atlantic TRM. For a winter coincidence factor, Navigant used a secondary literature source.[8]

4.3.1.4 Lighting Hours of Use

The hours of use for CFLs are an important parameter input to the energy savings algorithm, however the scope and budget of this evaluation did not support a full metering study to quantify operation hours. Navigant assessed the lighting operation hours via the following methods:

1. Collected self-report data from program participants during tenant phone surveys
2. Performed extensive review of the previous estimates for deemed savings
3. Performed a literature review to assess estimates from secondary sources

[8] RLW Coincidence Factor Study for New England State Program Working Group, https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/116_RLW_CF%20Res%20C&I%20ltg.pdf

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4. Applied self-report bias correction factor from previous study completed for Duke Energy

Navigant collected self-reported hours of use estimates from participants during the tenant phone surveys with 150 participants. The average self-reported estimate was 2.64 hours per day. Navigant recognizes that significant uncertainty exists in customer ability to estimate hours of use. For that reason, the evaluation team compared the self-report estimate of 2.64 with other sources.

Table 19 shows a comparison of estimated CFL operating hours from several sources. Navigant applied a self-reporting bias correction factor of 0.73 (a 27 percent reduction) to the self-reported operating hours, for a final value of 1.93 hours per day. The bias correction factor was sourced from a previous study completed for Duke Energy.[9]

Table 19. Comparison of CFL Operating Hours

Estimated Daily CFL Usage Hours	Method	Source
2.89	Metering Study	TecMarket Works, previous EM&V study for Property Manager CFL Program for Duke Energy[10]
2.21	Metering study	Navigant metering study for similar multifamily program in Southwestern U.S.
1.5-1.6	Meta data analysis	U.S. Department of Energy *Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates* (2012)[11]

Source: Navigant analysis

4.3.1.5 Effect of Baseline Wattage Requirements for EISA

It is important to address the topic of CFL baseline in more detail. The Energy Independence and Security Act (EISA) was enacted to increase the availability of reduced wattage lighting options, and hence shift the lighting market toward higher efficiency. In theory, this would eventually cause the program CFL baseline to eventually shift to a lower wattage as 60 watt incandescents become less-prominent. There is still uncertainty around what the exact baseline is in Duke Energy's service territories.

Navigant believes that EISA standards should be applied to new construction applications or replace-on-burnout scenarios. However, the Multifamily Energy Efficiency Program is primarily a direct install retrofit program targeting existing homes where the existing lamps likely have remaining useful life. The program implementer requires that all lamps being removed are incandescents. Furthermore, some program participants have reported that the lamps removed were higher than 60 watts. Due to the

[9] TecMarket Works and Building Metrics. "Duke Energy Residential Smart $aver® CFL Program in North Carolina and South Carolina". February 15, 2011. Pg. 35.

[10] *Process and Impact Evaluation of Duke Energy's Residential Smart $aver: Property Manager CFLs in the Carolinas*, TecMarket Works, 2013.

[11] http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf

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changing market for residential lighting, Navigant suggests that further research be conducted in future evaluation years to assess the baseline.

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 20. These were calculated using a weighted average of results from the onsite field verification inspections and the tenant phone surveys.

Table 20. In-Service Rates for Water Measures

Measure	ISR
Kitchen aerators	94%
Bathroom aerators	92%
Showerheads	95%
Pipe wrap	93%

Source: Navigant analysis

4.3.2.2 Energy Savings

The deemed savings for water measures in DEP are based on a recent EM&V report by Navigant for DEC, which was completed in November of 2015. The evaluation team used a similar approach for DEP, but supplemented or replaced inputs with data gathered during field verification. To calculate verified savings for aerators and showerheads, Navigant used a standard engineering equation taken shown in Equation 3, Equation 4, and Equation 5. Navigant subsequently applied inputs collected during field verification or assumptions as listed below in Table 21. The resulting estimates for impacts of aerators and showerheads are presented in Table 22.

Equation 3. Algorithm for Estimating Energy Savings for Faucet Aerators

$$kWh\ savings\ for\ faucet\ aerators = ISR\times\left[\frac{(GPM_{base}-GPM_{low})\times T_{home/day}\times 365\frac{days}{yr}\times DF\times(T_{out}-T_{in})\times 8.3\frac{Btu}{gal\cdot{}^{\circ}F}}{\#_{faucets}\times 3412\frac{Btu}{kWh}\times RE}\right]$$

Equation 4. Algorithm for Estimating Energy Savings for Low Flow Showerheads

$$kWh\ savings\ for\ low\ flow\ showerheads = ISR\times\left[\frac{(GPM_{base}-GPM_{low})\times T_{home/day}\times N_{showers/day}\times 365\frac{days}{yr}\times(T_{out}-T_{in})\times 8.3\frac{Btu}{gal\cdot{}^{\circ}F}}{\#_{showers}\times 3412\frac{Btu}{kWh}\times RE}\right]$$

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Equation 5. Algorithm for Estimating Coincident Demand Savings for Aerators and Showerheads

$$\Delta kW_{peak} = \Delta kWh/yr \times CF/365$$

Table 21. Input Parameters and Assumptions for Aerator Savings Calculations

Input	Definition	Value	Source
ISR	In-service rate	Refer to Table 20	Navigant field verification and phone surveys
GPM_{base}	Baseline flow rate	Aerators 2.2 Shower 2.5	Deemed savings assumptions from Duke Energy
GPM_{low}	Retrofit flow rate	Aerators 1 Shower 1.5	Deemed savings assumptions from Duke Energy[a]
$T_{home/day}$	Avg hot water use per day per home (minutes)	Kitchen 4.7 Bath 2.4 Shower 8.4	Building America Benchmark
$N_{showers/day}$	Number of showers per person per day	1	Navigant assumption
DF	Percent of water going down drain	Kitchen 75% Bath 90%	Navigant assumption
T_{out}	Temp of water flowing from faucets (F) Temp of water flowing from showerheads (F)	90[b] 105	Navigant field verification 2016 Mid-Atlantic TRM
T_{in}	Temp of water entering water heater (F)	66	Navigant field verification
#faucets/showers	Number of faucets in home (used to distribute minutes of use between different faucets)	Kitchen 1 Bathroom 1.33 Shower 1.2	Navigant field verification
RE	Recovery efficiency of water heater	0.98	Ohio TRM
CF (aerators)	Coincidence Factor	Summer 0.048 Winter 0.042	Building America Benchmark
CF (showerheads)	Coincidence Factor	Summer 0.03 Winter 0.118	Building America Benchmark

a. *Navigant measured flow rates during onsite field verification and they were lower than the reported flow rates for the measures installed. However, this was likely due to calcification or water pressure characteristics and suggests that baseline flow rates may also have been lower. Because we did not measure flow rates for baseline units, we chose to use the reported flow rates in both cases.*

b. *The actual measured hot water temperature was 109F. For analysis purposes, Navigant assumed that customers use water at a temperature of 90 degrees, or the average of 109F and 70F.*

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Table 22. Verified Estimates of per Unit Impacts for Aerators and Showerheads[12]

Measure	Annual Energy Savings per Unit (kWh)		Annual Summer Coincident Demand Savings per Unit (kW)		Annual Winter Coincident Demand Savings per Unit (kW)	
	Ex Post	Ex Ante	Ex Post	Ex Ante	Ex Post	Ex Ante
Kitchen aerator (1.0 GPM)	86	91	0.0114	0.0120	0.0099	0.010
Bathroom aerator (1.0 GPM)	40	43	0.0052	0.006	0.0045	0.005
Low flow showerhead (1.5 GPM)	237	232	0.0195	0.0190	0.0765	0.0750

Source: Navigant analysis

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 cold water pipes.[13] 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 2016 Mid-Atlantic TRM shown in Equation 6 and Equation 7 below.[14] The ex-post impacts are shown in Table 23.

Equation 6. Energy savings for water heater pipe wrap

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

Equation 7. Demand savings from water heater pipe wrap

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

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

R_e = R-value of existing, uninsulated pipe (R = 1)
R_n = insulation R-value of pipe after retrofit (R = 2.5)
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)
3413 = conversion from Btu to kWh

[12] The program offers aerators and showerheads at other flow rates. 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 22, so a verified savings are shown here for only those measures. A full list of savings is shown in Section 9

[13] http://www.energy.gov/energysaver/projects/savings-project-insulate-hot-water-pipes-energy-savings

[14] http://www.neep.org/mid-atlantic-technical-reference-manual-v6

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Table 23. Verified Impacts for Water Heater Pipe Wrap

Measure	Annual Energy Savings per Unit (kWh)	Annual Summer Coincident Demand Savings per Linear Foot (kW)	Annual Winter Coincident Demand Savings per Linear Foot (kW)
Ex Post	67	0.0077	0.0077
Ex Ante	37	0.0030	0.0030

Source: Navigant analysis

4.3.4 Measure Life

Navigant reviewed the measure life assumptions for all program measures and compared them to other sources from secondary literature research. The evaluation team believes all program measure lives are appropriate and not in need of an update.

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5. NET-TO-GROSS ANALYSIS

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

Table 24. NTG Results

Estimated Free Ridership	7.5%
Estimated Spillover	2.0%
Estimated NTG	0.94

Source: Navigant analysis

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.[15] 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.

[15] 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.

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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 8:

Equation 8. 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.

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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.[16] 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. If they would have installed at the same time as they did, they received a timing multiplier of 1; within one year, a multiplier of 0.67; and between one and two years, a multiplier of 0.33. Participants were also asked when they learned about the financial incentive; if they learned about it after the equipment was installed then they received a timing multiplier of 1.

5.1.3 Estimating Spillover

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

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

[16] 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).

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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.[17]

5.1.4 Combining Results Across Respondents

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

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

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

5.2.1 Review of Data Collection Efforts for Attribution Analysis

Surveys were conducted with decision makers to provide the information to estimate free ridership, and thus, NTG ratios. A total of 21 property managers were surveyed. These 21 property managers managed 39 total properties in the program. This sample represents about 10 percent of the total reported energy savings, as shown in Table 25.

Table 25. Property Manager Sample Representation

	Program Total	Sample Total	% of Program
Properties	449	39	9%
CFLs	418,121	39,942	10%
Bathroom faucet aerators	28,710	2,737	10%
Kitchen faucet aerators	18,862	1,948	10%
Showerheads	24,743	1,964	8%
Pipe wrap (ft)	73,338	10,189	14%
Total Energy Savings			**10%**

Source: Navigant analysis

5.2.2 Free Ridership Results

[17] 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.

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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 7.5 percent, which is a relatively low value as anticipated by Navigant.

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 did not have any prior plans for installing any of the energy efficient measures. The other seven respondents indicated that they did have plans, but for the most part, their plans were not very far along. These results indicate low free ridership.

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. Twelve respondents stated they "definitely would not have" installed the measures in the absence of the program, and six said they "may have".

Timing: 11 of 21 respondents stated they would have done the installation within two years or less in the absence of the program. The other 10 stated they would have done the installation after two years or never if not for the program. These findings are suggestive of low free ridership.

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, but their plans were not very far along.

5.2.3 Spillover Results

Three of the 21 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 LEDs in outdoor or common spaces, attic insulation, and water heater insulation wraps. In addition to the three property managers reporting spillover, eight tenants reported installing a small number of LEDs and other efficient lights after 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 2.0 percent.

5.2.4 NTG Results

The NTG ratio was calculated as written in Equation 9:

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Equation 9. Net-to-Gross Ratio

$$NTG = 1 - free\ ridership + spillover = 1 - 0.075 + 0.0197 = 0.9447$$

This suggests that for every one kWh reduced from program measures, about 0.94 kWh of savings can be directly attributed to the program.

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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 21 property managers representing 39 properties, an interview with the Duke Energy Program Manager, 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.
- Over 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.
- 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
- 75 percent of DEP tenants and 83 percent of DEC tenants noticed savings on their energy bills since the installation of the measures.
- 55 percent of tenants stated that the program CFLs were installed in the light fixtures used most in the home. Incandescent bulbs were listed as the most commonly removed type of bulb.
- 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”:
    - Over 65 percent of participants indicated 8-10 for satisfaction with the overall program
    - Over 80 percent of participants indicated 8-10 for satisfaction with the installer’s quality of work
    - Over 70 percent of 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.
- Satisfaction was higher for CFLs than for showerheads and aerators.
- During the tenant phone surveys, several participants expressed dissatisfaction with the low water pressure in their showers and sinks. Additionally, some 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.

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6.3 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 twenty-one property managers who were responsible for 39 properties representing over 56,000 measures or 10% of the program measures.

Overall, property managers indicated that their experience with the program was very favorable. Some key findings from the property manager interviews are listed below:

- Property managers expressed high satisfaction with the free program measures and free installation by an external contractor. Property manager's noted the contractor's quality of work as "well done and professional" and "impressive."
- Over 60% of property managers responsible for their energy bills noticed a decrease in the property energy bills since participating in the program.
- Over 95% 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:
  - "The program made it happen, otherwise it never would have."
  - "The program made it easy, so why not do it."
  - "[Duke Energy] did all the work and we just made the appointments available to get the efficient measures installed. Overall the cost and the work was done quickly."
  - "I didn't have to do anything. We just scheduled the appointment and they just came and did the installs."
  - "[I] saw that it would save move – just the electricity costs and everything it just made sense."
- One property's maintenance staff communicated that after 90 days, over 40% of the installed showerheads started leaking due to dirt buildup. The maintenance staff was able to clean the showerheads after discovering the root problem.
- One property's maintenance staff indicated that some tenants are confiscating program lightbulbs, showerheads, and aerators upon apartment turnover.
- A small number of property managers stated that they were not satisfied with the responsiveness of program staff if any rescheduling or additional follow-up work was needed.
- General suggestions for program improvement from property managers and maintenance staff include adding the following measures/material to the program: window weather stripping, outside or porch lights, and a reminder sticker below the thermostat to display a suggested air conditioner temperature.

6.4 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.

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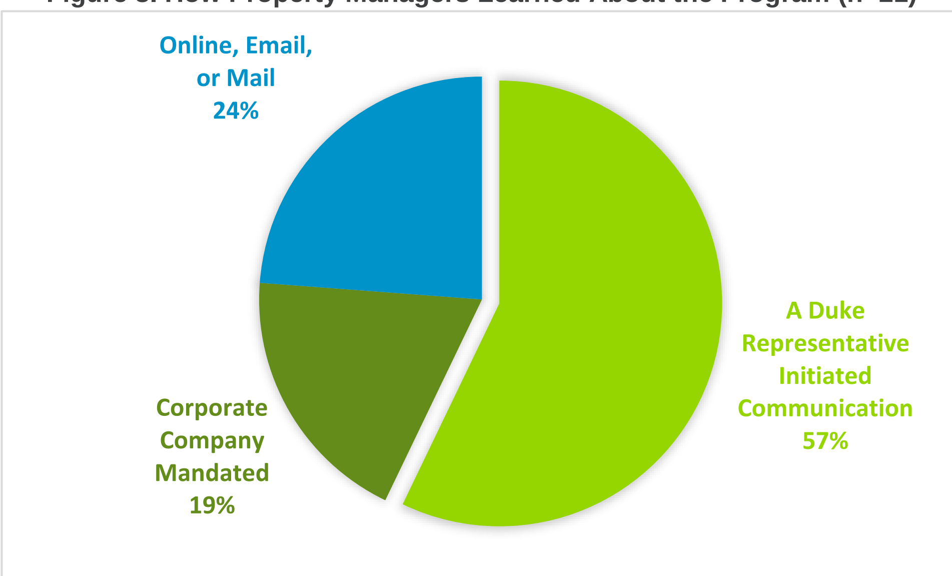
Table 26 and Figure 3 show how tenants and property managers learned about the program, respectively. Tenant participants were asked to indicate all of the sources through which they learned about the program, and about 70 percent indicated they had learned about the program through property managers as would be expected given the program model. Tenants also indicated having received notice via a Duke Energy mailing or bill stuffer. Property managers indicated that they were approached in-person by a program representative, or received a mail or email with program details.

Table 26. How Tenants Learned About the Program

How Tenants Learned About the Program (n=150)	
Through property manager	70%
Duke Energy mailing or bill stuffer	13%
Duke Energy website	5%
Through family, friend or neighbor	4%
Marketing by trade ally, vendor or contractor	1%
Duke Energy email	1%
Don't Know	6%

Source: Navigant analysis

Figure 3. How Property Managers Learned About the Program (n=21)



Source: Navigant analysis

6.5 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

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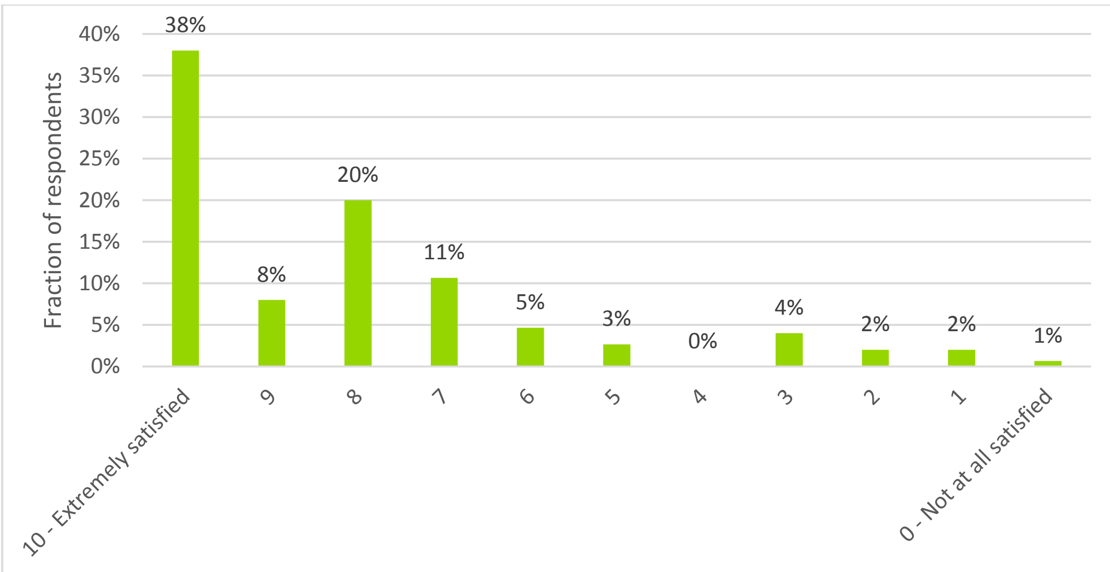
with new equipment, as well as questions to assess measure baseline and any measures removed by the tenant after participation.

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," two-thirds of customers rated satisfaction with the program as an 8-10 as shown in Figure 4. Participants who ranked their overall satisfaction low did so because they disliked the products or did not experience any energy savings. This chart includes data from both DEP and DEC territories as there were no significant satisfaction differences.

Figure 4. Tenant Satisfaction with Overall Program Experience (n=150)



Source: Navigant analysis

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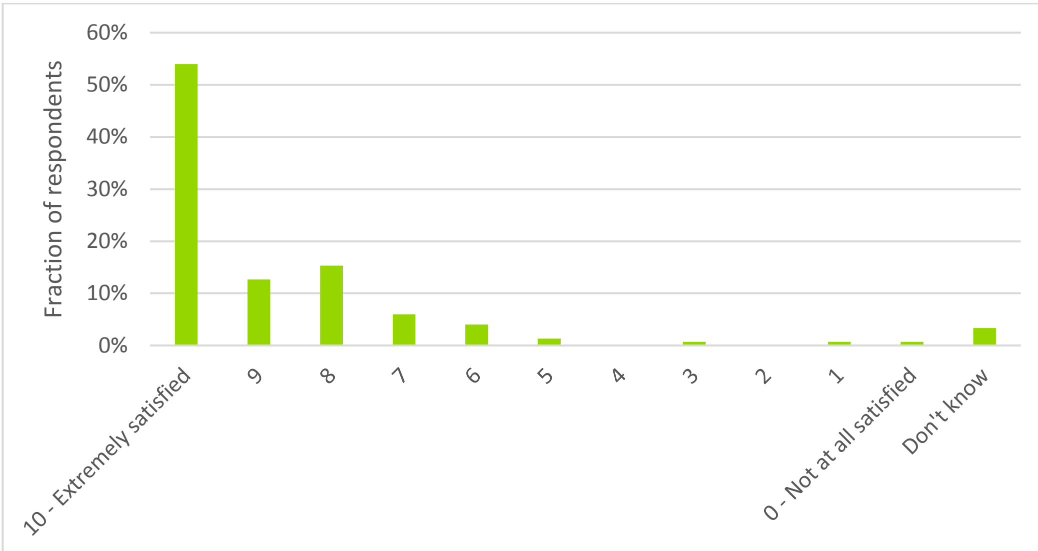
Customer satisfaction with the contractor quality of work was also high, as shown by Figure 5.

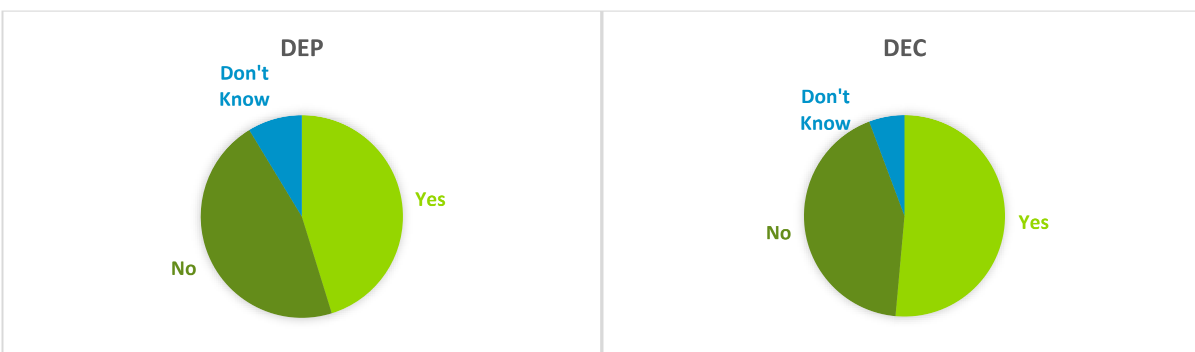
Figure 5. Tenant Satisfaction with Contractor's Quality of Work (n=150)



Source: Navigant analysis

As shown in Figure 6, about half of participants noticed a decrease in their energy bills after the new measures were installed.

Figure 6. Participants Who Noticed a Decrease in Their Energy Bill After Installing Program Measures (n=150)



Source: Navigant analysis

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 8.09 out of 10 for Pipe Wrap, to as low as 6.97 out of 10 for bathroom faucet aerators as shown in Figure 7.

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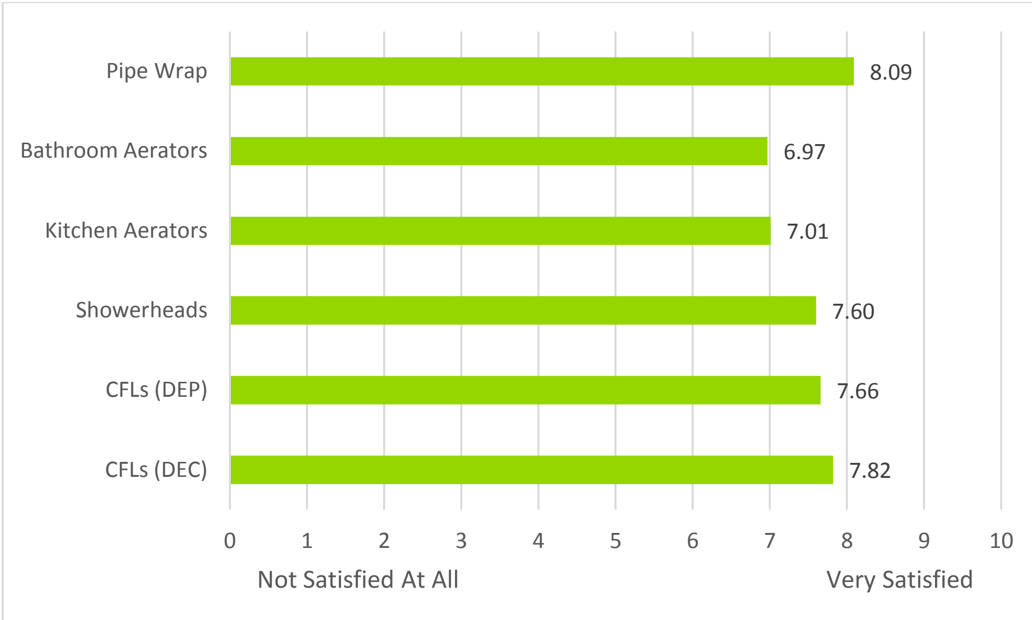
Figure 7. Tenant Satisfaction Rating for Each Measure (n=150)



Source: Navigant analysis

A small percentage of tenants removed the installed measure as shown in Figure 8. In the DEC territory, 100 percent of the CFLs removed by tenants were bulbs that had burned out. In the DEP territory, 57 percent of the CFLs removed by tenants were due to burnout, and the remainder were removed due to poor product quality. Participants indicated they removed bathroom faucet areators because of poor water pressure. Showerheads and kitchen faucet areators were removed because of leakage or excess water spray.

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Figure 8. Participants Who Removed Any Installed Measures

Source: Navigant analysis

6.5.1.1 Participant Suggestions

Navigant also included a question in the tenant satisfaction survey that allowed respondents to offer suggestions for improving the program. One-fourth of the respondents offered suggestions, which were as follows:

- Several respondents asked for a better quality of equipment, including the quality of CFLs, showerheads, and aerators
- Several participants asked for better notification of installation date and time
- Two participants requested LEDs instead of CFLs
- One respondent requested offering motion sensors

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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:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

Date:	June 27, 2017
Region:	Duke Energy Progress Duke Energy Carolinas
Evaluation Period	DEP 1/1/15 – 2/29/16 DEC 1/1/14 – 2/29/16
Annual kWh Savings	DEP 19,938,742 DEC 4,806,786
Per Participant kWh Savings	DEP 753 DEC 219
Net-to-Gross Ratio	0.94

Evaluation Methods

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

Impact Evaluation Details

- **Field inspections were conducted at 123 housing units.** The evaluation team inspected program equipment at 123 housing units to assess measure quantities and characteristics to be compared with the program tracking database.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 85% for CFLs to 95% for low flow showerheads.
- **Participants achieved an average of 753 kWh of energy savings per year in DEP, and 219 kWh in DEC.** The evaluation for DEC only included lighting measures, whereas the evaluation for DEP included lighting and water measures. Therefore, the two should not be compared directly.
- **The type of lamp removed during retrofit that was most commonly reported by participants was 60W incandescents.** Of the tenants who could recall what type of lamps were removed during lighting retrofits, the majority reported 60W incandescents. The evaluation team believes that evaluation periods covering dates beyond the end of this cycle will include a lower baseline wattage for retrofitted lamps.

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8. CONCLUSIONS AND RECOMMENDATIONS

Navigant's findings in this report suggest that Duke Energy's Multifamily Energy Efficiency Program is being delivered and tracked effectively in the DEC and DEP jurisdiction. Customer satisfaction is generally high, and the program measure installations appear to be tracked appropriately. Navigant presents the following list of recommendations that may help improve program delivery and impacts:

1. **Navigant recommends that Duke Energy should adopt the per-unit energy and demand impacts from this evaluation and use them going forward.** The engineering analysis and data collection described in this report provide support for updating the estimated impacts for each program measure. Duke Energy should consider additional research to investigate the baseline for CFLs for future evaluation cycles.
2. **Navigant recommends that no more than the first three feet of cold water inlet pipes be insulated for the water heater pipe wrap measure.** The U.S. Department of Energy recommends only insulating the first three feet of cold water inlet pipes. Beyond that, savings are likely negligible. During field verification, Navigant found that over half of the reported water heater pipe wrap was installed on cold water pipes (with just under 10 percent of those installations greater than three feet on the cold water heater pipes).
3. **Duke Energy should consider adding LEDs to the program.** Because of EISA, the baseline for the 13 watt CFL measure will eventually reach 40 watts instead of 60 watts. This will diminish the cost-effectiveness of program CFLs. LED options may provide increased savings and improved customer satisfaction.

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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 27 provides the measure-level inputs that can be used by Duke Energy Analytics for estimates of future program savings. Impacts for water measures apply to the DEP jurisdiction only, whereas impacts from CFLs apply to both DEP and DEC.

Table 27. Gross Measure-Level Impacts

Measure	Annual Energy Savings Per Unit (kWh)	Annual Summer Coincident Demand Savings Per Unit (kW)[1]	Annual Winter Coincident Demand Savings Per Unit (kW)[2]
Faucet Aerators MF Direct 0.5 GPM - bath	55.99	0.007	0.006
Faucet Aerators MF Direct 1.0 GPM - bath	39.52	0.005	0.005
Faucet Aerators MF Direct 1.0 GPM - kitchen	86.40	0.011	0.010
Faucet Aerators MF DIY 0.5 GPM - bath	45.46	0.006	0.005
Faucet Aerators MF DIY 1.0 GPM - bath	32.09	0.004	0.004
Faucet Aerators MF DIY 1.0 GPM - kitchen	68.98	0.009	0.008
LF Showerhead MF Direct 0.5 GPM	473.56	0.039	0.153
LF Showerhead MF Direct 1.0 GPM	355.17	0.029	0.115
LF Showerhead MF Direct 1.5 GPM	236.78	0.019	0.077
LF Showerhead MF DIY 0.5 GPM	374.70	0.031	0.121
LF Showerhead MF DIY 1.0 GPM	281.03	0.023	0.091
LF Showerhead MF DIY 1.5 GPM	187.35	0.015	0.061
Pipe Wrap MF Direct	67.03	0.008	0.008
Pipe Wrap MF DIY	54.08	0.006	0.006
13W CFLs	26.80	0.004	0.005

1. *The summer coincident period for DEP and DEC is defined as weekdays in July, hour ending 17.*
2. *The winter coincident period for DEP and DEC is defined as weekdays in January, hour ending 8.*

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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 21 property managers. As shown in Table 25, the sample of 21 property managers represented 39 properties. This section presents details of the interviews. The responses to each question shown are paraphrased to maintain confidentiality and summarize the key points.

Table 28. How did you learn about the Duke Energy Multifamily Energy Efficiency Program?

Respondent(s)	Response
1,2,5,7,10-12,14,16-18,21	Duke Energy online, mail or email
3,4,6,9	Corporate company mandated
8,13,15,19,20	Approached by a program representative

Source: Navigant analysis

Table 29. What were the primary reasons to participate in the program?

Respondent(s)	Response
1,7,10,	Energy Efficiency
3,4,14	Corporate mandated
5,8,9,12,13,15,18,21	To save money
2,6,11,16,17,19,20	To savings water cost for tenants

Source: Navigant analysis

Table 30. 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
1-4,7,9-12,14,18,20	10
5,20	9
13,16,17,19	8
8	7
6	5

Source: Navigant analysis

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Table 31. 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
3,4,6,10-12,14,16,18,21	10
1,2,5,7,15,20	9
8,9,13	8
19	7
17	5

Source: Navigant analysis

Table 32. 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
1,3,12	10
2,10,14	9
5-7,9,11,16,17,21	8 – because some of the tenants prefer the incandescent light bulbs because of look and color, but most really like the CFLs
8,15,19	7 – the kitchen aerators and showerheads are leaking and breaking, requiring equipment repairs
4,13,20	6
18	5 – water measures cut down water pressure noticeably

Source: Navigant analysis

Table 33. 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
1,7,9-12,14, 16,18,20,21	10
2,15,19	9
4,5	8
3,6,8,13,17,	7

Source: Navigant analysis

Table 34. Prior to participating in the program, had you considered installing the same energy efficient equipment at your facility?

Respondent(s)	Response
1-6,8,10-15,19	No
7, 16-18,20	Yes

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9	Yes – for lighting measures, not the water measures
21	Yes, they considered installing CFLs and the water measures to save on energy bills

Source: Navigant analysis

Table 35. 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
1-4,6,9,11-20	No
5	Yes, installing LED
7	Yes, remodeling apartments
8	Yes, installed more energy efficiency exterior lighting
21	Yes, insulation blankets on water heaters, insulation on attic, and caulked windows at multiple properties

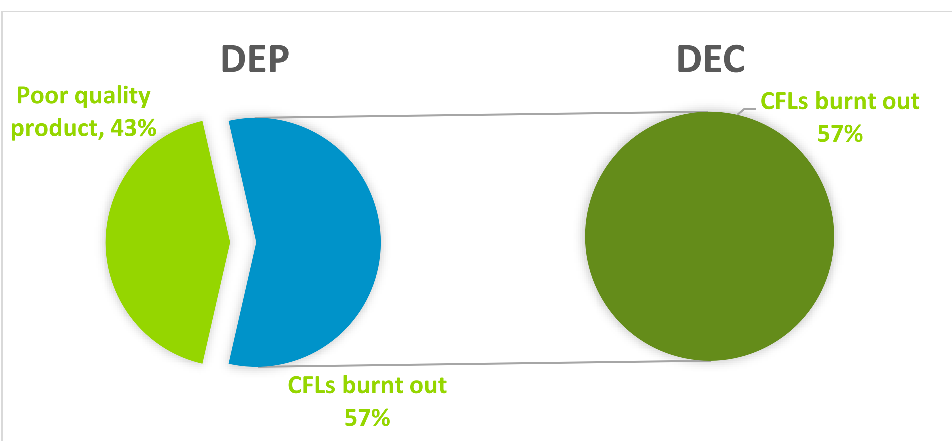
Source: Navigant analysis

A.2 Tenant Satisfaction Surveys

Satisfaction surveys were conducted with 150 program participants. Many of the results are presented in Section 6.5 of the main report, and this section serves as a supplement.

Figure 9 shows the reasons why tenants removed CFLs, the most common being burnout. For water measures, the most common reason for removal was low water pressure and leakage, although fewer measures had been removed.

Figure 9. Reasons Why Tenants Removed CFLs (DEP = 7; DEC=3)



Source: Navigant analysis

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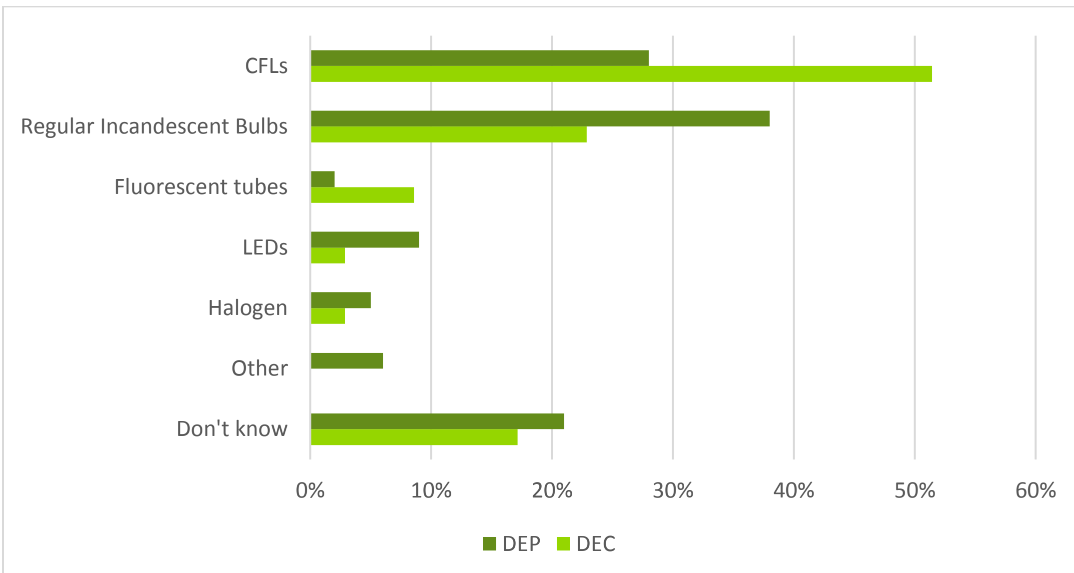
Figure 10 shows the types of light bulbs that tenants reported as being installed in the non-retrofitted fixtures in their homes. For the DEC territory, an important supplement to this figure is that just under 90 percent of tenants reported that program CFLs were installed in the fixtures used most in their homes, which demonstrates that the program is effective in reaching the fixtures with greatest savings potential. For the DEP territory, just under 50% of tenants reported that CFLs were installed in fixtures that are used most in the home. Additionally, for the DEP jurisdiction 60 percent of tenants reported that they were very likely to install CFLs in their home in the future; for the DEC jurisdiction 77 percent of tenants indicated they were very likely to purchase CFLs in the future.

Figure 10. Type of Bulbs Found 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 8.05 on a scale of 0 to 10 with 10 as very satisfied. However, ten of the 150 tenants reported a satisfaction of five or less with the program for the following reasons:

- No money savings (n=7)
- Dislike products (n=1)
- Mandated program participation by property management (n=1)

Tenants also reported a few suggestions for improving the program:

- Improve the kitchen faucet aerator (n=4)
- Improve the quality of products (n=3)
- Improve the quality of CFLs (n=3)
- Provide LEDs instead of CFLs (n=2)
- Provide participants a discount (n=1)
- Offer motion sensors (n=1)

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Duke Energy Carolinas Smart $aver® Prescriptive Incentive Program

July 17, 2016

Revised August 4, 2017

Evaluation, Measurement, & Verification Report

The Cadmus Group, Inc.

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Executive Summary

Duke Energy Carolinas (DEC) engaged Cadmus to perform an impact evaluation of the Smart $aver® Prescriptive Incentive Program (Prescriptive Program).

Cadmus performed engineering desk reviews on the work papers describing deemed energy and demand saving calculation methodologies for a sample of measures. We adjusted the per-unit energy and demand saving estimates, as necessary, and applied the updated values to all participants in each reviewed measure for the evaluation period. Finally, we calculated a lighting and non-lighting net-to-gross (NTG) ratio based on the results of process evaluation surveys and calculated net energy and demand saving estimates for the measures reviewed.

This evaluation period was January 2013 through July 2015. We included applications in this evaluation period according to the date on which DEC paid the incentive. Table 1 lists the measures reviewed as part of this evaluation.

Table 1. Summary of DEC Prescriptive Program Measures Reviewed

Measure Category	Evaluated Measure/Measure Group
Food Service	Electronically Commutated Motors (ECM) in Cooler, Freezer, and Display Cases
HVAC	Variable Frequency Drives (VFD) on HVAC Fans
	VFD on HVAC Pumps
Lighting	Linear Fluorescent High Bay Replacing High-intensity Discharge (HID) Fixtures
	High Performance Linear Fluorescents
	LED Lamps
	LED Downlights
Process	VFD on Process Pumps
	VSD on Air Compressors
Pump	High-Efficiency Pumps

Impact Evaluation Results

Table 2 shows the realization rate between the claimed and adjusted gross savings as well as the NTG ratio applied to the adjusted savings. Based on the desk review analysis of the ten measures sampled, Cadmus estimated realization rates ranging from 69% to 139%. We calculated an 86% NTG ratio for lighting measures and a 40% NTG ratio for non-lighting measures, resulting in a 78% NTG ratio for the program overall.

Cadmus' current impact evaluation covered only a selection of measures and the realization rates cannot be extrapolated to the entire Prescriptive Program. However, we selected the process evaluation survey sample from all measures in the program and categorized them based on whether they were lighting or non-lighting measures. Therefore, the calculated lighting and non-lighting NTG ratios are applicable to those respective measure categories.

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Table 2. Program Claimed, Adjusted, and Net Energy Impacts

Measure Category	Measure / Measure Group	Claimed Savings (kWh)	Realization Rate	Adjusted Gross Savings (kWh)	NTG	Net Savings (kWh)
Food Service	ECM Motors in Cooler, Freezer, and Display Cases	1,857,315	108%	2,013,547	40%	805,419
HVAC	VFDs on HVAC Fans	14,553,141	139%	20,236,854	40%	8,094,741
	VFDs on HVAC Pumps	5,480,481	69%	3,781,949	40%	1,512,779
Lighting	Linear Fluorescent High Bay	85,708,927	68%	58,154,366	86%	50,012,755
	High Performance Linear Fluorescent	17,420,130	85%	14,767,697	86%	12,700,220
	LED Lamps	16,471,533	118%	19,376,927	86%	16,664,158
	LED Downlights	2,025,100	120%	2,430,118	86%	2,089,902
Process	VFDs on Process Pumps	674,734	106%	713,460	40%	285,384
	VSDs on Air Compressors	1,543,273	93%	1,435,649	40%	574,260
Pump	High-Efficiency Pumps	121,749	129%	157,638	40%	63,055

Table 3 and Table 4 show the claimed and adjusted summer coincident peak (CP), and non-coincident peak (NCP) demand savings for the measures included in this evaluation.

Table 3. Program Claimed, Adjusted, and Net Summer CP Demand Impacts

Measure Category	Measure / Measure Group	Claimed Summer CP Savings (kW)	Realization Rate	Adjusted Gross Summer CP Savings (kW)	NTG	Net Summer CP Savings (kW)
Food Service	ECM Motors in Cooler, Freezer, and Display Cases	246	96%	236	40%	94
HVAC	VFDs on HVAC Fans	2,188	141%	3,086	40%	1,234
	VFDs on HVAC Pumps	799	42%	333	40%	133
Lighting	Linear Fluorescent High Bay	13,758	90%	12,327	86%	10,601
	High Performance Linear Fluorescent	4,404	75%	3,324	86%	2,859
	LED Lamps	4,028	100%	4,009	86%	3,448
	LED Downlights	495	104%	517	86%	445
Process	VFDs on Process Pumps	183	80%	147	40%	59
	VSDs on Air Compressors	371	62%	230	40%	92
Pump	High-Efficiency Pumps	26	123%	32	40%	13

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Table 4. Program Claimed, Adjusted, and Net NCP Demand Impacts

Measure Category	Measure / Measure Group	Claimed NCP Savings (kW)	Realization Rate	Adjusted Gross NCP Savings (kW)	NTG	Net Summer NCP Savings (kW)
Food Service	ECM Motors in Cooler, Freezer, and Display Cases	220	107%	236	40%	94
HVAC	VFDs on HVAC Fans	1,695	136%	2,310	40%	924
	VFDs on HVAC Pumps	603	72%	432	40%	173
Lighting	Linear Fluorescent High Bay	14,570	89%	12,976	86%	11,159
	High Performance Linear Fluorescent	3,568	71%	2,526	86%	2,173
	LED Lamps	4,476	116%	5,206	86%	4,477
	LED Downlights	550	122%	671	86%	577
Process	VFDs on Process Pumps	183	80%	147	40%	59
	VSDs on Air Compressors	371	62%	230	40%	92
Pump	High-Efficiency Pumps	33	123%	41	40%	16

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Table 5 provides the number of units per measure and the net energy and demand savings for each in the specified evaluation period.

Table 5. Per Unit Net Energy and NCP Demand Savings

Measure Category	Measure / Measure Group	Unit Count	Unit	NTG	Annual Adjusted Net Energy Savings Per Unit (KWh)	Adjusted Net NCP Demand Savings Per Unit (kW)
Food Service	ECM Motors in Cooler, Freezer, and Display Cases*	2,448	Per Motor	40%	329	0.04
HVAC	VFDs on HVAC Fans	10,592	Per Motor hp (horsepower)	40%	764	0.09
	VFDs on HVAC Pumps	1,976	Per Motor hp	40%	766	0.09
Lighting	Linear Fluorescent High Bay*	56,286	Per Fixture	86%	413	0.09
	High Performance Linear Fluorescent*	177,150	Per Fixture	86%	33	0.01
	LED Lamps	130,091	Per Fixture	86%	60	0.02
	LED Downlights	10,383	Per Fixture	86%	94	0.03
Process	VFDs on Process Pumps	705	Per Pump hp	40%	405	0.08
	VSDs on Air Compressors	2,595	Per Compressor hp	40%	221	0.04
Pump	High-Efficiency Pumps*	606	Per Pump hp	40%	104	0.03

* Savings are the average of the per-unit values provided in the work paper review section of the report.

Evaluation Parameters

The start and end dates for the review activities conducted for this impact evaluation were January 2013 to July 2015 for all measure groups.

Conclusions and Recommendations

Cadmus found the DEC Prescriptive Program work papers to be generally clear and well-documented. Cadmus made adjustments to work paper savings based on advancements in energy-efficient technologies, release of third-party field study results, and applicable codes and standards during the evaluation period.

Overall, Cadmus recommends that DEC perform verification on a representative sample of installed measures for an accurate *ex post* saving estimate in the next evaluation. Additionally, future program

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tracking may be improved significantly by tracking measure saving parameters (such as hp rating of motors) consistently, as well as by removing measure descriptions with generic base cases (when savings should be distinguished by base case). Detailed recommendations for future program tracking by measure is provided below.

Conclusion 1. For the ECM motors measure group, the size of the motors being replaced vary greatly; there is up to five times difference between the hp rating of the smallest and largest motors. The actual savings for a group of motors will vary widely based on the proportion of various sizes in the tracking database population.

Recommendation 1. Calculate refrigeration ECM motor savings on a per hp basis rather than a per motor basis.

Conclusion 2. For the VFDs on HVAC pumps measure, a recently completed metering study for Northeast Energy Efficiency Partnerships (NEEP) showed that there is a large variation in the amount of savings depending on what type of HVAC pump the VFD is installed on. For a VFD installed on a cooling water pump, a hot water pump, or a water source heat pump (WSHP) circulation pump, the typical savings ranged from 19% below to 34% above the average savings for all HVAC pumps.

Recommendation 2. Calculate the savings associated with the VFDs on HVAC pumps based on the pump's duty (cooling water versus hot water versus WSHP) as opposed to a general HVAC assumption.

Conclusion 3. Due to the great variability in pump sizing and configuration, Cadmus did not find an effective or accurate method to determine the average savings resulting from retrofitting an existing pump with a VFD, or to determine if an applicant's pump selection is an efficient choice through the Prescriptive program.

Recommendation 3. To accurately assess the savings potential of each application for the VFDs on process pumps or high-efficiency pump measures, administer incentives for these two measures through the Nonresidential Smart $aver Custom Program (Custom Program).

Conclusion 4. In the case of the VSD and VFD measures reviewed here, the savings depended on the quantity and the hp rating of the motors retrofitted. However, the hp rating of the motors were not always recorded or recorded accurately in the tracking database. Cadmus found this to be an issue in its review of the entire tracking database for measures whose total savings depended on not just the quantity of the measure but also additional parameters, such as hp rating of the motors.

Recommendation 4. Record the quantitative parameters for measure saving determination consistently to facilitate total measure savings and program saving calculations.

Conclusion 5. The tracking database includes three measure codes for VSDs on air compressors: one with a generic base case motor control scheme, one for load/unload controls, and one for variable displacement controls. The database does not include a measure code for the modulation base case control scheme identified in the work paper.

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Recommendation 5. Discontinue the generic air compressor control scheme measure code and add a measure code for the modulation base case control scheme.

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Introduction

Program Description

The Prescriptive Program is designed to influence business customer decisions to save energy by providing incentives to install qualifying high-efficiency measures such as lighting, HVAC, and motors. Duke Energy's commercial and industrial customers fund all energy-efficiency programs by paying an energy-efficiency rider based upon their kWh usage.

In the Prescriptive Program, customers may install selected energy-efficient measures and then submit an application for rebates. Customers must apply for the incentive within 90 days of installing the equipment and provide invoices with model numbers as proof of purchase. The Prescriptive Program is offered in conjunction with the Custom Program, which is being evaluated in a separate study. Energy-efficiency measures that are not part of the Prescriptive Program may still qualify for an incentive through the Custom Program. The measures offered through the Prescriptive Program have pre-calculated deemed energy savings, while the measures eligible for the Custom Program require customers to submit project-specific energy savings calculations with each application. The combination of both programs provides Duke Energy business customers with a flexible range of options to meet their individual needs for energy-efficient equipment.

DEC completed its last evaluation of the Prescriptive Program in 2013. This evaluation covered the high performance linear fluorescent and occupancy sensor measures and relied on verification of a sample of these measures installed.[1]

The biggest program changes from year to year have been the addition of new technologies to the list of qualifying prescriptive measures and the removal of technologies that have become common practice as a result of market transformation. In 2012, in response to the Energy Independence and Security Act (EISA) of 2007, Duke Energy ended incentives for replacing T12s with T5, Standard T8s, and High-Output T8s. In 2014, Duke Energy removed the chiller tune-up incentives from the program and added new information technology, LED lighting, HVAC, and food service measures to program. In 2016, Duke Energy removed server virtualization from the list of IT measures.

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[1] TecMarket Works. *Process and Impact Evaluation of the Non-Residential Smart $aver Prescriptive Program in the Carolina System: Lighting and Occupancy Sensors*. Prepared for Duke Energy. April 5, 2013.

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Table 6 Evaluated Measure Participation (by Date Paid – 01/2013 to 07/2015)

Measure Category	Measure	Participant Application Count
Food Service	ECM Motors in Cooler, Freezer, and Display Cases	139
HVAC	VFDs on HVAC Fans	93
	VFDs on HVAC Pumps	18
Lighting	Fluorescent High Bay Fixtures	687
	High Performance Linear Fluorescent	1,085
	LED Lamps	893
	LED Downlights	142
Process	VFDs on Process Pumps	5
	VSDs on Air Compressors	27
Pump	High-Efficiency Pumps	10

Evaluation Objectives

The evaluation objective was to review DECs' claimed savings for high-impact Prescriptive Program measures. The evaluation did not perform verification on the installed measures.

Researchable Issues

The researchable issues are summarized here:

- Do the work paper saving calculation methodology, assumptions, and inputs need adjustment based on secondary data sources?
- Do the work paper saving calculation methodology, assumptions, and inputs need to be updated as a result of recent changes in codes and standards?
- What is the level of freeridership and spillover in the program participants?

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Methodology

Overview of the Evaluation Approach

Study Methodology

Cadmus performed engineering desk reviews on DEC's work papers describing deemed energy and demand saving calculation methodologies. The work papers were prepared by Franklin Energy Services and are referred to in this document as FES work papers or work papers.

In evaluating DEC's Prescriptive Program, we performed the following activities:

- Selected measures with greatest impact on program savings during the evaluation period from each of the following measure categories: food service, HVAC, lighting, process, and pumps
- Performed a desk review of the work papers describing the measure saving calculation methodology, assumptions, inputs and per-unit savings
- Adjusted estimated energy, NCP demand, or CP demand savings, if necessary, for the selected measures
- Applied the adjusted per-unit saving values across all applicants for the measure reviewed
- Identified potential improvements to work paper for future program years

Duke Energy provided the tracking database containing the participant records for the evaluation period. We used the claimed savings for the population of participants to determine high-impact measures in each measure category. Duke Energy provided the work papers associated with each sampled measure.

Cadmus assessed the baseline and efficient equipment characteristic assumptions used in the work papers to estimate deemed savings for each measure evaluated. We referred to secondary sources that verified these inputs during the evaluation period, where available. If verified values were not available, we tested the assumptions against manufacturer data, national market assessment studies, and available TRMs.

Cadmus did not perform any verification of the quantity or characteristics of the measures installed that would require statistical sampling.

The work papers reviewed here calculate CP demand savings by making assumptions about the percentage of load during DEC peak periods.[2] Cadmus has reviewed these assumptions and provided any adjustments necessary. DEC may choose to use the adjusted work paper CP demand savings estimated in this report or those calculated based on DEC load profiles in their Demand Side Management Option Risk Evaluator (DSMore) software.

2 DEC has identified its summer peak hour as 16:00 – 17:00 in July and winter peak hour as 7:00-8:00 in January.

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Net-to-Gross Analysis

Cadmus calculated the applicable NTG ratio based on the results of participant surveys completed for DEC by TecMarket Works and Cadmus as part of the latest process evaluation of the Prescriptive Program.[3] TecMarket Works completed the first wave of surveys in October 2014 and Cadmus completed the second wave in October 2015.[4]

3 Cadmus. *Process Evaluation of the 2013-2014 Smart $aver Nonresidential Prescriptive Incentive Program in the Carolinas System.* Prepared for Duke Energy. April 15 2016.

4 Cadmus acquired TecMarket Works in March 2015.

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Impact Evaluation Analysis

This section presents the results of the analysis performed for DEC's Prescriptive Program in preparation for the work paper reviews. We have organized our findings into the following sections:

- Program tracking data review and measure selection
- Net savings analysis

Program Tracking Data Review and Measure Selection

The program tracking database identified the claimed per-unit gross energy and demand saving values for each application to which an incentive was paid. The database did not include the total savings claimed as a result of each application.

The total savings depend on the quantity of the measures installed. In most cases, the measure savings also depend on the total square foot, hp, or tonnage of the measure installed. These parameters are identified as *custom quantities* in DEC's tracking database. *Custom quantities* are not always recorded or recorded accurately in the database. Cadmus performed quality control on the *custom quantities* recorded and, where missing, we estimated values based on the incentive paid amounts. Cadmus then calculated total gross claimed savings for each application paid in the database, based on quantity, *custom quantity*, and the savings claimed per-unit. Table 7 lists the results.

Table 7. DEC Prescriptive Program Savings by Measure Category

Row Labels	Gross Energy Savings (%)	Gross Energy Savings (kWh)	Gross NCP (kW)	Gross CP (kW)
Food Service	2%	5,485,013	856	592
HVAC	14%	36,269,670	8,560	8,141
IT	2%	4,935,150	736	331
Lighting	81%	213,988,146	38,294	35,953
Process	1%	2,218,007	555	555
Pumps	0%	121,749	33	26
Total	**100%**	**263,017,736**	**49,033**	**45,598**

Cadmus' review of the tracking database revealed that the majority of the claimed savings are attributed to lighting and HVAC measures. The pumps measure category contributed the least to overall program savings. The program energy savings breakdown by measure category is shown in Figure 1.

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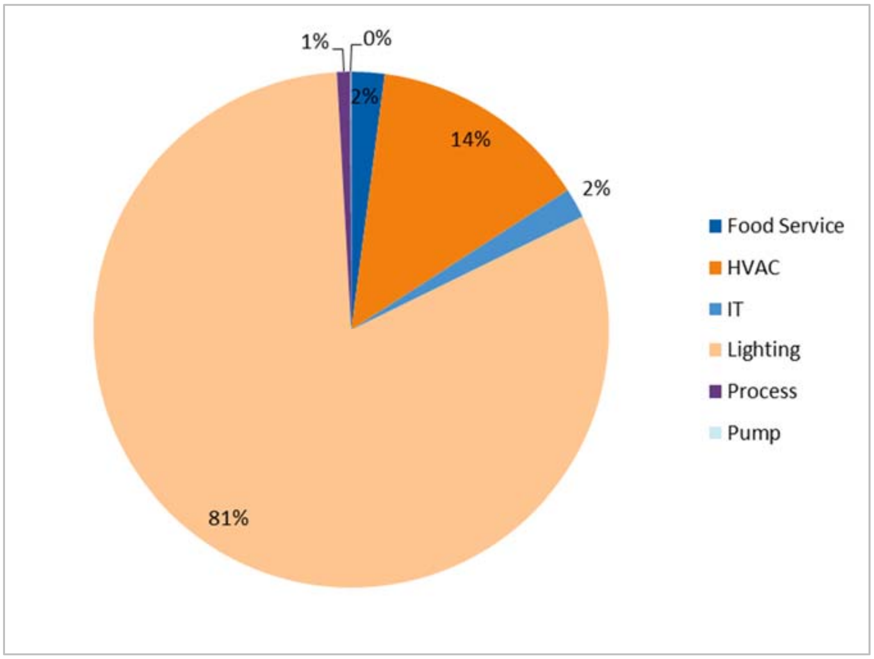
Figure 1. DEC Prescriptive Program Energy Savings by Measure Category (n=263,017,736 kWh)



Cadmus reviewed the contribution of measures (or measure groups) to the savings under each measure category, and selected a set of high-impact measures for desk reviews. We selected measures from all categories, except for Information Technology (IT). The breakdown of measures under each measure category and the measures chosen for review are described in the following sections.

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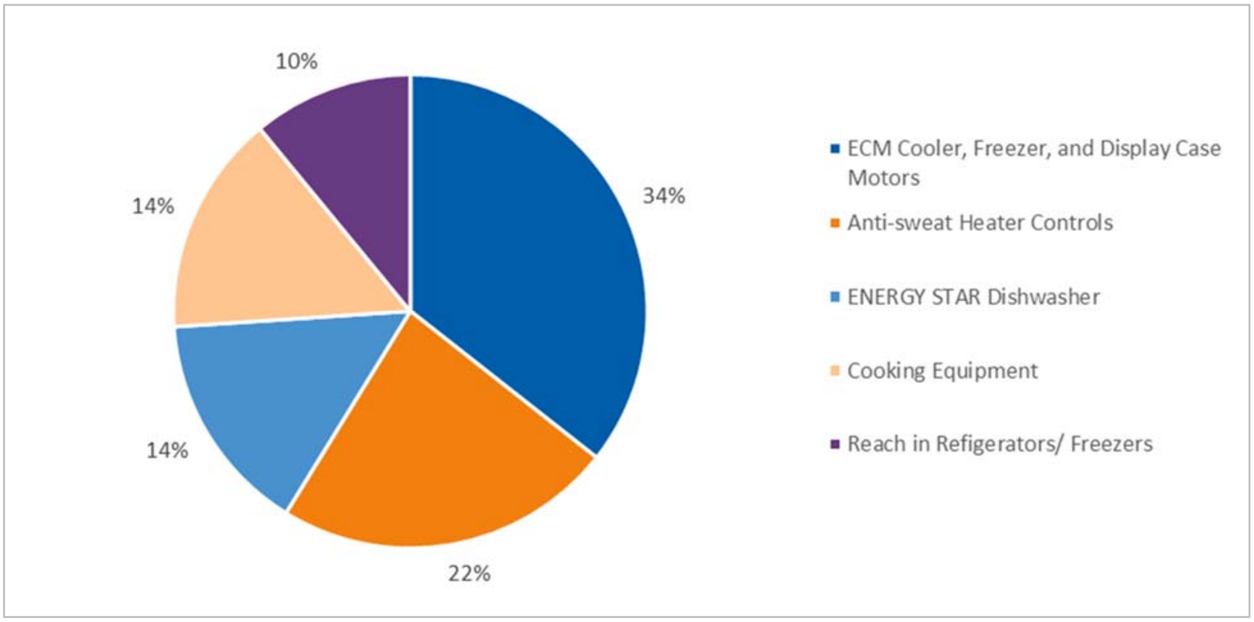
Food Service

Cadmus evaluated the ECM motors from the food service category for desk review. ECM motors contributed the majority (34%) of the savings. Figure 2 shows the breakdown of Food Service savings for measures contributing 10% or more total savings.

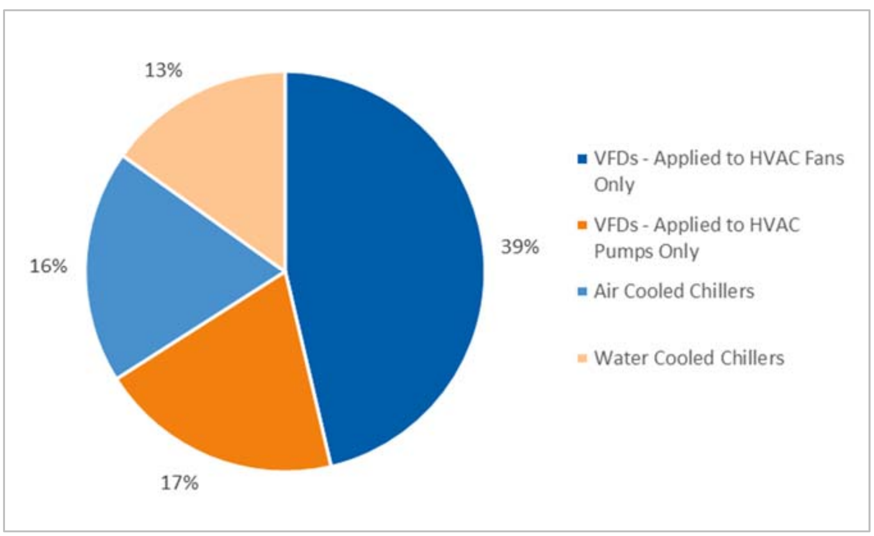
Figure 2. DEC Prescriptive Program Energy Savings: Food Service (n=5,485,013 kWh)



HVAC

For the HVAC category, we evaluated VFD measures applied to HVAC fans and pumps. Together these two measures contributed 56% to the measure category program savings. Figure 3 shows the breakdown of savings from HVAC measures that contributed 10% or more to total savings.

Figure 3. DEC Prescriptive Program Savings: HVAC (n=36,269,670 kWh)



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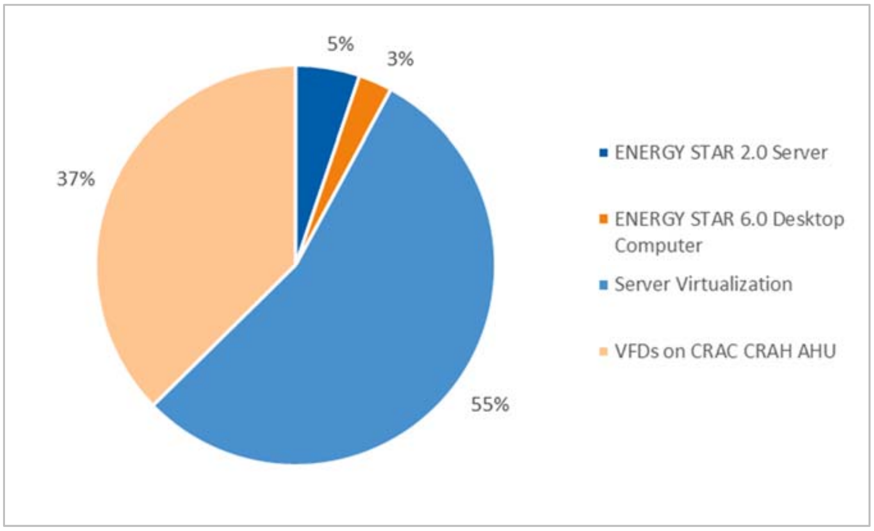
Information Technology

Server virtualization contributed more than half of the savings in the IT measure category. Though initially selected for review, we removed it from sampled measures as DEC no longer provided rebates for this measure in 2016.

Figure 4. DEC Prescriptive Program Energy Savings: IT (n=4,935,150 kWh)



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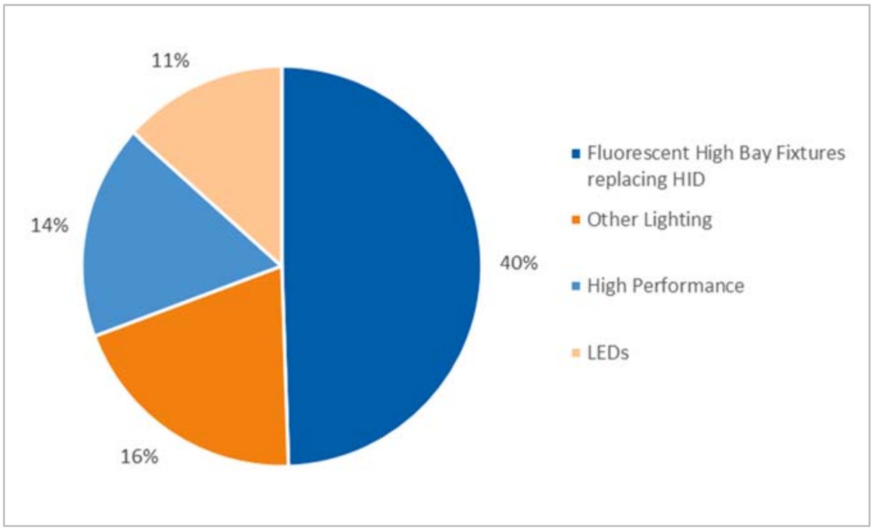
Lighting

Due to their large impact on program savings, the evaluation team chose the fluorescent high bay fixtures replacing HIDs, high performance linear fluorescent, and LEDs measure groups for the work paper review.

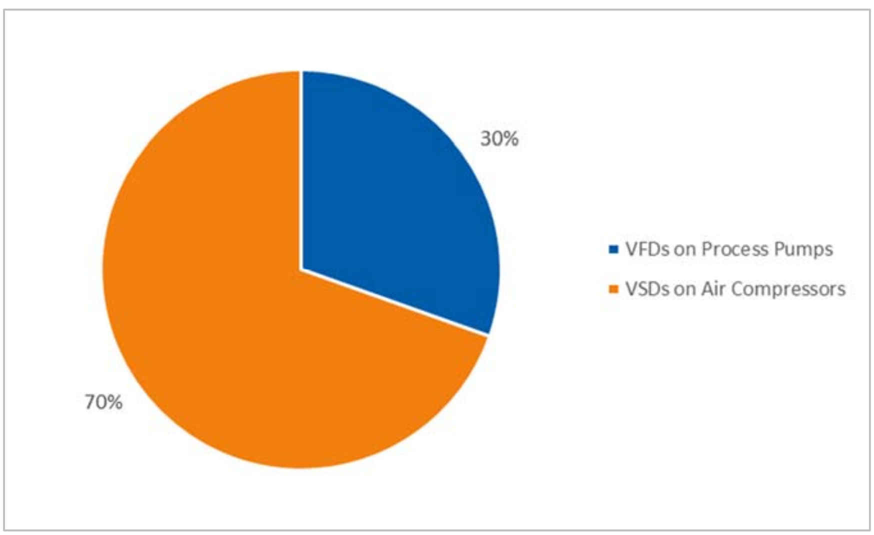
Figure 5. DEC Prescriptive Program Savings: Lighting (n=213,988,146 kWh)



Process Equipment

We reviewed all measures in the process measure category (Figure 6), which consisted of VFDs on process pumps and VSDs on air compressors.

Figure 6. DEC Prescriptive Program Savings: Process Equipment (n=2,218,007 kWh)



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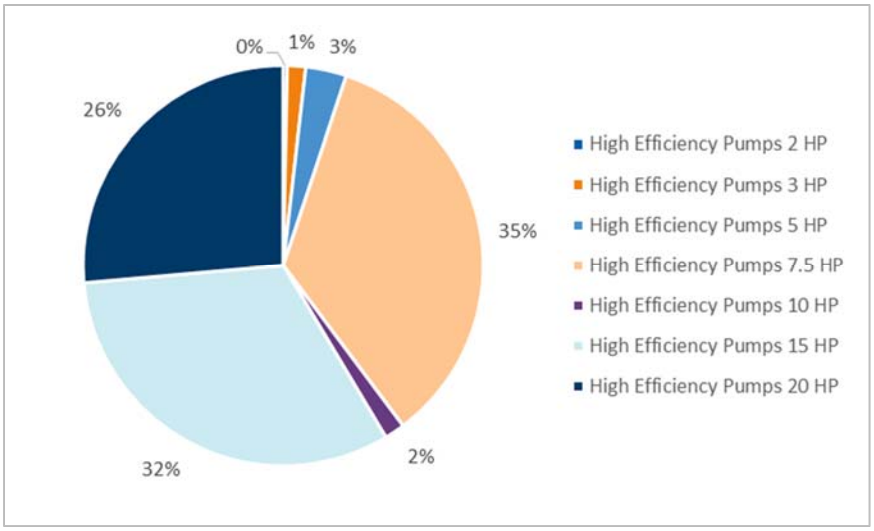
Pumps

Figure 7 shows the breakdown of energy savings for the high-efficiency pump measure category. A single work paper describes the saving calculation methodology for all pumps measures; therefore, Cadmus included all pump measures in the review.

Figure 7. DEC Prescriptive Program Savings: Pumps (n=121,749 kWh)



Net Savings Analysis

Cadmus calculated the applicable NTG ratios based on the results of participant surveys completed by TecMarket Works and Cadmus as part of the latest process evaluation of the Prescriptive Program.[5] TecMarket Works completed the first wave of surveys in October 2014, and Cadmus completed the second wave in October 2015.

Freeridership Methodology

The evaluation team used two different sets of questions from the participant surveys. The team asked each participant both sets of questions and combined the results to estimate the level of energy impacts attributable to freeridership.

For the first set of questions, the team began the survey by asking participants if they would have purchased the same equipment without the program and when that purchase would have occurred. The team then asked respondents who said they would have delayed their purchase to estimate how long they would have delayed the purchase. Cadmus used the results from these two questions to establish a "gateway" freeridership score.

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5 Cadmus. *Process Evaluation of the 2013-2014 Smart $aver Nonresidential Prescriptive Incentive Program in the Carolinas System.* Prepared for Duke Energy. April 15, 2016.

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Specifically, the first question within the first set of questions asked survey respondents what their behavior would have been if the rebate had not been available. Respondents provided responses within the following categories:

- Bought the same new unit at the same time
- Bought the same new unit at a later time
- Bought a used unit at the same or a later time
- Continued to use the previously installed unit and did not purchase a new or used unit

As shown in Table 8, Cadmus assigned each surveyed participant a gateway freeridership score. For participants who indicated that they would have bought the same unit at the same time, we assigned a gateway freeridership score of 100%. For participants who said that they would have continued using the currently installed unit, we assigned a freeridership score of 0%. To estimate freeridership for participants who indicated that they would have bought their units at a later time, we asked an additional question to determine when they would have purchased the units in the absence of the program. For the purposes of establishing the gateway freeridership score, we treated used units the same as new units and captured differences in efficiency levels between new and used units in the second of a two-step process for calculating freeridership.

Table 8. Step One: Gateway Score Based on Timing of Replacement

Gateway Question Responses	Gateway Freeridership Score
Bought same new unit at the same time	100%
Bought same new unit within 6 months	75%
Bought same new unit 6 to 12 months later	50%
Bought same new unit 12 to 24 months later	25%
Bought same new unit more than 24 months later/delayed purchase indefinitely	0%
Bought same new unit but do not know when	Average % all responses in the five rows above
Bought used unit at the same or later time	Same percentages as new units above
Continued using old unit	0%
Do not know what organization would have done	Mean of all valid responses above

In the second step for calculating freeridership, Cadmus used responses from a second set of questions that asked participants what they would have done without the incentive, and what they would have done without the Prescriptive Program information and technical assistance.

Respondents provided responses in the following four categories:

- Bought a unit with at least the same efficiency level
- Bought a unit with a different efficiency level

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- Would not have done the project
- Do not know what organization would have done

For participants who said that they would have bought the same efficiency level without the incentive or program information and assistance, we assigned a freeridership score equal to their gateway freeridership (Table 9). For participants who said they would have purchased less efficient units, we assigned freeridership scores equal to their gateway freeridership score multiplied by a discounting factor based on the relative level of efficiency compared to the unit they did purchase through the program. For participants who did not know what their organization would have done, we assigned a modifier to their gateway freeridership score based on the mean of responses from participants who answered the question.

Table 9. Step Two: Influence of Financial Incentive and Program Information/Technical Assistance

Response for "without financial incentive" and "without program information and technical assistance"	Modified Freeridership Score
Purchased a unit with the same level of efficiency as the new unit purchased through the program	Gateway freeridership X 100%
Different choice "almost as efficient as new model"	Gateway freeridership X 75%
Different choice "significantly more efficient than old model"	Gateway freeridership X 50%
Different choice "somewhat more efficient than old model"	Gateway freeridership X 25%
Different choice "efficiency similar to old model"	Gateway freeridership X 0%
Different choice "not sure what efficiency level"	Gateway freeridership X mean modifier of all other "different choice" responses
Would not have done this project	Gateway freeridership X 0%
Do not know what organization would have done	Mean of all valid responses above

Since the program includes both an incentive payment and technical assistance and program information, each of which can motivate a participant to purchase and install the more efficient choice, we scored the influence of the incentive on one path and the influence of the technical assistance or program information on another path. The final per-respondent freeridership estimate is the lower of their two freeridership scores resulting from these two paths.

For the final step in calculating freeridership, Cadmus weighted the individual freeridership estimates for the surveyed participants by their claimed savings. We chose to use claimed savings for the weighting analysis, since the impact evaluation described in this report covered only select measures in the program and adjusted gross savings were not available for all survey respondents.

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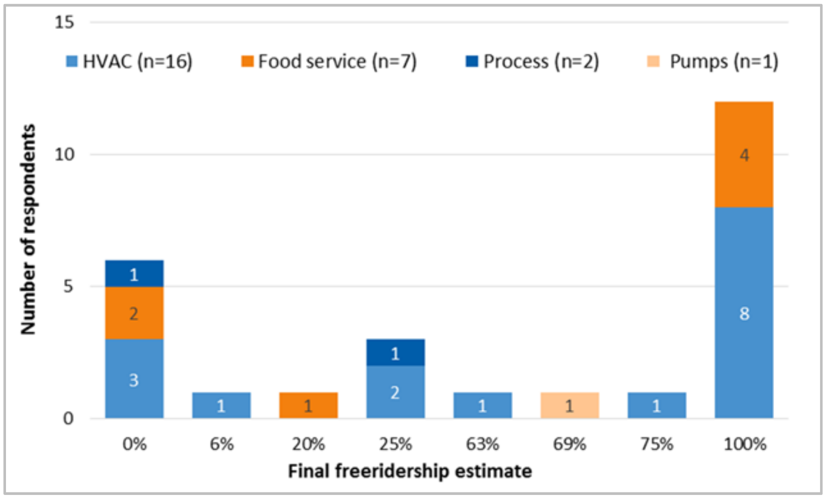
Freeridership Results

Non-lighting Participants

Figure 8 shows the distribution of final freeridership estimates for all 26 surveyed participants who answered the freeridership questions about non-lighting measures. The team assigned freeridership scores of 100% to about half (46%) of the surveyed participants, which indicates they are freeriders who did not contribute any savings to the program.

Figure 8. Distribution of Non-Lighting Freeridership Estimates for 26 Surveyed Participants



After weighting the respondents' freeridership scores by their organizations' gross claimed savings from their non-lighting projects, we calculated a savings weighted freeridership score of 60% for non-lighting measures. Thus, the estimated percentage of gross savings from non-lighting projects which are lost to freeridership is 60%. The following bullet list breaks down the freeridership results by measure category:

- For the 16 respondents who installed HVAC measures, the savings-weighted average freeridership is 63%.
- For the seven respondents who installed food service measures, we calculated 60% freeridership.
- For the two respondents who installed process measures, we calculated 13% freeridership.
- For the one respondent who installed pump measures, we calculated 69% freeridership.

Note that Cadmus provided the above non-lighting measure freeridership values for informational purposes only. Cadmus did not design the evaluation plan to achieve statistically significant estimates of freeridership at the measure level. The surveyed sample of non-lighting measures by category was further limited by the low levels of participation in those categories. The measure level freeridership values should not be used for program planning.

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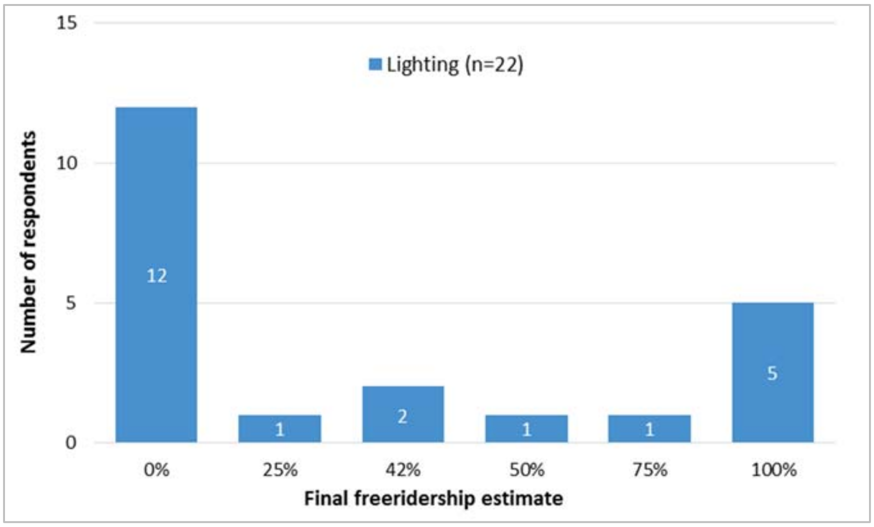
Lighting Participants

Figure 9 shows the distribution of freeridership estimates for 22 respondents. Cadmus calculated freeridership scores of 0% (no freeridership) to slightly more than half of surveyed lighting participants (55%). We assigned approximately a quarter of the surveyed lighting participants (23%) freeridership scores of 100%.

Figure 9. Distribution of Lighting Freeridership Estimates for 22 Surveyed Participants



After weighting the respondents' freeridership scores by their organizations' gross claimed savings from lighting projects, we calculated a savings weighted freeridership score of 14%.[6]

Spillover

The survey included questions to determine the extent to which the program's information and incentives motivated participants to take additional efficiency actions or install non-incented measures. We found very little evidence of spillover for this program.

Net to Gross Adjustment

The final step in calculating net to gross adjustments for this program is to calculate the NTG ratio for lighting and non-lighting measures.

Non-Lighting NTG

To estimate the net to gross adjustment for non-lighting measures, we compared the weighted average freeridership (60%) with negligible spillover. The average program-wide NTG ratio for this program is 40%, calculated as follows:

$$Non-lighting\ NTG = 100\% - Freeridership + Spillover = 100\% - 60\% + 0\% = 40\%$$

[6] Three of the 22 customers surveyed about lighting measures accounted for a combined 65% of the total savings, and all three were assigned freeridership scores of 0%.

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Lighting NTG

To estimate the NTG adjustment for lighting measures, we compared the weighted average freeridership (14%) with negligible spillover. The average program-wide NTG ratio for this program is 86%, calculated as follows:

$$Lighting\ NTG = 100\% - Freeridership + Spillover = 100\% - \ 14\% + 0\% = 86\%$$

Combined NTG

The combined NTG ratio for all measures in the program is 78%. It is calculated based on the lighting and non-lighting NTG ratios weighted by program savings:

$$Program\ level\ NTG = (86\%\ \mathrm{x}\ 81\%) + (40\%\ \mathrm{x}\ 19\%) = 78\%$$

The measure category and program-level NTG ratios only include adjustments for freeridership and short-term participant spillover. Cadmus did not estimate short- and long-term non-participant spillover or short- and long-term market effects as a part of this study.

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Work Paper Reviews

ECM Cooler, Freezer, and Display Case Motors

For the ECM cooler, freezer, and display case motor (ECM motor) measures, DEC applied a deemed savings per each motor replacing a low efficiency motor in commercial refrigeration applications. DEC incentivized 139 unique applications for this measure group, including 95 replacing permanent split capacitor (PSC) motors in walk-in coolers and freezers, 31 replacing shaded pole (SP) motors in walk-in coolers and freezers, and 44 replacing motors in display cases.

DEC used two different work papers to estimate the per-motor savings for these measures: one for ECM motors replacing PSC and SP motors in walk-in coolers and freezers and one for ECM motors replacing all motors in reach-in display cases.

Table 10 shows the deemed energy, NCP demand, and CP demand savings values in the work paper as well as the savings shown in the tracking database for the evaluation period.

Table 10 DEC Deemed Savings for ECM Motors

Replacement Type	Savings	Savings per Motor		
		Work Paper	Tracking Database	
			2013	2014-2015**
Replacing PSC in Cooler/Freezer*	Average NCP Demand (kW)	0.0660	0.2006	0.2006
	Summer CP Demand (kW)	0.0510	0.3296	0.1809
	Energy (kWh)	581	1,757	1,757
Replacing SP in Cooler/Freezer*	Average NCP Demand (kW)	0.2010	0.0663	0.0663
	Summer CP Demand (kW)	0.1810	0.1090	0.0590
	Energy (kWh)	1,757	581	581
Replacing Display Case Motor	Average NCP Demand (kW)	0.0456	0.0456	0.0456
	Summer CP Demand (kW)	0.0410	0.0668	0.0369
	Energy (kWh)	356	356	356

* Cadmus suspects that the savings figures were inverted between the PSC and SP motor replacement measures in the tracking database as they are exactly opposite of the work paper figures.

** The only difference between 2013 and 2014-2015 savings figures for cooler and freezer measures were summer CP demand savings. Cadmus could not find any documentation explaining this change.

Work Paper Methodology

Both work papers estimate the savings from the motors themselves as well as the savings from a reduced cooling load, as efficient motors produce less waste heat that must be removed by the refrigeration systems.

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Walk-in Coolers and Freezers

In this FES work paper, per-motor savings were estimated based on a weighted average of savings calculated for replacing PSC and SP motors ranging from 1/40 hp to 1/2 hp.

The work paper estimated the motor savings by subtracting the ECM efficient case assumed input wattages (W) from the existing assumed values. The assumed input wattages range from 1,060 W/hp to 3,600 W/hp depending on the rated motor size and technology. The savings resulting from the reduced cooling load were then estimated based on assumed refrigeration system efficiencies which in turn were based on assumed coefficient of performance (COP) values of 2.5 and 1.3 for coolers and freezers, respectively.

The work paper does not cite a source for the assumed motor input wattages, the refrigeration system efficiencies, or the basis for weighting the savings associated with PSC and SP motor replacements and those associated with the various motor sizes.

The work paper assumes operating hour for motors in both coolers and freezer to be 8,760 and a peak demand CF of 0.9 based on the 2010 Wisconsin TRM. However, Cadmus could not find the CF value in the TRM.

Display Cases

In this work paper, per-motor savings are based on calculations found in the 2009 Ohio TRM. [7] The TRM assumes that the average SP motor input power, regardless of rated size, is 41.3W and the average ECM motor input power is 11.3 W. The TRM estimates the savings resulting from reduced refrigeration load by applying a bonus factor of 1.3 for coolers and 1.5 for freezers based on assumed and uncited refrigeration efficiencies. The TRM assumes operating hour for motors in both coolers and freezer to be 8,760 and duty cycles of 100% for coolers and 94% for freezers. The work paper assumes a CF = 0.9 and states that this is based on the 2010 Wisconsin TRM. However, Cadmus could not find the 0.9 value in the TRM.

Work Paper Methodology Adjustments Necessary

The motor input wattages used, for both the baseline and efficient cases, did not include sources and thus could not be verified. Cadmus updated the input wattages for the baseline SP motor cases and efficient ECM motor cases using data Cadmus collected as part of the commercial refrigeration load shape project performed on behalf of NEEP in 2012 - 2013.[8] This study included direct power measurement of a large sample of verified installations to determine an average input wattage normalized by motor hp rating. The average normalized input wattages found in this study were 2,088

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[7] The Public Utilities Commission of Ohio. Technical Reference Manual for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE-UNC. October 15, 2009.

[8] Cadmus. *Commercial Refrigeration Loadshape Project Final Report.* Prepared for Northeast Energy Efficiency Partnerships Regional Evaluation, Measurement, and Verification Forum. October 9, 2015.

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W/hp and 758 W/hp for SP and ECM motors, respectively. The study did not have enough data to normalize input wattages of PSC motors so we used data included on vender specification sheets for PSC motors.[9]

Instead of using the refrigeration efficiencies of only a handful of display case models, Cadmus used values from the DOE2.2R refrigeration modeling software as the values are more representative of the wide range of coolers and freezer installations. We used an energy-efficiency ratio (EER) of 9.8 for coolers and 4.0 for freezers for both the walk-in and display case measures.

Given the lack of documentation or explanation for how FES weighted the savings between the various motor sizes, Cadmus weighted the estimated per-motor savings based on the proportions of the different motors sizes in the tracking database during the evaluation period.

Table 11 shows the proportions of the different motor replacements for the walk-in PSC measure. The population weighting used in the work paper for the walk-in PSC measure varied significantly from the distribution shown in the tracking database. The work paper assumes that only 20% of the PSC motor replacements are for 1/20 hp motors or smaller. However, as shown in Table 11, 85% of the PSC motor replacements were for 1/20 hp and 15% for 1/15 hp. This is the main factor contributing to the low realization rate for the walk-in PSC replacement measure as smaller motors receive less savings.

Table 11. Walk-in PSC Motor Replacements Weighting Distribution

Motor Size (hp)	Number of Motors	% of Total (Weighting Factor)
1/20	50	84.7%
1/15	9	15.3%
Total	**59***	**100.0%**

* Cadmus only used the applications that included clear hp ratings to determine the weighting.

Table 12 shows the proportions of the different motor replacements for the walk-in SP measure. The population weighting used in the work paper for the walk-in SP measure varied significantly from the distribution shown in the tracking database. For example, the work paper assumes that only 17% of SP motor replacements are for 1/20 hp motors. However, as shown in Table 12, nearly four times that fraction of SP motor replacements (63%) were for 1/20 hp motors.

9 Specification sheets are available online: https://www.grainger.com/product/DAYTON-1-20-hp-3RCX2?functionCode=P2IDP2PCP

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Table 12 Walk-in SP Motor Replacements Weighting Distribution

Motor Size (hp)	Number of Motors	% of Total (Weighting Factor)
1/50	1	3.3%
1/20	19	63.3%
1/15	10	33.3%
Total	**30***	**100.0%**

* Cadmus only used the applications that included clear hp ratings to determine the weighting.

Table 13 shows the proportions of the different motor replacements for the display case motor replacement measure. For the display case measure, the adjusted savings are much greater than the work paper and tracked savings. This is mainly because the work paper figures assume that most motor replacements were for much smaller motors than what is shown in the tracking database. Because most replaced motors are much greater in size than the work paper assumptions, the adjusted savings are much greater.

Table 13. Display Case Motor Replacements Weighting Distribution

Motor Size (hp)	Number of Motors	% of Total (Weighting Factor)
1/50	5	25.0%
1/30	4	20.0%
1/20	5	25.0%
1/15	4	20.0%
1/10	2	10.0%
Total	**20***	**100.0%**

* Cadmus only used the applications that included clear hp ratings to determine the weighting.

Because the tracking database does not indicate whether the motors are in coolers or freezers, Cadmus estimated the average savings based on assumed equal distribution. We assumed a CF of 1.0 because it is highly likely that the refrigeration systems that these motors are a part of will have high cooling demand during peak grid demand periods.

Work Paper Adjustment Results

Table 14 shows the adjusted deemed savings in comparison with the program tracking values for the three ECM motor measures.

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Table 14. Adjusted ECM Motors Measure Savings

Measure	Savings	Work paper [A]	Adjusted [B]	Adjustment Factor [B/A]
ECM Replacing PSC in Cooler/Freezer	Average NCP Demand (kW)	0.0660	0.0891	135%
	Summer CP Demand (kW)	0.0510	0.0891	175%
	Energy (kWh)	581	758	130%
ECM Replacing SP in Cooler/Freezer	Average NCP Demand (kW)	0.2010	0.0999	50%
	Summer CP Demand (kW)	0.1810	0.0999	55%
	Energy (kWh)	1,757	874*	50%
ECM Replacing Display Case Motor	Average NCP Demand (kW)	0.0456	0.0990	217%
	Summer CP Demand (kW)	0.0410	0.0990	241%
	Energy (kWh)	356	844	237%

* Cadmus produced the NEEP Commercial Refrigeration Load Shape Study in 2015 based on field metering. Using the average rated hp from the distribution presented in Table 15, the NEEP Study predicts annual energy and summer peak demand savings of 770 kWh and 0.088 kW for SP to ECM cooler retrofits and 979 kWh and 0.112 kW for SP to ECM freezer retrofits. Therefore, the savings values will depend greatly on the relative mix of coolers and freezers.

The main factor affecting the results of all three measures was the update to the input wattages and the weighting used to estimate the per-motor savings. For the PSC measure, this resulted in a reduction in savings. For the SP cooler, freezer, and display case measures, this resulted in an increase in the savings. Additionally, for the PSC and SP motor measures, a major factor affecting the results was an apparent clerical error in recording the per-motor savings associated with the SP and SP motors in the tracking database (refer to Table 10).

Table 15 lists the total claimed and adjusted savings for the three measures.

Table 15. Total Claimed and Adjusted Savings for ECM Motors

Measure	Claimed Savings			Adjusted Savings			Realization Rates		
	Energy (kWh) [A]	NCP Demand (kW) [B]	CP Demand (kW) [C]	Energy (kWh) [D]	NCP Demand (kW) [E]	CP Demand (kW) [F]	Energy [D/A]	NCP Demand [E/B]	CP Demand [F/C]
Display Case	571,380	73	77	1,355,079	159	159	237%	217%	207%
Walk-in PSC	1,189,489	136	151	513,269	60	60	43%	44%	40%
Walk-in SP	96,446	11	18	145,198	17	17	151%	151%	92%
Total	**1,857,315**	**220**	**246**	**2,013,547**	**236**	**236**	**108%**	**107%**	**96%**

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Conclusions and Recommendations

Conclusion 1. For the ECM motors measure group, the size of the motors being replaced vary greatly; there is up to five times difference between the hp rating for the smallest and largest motors in the tracking database. The actual savings for a group of motors will vary widely based on the proportion of various sizes in the tracking database population.

Recommendation 1. Calculate refrigeration ECM motor savings on a per hp basis rather than a per motor basis. Table 16 shows recommended per hp savings based on Cadmus's findings in the NEEP Commercial Refrigeration Load Shape Study which can be applied to both walk-in and display case measures.

Table 16. Recomended ECM Motor per hp Savings

Base Case Motor	Savings Per Horsepower	
	Energy (kWh)	NCP and CP (kW)
SP	11,359	1.3295
PSC	9,090	1.0640

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VFD on HVAC Fans and Pumps

DEC provided incentives for a total of 93 unique VFDs on HVAC Fan retrofit applications and 18 unique VFDs on HVAC Pump retrofit applications.

Table 17 and Table 18 show the deemed savings values in the applicable work paper as well as the savings shown in the tracking database for the evaluation period. DEC updated the tracking database values in 2014 based on an update memo provided by TecMarket Works.[10]

Table 17. DEC Deemed Savings for VFD on HVAC Fans

Savings	Savings per hp		
	Work Paper	Tracking Database (2013)	Tracking Database (2014-2015)
Average NCP Demand (kW)	0.1920	0.1600	0.1600
Summer CP Demand (kW)[11]	0.1720	0.2580	0.1570
Energy (kWh)	1,281	1,374	1,374

Table 18. DEC Deemed Savings for VFD on HVAC Pumps

Savings	Savings per hp		
	Work paper	Tracking Database (2013)	Tracking Database (2014-2015)
Average NCP Demand (kW)	0.5130	0.3050	0.3050
Summer CP Demand (kW)[12]	0.3210	0.5200	0.2990
Energy (kWh)	3,698	2,774	2,774

Work Paper Methodology

BuildingMetrics developed a set of commercial prototypical building models by using the DOE-2.2 building energy simulation program for each of the market segments defined such as hospitals, hotels, and large office buildings. The prototypes are based on the models used in the California Database for Energy Efficiency Resources studies, with appropriate modifications to adapt these models to local design practices and climate.[13]

10 TecMarket Works. *Carolinas - Non-Residential Smart $aver - VFD Update Memo*. Technical Memorandum. February 2, 2012.

11 Cadmus could not find the source of the VFD on HVAC fans summer CP demand savings in the tracking database and, thus, assumes that they are based on DEC DSMore analysis.

12 Cadmus could not find the source of the VFD on HVAC pumps summer CP demand savings in the tracking database and, thus, assumes that they are based on DEC DSMore analysis.

13 These prototypes are described in more detail in Building Metrics, Inc., Duke Energy Measure Savings Database – Weather Sensitive Retrofit Measures for Residential and Commercial Buildings. Technical memorandum. July 2010.

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The work paper estimates annual energy, summer peak, and winter peak demand savings based on differences between the simulated energy consumption and peak demand at the baseline and the measure efficiency levels. The work paper assumed that summer peak demand occurs during the month of July, while winter peak impacts were calculated during the month of January. The savings were based on a calculated average of savings from 75 models with different HVAC systems, building types, and locations (described in the Table 19).

Table 19 Variation in Work paper Model Inputs

Types	Location*	System Type
• Hospital • Hotel • Large Office	• Asheville, NC • Charlotte, NC • Greenville, NC • Indianapolis, IN • Cincinnati, OH	• VAV reheat with economizer with air cooled chiller (fan measure only) • VAV reheat with economizer with water cooled chiller (fan measure only) • CV reheat with economizer (pump measure only) • CV reheat with no economizer (pump measure only) • VAV reheat with economizer (pump measure only)

* Though the last two cities are not in the Carolinas, they were included in the work paper analysis.

The TecMarket Works memo used by DEC to update the savings in 2014 mapped all of the previous year's applications to the savings based on the specific building type and location to find more application specific savings for this measure. TecMarket Works calculated the average, per fan hp and per pump hp savings to inform to future projects.

Work Paper Methodology Adjustments Necessary

Cadmus used the results from a recent HVAC VFD load shape project performed by Cadmus on behalf of NEEP. The VFD Load Shape Study report, and accompanying MS Excel tool,[14] describe a measurement based study to determine the annual peak and hourly demand impacts from installations on HVAC fans and pumps. The study metered 392 individual HVAC motors with VFDs for over a year (June 2012 – September 2013). The study compared metered energy consumption of each motor to a baseline of either metered consumption (pre-installation, when available) or of the DOE2.2 modeled consumption of the system without a VFD. The results of the study, similar to those in the work paper, are summarized in terms of energy and demand savings per hp.

Though the study focuses on cities in the Northeast, one of the major observations of the study was that a variation in climate and outdoor air conditions had negligible impact on the load shape. This, and other key findings include the following:

- Variable speed drives frequently operate at constant speed.
- Operators may select constant speed operation over variable speed operation.

14 The Cadmus Group. *Variable Speed Drive Load shape Project*. Northeast Energy Efficiency Partnership, n.d. Available online: http://www.neep.org/variable-speed-drive-load shape-study-final-report.

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- Variable speed drive performance often does not track outside temperature.
- The savings estimates for each weather region are similar and similarly diverse.

Because of this, Cadmus concluded that the NEEP savings figures are applicable to DEC projects. Moreover, the aggregate results of the NEEP report included instances where the VFD installed motors were not operating at optimal efficiency (e.g., controls bypassed and running at full speed or single speed set by operator). This means that the average deemed savings figures, applied program-wide, will account for cases where the controls are not implemented as planned. Cadmus has encountered these cases in our verifications for Duke Energy Ohio.[15]

The NEEP study also shows that there is a large variation in the amount of savings depending on what type of HVAC pump the VFD is installed on. As shown in Table 20, for a VFD installed on a cooling water pump, a hot water pump, or a water source heat pump (WSHP) circulation pump, the typical savings ranged from 19% below to 34% above the average savings for all HVAC pumps. The variation between the two types of HVAC fans analyzed (supply and return) was not as large (±6%).

Because the tracking database did not contain enough information to determine the type of pump associated with each application, we could not make any adjustments based on these findings. In order to estimate more accurate program savings in the future, we recommend that the VFD on HVAC pumps measure be administered by pump duty (cooling water vs. hot water vs. WSHP).

Table 20. Comparison of Savings for VFDs on HVAC Pumps Depending on Pump Duty Based on NEEP Variable Speed Drive Load shape Project

Equipment Type	Savings per Pump (hp)			
	Energy (kWh)	Energy Difference from Average	Average NCP Demand (kW)	Average NCP Demand Difference from Average
Cooling Water Pump	1,633	-14.7%	0.1860	-14.8%
Hot Water Pump	1,548	-19.1%	0.1770	-18.9%
WSHP Circulation Pump	2,562	33.8%	0.2920	33.7%
Average All Pump	1,914	0.0%	0.2183	0.0%

Work Paper Adjustment Results

Table 21 and Table 22 show per hp adjusted savings figures for HVAC fans and pumps, respectively.

The main reason for the difference is because Cadmus based the adjusted savings on real-world metering as opposed to modeled savings. Table 23 and Table 24 show the claimed savings, the adjusted savings, and the realization rates for HVAC fans and pumps, respectively.

15 Cadmus. *Evaluation of the Smart $aver Nonresidential Custom Incentive Program in Ohio.* Evaluation, Measurement, & Verification for Duke Energy Ohio. November 15, 2015.

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Table 21 Adjusted VFDs on HVAC Fans Measure Savings

Savings Parameter (per hp)	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Energy (kWh)	1,281	1,910	149%
Average NCP Demand (kW)	0.1920	0.2181	114%
Summer CP Demand (kW)	0.1720	0.2914	169%
Winter CP Demand (kW)	n/a	0.2990	n/a

Table 22 Adjusted VFDs on HVAC Pumps Measure Savings

Savings Parameter (per hp)	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Energy (kWh)	3,698	1,914	52%
Average NCP Demand (kW)	0.5130	0.2185	43%
Summer CP Demand (kW)	0.3210	0.1687	53%
Winter CP Demand (kW)	n/a	0.2408	n/a

Table 23. Total Claimed and Adjusted Savings for HVAC Fans

Savings	Total Savings (kWh)	Total NCP Savings (kW)	Total CP Savings (kW)
Claimed [A]	14,553,141	1,695	2,188
Adjusted [B]	20,236,854	2,310	3,086
Realization Rate [B/A]	139%	136%	141%

Table 24. Total Claimed and Adjusted Savings for HVAC Pumps

Savings	Total Savings (kWh)	Total NCP Savings (kW)	Total CP Savings (kW)
Claimed [A]	5,480,481	603	799
Adjusted [B]	3,781,949	432	333
Realization Rate [B/A]	69%	72%	42%

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Conclusions and Recommendations

Conclusion 1. A recently completed metering study by Cadmus on behalf of NEEP showed that there is a large variation in the amount of savings depending on what type of HVAC pump the VFD is installed on**.** For a VFD installed on a cooling water pump, a hot water pump, or a WSHP circulation pump, the typical savings ranged from 19% below to 34% above the average savings for all HVAC pumps.

Recommendation 1. Calculate savings based on the pump's duty (cooling water vs. hot water vs. WSHP) as opposed to a general HVAC pump assumption. The recommended savings by pump duty cycle were shown in Table 20.

Conclusion 2. The savings for VFDs on HVAC Fans and Pumps depended on the quantity and the hp rating of the motors retrofitted. However, the hp rating of the motors were not always recorded or recorded accurately in the tracking database. Cadmus found this to be an issue in its review of the entire tracking database for measures where total savings depended on not just the quantity of the measure, but also additional parameters such as hp rating of the motors.

Recommendation 2. Record the quantitative parameters for measure saving determination consistently to facilitate total measure savings and program saving calculations.

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Linear Fluorescent High Bay Fixtures Replacing HID

The linear fluorescent high bay measure group work paper identifies DEC savings resulting from retrofitting HID fixtures with high-output T5 and T8 linear fluorescent fixtures in two, three, four, and eight lamp configurations. DEC provides incentives for 11 measures identified in the work paper. DEC also provides incentives for one additional retrofit scenario, high-bay 2 lamp T8, even though the savings for this configuration were not addressed in the work paper. Table 25 and Table 26 summarize these 12 retrofit scenarios and the associated work paper energy and demand savings.

The high bay measure was part of an evaluation performed by TecMarket Works in 2011.[16] DEC applied evaluated savings prospectively in the tracking database after that evaluation. Therefore, as shown in Table 25 and Table 26, the values in the tracking database are different from those in the work paper. This current evaluation includes a review of the work paper methodology; however, the total adjusted savings are presented in comparison to the DEC claimed saving values in the tracking database at the end of this section.

Table 25. DEC Deemed Energy Savings for Linear Fluorescents High Bay

Efficient Fixture	Existing HID Fixture (W)	Savings per Fixture	
		Work Paper (kWh)	Tracking Database (kWh)
High Bay 2-L T5	150-249	300	561
High Bay 3-L T5	250-399	449	843
High Bay 4-L T5	400-999	882	1,748
High Bay 6-L T5	400-999	374	835
High Bay 8-L T5	750-999	1,514	2,842
2 High Bay 6-L T5	1,000	1,456	1,456
High Bay 2-L T8	150-249	n/a	513
High Bay 3-L T8	150-249	341	641
High Bay 4-L T8	250-399	616	1,124
High Bay 6-L T8	400-999	961	1,811
High Bay 8-L T8	400-999	649	1,218
2 High Bay 8-L T8 (single fixture 16 lamps)	1,000	2,005	2,005

[16] TecMarket Works. *Evaluation of the Non-Residential Smart $aver Prescriptive Program in North and South Carolina: Results of a Results of a Process and Impact Evaluation*. Prepared for Duke Energy. Final: February 6, 2011 (Revised: June 16, 2011).

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Table 26. DEC Deemed Average NCP and CP Demand Savings for Linear Fluorescents High Bay

Efficient Fixture	NCP Demand (kW)		CP Demand (kW)	
	Work Paper	Tracking Database	Work Paper	Tracking Database
High Bay 2-L T5 High Output	0.0720	0.0950	0.0684	0.0900
High Bay 3-L T5 High Output	0.1080	0.1430	0.1026	0.1354
High Bay 4-L T5 High Output	0.2120	0.2960	0.2014	0.2803
High Bay 6-L T5 High Output	0.0900	0.1410	0.0855	0.1335
High Bay 8-L T5 High Output	0.3640	0.4810	0.3458	0.4555
2 High Bay 6-L T5 High Output	0.3500	0.3500	0.3325	0.3325
High Bay 2-L T8	n/a	0.1261	n/a	0.1030
High Bay 3-L T8	0.0820	0.1090	0.0779	0.1032
High Bay 4-L T8	0.1480	0.1900	0.1406	0.1799
High Bay 6-L T8	0.2310	0.3060	0.2195	0.2878
High Bay 8-L T8	0.1560	0.2060	0.1482	0.1951
2 High Bay 8-L T8 (single fixture 16 lamps)	0.4820	0.4820	0.4579	0.4579

Work Paper Methodology

The work paper assesses the equivalency of various efficient high bay linear fluorescent fixtures with existing metal halide fixtures in terms of light output. The light output for each fixture is assumed to be equal to the mean lumens of the lamps in each fixture. By developing the equivalency based on mean lumens, the light output of a lamp at 40% of its rated life, the work paper has accounted for the depreciation in light output during the lifetime of a lamp. The work paper considers a differential light output of less than 25% as acceptable.

FES then compares the input wattages of equivalent existing and efficient fixtures to calculate energy and NCP demand savings. The work paper uses 4,160 annual hours based on the Focus on Energy deemed savings manual, using a 50/50 weighting of industrial and commercial hours of use values.[17] However, the value is not supported in the Focus on Energy deemed savings manual (the evaluation team calculates 4,238 using the same weighting method). The work paper assumed a CF of 0.95 which is an internal FES standard value. The work paper does not account for the interactive effects of lighting and HVAC.

Work Paper Adjustments Necessary

Cadmus found the work paper methodology reasonable in developing equivalent retrofit scenarios and assigning wattages to the baseline and efficient fixtures in each scenario. Note that the savings depend

17 Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

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significant on the baseline fixture installed. Cadmus verified that the Prescriptive Program application specifies the baseline fixture for each measure.[18]

However, we found the following adjustments necessary:

We used the following saving algorithm from the Ohio TRM, which incorporates the interactive effects of lighting and HVAC in the adjusted saving calculation:

Energy Savings

$$\Delta \text{kWh} = (WATTS_{BASE} - WATTS_{EE}) * HOURS * (1 + WHF_E) / 1{,}000$$

Where:

$WATTS_{BASE}$	=	connected wattage of the baseline fixtures
$WATTS_{EE}$	=	connected wattage of high-efficiency fixtures
HOURS	=	annual lighting operating hours
WHF_E	=	lighting-HVAC interaction factor

Summer CP Demand Reduction

$$\Delta \text{kW} = ((WATTS_{BASE} - WATTS_{EE}) * CF * (1 + WHF_{D}))/1{,}000$$

Where:

WHF_D	=	lighting-HVAC waste heat factor for demand and
CF	=	summer peak coincidence factor.

Cadmus used the weighted average HVAC interactive effects multipliers calculated by TecMarket Works in a previous evaluation of the high-performance linear fluorescents measure in the Carolinas, [19] which are 0.22 for demand and 0.042 for energy.

The work paper used 4,160 as the annual hours of operation for the metal halide lamps as a place-holder. The 2011 TecMarket Works evaluation of the high bay measure found that on average, the metered hours of use predicted about 2% fewer annual operating hours in North Carolina and 15% more annual hours of use in South Carolina compared with the participants self-reported hours of use. [20]

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18 Duke Energy. *North Carolina and South Carolina Lighting Smart $aver Prescriptive Incentive Application.* 1/2016 v3. Available online: http://www.duke-energy.com/pdfs/NC_Lighting.pdf

19 TecMarket Works. *Process and Impact Evaluation of the Non-Residential Smart $aver Prescriptive Program in the Carolina System: Lighting and Occupancy Sensors.* Prepared for Duke Energy. April 5, 2013.

20 TecMarket Works. *Evaluation of the Non-Residential Smart $aver Prescriptive Program in North and South Carolina: Results of a Results of a Process and Impact Evaluation.* Prepared for Duke Energy. Final: February 6, 2011 (Revised: June 16, 2011. P. 60).

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Cadmus calculated the average self-reported and logged hours of use weighted by the evaluated savings in the 2011 TecMarket Works evaluation. The ratio of weighted average logged over self-reported hours of use in the evaluation for both states together was 117%.

Cadmus calculated the average self-reported hours of use for the participants in the current tracking database weighted by claimed savings. We used the self-reported hours of use from 687 applications in the tracking database in our calculation. Cadmus increased the self-reported average hours of use by the ratio of logged over self-reported hours of use calculated based on the TecMarket Works evaluation. We used this value as the average annual hours of use in the current evaluation. Table 27 lists the results.

Table 27. Adjusted Hours of Use Calculation Based on Self-reported Annual Hours of Operation

	Annual Hours of Operation
Tracking Database Self-Reported Weighted Average [A]	4,488
Ratio of Logged / Self-Reported from Previous Evaluation [B]	1.17
Adjusted Hours of Use [A x B]	5,246

We also calculated the CF verified by TecMarket Works in 2011, weighted by the evaluated savings (0.97) and deemed the work paper CF value of 0.95 as reasonable.

Work Paper Adjustment Results

Table 28, Table 29, and Table 30 show the adjusted savings values and how they compare to the work paper values. The main factors causing the higher kWh savings are the addition of HVAC interactive effects and the adjusted annual hours of operation. The main factor causing the higher kW savings is the addition of HVAC interactive effects.

Table 28. Adjusted Linear Fluorescent High Bay Measure Energy Savings

Efficient Fixture	Work Paper (kWh) [A]	Adjusted Savings (kWh) [B]	Adjustment Factor [B/A]
High Bay 2-L T5	300	394	131%
High Bay 3-L T5	449	591	131%
High Bay 4-L T5	882	1,159	131%
High Bay 6-L T5	374	492	131%
High Bay 8-L T5	1,514	1,990	131%
2 High Bay 6-L T5	1,456	1,914	131%
High Bay 2-L T8	n/a	621	n/a
High Bay 3-L T8	341	448	131%
High Bay 4-L T8	616	809	131%
High Bay 6-L T8	961	1,263	131%
High Bay 8-L T8	649	853	131%
2 High Bay 8-L T8 (or single fixture 16 lamps)	2,005	2,635	131%

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Table 29. Adjusted Linear Fluorescent High Bay Measure CP Demand Savings

Efficient Fixture	Work Paper (kW) [A]	Adjusted Savings (kW) [B]	Adjustment Factor [B/A]
High Bay 2-L T5	0.0684	0.0834	122%
High Bay 3-L T5	0.1026	0.1252	122%
High Bay 4-L T5	0.2014	0.2457	122%
High Bay 6-L T5	0.0855	0.1043	122%
High Bay 8-L T5	0.3458	0.4219	122%
2 High Bay 6-L T5	0.3325	0.4057	122%
High Bay 2-L T8	n/a	0.1315	n/a
High Bay 3-L T8	0.0779	0.0950	122%
High Bay 4-L T8	0.1406	0.1715	122%
High Bay 6-L T8	0.2195	0.2677	122%
High Bay 8-L T8	0.1482	0.1808	122%
2 High Bay 8-L T8 (or single	0.4579	0.5586	122%

Table 30. Adjusted Linear Fluorescent High Bay Measure NCP Demand Savings

Efficient Fixture	Work Paper (kW) [A]	Adjusted (kW) [B]	Adjustment Factor [B/A]
High Bay 2-L T5	0.0720	0.0878	122%
High Bay 3-L T5	0.1080	0.1318	122%
High Bay 4-L T5	0.2120	0.2586	122%
High Bay 6-L T5	0.0900	0.1098	122%
High Bay 8-L T5	0.3640	0.4441	122%
2 High Bay 6-L T5	0.3500	0.4270	122%
High Bay 2-L T8	n/a	0.1385	n/a
High Bay 3-L T8	0.0820	0.1000	122%
High Bay 4-L T8	0.1480	0.1806	122%
High Bay 6-L T8	0.2310	0.2818	122%
High Bay 8-L T8	0.1560	0.1903	122%
2 High Bay 8-L T8 (single	0.4820	0.5880	122%

A summary of the savings associated with all linear fluorescent high bay applications in the evaluation period, including the claimed savings, the adjusted savings, and the realizations rates are shown in Table 31. Cadmus used the tracking database per-unit savings for each efficient fixture to calculate claimed savings. As mentioned previously and noted in Table 25 and Table 26, the DEC tracking database per-unit savings and hence the total claimed savings calculated by Cadmus, include the realization rates from the previous evaluation (1.77 and 1.14 for energy and CP demand respectively in NC and 1.62 and 1.02 for energy and CP demand respectively in SC). Therefore, the realization rates noted in Table 31 are lower than the adjustment rates shown for the work paper savings in the previous tables.

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Table 31. Total Claimed and Adjusted Savings for the Linear Fluorescent High Bay Measure

Savings	Energy (kWh)	NCP Demand (kW)	CP Demand (kW)
Claimed [A]	85,708,927	14,570	13,758
Adjusted [B]	58,154,366	12,976	12,327
Realization Rate [B/A]	68%	89%	90%

Conclusions and Recommendations

None.

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High Performance Linear Fluorescent

The high performance linear fluorescent measure group includes 38 unique measures:

- Nine measures provide incentives for retrofitting standard T8 fixtures with *high-performance* or *reduced-wattage* T8s as designated by the Consortium for Energy Efficiency (CEE).[21]
- Ten measures provide incentives for retrofitting standard or high output T12 fixtures with *high-performance* or *reduced-wattage* T8 fixtures as designated by CEE.
- Nineteen measures provide incentives for retrofitting four-foot T12 fixtures with regular or high output T8 or T5 lamps and retrofitting eight-foot T12 fixtures with *high-performance* T8s. DEC discontinued these measures as of January 2013 in response to the federal standards that went into effect in July of 2012. The federal standards include efficacy requirements that cannot be met by standard T12 lamps (with a few exception) and instead can be met with T8 lamps. Although there are instances of incentives paid to these measures in the DEC tracking database, the evaluation team assumed that these incentives were applied for before the measures were discontinued in 2013 (and paid for after 2013). Therefore, these measures are not included in the work paper review.

The high-performance linear fluorescent measure was part of an evaluation performed by TecMarket Works in 2013.[22] DEC applied evaluated savings prospectively in the tracking database after this evaluation. Therefore, as shown in Table 32, the values in the tracking database are different from those in the FES work paper. This current evaluation includes a review of the work paper methodology; however, the total adjusted savings are presented in comparison to the DEC claimed saving values in the tracking database at the end of this section.

[21] The qualifying lists can be found at: https://www.cee1.org.

[22] TecMarket Works. *Process and Impact Evaluation of the Non-Residential Smart $aver Prescriptive Program in the Carolina System: Lighting and Occupancy Sensors.* Prepared for Duke Energy. April 5, 2013.

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Table 32. DEC Deemed Savings for High Performance Linear Fluorescents

Measure	Energy		NCP Demand		CP Demand	
	Work Paper (kWh)	Tracking Database (kWh)	Work Paper (kW)	Tracking Database (kW)	Work Paper (kW)	Tracking Database (kW)
High-Performance (HP) T8 Replacing T12s						
HP T8 32W - 4' 1 Lamp	43	75	0.0118	0.0190	0.0106	0.0160
HP T8 32W - 4' 2 Lamp	58	101	0.0158	0.0255	0.0142	0.0215
HP T8 32W - 4' 3 Lamp	97	169	0.0265	0.0427	0.0238	0.0360
HP T8- 32W - 4' 4 Lamp	111	192	0.0301	0.0486	0.0271	0.0410
HP T8 Replacing Standard T8s						
HP T8 32W - 4' 1 Lamp	19	33	0.0053	0.0083	0.0047	0.0068
HP T8 32W - 4' 2 Lamp	31	54	0.0083	0.0136	0.0075	0.0109
HP T8 32W - 4' 3 Lamp	35	61	0.0095	0.0154	0.0085	0.0123
HP T8- 32W - 4' 4 Lamp	52	90	0.0141	0.0228	0.0127	0.0191
Low-Wattage (LW) T8 Replacing T8s						
LW 25/28W - 4' 1 Lamp	29	50	0.0079	0.0127	0.0071	0.0097
LW 25/28W - 4' 2 Lamp	48	83	0.0131	0.0211	0.0118	0.0160
LW 25/28W - 4' 3 Lamp	62	108	0.0170	0.0272	0.0153	0.0208
LW 25/28W - 4' 4 Lamp	92	160	0.0250	0.0404	0.0225	0.0307
LW T8 Replacing T12s						
LW 25/28W - 4' 1 Lamp	53	92	0.0144	0.0232	0.0130	0.0196
LW 25/28W - 4' 2 Lamp	76	132	0.0206	0.0333	0.0185	0.0280
LW 25/28W - 4' 3 Lamp	125	217	0.0340	0.0548	0.0306	0.0463
LW 25/28W - 4' 4 Lamp	151	262	0.0410	0.0662	0.0369	0.0559
HP T8 Replacing 8' HO T12s						
HP T8 32W - 4' 2 Lamp	123	213	0.0333	0.0537	0.0300	0.0454
HP T8- 32W - 4' 4 Lamp	225	389	0.0610	0.0985	0.0549	0.0831
LW T8 Replacing T8 – Lamp Only						
LW T8 – 4’ 1 lamp	15	26	0.0040	0.0066	0.0036	0.0054

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Work Paper Methodology

The work paper uses common T12 and T8 wattages for the baseline fixtures and qualifying *high-performance* and *reduced-wattage* system wattages listed by the CEE for the replacements fixtures. Wattages for *reduced-wattage* replacement fixtures are determined based on a weighted average of 25W and 28W CEE qualified *reduced-wattage* T8 systems. Wattages for *high-performance* replacement fixtures are determined based on a weighted average of qualified *high-performance* fixtures using a low ballast factor (LBF), normal ballast factor (NBF), and high ballast factor (HBF). The work paper makes the following assumptions for calculating the weighted average wattage for the high-performance replacement fixtures:

- Four-foot T12 and T8 systems are replaced with *high-performance* or *reduced-wattage* T8 systems with 75% LBF ballasts and 25% NBF ballasts.
- Eight-foot T12 systems are replaced with *high-performance* systems with 100% NBF ballasts.
- Eight-foot T12 high output systems are assumed to be replaced with *high-performance* systems with 50% NBF ballasts and 50% HBF ballasts.

The work paper uses 3,680 annual hours of use based on the Focus on Energy deemed savings manual.[23] Cadmus could not verify this value based on the same reference (3,730 is the commercial building hours of use according to the manual). The work paper assumed a CF of 0.90 which is an internal FES standard value. The work paper does not account for the interactive effects of lighting and HVAC.

Work Paper Adjustments Necessary

Cadmus found the work paper methodology in assigning input wattages to the baseline and efficiency lighting fixtures reasonable. We made the following adjustments:

- We used the common lighting saving algorithm presented in the Linear Fluorescent High Bay Fixtures Replacing HID section, which incorporates the interactive effects of lighting and HVAC in the adjusted saving calculation. We used the following weighted average energy and demand waste heat factors determined in the 2013 evaluation of this measure by TMW:[24]
  - WHFD = 0.220
  - WHFE = 0.042

[23] Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

[24] TecMarket Works. *Process and Impact Evaluation of the Non-Residential Smart $aver Prescriptive Program in the Carolina System: Lighting and Occupancy Sensors*. Prepared for Duke Energy. April 5, 2013. p.25.

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- The work paper used 3,680 as the annual hours of operation for linear fluorescent lamps. The 2013 TecMarket Works evaluation of the high performance linear fluorescent measure found that on average, the metered hours of use predicted 14% more than the participant self-reported hours of use, and 170% times more operating hours than the 3,680 assumption in the work paper.[25] The TecMarket Works logged and self-reported hours of use were weighted by the evaluated savings in the evaluation. Of the 1,085 applications recorded for this measure group in the tracking database, 494 had self-reported hours of use. Cadmus calculated the average self-reported hours of use by application, weighted by the claimed savings for each application. Cadmus increased the self-reported average hours of use by the ratio of logged over self-reported hours of use calculated in the 2013 TecMarket Works evaluation. Cadmus used this value as the average annual hours of use in the adjusted savings. The results are summarized in Table 33.

Table 33. Adjusted Hours of Use Calculation Based on Self-reported Annual Hours of Operation

	Annual Hours of Operation
Tracking Database Self-reported Weighted Average [A]	4,563
Ratio of Logged / Self-reported from TecMarket Works 2013 Evaluation [B]	1.14
Adjusted Hours of Use [C] (=AxB)	5,202

- In lieu of the 0.9 CF used in the work paper, an internal FES value, the evaluation team used the weighted average verified CF determined in the 2013 TecMarket Works evaluation (0.76).[26]

Work Paper Adjustment Results

Table 34 , Table 35, and Table 36 show the adjusted savings figures and how they compare to the work paper values. The factors causing the higher kWh savings are the addition of HVAC interactive effects and the adjusted annual hours of operation. The factors affecting the demand savings are the addition of HVAC interactive effects and the adjusted CF.

A summary of the savings associated with all high performance linear fluorescent applications in the evaluation period, including the claimed savings, the adjusted savings, and the realizations rates are shown in Table 36. Cadmus used the per-unit savings and the quantities recorded in the tracking database for each measure to calculate claimed savings. As mentioned previously and noted in Table 32, the program tracking savings recorded by DEC and hence the total claimed savings calculated by Cadmus, include the realization rate from the previous evaluation (1.73, 1.61, 1.47 for energy, NCP demand, and CP demand savings on average respectively).Therefore, the realization rates noted in Table 36 are lower than the adjustment rates shown for the work paper savings in the tables above.

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25 Ibid. Pp 23-24.

26 Ibid. P 23.

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Table 34. Adjusted High Performance Linear Fluorescent Measure Energy Savings

Measure	Work Paper (kWh) [A]	Adjusted Savings (kWh) [B]	Adjustment Factor [B/A]
HP T8 Replacing T12s			
HP T8 32W - 4' 1 Lamp	43	64	147%
HP T8 32W - 4' 2 Lamp	58	86	147%
HP T8 32W - 4' 3 Lamp	97	143	147%
HP T8- 32W - 4' 4 Lamp	111	163	147%
HP T8 Replacing Standard T8s			
HP T8 32W - 4' 1 Lamp	19	28	147%
HP T8 32W - 4' 2 Lamp	31	45	147%
HP T8 32W - 4' 3 Lamp	35	51	147%
HP T8- 32W - 4' 4 Lamp	52	76	147%
LW T8 Replacing T8s			
LW 25/28W - 4' 1 Lamp	29	43	147%
LW 25/28W - 4' 2 Lamp	48	71	147%
LW 25/28W - 4' 3 Lamp	62	92	147%
LW 25/28W - 4' 4 Lamp	92	136	147%
LW T8 Replacing T12s			
LW 25/28W - 4' 1 Lamp	53	78	147%
LW 25/28W - 4' 2 Lamp	76	112	147%
LW 25/28W - 4' 3 Lamp	125	184	147%
LW 25/28W - 4' 4 Lamp	151	222	147%
HP T8 Replacing 8'HO T12s			
HP T8 32W - 4' 2 Lamp	123	180	147%
HP T8- 32W - 4' 4 Lamp	225	331	147%
LW T8 Replacing T8 – Lamp Only			
LW T8 – 4’ 1 lamp	15	22	147%

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Table 35. Adjusted High Performance Linear Fluorescent Measure Demand Savings

Measure	NCP (kW)			CP (kW)		
	Work Paper [A]	Adjusted Savings [B]	Adjustment Factor [B/A]	Work Paper [C]	Adjusted Savings [D]	Adjustment Factor [D/C]
HP T8 Replacing T12s						
HP T8 32W - 4' 1 Lamp	0.0118	0.0143	122%	0.0106	0.0109	103%
HP T8 32W - 4' 2 Lamp	0.0158	0.0193	122%	0.0142	0.0146	103%
HP T8 32W - 4' 3 Lamp	0.0265	0.0323	122%	0.0238	0.0245	103%
HP T8- 32W - 4' 4 Lamp	0.0301	0.0367	122%	0.0271	0.0279	103%
HP T8 Replacing Standard T8s						
HP T8 32W - 4' 1 Lamp	0.0053	0.0064	122%	0.0047	0.0049	103%
HP T8 32W - 4' 2 Lamp	0.0083	0.0101	122%	0.0075	0.0077	103%
HP T8 32W - 4' 3 Lamp	0.0095	0.0115	122%	0.0085	0.0088	103%
HP T8- 32W - 4' 4 Lamp	0.0141	0.0172	122%	0.0127	0.0131	103%
LW T8 Replacing T8s						
LW 25/28W - 4' 1 Lamp	0.0079	0.0097	122%	0.0071	0.0073	103%
LW 25/28W - 4' 2 Lamp	0.0131	0.0160	122%	0.0118	0.0121	103%
LW 25/28W - 4' 3 Lamp	0.0170	0.0207	122%	0.0153	0.0157	103%
LW 25/28W - 4' 4 Lamp	0.0250	0.0305	122%	0.0225	0.0232	103%
LW T8 Replacing T12s						
LW 25/28W - 4' 1 Lamp	0.0144	0.0176	122%	0.0130	0.0134	103%
LW 25/28W - 4' 2 Lamp	0.0206	0.0251	122%	0.0185	0.0191	103%
LW 25/28W - 4' 3 Lamp	0.0340	0.0414	122%	0.0306	0.0315	103%
LW 25/28W - 4' 4 Lamp	0.0410	0.0500	122%	0.0369	0.0380	103%
HP T8 Replacing 8'HO T12s						
HP T8 32W - 4' 2 Lamp	0.0333	0.0406	122%	0.0300	0.0309	103%
HP T8- 32W - 4' 4 Lamp	0.0610	0.0744	122%	0.0549	0.0566	103%
LW T8 Replacing T8 – Lamp Only						
LW T8 – 4’ 1 lamp	0.0040	0.0049	122%	0.0036	0.0037	103%

Table 36. Total Claimed and Adjusted Energy Savings for High Performance Linear Fluorescents

Savings	Energy (kWh)	NCP Demand (kW)	CP Demand (kW)
Claimed [A]	17,420,130	4,404	3,568
Adjusted [B]	14,767,697	3,324	2,526
Realization Rate [B/A]	85%	75%	71%

Conclusions and Recommendations

None.

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LED Lamps and Downlights

The LED lamps measure provides incentives for replacing incandescent bulbs with ENERGY STAR® LEDs. The work paper assumes a 60W incandescent bulb as the baseline in 2012. The 60W incandescent bulb was subject to EISA 2007 requiring that a former 60W lamp manufactured and sold on or after January 1, 2014, use 43W or less, while providing the same amount of light.[27] Therefore, the work paper (and DEC) changed the baseline for the LED lamps measure in 2014 to reflect the 43W minimum standard. The deemed energy and demand savings for this measure changed from 2013 to 2014 as a result in the tracking database.

The LED downlights measure provides incentives for replacing 60W to 100W incandescent bulbs with ENERGY STAR qualified LED downlights of 18W or less.

Table 37 shows deemed savings per lamp for LED lamps and downlights in 2013 and beyond.

Table 37. DEC Deemed Savings for LED Lamps and Downlights

Savings	Energy (kWh)		NCP Demand (kW)		CP Demand (kW)	
Evaluation Year	2013	2014-2015	2013	2014-2015	2013	2014-2015
LED Lamps	177	114	0.0481	0.0310	0.0432	0.0310
LED Downlights	195	195	0.0530	0.0530	0.0477	0.0477

Work Paper Methodology

The LED lamps and downlights work paper includes the following assumptions:

LED Lamp Assumptions

- Existing watts/fixture = 60W (2013); 43W (2014 and beyond)
- Efficient watts/fixture = 12W
- CF = 0.77
- Annual Operating Hours = 3,680

LED Downlight Assumptions

- Existing watts/fixture = 65W
- Baseline watts/fixture = 12W
- CF = 0.77
- Annual operating hours = 3,680

[27] The EISA 2007 minimum efficacy standards applied to 100W lamps in 2012, 75W lamps in 2013, and 60W/45W lamps in 2014.

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The work paper uses 3,680 as the annual hour of use based on the Focus on Energy deemed savings manual.[28] Cadmus could not verify this value based on the same reference (3,730 is the commercial building hours of use according to the manual). The work paper assumed a CF of 0.90, which is an internal FES standard value. The work paper does not account for the interactive effects of lighting and HVAC.

Work Paper Adjustments Necessary

Cadmus used the weighted average HVAC interactive effects multipliers calculated by TecMarket Works in a previous evaluation of the high-performance linear fluorescents measure in the Carolinas, [29] which are 0.22 for demand and 0.042 for energy. We also determined the Focus on Energy deemed savings manual CF of 0.77 is appropriate for the adjusted peak demand saving calculations. The remaining adjustments are described separately for LED lamps and downlights.

LED Lamp Assumptions

Cadmus found the efficient wattage assumption (12W) for the LED lamps measure is appropriate. We calculated 12.45W as the average wattage of the 60W equivalent LED lamps in the ENERGY STAR data base available during the evaluation period. [30]

However, Cadmus found that the 2013 baseline wattage assumption (60W) for the LED does not agree with the average wattage of incandescent lamps in use in commercial and industrial buildings according to the 2010 characterization of the lighting market as issued by the Department of Energy (52W).[31] We revised the baseline wattage assumption from 60W to 52W in the adjusted saving calculations for 2013. We determined that in 2014 and 2015 the EISA baseline of 43W is appropriate.

The weighted average of self-reported hours of use for LED lamps in the tracking database is 4,358. In order to calculate this weighted average hours of use, Cadmus used 1,030 of the 1,553 applications for LED lamps in the DEC tracking database, which had self-reported hours of use recorded. Cadmus calculated the average self-reported hours of use, by application, weighted by the claimed savings for each application. Cadmus used 4,358 as the adjusted hours of use.

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[28] Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

[29] TecMarket Works. *Process and Impact Evaluation of the Non-Residential Smart $aver Prescriptive Program in the Carolina System: Lighting and Occupancy Sensors.* Prepared for Duke Energy. April 5, 2013.

[30] ENERGY STAR-certified lamps available after 2012, but before July 2015, filtered to 700-1100 lumens in brightness, excluding the decorative lamp category. The full database is available for download at: https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Light-Bulbs

[31] U.S. Department of Energy. *U.S. Lighting Market Characterization 2010*. 2013.

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LED Downlight Assumptions

Cadmus found the work paper's 60W average wattage is appropriate given the federal standards that took effect in July 2012. We calculated 72W as the average wattage of incandescent reflector lamps in downlights in commercial and industrial buildings according to the 2010 U.S. Lighting Market Characterization Report.[32] However, the DOE standards increased average efficacy of reflector lamps manufactured for sale and reduced the average wattage of available reflector lamps by as much as 10W.[33]

Cadmus calculated 15W as the average wattage of directional lamps rated for enclosed fixtures in the ENERGY STAR data base available during the evaluation period.[34] Given the relatively small change between this and the wattage calculated in the work paper (12W), we decided to not adjust the baseline or efficient wattages for this measure.

There were 143 applications in the DEC tracking database for this measure, and only 127 had self-reported hours of use recorded. Therefore, we used the average annual hours of use between commercial and industrial uses in the Focus on Energy manual, which is 4,238.

Work Paper Adjustment Results

Table 38 and Table 39 show the adjusted savings figures and how they compare to the work paper values. The main factors causing the higher kWh savings are the adjusted annual hours of operation. The main factor causing the higher CP demand savings is the addition of HVAC interactive effects. Due to a reduction in the adjusted CF, CP demand increased only slightly.

Table 38. Adjusted LED lamps Measure Savings

Savings Parameter	Work Paper		Adjusted		Adjustment Factor (2013) [C/A]	Adjustment Factor (2014-2015) [D/B]
	2013 [A]	2014-2015 [B]	2013 [C]	2014-2015 [D]		
Energy (kWh/year)	177	114	182	141	103%	123%
NCP (kW)	0.0480	0.0310	0.0488	0.0378	102%	122%
CP (kW)	0.0432	0.0279	0.0376	0.0291	87%	104%

32 US Department of Energy. *U.S. Lighting Market Characterization 2010*. 2013.

33 In a Cadmus internal assessment, the average of available incandescent reflector lamps wattage reduced by 9W within a year after EISA regulations took effect in California.

34 Directional lamps available after 2012 but before July 2015, filtered to 600 to 1,500 lumens in brightness, rated for enclosed fixtures. The full database is available for download at: https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Light-Bulbs

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Table 39. Adjusted LED Downlights Measure Savings

Savings Parameter	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Energy (kWh/year)	195	234	120%
NCP (kW)	0.0530	0.0647	122%
CP (kW)	0.0477	0.0498	104%

A summary of the savings associated with all LED lamps and downlights applications in the evaluation period, including the claimed savings, the adjusted savings, and the realizations rates, are shown in Table 40 and Table 41.

Table 40. Total Claimed and Adjusted Energy Savings for LED Lamps (2013 – 2015)

Savings	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Energy (kWh/year)	16,471,533	19,376,927	118%
NCP (kW)	4,476	5,206	116%
CP (kW)	4,028	4,009	100%

Table 41. Total Claimed and Adjusted Energy Savings for LED Downlights

Savings	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Energy (kWh/year)	2,025,100	2,430,118	120%
NCP (kW)	550	671	122%
CP (kW)	495	517	104%

Conclusions and Recommendations

None.

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VFDs on Process Pumps

DEC applied a deemed savings per hp for each VFD installed on an industrial process pump that received incentives to calculate the energy and demand savings for eight applications. Table 42 shows the savings values in the work paper as well as the savings shown in the tracking database during the evaluation period. The values in the tracking database are different from those in the work paper because they were updated in 2013 based on an update memo prepared by TecMarket Works in 2012.[35]

Table 42. DEC Deemed Savings for VFDs on Process Pumps

Savings	Savings per hp	
	Work paper	Tracking Database
Average NCP Demand (kW)	0.2480	0.2600
Summer CP Demand (kW)	0.2480	0.2600
Energy (kWh)	912	957

Work Paper Methodology

The work paper calculated the savings figures by comparing the modeled energy consumption of a pumped system utilizing throttling control against one utilizing VFD control with a flow profile that averages 70% flow. Using throttling as the base case control scheme is appropriate because it is a more common control method in industrial applications. Additionally, the measure savings are more conservatively estimated using a throttling control as the base case control scheme than a bypass loop.

The work paper utilizes a curve fit for a 20 hp pump.

The work paper uses 3,680 hours based on the Focus on Energy deemed savings manual.[36] Cadmus could not verify this value based on the same reference (3,730 is the commercial building hours of use according to the manual).

The work paper assumes a CF of 0.78 that was taken from a NYSERDA program. However the TecMarket update memo and the tracked savings database, assumes a CF of 1.0.

The paper did not provide a source for the assumed motor efficiency (92%). However, the assumed efficiency is reasonable when compared to the average minimum efficiency from the EISA efficiency standards for motor sizes 5 to 50 hp. The work paper assumed a full load motor load factor of 85% for industrial processes.

[35] TecMarket Works. *Carolinas - Non-Residential Smart $aver - VFD Update Memo.* Technical Memorandum. February 2, 2012.

[36] Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

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Work Paper Methodology Adjustments Necessary

While the work paper allows DEC to assign a single energy or demand saving figure per VFD on industrial pump, Cadmus found large uncertainty in the inputs and assumptions used to calculate this saving figure. There is significant variability in sizing, configuration, and operation of pumps (including the operational hours, the pressure difference through the pump, the pump flow profile, and even the fluid being pumped). We recommend including this measure in the Custom Program in the future. However, for the applications submitted during the evaluation period, Cadmus made the following adjustments:

- Used three typical flow profiles as opposed to a single flow profile more accurately represents all possible VFD retrofit scenarios. We used the average savings resulting from 60%, 70%, and 80% flows, as opposed to a single 70%.
- Assumed a full load motor load factor of 75%, based on the review team's experience. This is a more conservative estimate than the work paper.
- Used a generic performance curve for both base and measure cases instead of a single pump curve for a 20 hp pump.[37] The generic curve is an approximation based on a variety of pump configurations, whereas the work paper model assumes a single, specific, pump configuration.
- Assumed annual hours of 3,733 based on a national market assessment study of industrial electric motors.[38] This number is slightly higher than the hours used in the work paper. This estimate is specific to process pumping systems. This is the weighted average, based on the distribution of pump motor sizes, of the national average hours of operation for pump applications for motor sizes 1 to 50 hp. The self-reported operating hours in the tracking database ranged from 21% less to 131% greater than the assumed hours of operation in the DEC work paper. The updated hours are within less than 1% of the average of the self-reported hours.
- Assumes that the summer coincident and non-coincident kW savings are the same as process pumps are typically not affected seasonally or by weather. This assumption follows the methodology of the FES work paper.

Work Paper Adjustment Results

Table 43 shows the adjusted savings figures and how they compare to the program tracking values. The main factors affecting the higher kWh savings is an increase in the assumed hours of operation. The main factors affecting the lower kW savings is a lower assumed full load motor load factor of the pumps.

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37 Bonneville Power Administration. ASD Calculator for Fan & Pump Applications – Summary of information provided in Flow Control. Westinghouse publication, Bulletin B-851, F/86/Rev–CMS 8121.

38 United States Industrial Electric Motor Systems Market Opportunities Assessment. December 2002. p. B-2 <http://www1.eere.energy.gov/industry/bestpractices/pdfs/mtrmkt.pdf

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Table 43. Adjusted VFDs on Process Pumps Measure Savings

Savings Parameter	Work Paper	Adjusted Savings	Adjustment Factor
Average NCP Demand (kW)	0.2480	0.2090	84%
Summer CP Demand (kW)	0.2480	0.2090	84%
Energy (kWh)	912.00	1,012.00	111%

A summary of each application for this measure in the evaluation period, including the originally claimed savings, the adjusted savings, and the realizations rates are shown in Table 44.

Conclusions and Recommendations

Conclusion 1. Due to the great variability in pump sizing and configuration, Cadmus did not find an effective or accurate method to determine the average savings resulting from retrofitting an existing pump with a VFD.

Recommendation 1. To accurately assess the savings potential of each VFDs on process pumps application, administer incentives for this measure though the Custom Program.

Table 44. Total Claimed and Adjusted VFDs on Process Pump Savings

Savings	Total Savings (kWh)	Total NCP Savings (kW)	Total CP Savings (kW)
Claimed [A]	674,734	183	183
Adjusted [B]	732,495	147	147
Realization Rate [B/A]	109%	80%	80%

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VSDs on Air Compressors

DEC applied a deemed savings per hp for each compressor to calculate energy and demand savings for 27 applications. The savings are significantly affected by the base case control scheme; therefore, the work paper provides three sets of savings for variable displacement, load/unload, and modulation. Table 41 shows the deemed savings according to the work paper.

Table 45. DEC Deemed Savings for VSDs on Air Compressors

Base Case	Number of Applications	Savings	Savings per hp
Variable Displacement	1	Average NCP Demand (kW)	0.0450
		Summer CP Demand (kW)	0.0450
		Energy (kWh)	188
Load/Unload	4	Average NCP Demand (kW)	0.1210
		Summer CP Demand (kW)	0.1210
		Energy (kWh)	501
Modulation	22	Average NCP Demand (kW)	0.1510
		Summer CP Demand (kW)	0.1510
		Energy (kWh)	629

The values in the tracking database match the work paper values. However, there are three measure descriptions for the VSDs on air compressors measure group in the tracking database:

- VSDs on Air Compressors
- VSDs on Air Compressors replacing load/unload
- VSDs on Air Compressors replacing variable displacement

The load/unload and variable displacement base cases are distinguished in the database. However, there are no measure descriptions for the modulation base case. Cadmus could not verify the base cases associated with the applications recorded under the *VSDs on Air Compressors* measure description (and most of the applications are recorded under this measure code). Since the savings assigned by DEC to these applications match those in the work paper for the modulation base case, Cadmus assumed that the base case for the retrofit in these applications is modulation. In order to improve program tracking in the future, each application should be specifically assigned to one of the three base cases in the tracking database.

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Work Paper Methodology

The work paper algorithms used to determine savings are based on the percentage of kW input versus the percentage of capacity for various air compressor control types published by the Compressed Air Challenge (note below).[39]

Modulating Control

$kW_{Mod} \quad = \quad Max\ kW_{Mod} * (\%\ Max\ Flow_{Mod} * 0.3 + 0.7)$

Load/No Load Control

$kW_{L/NL} \quad = \quad Max\ kW_{L/NL} * (0.25 + 1.166 * \%\ Max\ Flow_{L/NL} - 0.416 * \%\ Max\ Flow_{L/NL}{}^{2})$

Variable Displacement

$kW_{VD} \quad = \quad Max\ kW_{VD} * (0.77 * \%\ Max\ Flow_{VD} + 0.23)$

Variable Speed Control

$kW_{VFD} \quad = \quad Max\ kW_{VFD} * \%\ Max\ Flow_{VFD}$

Where:

Max kW = Compressor input power as design cfm
% Max Flow = Compressed air max design cfm

The work paper also includes these assumptions:

- The full load performance of each base case and the measure case was taken from Compressed Air and Gas Institute (CAGI) datasheets of Ingersoll Rand 100 hp, air-cooled, oil-injected units at 100 pounds per square inch utilizing the four different output control methods (modulating, load/no load, variable displacement, and variable speed control).
- The annual operating hours were assumed to be 4,160, based on 80 hours per week, 52 weeks a year. This value was rounded from the average operating hours for all manufacturing motors under 200 hp from the Department of Energy's (DOE's) market assessment of industrial electrical motors.[40]
- Average flows were assumed at 75% full load for energy and demand savings, this provides somewhat conservative savings, since the lower the load factor the greater the savings for VSD control. This is what was used in the "%Max Flow" variables in the above equations.

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[39] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Compressed Air Challenge, *Improving Compressed Air System Performance*, DOE/GO-102003-182. November 2003. Accessed online: https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/compressed_air_sourcebook.pdf

[40] U.S. Department of Energy. United States Industrial Electric Motor Systems Market Opportunities Assessment. December 2002.

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- The compressors were assumed to have a design factor of 33%. This means that the VFD compressors will typically only operate at ~75% [1/(1+33%)] of its output capacity during peak air demand periods.
- The work paper assumes that the compressors will be running at design air demand during peak electrical demand periods. Also, an Industrial compressed air systems operation is rarely dependent on seasons or weather. Thus, the measure NCP and summer CP demand savings are assumed to be the same (CF = 1.0).

Work Paper Methodology Adjustments Necessary

Cadmus found the work paper methodology and calculator to be appropriate. However, the following adjustments were necessary:

- The models of compressors used for the full load performance were updated from Ingersoll Rand (IR) to Gardener Denver as IR does not manufacture variable displacement units. Furthermore, the IR units used in the work paper analysis are particularly inefficient and no longer manufactured, thus the adjusted savings are more conservative.
- Instead of using the part-load curves from Compressed Air Challenge (CAC) for VFD case, Cadmus used the actual CAGI performance curve of the VFD because VFD technology has improved since the time that the CAC was published in 2003. The base case technologies have not changed significantly since its publishing, thus those curves are still valid.
- Cadmus updated the assumed design factor from 33% to 20% based on the engineering teams experience that manufactures rarely oversize their compressors more than 20%.

Cadmus updated hours of operation to be 4,066 per year based on the DOE's market assessment study. Whereas the work paper assumes the average hours for all industrial motors, we used the information provided in the market assessment study to determine the average operating hours of motors only associated with compressed air systems. We weighted the average by the number of applications in each motor size category as shown in Table 46.

Table 46. Weighted Average Annual Hours of Operation Calculated for Various Motor Sizes

Size Category	DOE Market Assessment Annual Hours	DEC Tracking Database Number of Applications (2013-2015)	Percentage of Total Application Population
6 - 20 hp	2,131	0	0%
21 - 50 hp	3,528	15	56%
51 - 100 hp	4,520	5	19%
101 - 200 hp	4,685	6	22%
201 - 500 hp	6,148	1	4%
501 - 1000 hp	6,156	0	0%
1000+ hp	7,485	0	0%
Weighted Average	**4,066**	**27**	**100%**

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Though each of the 27 applications in the tracking database contained self-reported operating hours, Cadmus did not use these to determine the adjusted savings for this measure. The self-reported hours varied from 74% less than to 115% greater than the adjusted hours.

Work Paper Adjustment Results

Aside from the quantity of VSDs installed as part of each application, the savings depend on the hp rating of the pump. The hp ratings are identified as *custom quantities* in DEC's tracking database. *Custom quantities* are not always recorded or recorded accurately in the DEC database. For the VSDs measure, the hp ratings were entered into the *quantity*, the *custom quantity*, or the *hp* column. This made it difficult to determine the savings for each application. Cadmus found this to be a persistent issue in the entire tracking database where the total measure savings depended on not just the quantity of the measure but also additional parameters, such as hp rating of motors or pumps. Where necessary, Cadmus calculated the actual hp values based on the incentive amounts paid to each application.

The adjusted per hp savings for each of the different base cases are shown in Table 47. The adjusted savings for VSD air compressor projects for the program years 2013 through 2015 are shown in Table 48.

The largest factor effecting the savings in the evaluated figure was better performance of the updated base case compressors and the reduction in the hours of use.

Table 47. Adjusted VSDs on Air Compressors Measure Savings

Base Case	Savings Parameter	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Variable Displacement	NCP kW	0.0450	0.0081	18%
	Summer CP kW	0.0450	0.0081	18%
	Annual kWh	188	112	60%
Load/Unload	NCP kW	0.1210	0.0624	52%
	Summer CP kW	0.1210	0.0624	52%
	Annual kWh	501	388	77%
Modulation	NCP kW	0.1510	0.0973	64%
	Summer CP kW	0.1510	0.0973	64%
	Annual kWh	629	607	96%

Table 48. Total Claimed and Adjusted Savings for VSDs on Air Compressors

Savings	Total Savings (kWh)	Total NCP Savings (kW)	Total CP Savings (kW)
Claimed [A]	1,543,273	371	371
Adjusted [B]	1,435,649	230	230
Realization Rate [B/A]	93%	62%	62%

Conclusions and Recommendations

Conclusion 1. In the case of the VSDs on air compressors measure, the savings depended on the quantity and the hp rating of air compressor motors. However, the hp rating of the motor was not always recorded or recorded accurately in the tracking database. Cadmus found this to be an issue in its review of the entire tracking database for measures whose total savings depended on not just the quantity of the measure but also additional parameters, such as hp rating of the motors.[41]

Recommendation 1. Record the quantitative parameters for measure saving determination consistently to facilitate total measure savings and program saving calculations.

Conclusion 2. The tracking database includes three measure codes for VSDs on air compressors: one with a generic base case motor control scheme, one for load/unload controls, and one for variable displacement controls. The database does not include a measure code for the modulation base case control scheme identified in the work paper.

Recommendation 2. Discontinue the generic air compressor control scheme measure code and add a measure code for the modulation base case control scheme.

41 Further discussion of this issue was provided in this report under Program Tracking Data Review and Measure Selection.

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High-Efficiency Pumps

DEC applied a deemed savings per hp for each pump in the 10 applications for high-efficiency pumps. Table 49 shows the deemed savings per pumping hp for program years 2013 through 2014. The table shows deemed annual energy, NCP demand, and summer CP demand, savings included in the work paper.

Table 49. DEC Deemed Saving for High-Efficiency Pumps

Savings	Savings per hp
Average NCP Demand (kW)	0.0550
Summer CP Demand (kW)	0.0430
Energy (kWh)	201.00

Work Paper Methodology

According to the work paper, the deemed energy and demand savings per hp were calculated by averaging the energy and demand savings for 17 high-efficiency pump configurations. The configurations compared standard efficiency Bell Gossett pumps to comparable more efficient Bell Gossett pumps ranging from 2 to 20 hp. The 17 configurations had pressure heads that ranged from 20 to 100 feet and flows that ranged from 100 to 500 gallons per minute. The average loading of the pumps was assumed to be 65% based on findings in the *United States Industrial Electric Motor Systems Market Opportunities Assessment, December 2002 (MSMA).*[42] DEC used the following algorithm to calculate the energy and demand savings for each configuration.

$$\Delta kW_{NCP} = (Bhp_{Base} - Bhp_{Eff}) / \eta_{motor} \times 0.746 \text{ kW/hp}$$

$$\Delta kWh = \Delta kW_{NCP} \times H$$

$$\Delta kW_{CP} = \Delta kW_{NCP} \times CF$$

Where,

Bhp = Break hp

η_{motor} = motor efficiency, assumed, 90%

H = annual operating hours, assumed, 3,680[43] hours per year

[42] U.S. Department of Energy. United States Industrial Electric Motor Systems Market Opportunities Assessment. December 2002.

[43] Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

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CF = coincidence factor[44], 0.78

The work paper cites the Focus on Energy Deemed Savings Manual for annual hours of use.[45] The CF is stated to be the NYSERDA program value. The paper did not provide a source for motor efficiency.

Work Paper Methodology Adjustments Necessary

While the work paper allows DEC to assign a single energy or demand saving figure per pump hp, Cadmus found large uncertainty in the inputs and assumptions used to calculate this saving figure. There is significant variability in sizing, configuration, and operation of pumps (including the operational hours, the pressure difference through the pump, the pump flow profile, and even the fluid being pumped). One pump model may be efficient in one configuration while being very inefficient in another. Cadmus recommends this measure be included as a Custom Program measure in the future. However, for the applications submitted during the evaluation period, the following adjustments are necessary:

- The work paper methodology to normalize the savings based on a pump load factor of 65% is not correct. The source used to identify this 65% load factor was referring to the motor load factor, not the pump load factor. A pump's load factor is dependent on the specific pump output configuration and selection and Cadmus determined that the different configurations used in the 17 models were a good representation of typical pump systems. Thus, normalizing the savings to an average pump load factor is not necessary.
- The assumed motor efficiency of 90% was updated to 88.5% based on the EISA 2007 Mandatory Minimum Full-Load Efficiency Standards for motor sizes from 1-20 hp. [46]
- All of the applications included self-reported annual operating hours, which ranged from 2,130 to 8,736 hours. The hours used in the work paper are based on commercial equipment operation only. However, this measure is applicable for both commercial and industrial pumps. Thus, Cadmus determined that using the self-reported hours on each individual measure line item as appropriate for the adjustment calculations.

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44 Coincident factor is the likelihood that a piece of equipment will be running at the designed load during peak grid demand hours.

45 Kema, Inc. *Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0.* Prepared for State of Wisconsin Public Service Commission of Wisconsin. March 22, 2010.

46 http://energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf (pg. 2-4)

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Work Paper Adjustment Results

Table 50 shows the adjusted per hp savings rates and the realization rates for the previous rates. Table 51 shows the adjusted savings figures and how they compare to the program values used in the previous years for the three ECM motor measures.

Table 50 Adjusted High-Efficiency Pumps Measure Savings

Savings	Savings per hp		
	Work Paper [A]	Adjusted [B]	Adjustment Factor [B/A]
Average NCP Demand (kW)	0.0550	0.0674	123%
Summer CP Demand (kW)	0.0430	0.0526	122%
Energy (kWh)	201.00	248.19	123%

Conclusions and Recommendations

Conclusion 1. Due to the great variability in pump sizing and configuration, Cadmus did not find an effective or accurate method to determine if an applicant's pump selection is actually an efficient choice through a Prescriptive Program.

Recommendation 1. Administer incentives for high-efficiency pumps through the Custom Program instead of the Prescriptive Program in order to accurately assess the savings potential of each application.

Table 51. Total Claimed and Adjusted Savings for High-Efficiency Pumps

Savings	Total Savings (kWh)	Total NCP Savings (kW)	Total CP Savings (kW)
Claimed [A]	121,749	33	26
Adjusted [B]	157,638	41	32
Realization Rate [B/A]	129%	123%	123%

Appendix A. Charts with Measure-Level Inputs for Duke Energy Analytics

Table 52 and Table 53 include adjusted gross and net measure savings as recommended in this evaluation:

- The tables include no savings for measure descriptions with generic base cases (when savings should be distinguished by base case). Cadmus has added new measure descriptions with the associated savings distinguished by base case.
- The tables include no savings for measures where we recommend that the unit of measure be changed. Cadmus has recommended new measure descriptions with the associated savings.
- The tables include no savings for measures where we recommend that the measure be moved to the Custom Program.

Table 52. Gross Savings Chart with Measure-Level Inputs

Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
ECM Case Motors	Discontinue	NC					Per motor	60.00%
ECM Case Motors	Discontinue	SC					Per motor	60.00%
ECM Walk-In Cooler and Freezer Motors - ECM replacing PSC (retrofit only)	Discontinue	NC					Per motor	60.00%
ECM Walk-In Cooler and Freezer Motors - ECM replacing SP (retrofit only)	Discontinue	NC					Per motor	60.00%
ECM Case Motors replacing PSC (per hp)	New	NC/SC	9090.45	1.0640	1.0640	1.0640	Per HP	60.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
ECM Case Motors replacing SP (per hp)	New	NC/SC	11359.25	1.3295	1.3295	1.3295	Per HP	60.00%
ECM Walk-In Cooler and Freezer Motors - ECM replacing PSC (per hp)	New	NC/SC	9090.45	1.0640	1.0640	1.0640	Per HP	60.00%
ECM Walk-In Cooler and Freezer Motors - ECM replacing SP (per hp)	New	NC/SC	11359.25	1.3295	1.3295	1.3295	Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC Fans Only	Continue	NC	1910.61	0.2181	0.2914	0.2990	Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC Fans Only	Continue	SC	1910.61	0.2181	0.2914	0.2990	Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC Pumps Only	Discontinue	NC					Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC Pumps Only	Discontinue	SC					Per HP	60.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
Variable Frequency Drives (VFDs) - Applied to HVAC Cooling Water Pumps	New	NC/SC	1633.12	0.1860	0.1846	0.1957	Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC Hot Water Pumps	New	NC/SC	1547.74	0.1770	0.0935	0.2319	Per HP	60.00%
Variable Frequency Drives (VFDs) - Applied to HVAC WSHP Circulation Pumps	New	NC/SC	2561.95	0.2920	0.2280	0.2949	Per HP	60.00%
Variable Frequency Drives (VFDs) - For Process Fluid Pumping Only	Discontinue	NC					Per HP	60.00%
15 Horse Power High Efficiency Pumps	Discontinue	SC					Per HP	60.00%
20 Horse Power High Efficiency Pumps	Discontinue	SC					Per HP	60.00%
3 Horse Power High Efficiency Pumps	Discontinue	SC					Per HP	60.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
7.5 Horse Power High Efficiency Pumps	Discontinue	SC					Per HP	60.00%
High Efficiency Pumps 10 HP	Discontinue	NC					Per HP	60.00%
High Efficiency Pumps 15 HP	Discontinue	NC					Per HP	60.00%
High Efficiency Pumps 2 HP	Discontinue	NC					Per HP	60.00%
20 Horse Power High Efficiency Pumps	Discontinue	NC					Per HP	60.00%
3 Horse Power High Efficiency Pumps	Discontinue	NC					Per HP	60.00%
High Efficiency Pumps 5 HP	Discontinue	NC					Per HP	60.00%
7.5 Horse Power High Efficiency Pumps	Discontinue	NC					Per HP	60.00%
VSD Air Compressors	Discontinue	NC					Per HP	60.00%
VSD Air Compressors	Discontinue	SC					Per HP	60.00%
VSD Air COMP replacing modulation	New	NC/SC	607.10	0.0973	0.0973	0.0973	Per HP	60.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
VSD Air COMP replacing load no load COMP	Continue	NC	388.20	0.0624	0.0624	0.0624	Per HP	60.00%
VSD Air COMP replacing variable displacement COMP	Continue	SC	111.90	0.0081	0.0081	0.0081	Per HP	60.00%
High Bay 2L T-5 High Output	Continue	NC	393.68	0.0878	0.0834	9,999	Per Fixture	14.00%
High Bay 4L T-5 High Output	Continue	NC	1159.16	0.2586	0.2457	9,999	Per Fixture	14.00%
High Bay 6L T-5 High Output	Continue	NC	492.10	0.1098	0.1043	9,999	Per Fixture	14.00%
High Bay 8L T-5 High Output	Continue	NC	1990.26	0.4441	0.4219	9,999	Per Fixture	14.00%
High Bay T8 4ft Fluorescent 4 Lamp (F32 Watt T8)	Continue	NC	809.22	0.1806	0.1715	9,999	Per Fixture	14.00%
High Bay T8 4ft Fluorescent 6 Lamp (F32 Watt T8)	Continue	NC	1263.05	0.2818	0.2677	9,999	Per Fixture	14.00%
T8 HB 4ft 8L replacing a 400-999W HID(retrofit only)	Continue	NC	852.97	0.1903	0.1808	9,999	Per Fixture	14.00%
2 High Bay 6L T-5 High Output	Continue	SC	1913.71	0.4270	0.4057	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
replacing 1000W HID								
High Bay 4L T-5 High Output	Continue	SC	1159.16	0.2586	0.2457	9,999	Per Fixture	14.00%
High Bay 6L T-5 High Output	Continue	SC	492.10	0.1098	0.1043	9,999	Per Fixture	14.00%
High Bay T8 4ft Fluorescent 4 Lamp (F32 Watt T8)	Continue	SC	809.22	0.1806	0.1715	9,999	Per Fixture	14.00%
T8 HB 4ft 3L replacing 150-249W HID(retrofit only)	Continue	SC	448.35	0.1000	0.0950	9,999	Per Fixture	14.00%
High Bay T8 4ft Fluorescent 8 Lamp (F32 Watt T8)	Continue	SC	852.97	0.1903	0.1808	9,999	Per Fixture	14.00%
2 High Bay 6L T-5 High Output replacing 1000W HID	Continue	NC	1913.71	0.4270	0.4057	9,999	Per Fixture	14.00%
2 fixtures - T8 HB 4ft 8 Lamp (32W) (or single fixture 16 lamps) replacing 1,000 W HID (2 for 1 replacement retrofit only)	Continue	NC	2635.45	0.5880	0.5586	9,999	Per Fixture	14.00%
High Bay 3L T-5 High Output	Continue	NC	590.52	0.1318	0.1252	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
High Bay T8 4ft Fluorescent 3 Lamp (F32 Watt T8)	Continue	NC	448.35	0.1000	0.0950	9,999	Per Fixture	14.00%
High Bay T8 4ft Fluorescent 6 Lamp (F32 Watt T8)	Continue	SC	1263.05	0.2818	0.2677	9,999	Per Fixture	14.00%
T8 HB 4ft 2L rplcng 150-249W HID (retrofit only)	Continue	NC	620.59	0.1385	0.1315	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 1 lamp, replacing standard T8	Continue	SC	42.91	0.0097	0.0073	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 2 lamp, replacing standard T8	Continue	SC	70.87	0.0160	0.0121	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 3 lamp, replacing standard T8	Continue	SC	91.93	0.0207	0.0157	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 4 lamp, replacing standard T8	Continue	SC	135.52	0.0305	0.0232	9,999	Per Fixture	14.00%
High Performance T8 4ft 2 lamp	Continue	SC	85.58	0.0193	0.0146	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
fixture replacing T12 4ft 2 lamp								
High Performance T8 4ft 2 lamp, replacing T12 High Output 8ft 1 lamp	Continue	SC	180.48	0.0406	0.0309	9,999	Per Fixture	14.00%
High Performance T8 4ft 4 lamp, replacing T12 High Output 8ft 2 lamp	Continue	SC	330.72	0.0744	0.0566	9,999	Per Fixture	14.00%
High Performance T8 4ft 1 lamp, replacing standard T8	Continue	SC	28.46	0.0064	0.0049	9,999	Per Fixture	14.00%
High Performance T8 4ft 1 lamp, replacing T12-HPT8	Continue	SC	63.69	0.0143	0.0109	9,999	Per Fixture	14.00%
High Performance T8 4ft 2 lamp, replacing standard T8	Continue	SC	44.93	0.0101	0.0077	9,999	Per Fixture	14.00%
High Performance T8 4ft 3 lamp, replacing standard T8	Continue	SC	51.23	0.0115	0.0088	9,999	Per Fixture	14.00%
High Performance T8 4ft 3 lamp, replacing T12-HPT8	Continue	SC	143.38	0.0323	0.0245	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
High Performance T8 4ft 4 lamp, replacing standard T8	Continue	SC	76.43	0.0172	0.0131	9,999	Per Fixture	14.00%
Low Watt T8 lamps 2-4ft, replacing standard 32 Watt T8	Continue	SC	21.68	0.0049	0.0037	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 1 lamp, replacing standard T8	Continue	NC	42.91	0.0097	0.0073	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 2 lamp, replacing standard T8	Continue	NC	70.87	0.0160	0.0121	9,999	Per Fixture	14.00%
High Performance Low Watt T8 4ft 3 lamp, replacing standard T8	Continue	NC	91.93	0.0207	0.0157	9,999	Per Fixture	14.00%
High Performance T8 4ft 2 lamp fixture replacing T12 4ft 2 lamp	Continue	NC	85.58	0.0193	0.0146	9,999	Per Fixture	14.00%
Relamp T8 4ft 32W fixtures with Reduced Wattage	Continue	NC	21.68	0.0049	0.0037	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
T8 lamps 28 watts or less								
High Performance T8 4ft 4 lamp, replacing T12-HPT8	Continue	NC	163.16	0.0367	0.0279	9,999	Per Fixture	14.00%
High Performance T8 4ft 1 lamp, replacing standard T8	Continue	NC	28.46	0.0064	0.0049	9,999	Per Fixture	14.00%
High Performance T8 4ft 1 lamp fixture replacing T12 4ft 1 lamp	Continue	NC	63.69	0.0143	0.0109	9,999	Per Fixture	14.00%
High Performance T8 4ft 2 lamp, replacing standard T8	Continue	NC	44.93	0.0101	0.0077	9,999	Per Fixture	14.00%
High Performance T8 4ft 3 lamp, replacing standard T8	Continue	NC	51.23	0.0115	0.0088	9,999	Per Fixture	14.00%
High Performance T8 4ft 3 lamp, replacing T12-HPT8	Continue	NC	143.38	0.0323	0.0245	9,999	Per Fixture	14.00%
High Performance T8 4ft 4 lamp,	Continue	NC	76.43	0.0172	0.0131	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
replacing standard T8								
High Performance Low Watt T8 4ft 4 lamp, replacing standard T8	Continue	NC	135.52	0.0305	0.0232	9,999	Per Fixture	14.00%
High Performance T8 4ft 2 lamp, replacing T12 High Output 8ft 1 lamp	Continue	NC	180.48	0.0406	0.0309	9,999	Per Fixture	14.00%
High Performance T8 4ft 4 lamp, replacing T12 High Output 8ft 2 lamp	Continue	NC	330.72	0.0744	0.0566	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 1 lamp of 28W or less & ballast replacing standard T12 4ft 1 lamp	Continue	NC	78.14	0.0176	0.0134	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 1 lamp of 28W or less & ballast replacing standard T12 4ft 1 lamp	Continue	SC	78.14	0.0176	0.0134	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
Reduced Wattage T8 4ft 2 lamp of 28 W or less & ballast replacing standard T12 4 ft 2 lamp	Continue	NC	111.52	0.0251	0.0191	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 2 lamp of 28 W or less & ballast replacing standard T12 4 ft 2 lamp	Continue	SC	111.52	0.0251	0.0191	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 3 lamp of 28 W or less & ballast replacing standard T12 4 ft 3 lamp	Continue	NC	184.08	0.0414	0.0315	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 3 lamp of 28 W or less & ballast replacing standard T12 4 ft 3 lamp	Continue	SC	184.08	0.0414	0.0315	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 4 lamp of 28 W or less & ballast replacing standard T12 4 ft 4 lamp	Continue	NC	222.25	0.0500	0.0380	9,999	Per Fixture	14.00%
Reduced Wattage T8 4ft 4 lamp of 28 W or less & ballast	Continue	SC	222.25	0.0500	0.0380	9,999	Per Fixture	14.00%

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Measure Name	Evaluation Recommendation	State	EM&V Gross Target Annual kWh Savings/Unit	EM&V Gross Target Annual Non-Coincident kW/Unit	EM&V Gross Target Annual Summer Coincident kW/Unit	EM&V Gross Target Annual Winter Coincident kW/Unit	Unit of Measure	Combined Free Rider % - Spillover%
replacing standard T12 4 ft 4 lamp								
Replace 60-100W incandescent with ENERGY STAR qualified LED downlight 18 Watts or less. (retrofit only)	Continue	NC	234.05	0.0647	0.0498	9,999	Per Fixture	14.00%
Replace 60-100W incandescent with ENERGY STAR qualified LED downlight 18 Watts or less. (retrofit only)	Continue	SC	234.05	0.0647	0.0498	9,999	Per Fixture	14.00%
Replace incandescent bulbs with Energy Star LED (retrofit only)	Continue	NC	140.76	0.0378	0.0291	9,999	Per Lamp	14.00%
Replace incandescent bulbs with Energy Star LED (retrofit only)	Continue	SC	140.76	0.0378	0.0291	9,999	Per Lamp	14.00%

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Table 53. Net Savings Chart with Measure-Level Inputs and Recommendations

Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
ECM Case Motors	Discontinue					3743	Cadmus recommends the savings be calculated by hp, not by motor, and distinguished between SP and PSC motors.
ECM Case Motors	Discontinue					3744	Cadmus recommends the savings be calculated by hp, not by motor, and distinguished between SP and PSC motors.
ECM Walk-In Cooler and Freezer Motors - ECM replacing PSC (retrofit only)	Discontinue					3748	Cadmus recommends the savings be calculated by hp, not by motor, and distinguished between SP and PSC motors.

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
ECM Walk-In Cooler and Freezer Motors - ECM replacing SP (retrofit only)	Discontinue					3753	Cadmus recommends the savings be calculated by hp, not by motor, and distinguished between SP and PSC motors.
ECM Case Motors replacing PSC (per hp)	New	3636.18	0.4256	0.4256	9,999		New code for case motors SP
ECM Case Motors replacing SP (per hp)	New	4543.70	0.5318	0.5318	9,999		New code for case motors PSC
ECM Walk-In Cooler and Freezer Motors - ECM replacing PSC (per hp)	New	3636.18	0.4256	0.4256	9,999		New code for walk-ins SP
ECM Walk-In Cooler and Freezer Motors - ECM replacing SP (per hp)	New	4543.70	0.5318	0.5318	9,999		New code for walk-ins PSC
Variable Frequency	Continue	764.25	0.0872	0.1165	0.1196	3637	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
Drives (VFDs) - Applied to HVAC Fans Only							
Variable Frequency Drives (VFDs) - Applied to HVAC Fans Only	Continue	764.25	0.0872	0.1165	0.1196	3639	
Variable Frequency Drives (VFDs) - Applied to HVAC Pumps Only	Discontinue					3642	Cadmus recommends distinguishing savings by pump duty.
Variable Frequency Drives (VFDs) - Applied to HVAC Pumps Only	Discontinue					3644	Cadmus recommends distinguishing savings by pump duty.
Variable Frequency Drives (VFDs) - Applied to HVAC Cooling Water Pumps	New	653.25	0.0744	0.0739	0.0783		New code for savings by pump duty
Variable Frequency Drives (VFDs) - Applied to HVAC	New	619.09	0.0708	0.0374	0.0928		New code for savings by pump duty

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
Hot Water Pumps							
Variable Frequency Drives (VFDs) - Applied to HVAC WSHP Circulation Pumps	New	1024.78	0.1168	0.0912	0.1179		New code for savings by pump duty
Variable Frequency Drives (VFDs) - For Process Fluid Pumping Only	Discontinue					3647	Cadmus recommends moving to Custom program.
15 Horse Power High Efficiency Pumps	Discontinue					1324	Cadmus recommends moving to Custom program.
20 Horse Power High Efficiency Pumps	Discontinue					1328	Cadmus recommends moving to Custom program.
3 Horse Power High Efficiency Pumps	Discontinue					1330	Cadmus recommends moving to Custom program.

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
7.5 Horse Power High Efficiency Pumps	Discontinue					1333	Cadmus recommends moving to Custom program.
High Efficiency Pumps 10 HP	Discontinue					1422	Cadmus recommends moving to Custom program.
High Efficiency Pumps 15 HP	Discontinue					1427	Cadmus recommends moving to Custom program.
High Efficiency Pumps 2 HP	Discontinue					1438	Cadmus recommends moving to Custom program.
20 Horse Power High Efficiency Pumps	Discontinue					1440	Cadmus recommends moving to Custom program.
3 Horse Power High Efficiency Pumps	Discontinue					1446	Cadmus recommends moving to Custom program.

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
High Efficiency Pumps 5 HP	Discontinue					1452	Cadmus recommends moving to Custom program.
7.5 Horse Power High Efficiency Pumps	Discontinue					1455	Cadmus recommends moving to Custom program.
VSD Air Compressors	Discontinue					3853	Cadmus recommends distinguishing savings by base case control scheme.
VSD Air Compressors	Discontinue					3854	Cadmus recommends distinguishing savings by base case control scheme.
VSD Air COMP replacing modulation	New	242.84	0.0389	0.0389	9,999		New code for modulation base case control
VSD Air COMP replacing load no load COMP	Continue	155.28	0.0250	0.0250	9,999	6062	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
VSD Air COMP replacing variable displacement COMP	Continue	44.76	0.0032	0.0032	9,999	6182	
High Bay 2L T-5 High Output	Continue	338.56	0.0755	0.0718	9,999	1181	
High Bay 4L T-5 High Output	Continue	996.88	0.2224	0.2113	9,999	1182	
High Bay 6L T-5 High Output	Continue	423.20	0.0944	0.0897	9,999	1183	
High Bay 8L T-5 High Output	Continue	1711.62	0.3819	0.3628	9,999	1184	
High Bay T8 4ft Fluorescent 4 Lamp (F32 Watt T8)	Continue	695.93	0.1553	0.1475	9,999	1185	
High Bay T8 4ft Fluorescent 6 Lamp (F32 Watt T8)	Continue	1086.22	0.2424	0.2302	9,999	1186	
T8 HB 4ft 8L replacing a 400-999W HID(retrofit only)	Continue	733.55	0.1637	0.1555	9,999	1187	
2 High Bay 6L T-5 High Output	Continue	1645.79	0.3672	0.3489	9,999	1325	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
replacing 1000W HID							
High Bay 4L T-5 High Output	Continue	996.88	0.2224	0.2113	9,999	1370	
High Bay 6L T-5 High Output	Continue	423.20	0.0944	0.0897	9,999	1371	
High Bay T8 4ft Fluorescent 4 Lamp (F32 Watt T8)	Continue	695.93	0.1553	0.1475	9,999	1373	
T8 HB 4ft 3L replacing 150-249W HID(retrofit only)	Continue	385.58	0.0860	0.0817	9,999	1376	
High Bay T8 4ft Fluorescent 8 Lamp (F32 Watt T8)	Continue	733.55	0.1637	0.1555	9,999	1377	
2 High Bay 6L T-5 High Output replacing 1000W HID	Continue	1645.79	0.3672	0.3489	9,999	1431	
2 fixtures - T8 HB 4ft 8 Lamp (32W) (or single fixture 16 lamps) replacing 1,000	Continue	2266.49	0.5057	0.4804	9,999	1434	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
W HID (2 for 1 replacement retrofit only)							
High Bay 3L T-5 High Output	Continue	507.84	0.1133	0.1076	9,999	1547	
High Bay T8 4ft Fluorescent 3 Lamp (F32 Watt T8)	Continue	385.58	0.0860	0.0817	9,999	1550	
High Bay T8 4ft Fluorescent 6 Lamp (F32 Watt T8)	Continue	1086.22	0.2424	0.2302	9,999	1806	
T8 HB 4ft 2L rplcng 150-249W HID (retrofit only)	Continue	533.71	0.1191	0.1131	9,999	6036	
High Performance Low Watt T8 4ft 1 lamp, replacing standard T8	Continue	36.90	0.0083	0.0063	9,999	1393	
High Performance Low Watt T8 4ft 2 lamp,	Continue	60.94	0.0137	0.0104	9,999	1394	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
replacing standard T8							
High Performance Low Watt T8 4ft 3 lamp, replacing standard T8	Continue	79.06	0.0178	0.0135	9,999	1395	
High Performance Low Watt T8 4ft 4 lamp, replacing standard T8	Continue	116.55	0.0262	0.0199	9,999	1396	
High Performance T8 4ft 2 lamp fixture replacing T12 4ft 2 lamp	Continue	73.60	0.0166	0.0126	9,999	1397	
High Performance T8 4ft 2 lamp, replacing T12 High Output 8ft 1 lamp	Continue	155.22	0.0349	0.0266	9,999	1398	
High Performance T8 4ft 4 lamp,	Continue	284.42	0.0640	0.0487	9,999	1400	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
replacing T12 High Output 8ft 2 lamp							
High Performance T8 4ft 1 lamp, replacing standard T8	Continue	24.47	0.0055	0.0042	9,999	1401	
High Performance T8 4ft 1 lamp, replacing T12-HPT8	Continue	54.77	0.0123	0.0094	9,999	1402	
High Performance T8 4ft 2 lamp, replacing standard T8	Continue	38.64	0.0087	0.0066	9,999	1403	
High Performance T8 4ft 3 lamp, replacing standard T8	Continue	44.06	0.0099	0.0075	9,999	1405	
High Performance T8 4ft 3 lamp, replacing T12-HPT8	Continue	123.30	0.0278	0.0211	9,999	1406	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
High Performance T8 4ft 4 lamp, replacing standard T8	Continue	65.73	0.0148	0.0112	9,999	1407	
Low Watt T8 lamps 2-4ft, replacing standard 32 Watt T8	Continue	18.65	0.0042	0.0032	9,999	1426	
High Performance Low Watt T8 4ft 1 lamp, replacing standard T8	Continue	36.90	0.0083	0.0063	9,999	1553	
High Performance Low Watt T8 4ft 2 lamp, replacing standard T8	Continue	60.94	0.0137	0.0104	9,999	1554	
High Performance Low Watt T8 4ft 3 lamp, replacing standard T8	Continue	79.06	0.0178	0.0135	9,999	1555	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
High Performance T8 4ft 2 lamp fixture replacing T12 4ft 2 lamp	Continue	73.60	0.0166	0.0126	9,999	1557	
Relamp T8 4ft 32W fixtures with Reduced Wattage T8 lamps 28 watts or less	Continue	18.65	0.0042	0.0032	9,999	1568	
High Performance T8 4ft 4 lamp, replacing T12-HPT8	Continue	140.32	0.0316	0.0240	9,999	1793	
High Performance T8 4ft 1 lamp, replacing standard T8	Continue	24.47	0.0055	0.0042	9,999	1794	
High Performance T8 4ft 1 lamp fixture replacing T12 4ft 1 lamp	Continue	54.77	0.0123	0.0094	9,999	1795	
High Performance T8	Continue	38.64	0.0087	0.0066	9,999	1796	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
4ft 2 lamp, replacing standard T8							
High Performance T8 4ft 3 lamp, replacing standard T8	Continue	44.06	0.0099	0.0075	9,999	1797	
High Performance T8 4ft 3 lamp, replacing T12-HPT8	Continue	123.30	0.0278	0.0211	9,999	1798	
High Performance T8 4ft 4 lamp, replacing standard T8	Continue	65.73	0.0148	0.0112	9,999	1799	
High Performance Low Watt T8 4ft 4 lamp, replacing standard T8	Continue	116.55	0.0262	0.0199	9,999	1807	
High Performance T8 4ft 2 lamp, replacing T12	Continue	155.22	0.0349	0.0266	9,999	1826	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
High Output 8ft 1 lamp							
High Performance T8 4ft 4 lamp, replacing T12 High Output 8ft 2 lamp	Continue	284.42	0.0640	0.0487	9,999	1827	
Reduced Wattage T8 4ft 1 lamp of 28W or less & ballast replacing standard T12 4ft 1 lamp	Continue	67.20	0.0151	0.0115	9,999	3823	
Reduced Wattage T8 4ft 1 lamp of 28W or less & ballast replacing standard T12 4ft 1 lamp	Continue	67.20	0.0151	0.0115	9,999	3824	
Reduced Wattage T8 4ft 2 lamp of 28 W or less & ballast replacing	Continue	95.91	0.0216	0.0164	9,999	3828	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
standard T12 4 ft 2 lamp							
Reduced Wattage T8 4ft 2 lamp of 28 W or less & ballast replacing standard T12 4 ft 2 lamp	Continue	95.91	0.0216	0.0164	9,999	3829	
Reduced Wattage T8 4ft 3 lamp of 28 W or less & ballast replacing standard T12 4 ft 3 lamp	Continue	158.30	0.0356	0.0271	9,999	3833	
Reduced Wattage T8 4ft 3 lamp of 28 W or less & ballast replacing standard T12 4 ft 3 lamp	Continue	158.30	0.0356	0.0271	9,999	3834	
Reduced Wattage T8 4ft 4 lamp of 28 W or less & ballast	Continue	191.13	0.0430	0.0327	9,999	3838	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
replacing standard T12 4 ft 4 lamp							
Reduced Wattage T8 4ft 4 lamp of 28 W or less & ballast replacing standard T12 4 ft 4 lamp	Continue	191.13	0.0430	0.0327	9,999	3839	
Replace 60-100W incandescent with ENERGY STAR qualified LED downlight 18 Watts or less. (retrofit only)	Continue	201.28	0.0556	0.0428	9,999	3813	
Replace 60-100W incandescent with ENERGY STAR qualified LED downlight 18 Watts or less. (retrofit only)	Continue	201.28	0.0556	0.0428	9,999	3814	
Replace incandescent	Continue	121.05	0.0325	0.0250	9,999	3818	

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Measure Name	Evaluation Recommendation	EM&V Net Target Annual kWh Savings/Unit	EM&V Net Target Annual Non-Coincident kW/Unit	EM&V Net Target Annual Summer Coincident kW/Unit	EM&V Net Target Annual Winter Coincident kW/unit	SRC_PGM_MEAS_ID	Notes
bulbs with Energy Star LED (retrofit only)							
Replace incandescent bulbs with Energy Star LED (retrofit only)	Continue	121.05	0.0325	0.0250	9,999	3819	

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Appendix B. Summary Form

DUKE ENERGY

Smart $aver Nonresidential Prescriptive Incentive Program

Duke Energy Carolinas
Completed EM&V Fact Sheet
2016 Evaluation – Cadmus

Program Description

The Duke Energy Smart $aver Nonresidential Prescriptive Incentive Program encourages energy efficiency by providing incentives for qualifying high-efficiency measures such as lighting, HVAC, and motors. Duke Energy business customers may install the energy-efficient measures and then apply for the incentive within 90 days of installing the equipment and provide proof of purchase.

Date	August 4, 2017
Region(s)	Carolinas
Evaluation Period	Applications Paid from January 2013 through July 2015
Gross Energy Savings (kWh)	Adjusted savings calculated for select measures
Net Coincident kW Impact (Summer)	Adjusted savings calculated for select measures
Measure life	Various
Net Energy Savings (kWh)	Adjusted savings calculated for select measures
Process Evaluation	Yes, reported separately.
Previous Evaluation(s)	Yes.

Evaluation Methodology

The evaluation team performed engineering desk reviews on the work papers describing deemed energy and demand saving calculation methodologies for the following measures: ECM motors, high efficiency pumps, high efficiency linear fluorescents, high-bay linear fluorescents, LEDs, VFDs on motors, and VSDs on air compressors.

The evaluation team adjusted the claimed per-unit energy and demand saving estimates, as necessary, and applied the updated values to all measure participants. The evaluation team calculated a lighting and non-lighting Net-to-Gross (NTG) ratio and calculated net energy and demand saving estimates for the measures reviewed.

Impact Evaluation Details:

- The majority of the claimed program savings are attributed to lighting and HVAC measures. The pumps measure category contributed the least to the overall claimed program savings.
- The desk review analysis for the ten measures sampled produced realization rates ranging from 68% to 139%.
- The evaluation team calculated 40% NTG ratio for lighting and 86% NTG ratio for non-lighting projects.

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REPORT

Save Energy and Water Kits 2016 Program Year Evaluation Report

Submitted to Duke Energy
in partnership with Research into Action

November 29th, 2017

Principal authors:

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1 Executive Summary

1.1 Program Summary

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 the Duke Energy Progress (DEP) and Duke Energy Carolinas (DEC) jurisdictions. The kits include aerators for kitchen and bathroom sink faucets, one or two showerheads, and water heater insulating pipe tape.

1.2 Evaluation Objectives and Results

This report presents the results and findings of evaluation activities for DEP/DEC SEWKP conducted by the evaluation team, collectively Nexant Inc. and our subcontracting partner, Research into Action, for the program year of January – December 2016.

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 DEP and DEC Save Energy and Water Kit programs. The evaluation was divided into two research areas - to determine gross 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 SEWKP kit. Net impacts reflect the degree to which the gross savings are a result of the program efforts and funds.

Table 1-1 and Table 1-2 present the summarized findings of the impact evaluation for the DEP jurisdiction.

Table 1-1: 2016 DEP Energy Savings per Kit

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	432.0	91.7%	396.1	93.4%	370.1
Demand (kW)	0.07	188.6%	0.133		0.124

Table 1-2: 2016 DEP Program Level Energy Savings

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	12,162,634	91.7%	11,153,216	93.4%	10,418,681
Demand (kW)	1,985.2	188.6%	3,744.5		3,497.9

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The findings of the impact evaluation for the DEC jurisdiction are summarized in Table 1-3 and Table 1-4.

Table 1-3: 2016 DEC Energy Savings per Kit

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	595.2	47.0%	279.6	93.2%	260.5
Demand (kW)	0.245	38.8%	0.095		0.089

Table 1-4: 2016 DEC Program Level Energy Savings

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	19,669,692	47.0%	9,239,316	93.2%	8,608,979
Demand (kW)	8,101.2	38.8%	3,147.3		2,932.6

Gross verified energy and demand savings by measure and net to gross ratio details for both the DEP and DEC jurisdictions are presented in Figure 1-1 and Figure 1-2; Table 1-5 and Table 1-6, respectively.

Figure 1-1: 2016 DEP Gross Verified Energy Savings

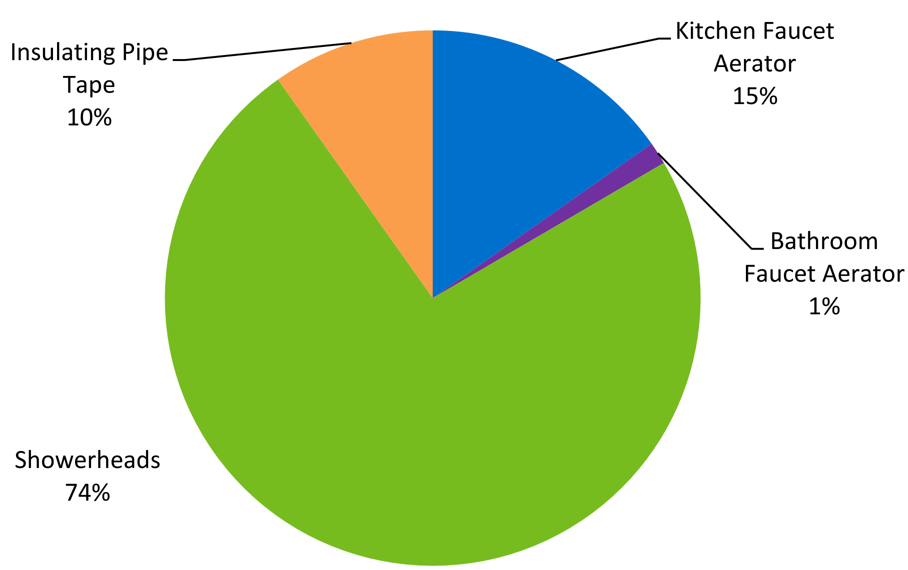

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Table 1-5: DEP Program Year 2016 Verified Impacts by Measure

Measure	Gross Energy Savings per unit (kWh)	Gross Demand per unit (kW)	Free Ridership	Spillover	Net to Gross Ratio
1.5 GPM Showerhead	291.6	0.093	0.16	0.08	0.934
1.0 GPM Bathroom Faucet Aerator	5.4	0.003	0.15		
1.0 GPM Kitchen Faucet Aerator	60.3	0.032	0.13		
Insulating Pipe Tape*	38.8	0.004	0.10		
Total Kit Impacts	**396.1**	**0.133**	**0.15**	**0.08**	**0.934**

*Per package of pipe tape installed.

Figure 1-2: 2016 DEC Gross Verified Energy Savings

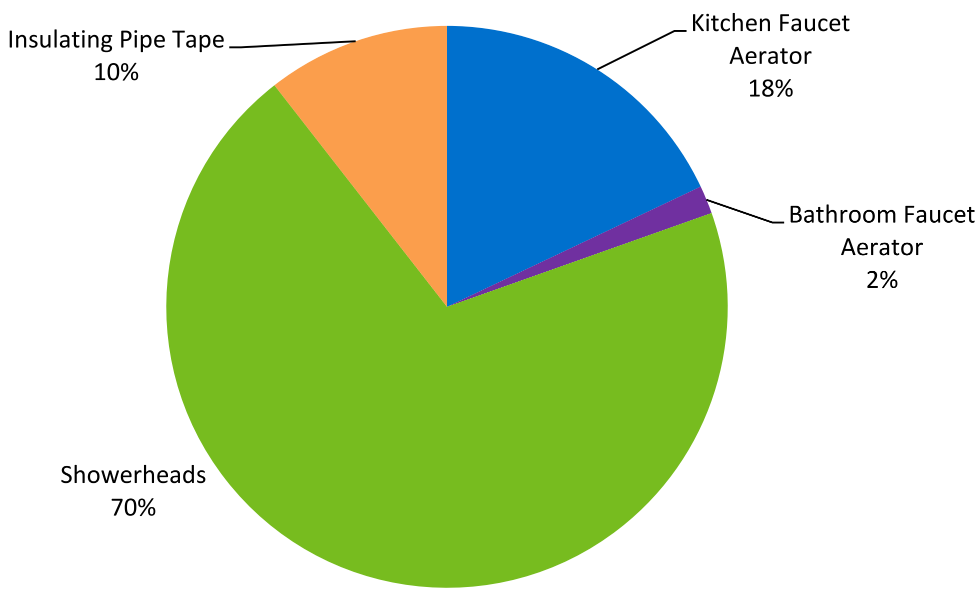

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Table 1-6: DEC Program Year 2016 Verified Impacts by Measure

Measure	Gross Energy Savings per unit (kWh)	Gross Demand per unit (kW)	Free Ridership	Spillover	Net to Gross Ratio
1.5 GPM Showerhead	195.4	0.063	0.19	0.10	0.932
1.0 GPM Bathroom Faucet Aerator	4.5	0.002	0.10		
1.0 GPM Kitchen Faucet Aerator	50.2	0.027	0.13		
Insulating Pipe Tape	29.5	0.003	0.11		
Total Kit Impacts	**279.6**	**0.095**	**0.17**	**0.10**	**0.932**

*Per package of pipe tape installed.

1.2.2 Process Evaluation

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

The evaluation team reviewed program documents and conducted telephone and web surveys with households that received a kit (DEP n=131; DEC n=114). The team also conducted in-depth interviews with utility and implementation staff.

Program Successes
The 2016 DEP/DEC SEWKP evaluation found successes in the following areas:

Kit instructions are perceived as highly helpful among SEWKP participants. About four-fifths of participants in either jurisdiction (84% DEP; 82% DEC) said they read the instructional insert from their kit that offers detailed instructions on self-installing the measures, the majority of which said the instructions were highly helpful. These paper instructions are likely sufficient for most participants, as few respondents reported viewing the online instructional videos.

The program influenced household to install kit measures. Nearly all participating households installed at least one measure from the kit and the vast majority of measures, once installed, remained installed. Participants were highly influenced by the program to install kit measures, as demonstrated by low free ridership rates. Further, about one-third of respondents in either jurisdiction (30% DEP; 33% DEC) reported spillover actions.

Most participants are satisfied with kit items and report high satisfaction with the overall program. Ten percent or fewer of participants reported dissatisfaction with any of the specific measures they installed. Over four-fifths of participants in either jurisdiction (84% DEP; 86% DEC) reported they were highly satisfied with the overall program.

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The kit size assignment algorithm is highly accurate. The kit size assignment algorithm assigns smaller kits to smaller homes (less than 1,500 square feet) and medium kits to larger homes (1,500 square feet or more). As a result, SEWKP typically delivers a useable number of units to most homes.

Program Challenges

The 2016 DEP/DEC SEWKP evaluation found some challenges in the following areas:

Insulating pipe tape is the least popular measure. Pipe tape was the least installed measure type, with less than half of participants in either jurisdiction (47% DEP; 40% DEC) reporting installing it.

Low water pressure is a significant contributor to dissatisfaction and uninstalls. Complaints of excessively low water pressure were the primary drivers of dissatisfaction with and uninstallation of water saving measures. However, only a minority of participants (were dissatisfied with (2% DEP; 0% DEC) or uninstalled them (6% DEC; 0% DEC).

Inadequate size is a common barrier hindering aerator installation. Of those who did not install the kitchen faucet aerator, over one-third (39% DEP; 41% DEC) reported they did not install the measure because it did not fit on their faucet. Similarly, over one-third (38% DEC; 46% DEC) of respondents who did not install any of the bathroom faucet aerators cited sizing issues.

A sizable minority of participants reported having natural gas water heaters. While the program targets customer homes with electric water heat, the evaluation team found that 18% of DEP and 29% of DEC customers reported having non-electric water heaters in their homes.

Many items do not get installed, especially multi-count measures. Across the DEP and DEC jurisdictions, ISRs ranged from 23% to 63%. ISRs were lowest for multi-count measures.

Medium kits had lower ISRs on every measure. Across the DEP and DEC jurisdictions, medium kits had lower ISRs than small kits on every measure.

1.3 Evaluation Conclusions and Recommendations

Based on evaluation findings, the evaluation team concludes the following and provides several recommendations for program improvement:

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. Most participants installed at least one measure from the kit and the vast majority of measures, once installed, stayed installed. Participants were highly influenced by the program to install these kit

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measures, as demonstrated by low free ridership rates. Further, about one-third of respondents in either jurisdiction reported spillover actions.

> **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 satisfaction and uninstallation issues. Complaints of excessively low water pressure were the primary drivers of item dissatisfaction and uninstallation. However, only a minority of participants was dissatisfied with or uninstalled water saving items.

> **Recommendation**: Consider expanding participant-facing messaging around low-flow measures; water measure ISRs and satisfaction may increase if participants have better upfront expectations on the flow rates of the measures and better understand the energy saving benefits of low-flow fixtures.

> **Recommendation**: Consider investigating alternative products that provide the same GPM as the current aerator and showerhead offerings but offer higher perceived water pressure.

Conclusion 3: Despite delivering a useable number of units to most homes, there may be cost- effectiveness benefits to reducing the number of items delivered. The kit size assignment algorithm works fairly well:

- Small and medium kit recipients largely got the appropriate number of kitchen and bathroom aerators, given the number of faucets in their home.
- However, more than half of small kit recipients have two or more showers in their home.

Nonetheless, many items do not get installed, especially multi-count measures:

- Recipients of either kit size installed one bathroom aerator and one showerhead on average.
- Medium kits had lower ISRs on every measure, suggesting that delivering too many items may overwhelm participants and consequently hinder installations.

> **Recommendation**: Consider if there is a significant enough cost-effectiveness benefit to justify reducing the number of kit sizes and multi-count units offered. Reducing the number of items included in the kit, particularly the number of bathroom aerators provided, could increase ISRs and reduce program costs as the survey data reveals there is a negative relationship with number of kit items delivered and ISRs (that is, the more items Duke Energy provides, the lower the ISRs).

Conclusion 4: A high amount of non-electric water heater customers participated in the program. In total, the evaluation found that 18% of DEP and 29% of DEC customers in the

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program had non-electric water heaters. These saturations are comparable to the 2013 general population Duke Residential Appliance Saturation Survey which reflects non-electric water heat saturation of 25%.

> **Recommendation:** For future program recruitment, Duke Energy should continue to review and refine its customer screening techniques to better filter non-electric water heater customers from the program's solicitation.

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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 Progress (DEP) and Duke Energy Carolinas (DEC) territory. The kits include aerators for kitchen and bathroom sink faucets, one or two showerheads, and water heater insulating 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 and bathroom aerators 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: 2016 Kit Measures

Measures	Small Kit Count	Medium Kit Count
1.5 GPM Showerhead	1 low-flow showerhead	2 low-flow showerheads
1.0 GPM Bathroom Faucet Aerator	2 low-flow faucet aerators	4 low-flow faucet aerators
0.5/1.0/1.5 (adjustable) GPM Kitchen Faucet Aerator	1 low-flow kitchen aerator	1 low-flow kitchen aerator
Insulating Pipe Tape (2 inches wide, 15 feet long)	1 roll of pipe tape	1 roll of pipe tape

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 data. Next, Duke Energy mails business reply cards (BRC) to all pre-selected households. Simultaneously, Duke Energy sends the implementer – Energy Federation, Inc. (EFI) – a list of pre-selected accounts that received the BRC that month. Households that receive the BRC simply detach the reply form and put it back in the mail (postage is pre-paid). These BRC reply forms are mailed to EFI. Upon receipt, EFI scans the unique barcodes on the BRCs to register

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responding households as participants. Alternatively, customers may also call a toll free number, provided on the 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 January 2016 through December 2016, the program recorded a total of 63,876 kit recipients (28,799 kits distributed in DEP; 35,077 kits distributed in DEC). During survey recruitment of customers, 2.2% of sampled DEP participants and 5.8% of sampled DEC participants notified the evaluation team that their kits never arrived. The causation of this reported rate of non-received kits could not be fully identified by the evaluation team. Due to the program design of soliciting customers via a program mailer, customer address accuracy is expected to be very high for the program. However, this does not account for issues related to third party delivery failure or inaccurate customer recall.

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 DEP and DEC 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;

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- 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 DEP and DEC 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 2016 program participants.

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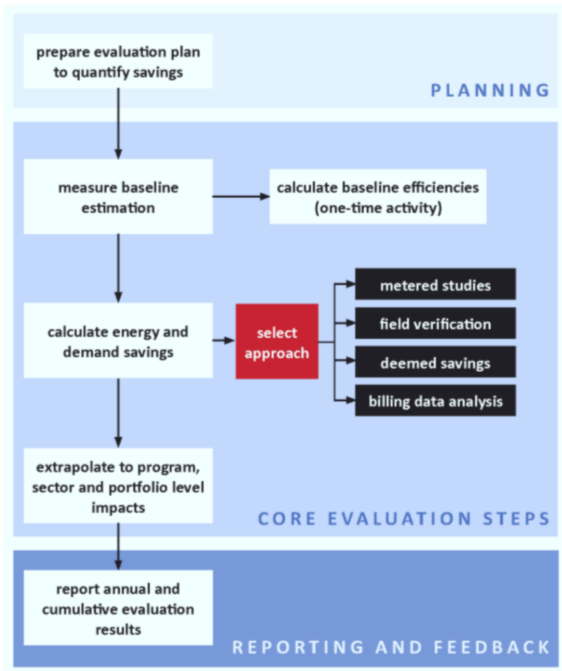
2.4.1 Impact Evaluation

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 and on-site inspections 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.

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- **Calculate Impacts:** Data collected via surveys enabled the evaluation team to calculate gross verified energy and demand savings[1] 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 evaluation, measurement, and verification (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 DEP/DEC SEWKP process and impact evaluation.

Table 2-2: DEP/DEC SEWKP Summary of Evaluation Activities

Target Group	2016 Survey Population	Sample	Confidence /Precision	Method
Impact Activities				
DEP Participants	28,799	131	90/7.2	Telephone/Web Survey
DEC Participants	35,077	114	90/7.7	Telephone/Web Survey
Process Activities				
DEP Participants	28,799	131	90/7.2	Telephone/Web Survey
DEC Participants	35,077	114	90/7.7	Telephone/Web Survey
Duke Energy Program Staff	N/A	1	N/A	Telephone IDI
Implementer Staff: EFI	N/A	1	N/A	Telephone IDI

[1] Due to the small size of the measure and overall program impacts relative to annual consumption, a utility bill regression analysis was not feasible as such an analysis cannot effectively isolate the impacts from inherent noise in the billing data in absence of a randomized control trial. Therefore, the impact analysis relied on engineering algorithms to assess the program's savings impacts.

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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 January 2016 through December 2016. The evaluation was divided into two research areas: to determine gross 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 DEP and DEC participant databases.
- 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-verified 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 Database and Historical Evaluation Review

Duke Energy provided the evaluation team with a program database for the SEWKP participation within each jurisdiction. The program database provided participant contact information including account number, address, phone number, email address (if available), and whether or not the participant was willing to be contacted. Because Duke Energy was able to provide both phone numbers and email addresses, we were able to design a sampling approach that could take advantage of both phone and web-based surveying.

The evaluation team conducted a benchmarking review of the uncertainty of ex-ante savings estimates by comparing multiple technical reference manuals (TRMs) and SEWK evaluations conducted in select Duke Energy jurisdictions. The details of the benchmarking review are referenced in Table 3-1. The listed savings values include the impact of in-service rates.

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Table 3-1: Comparison of Ex-Ante SEWKP Energy Savings to Peer Group Estimates

Measure	Duke Energy Carolinas 2015 SEWKP evaluation[1]	Duke Energy Progress SEWKP ex ante savings[2]	Mid-Atlantic 2016 TRM[3]	Indiana 2012 TRM[4]	Texas 2015 TRM[5]	Pennsylvania 2016 TRM[6]
1.5 GPM Showerhead	293.87	143.00	296.63	71.59	340.26	327.96
1.0 GPM Bathroom Faucet Aerator	6.45	73.00	37.63	22.44	61.59	21.69
Adjustable Kitchen Faucet Aerator	183.37	61.00	37.63	33.66	61.59	130.73
Insulating Pipe Tape	111.50	155.00[7]	111.22	111.42	35.74	47.15

[1]Duke Energy Carolinas Save Energy and Water Kit Program evaluation. The Cadmus Group, revised April, 2016.
[2]Duke Energy provided.
[3]Mid-Atlantic Technical Reference Manual version 6.0. May, 2016.
[4]Indiana Technical Reference Manual, version 1.0. December, 2012.
[5]Texas Technical Reference Manual, version 3.0, Volume 2 Residential Measures. April, 2015.
[6]State of Pennsylvania Technical Reference Manual. June, 2016.
[7]DEP ex ante savings for pipe insulation based on an assumed installation of five feet of hot water pipe tape.

While Table 3-1 does illustrate variation in deemed savings among each source for each given measure, much of this variation reflects different in-service rate and water heat fuel type assumptions. Also of note is that the Mid-Atlantic, Indiana, and Texas TRMs do not differentiate parameter assumptions between bathroom and kitchen faucet aerators. For this reason, the evaluation team ultimately used assumptions outlined by the Pennsylvania TRM to capture different usage patterns between each aerator location. All other parameters not mined from the participant survey generally relied on the Mid-Atlantic TRM assumptions.

3.3 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 across both jurisdictions assuming a coefficient of variation (C_v) equal to 0.5.

3.3.1 DEP Sample

After reviewing the program database, we identified a population of 28,799 participants within our defined evaluation period. Based on this population, the evaluation team established sub-sample frames for phone and web-based survey administration. As illustrated in Table 3-2 below, we completed a total of 131 surveys. This sample size resulted in an achieved confidence and precision of 90/7.2.

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Table 3-2: DEP Impact Sampling

Survey Mode	Sample Frame	Sampled Participants	Achieved Confidence/ Precisions
Phone	900[1]	37	90/7.2
Web-based	1,387	94	
Total	**2,287**	**131**	

[1]The total desired phone quota was completed before exhausting the sample frame. A total of 281 calls were dialed.

3.3.2 DEC Sample

The evaluation team identified a population of 35,077 participants within our defined evaluation period. Based on this population, we again established sub-sample frames for phone and web-based survey administration. As illustrated in Table 3-3 below, we completed a total of 114 surveys. This sample size resulted in an achieved confidence and precision of 90/7.7.

Table 3-3: DEC Impact Sampling

Survey Mode	Sample Frame	Sampled Participants	Achieved Confidence/ Precisions
Phone	900[1]	34	90/7.7
Web-based	1,613	80	
Total	**2,513**	**114**	

[1]The total desired phone quota was completed before exhausting the sample frame. A total of 260 calls were dialed.

3.4 Description of Analysis

3.4.1 Telephone and web-based surveys

The evaluation team performed telephone and web-based surveys to gain 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 3-4.

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Table 3-4: Participant Data Collected and Used for Analysis

Measure	Data Collected	Assumption
1.5 GPM Showerhead 1.0 GPM Bathroom Faucet Aerator Adjustable Kitchen Faucet Aerator	Units Installed	In-Service Rate
	Units Later Removed	
	Hot Water Fuel Type	% Electric DHW
	Adjustable Aerator Flow Rate	GPM Installed
	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

3.4.2 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 3-5 and Table 3-6.

Table 3-5: DEP SEWKP In-Service Rates

Measure	Distributed	Installed	Removed	ISR
1.5 GPM Showerhead	232	126	11	50%
1.0 GPM Bathroom Faucet Aerator	464	137	8	28%
Adjustable Kitchen Faucet Aerator	131	64	6	44%
Insulating Pipe Tape*	131	52	1	39%

*Quantity of pipe tape packages.

Table 3-6: DEC SEWKP In-Service Rates

Measure	Distributed	Installed	Removed	ISR
1.5 GPM Showerhead	193	96	9	45%
1.0 GPM Bathroom Faucet Aerator	386	96	5	24%
Adjustable Kitchen Faucet Aerator	114	50	5	39%
Insulating Pipe Tape*	114	35	0	31%

*Quantity of pipe tape packages.

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3.4.3 Faucet Aerators

The Save Energy and Water Kit contained one kitchen faucet aerator and multiple bathroom faucet aerators. Participants receiving a small kit received two bathroom faucet aerators; those qualifying for a medium kit received four bathroom faucet aerators. The equations below outline the algorithms utilized to estimate savings accrued by the faucet aerator measures with parameters defined in Table 3-7. The algorithm used to estimate aerator impacts is based on the Pennsylvania TRM [2].

Equation 3-1: Faucet Aerator Energy Savings

$$\Delta kWh = ISR \times ELEC \times \left[\frac{\Delta GPM \times T_{person/day} \times N_{persons} \times 365\,\frac{days}{year} \times DF \times \Delta T \times 8.3\,\frac{BTU}{gal \cdot °F}}{\#_{faucets} \times 3{,}412\,\frac{BTU}{kWh} \times RE}\right]$$

Equation 3-2: Faucet Aerator Demand Savings

$$\Delta kW = ETDF \times \Delta kWh$$

Table 3-7: Inputs for Faucet Aerator Measures Savings Calculations

Input	Units	DEC Value*	DEP Value*	Source
ISR	N/A	Bath: 24% Kitchen: 39%	Bath: 28% Kitchen: 44%	Survey responses
ELEC	N/A	Bath: 70% Kitchen: 80%	Bath: 81% Kitchen: 85%	Survey responses
ΔGPM	GPM	Bath: 1.2 Kitchen: 1.21		Product specification sheet and survey responses compared against federal code minimum
$T_{person/day}$	Minutes	Bath: 1.6 Kitchen: 4.5		Pennsylvania 2016 TRM
$N_{persons}$	Persons	Bath: 2.4 Kitchen: 2.5	Bath: 2.5 Kitchen: 2.5	Survey responses
DF	N/A	Bath: 90% Kitchen: 75%		Pennsylvania 2016 TRM
ΔT	°F	Bath: 19.1 Kitchen: 19.1		Mid-Atlantic 2016 TRM
$\#_{faucets}$	Units	Bath: 2.6	Bath: 3.1	Survey responses

[2] The prior evaluation conducted for DEC SEWKP relied on the Mid-Atlantic TRM. The evaluation team opted to use the Pennsylvania TRM as it provides a more comprehensive algorithm and differentiates between bathroom aerator and kitchen aerator assumptions.

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Input	Units	DEC Value*	DEP Value*	Source
		Kitchen: 1.1	Kitchen: 1.1	
ETDF	N/A	Bath: 0.00053 Kitchen: 0.00053		Pennsylvania 2016 TRM
RE	N/A	98%		Mid-Atlantic 2016 TRM

*Parameter values are estimated based on participants who installed the measure. For example, the water heat saturation is representative of participants who installed the faucet aerator as opposed to the full sample of participants which would include participants who did not install a faucet aerator.

The evaluation team determined that the 2016 Pennsylvania's TRM provided the most applicable calculations by differentiating between kitchen and bathroom water use and providing more comprehensive algorithms. Where the Mid-Atlantic 2016 TRM made appropriate distinctions, the evaluation team used the Mid-Atlantic parameter assumptions due to its geographic relevance to the DEP and DEC territory. However, where the Mid-Atlantic TRM lacked granularity, the evaluation team elected to use the Pennsylvania TRM as the secondary data source for estimating savings.

3.4.4 Showerheads

The Save Energy and Water Kit contained multiple low-flow showerheads with the quantity depending on the size of the kit received. Participants receiving a small kit 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 faucet aerator measures with parameters defined in Table 3-8. The algorithm used to estimate showerhead impacts is based on the Pennsylvania TRM.

Equation 3-3: Showerhead Energy Savings

$$\Delta kWh = ISR \times ELEC \times \left[\frac{\Delta GPM \times T_{person/day} \times N_{persons} \times 365\,\frac{days}{year} \times N_{showers-day} \times \Delta T \times 8.3\,\frac{BTU}{gal \cdot {}^{\circ}F}}{3{,}412\,\frac{BTU}{kWh} \times RE}\right]$$

Equation 3-4: Showerhead Demand Savings

$$\Delta kW = ETDF \times \Delta kWh$$

Table 3-8: Inputs for Showerhead Savings Calculations

Input	Units	DEC Value*	DEP Value*	Source
ISR	N/A	45%	50%	Survey responses
ELEC	N/A	74%	83%	Survey responses
ΔGPM	GPM	1.0		Product specification sheet compared against federal code minimum
$T_{person/day}$	Minutes	7.9	9.4	Survey responses
$N_{persons}$	Persons	2.3	2.5	Survey responses

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Input	Units	DEC Value*	DEP Value*	Source
$N_{showers\text{-}day}$	Persons	0.8	0.8	Survey responses
ΔT	°F	44.1		Mid-Atlantic 2016 TRM
ETDF	N/A	0.00032		Pennsylvania 2016 TRM
RE	N/A	98%		Mid-Atlantic 2016 TRM

*Parameter values are estimated based on participants who installed the measure. For example, the water heat saturation is representative of participants who installed the showerhead as opposed to the full sample of participants which would include participants who did not install a showerhead.

The evaluation team determined that the 2016 Pennsylvania's TRM provided the most applicable and rigorous algorithm. However, we did rely on the Mid-Atlantic 2016 TRM for parameter assumptions that were more geographically relevant to the DEP and DEC territory.

3.4.5 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. The algorithm used to estimate pipe wrap impacts is based on the Mid-Atlantic TRM.

Equation 3-5: Insulating Pipe Tape Energy Savings

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

Equation 3-6: Insulating Pipe Tape Demand Savings

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

Table 3-9: Inputs for Insulating Pipe Tape Savings Calculations

Input	Units	DEC Value*	DEP Value*	Source
ISR	N/A	31%	39%	Survey Responses
ELEC	N/A	74%	78%	Survey Responses
R_{ex}	N/A	1.00		Federal Code Minimum
R_{new}	N/A	3.00		Product Sheet Specification
L	Feet	5.8	5.7	Survey Responses**
C	Feet	0.20		Mid-Atlantic 2016 TRM (Average of 1/2" and 3/4" pipe)
ΔT	°F	65.0		Mid-Atlantic 2016 TRM
ηDHW	N/A	0.98		Mid-Atlantic 2016 TRM
ETDF	N/A	0.00011		Mid-Atlantic 2016 TRM (Calculated)

*Parameter values are estimated based on participants who installed the measure. For example, the water heat saturation is representative of participants who installed the pipe tape as opposed to the full sample of participants which would include participants who did not install pipe tape.
**Participant-provided estimated lengths of hot water pipe covered by the pipe tape was used to estimate verified savings.

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Reported savings for this measure assumes five feet of pipe is covered.

Through a combination of participant survey responses as well as TRM and other deemed values, we estimated the parameter inputs presented above in Table 3-9.

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 for both jurisdictions. The final DEP sample yielded a relative precision of +/- 7.2% at the 90% confidence level while the DEC sample yielded a relative precision of +/- 7.7% at the 90% confidence level (Table 3-10).

Table 3-10: Targeted and Achieved Confidence and Precision

Program	Targeted Confidence/Precision	Achieved Confidence/Precision
DEP SEWKP	90/10.0	90/7.2
DEC SEWKP		90/7.7

3.6 Results

3.6.1 DEP findings

Measure-level and kit-level energy savings values for the DEP jurisdiction are detailed in Figure 3-1 and Table 3-11.

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Figure 3-1: 2016 DEP Gross Verified Energy Savings

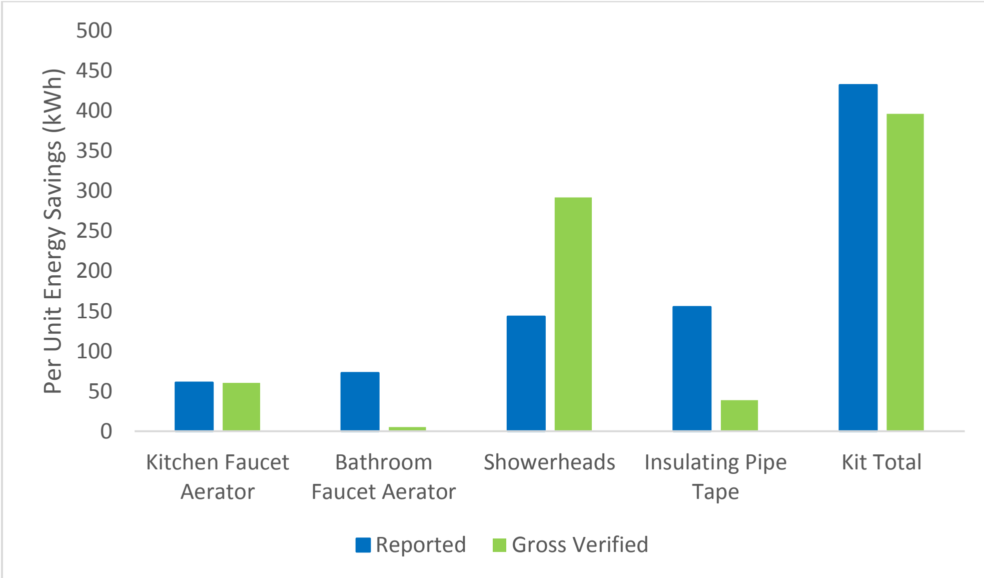

Table 3-11: DEP Measure-Level Reported and Verified Gross Energy Savings

Measure	Reported Energy Savings, per unit (kWh)	Realization Rate	Verified Gross Energy Savings, per unit (kWh)	Total Verified Gross Energy Savings (kWh)
Low-flow Showerhead (1.5 GPM)	143.0	203.9%	291.6	8,210,886
Low-flow Bathroom Aerator (1.0 GPM)	73.0	7.4%	5.4	151,412
Low-flow Kitchen Aerator (1.0 GPM)	61.0	98.8%	60.3	1,697,285
Insulating Pipe Tape*	155.0	25.1%	38.8	1,093,634
Total	**432.0**	**91.7%**	**396.1**	**11,153,216**

*Reported savings for pipe tape based on an assumed installation of five feet of tape.

Measure-level and kit-level demand savings are detailed in Table 3-12.

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Table 3-12: DEP Measure-Level Reported and Verified Demand Gross Savings

Measure	Reported Demand Savings, per unit (kW)	Realization Rate	Verified Gross Demand Savings, per unit (kW)	Total Verified Gross Demand Savings (kW)
Low-flow Showerhead (1.5 GPM)	0.03	285.3%	0.093	2,632.0
Low-flow Bathroom Aerator (1.0 GPM)	0.02	17.2%	0.003	80.9
Low-flow Kitchen Aerator (1.0 GPM)	0.01	230.7%	0.032	906.8
Insulating Pipe Tape*	0.01	63.1%	0.004	124.8
Total	**0.07**	**188.6%**	**0.133**	**3,744.5**

*Reported savings for pipe tape based on an assumed installation of five feet of tape.

The impact evaluation for the 2016 program resulted in a program energy realization rate of 91.7% and a demand realization rate of 188.6% as presented in Table 3-13.

Table 3-13: 2016 DEP Energy Savings per Kit

Measurement	Reported	Realization Rate	Gross Verified
Energy (kWh)	432.0	91.7%	396.1
Demand (kW)	0.07	188.6%	0.133

Table 3-14 presents the reported and verified energy and demand savings for the 2016 program year.

Table 3-14: 2016 DEP Program Level Energy Savings

Measurement	Reported	Realization Rate	Gross Verified
Energy (kWh)	12,162,634	91.7%	11,153,216
Demand (kW)	1,985.2	188.6%	3,744.5

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3.6.2 DEC findings

Measure-level and kit-level energy savings values for the DEC jurisdiction are detailed in Figure 3-2 and Table 3-15.

Figure 3-2: 2016 DEC Gross Verified Energy Savings

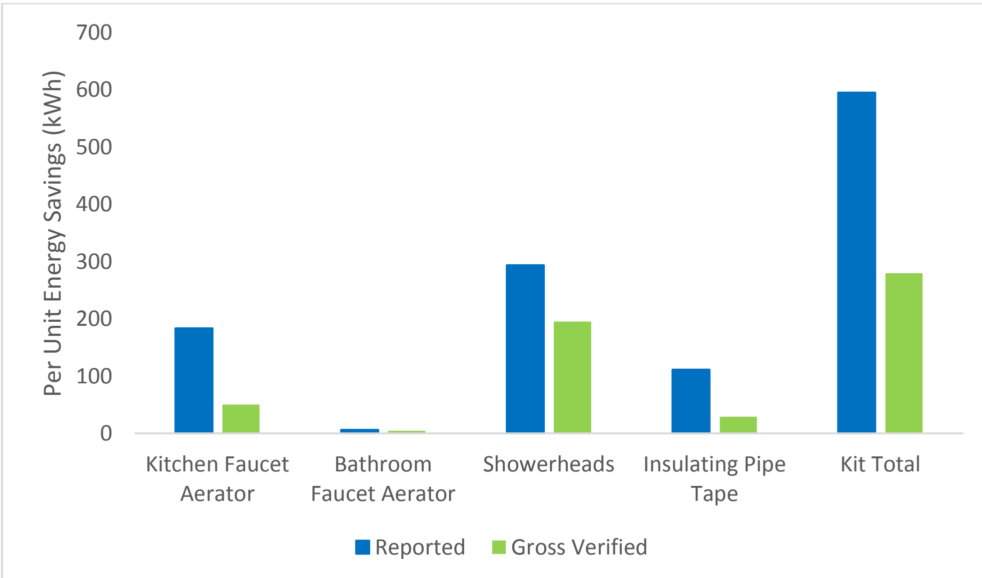

Table 3-15: DEC Measure-Level Reported and Verified Gross Energy Savings

Measure	Reported Energy Savings, per unit (kWh)	Realization Rate	Verified Gross Energy Savings, per unit (kWh)	Total Verified Gross Energy Savings (kWh)
Low-flow Showerhead (1.5 GPM)	293.9	66.5%	195.4	6,456,514
Low-flow Bathroom Aerator (1.0 GPM)	6.5	70.2%	4.5	149,610
Low-flow Kitchen Aerator (1.0 GPM)	183.4	27.4%	50.2	1,659,508
Insulating Pipe Tape*	111.5	26.4%	29.5	973,684
Total	**595.2**	**47.0%**	**279.6**	**9,239,316**

*Reported savings for pipe tape based on an assumed installation of five feet of tape.

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Measure-level and kit-level demand savings are detailed in Table 3-16.

Table 3-16: DEC Measure-Level Reported and Verified Demand Gross Savings

Measure	Reported Demand Savings, per unit (kW)	Realization Rate	Verified Gross Demand Savings, per unit (kW)	Total Verified Gross Demand Savings (kW)
Low-flow Showerhead (1.5 GPM)	0.13	48.1%	0.063	2,069.6
Low-flow Bathroom Aerator (1.0 GPM)	0.00	69.3%	0.002	79.9
Low-flow Kitchen Aerator (1.0 GPM)	0.10	36.1%	0.027	886.6
Insulating Pipe Tape*	0.01	27.8%	0.003	111.2
Total	**0.25**	**38.8%**	**0.095**	**3,147.3**

*Reported savings for pipe tape based on an assumed installation of five feet of tape.

The impact evaluation for the 2016 program resulted in a program energy realization rate of 47.0% and a demand realization rate of 38.8% as presented in Table 3-17.

Table 3-17: 2016 DEC Energy and Demand Savings per Kit

Measurement	Reported	Realization Rate	Gross Verified
Energy (kWh)	595.2	47.0%	279.6
Demand (kW)	0.25	38.8%	0.095

Table 3-18 presents the reported and verified energy and demand savings for the 2016 program year.

Table 3-18: 2016 DEC Program Level Energy and Demand Savings

Measurement	Reported	Realization Rate	Gross Verified
Energy (kWh)	19,669,692	47.0%	9,239,316
Demand (kW)	8,101.2	38.8%	3,147.3

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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).[3] 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, 0 being no free ridership and 1 being total free ridership, with values in between representing varying degrees of partial 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

[3] 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.* Retrieved August 29, 2016 from http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf.

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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	$\frac{\text{Count respondent said would install on their own}}{\text{Count respondent installed through program}}$
Don't know	0.25

*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 five 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:[4]

- 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).

[4] To reduce response fatigue, we only asked respondents to rate program influence on their decision to install the measures (as a whole). Thus, we did not collect separate influence data for each measure included in the kit.

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Table 4-2: Free Ridership Influence Values

Highest Influence Rating	FRI Value
0	0.50
1	0.45
2	0.40
3	0.35
4	0.30
5	0.25
6	0.20
7	0.15
8	0.10
9	0.05
10	0.00

4.1.3 End-Use-Specific Total Free Ridership

The evaluation team calculated total free ridership by measure, by:

- First, calculating measure-specific FR scores for each respondent by summing each respondent's measure-specific FRC score with their FRI score.
- Second, calculating a weighted mean FR score for each measure from the individual measure-specific FR scores; we weighted measure-specific FR scores by the number of units installed by each respondent.

Table 4-3 presents the measure-use FR estimates.

Table 4-3: Measure-Specific Free Ridership Scores

End-use	Measure-Specific Free Ridership	
	DEP	DEC
Showerhead	0.16	0.19
Kitchen Faucet Aerator	0.13	0.13
Bathroom Faucet Aerator	0.15	0.10
Insulating Pipe Tape	0.10	0.11

4.1.4 Program-Level Free Ridership

The evaluation team estimated program-level free ridership by calculating a savings-weighted mean of the measure-specific FR scores presented in Table 4-3. Overall free ridership for the DEP kits is 15%. Overall free ridership for the DEC kits is 17%.

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

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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 ENERGY STAR® calculators as well as based on algorithms and parameter assumptions listed in the 2016 Pennsylvania and Mid-Atlantic TRMs.

Lighting measures (namely, LEDs and CFLs) were commonly reported spillover measures. Since Duke Energy offered discounted lighting at participating retailers through their Energy Efficient Lighting (EEL) program as well through their online lighting store, we asked respondents to confirm they did not use Duke Energy's website to find or purchase discounted lighting. As to not double-count these savings, respondents who indicated they used Duke Energy's website to find or purchase discounted lighting did not count towards spillover estimates.

Participant measure spillover is calculated as follows:

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

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

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

Measure Category	Total kWh for Category	Percent Share of kWh
LEDs	1,915.3	44%
CFLs	1,625.0	37%
Appliances	531.9	12%
Insulation	106.0	2%
HVAC	67.4	2%
Other	120.6	3%
Total	**4,366.2**	**100%**

Table 4-5: DEC PMSO, by Measure by Category

Measure Category	Total kWh for Category	Percent Share of kWh
LEDs	1,679.2	54%

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Measure Category	Total kWh for Category	Percent Share of kWh
Appliances	883.9	28%
CFLs	290.9	9%
Windows	193.8	6%
HVAC	62.9	2%
Insulation	21.7	1%
Total	**3,132.4**	**100%**

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

Table 4-6: DEP Sample's Gross Program Savings (n=131)

Measure	Average per Household Savings (kWh)	Verified Sample Savings (kWh)
Showerhead	291.6	38,204.8
Kitchen Faucet Aerator	60.3	7,899.3
Bathroom Faucet Aerator	5.4	707.4
Insulating Pipe Tape	38.8	5,088.6
Total	**396.1**	**51,900.1**

Table 4-7: DEC Sample's Gross Program Savings (n=114)

Measure	Average per Household Savings (kWh)	Verified Sample Savings (kWh)
Showerhead	195.4	22,272.1
Kitchen Faucet Aerator	50.2	5,724.6
Bathroom Faucet Aerator	4.5	516.1
Insulating Pipe Tape	29.5	3,358.8
Total	**279.6**	**31,871.5**

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:

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

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$$DEP\ SO = \frac{4{,}366.2}{51{,}900.1}$$

$$DEC\ SO = \frac{3{,}132.4}{31{,}871.5}$$

These calculations produced a spillover estimate of 8% for the DEP program and 10% for the DEC program.

4.3 Net-to-Gross

Inserting the FR and SO estimates into the NTG formula (NTG = 1 – FR + SO) produces an NTG value of 0.93 for both DEP and DEC programs (Table 4-8). The evaluation team applied the NTG ratio of 0.93 to program-wide verified gross savings to calculate SEWKP kit net savings for each jurisdiction.

Table 4-8: Net-to-Gross Results

Jurisdiction	Free Ridership	Spillover	NTG
DEP	0.15	0.08	0.934
DEC	0.17	0.10	0.932

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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 evaluation 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
DEP participants	Mixed mode (web/phone) survey	131	28,799	90/7.2
DEC participants	Mixed mode (web/phone) survey	114	35,077	90/7.7

5.2 DEP Process Evaluation Findings

Motivations for Requesting Kit

The majority of DEP participants requested the Save Energy and Water Kit to conserve water (70%) and/or electricity (60%) (Table 5-2). More than half (53%) said they requested the kit because "it was free."

Table 5-2: DEP Participant Motivations for Requesting Kit (Multiple Responses Allowed; n=131)

Motivation	Percent Reporting
Wanted to conserve water	70%
Wanted to conserve electricity	60%
It was free	53%
It was offered by Duke Energy	34%
It was easy	33%
To save money	4%
Other	4%

Installation Rates

The majority (85%) 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 (69%) or the bathroom faucet aerators (56%), with a smaller proportion reporting installing the other measures. Of the respondents who received a medium-sized kit, 49% installed both

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showerheads.[5] Regardless of kit size received, participants installed one bathroom aerator and one showerhead on average.

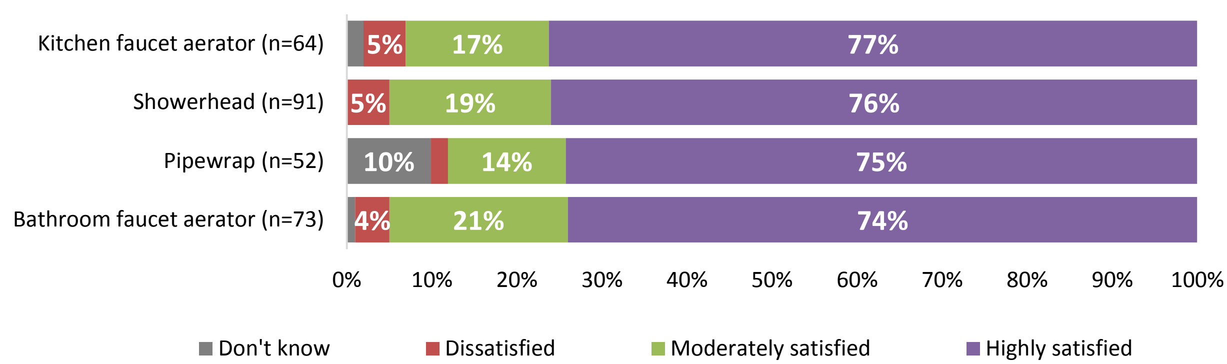
Of the respondents who installed at least one item from the kit, 15% said they later uninstalled at least one of the measures, five of whom uninstalled everything they had installed. In total, 5% of all installed measure types were later uninstalled. Showerheads and bathroom faucet aerators had the highest uninstallation rates, with about one-tenth of respondents who installed them later uninstalling them. 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-fifth (18%) of respondents reported installing all measure types. Of the respondents who did not install all measure types, 30% 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 already had the item, they had not "gotten around to it", or the item did not fit on their fixture.

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 reported similar levels of satisfaction with all four measures. Open-ended comments revealed dissatisfied respondents were displeased with the water-saving measures due to water pressure being too low.

Figure 5-1: 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 insert booklet that provides information on how to install the provided measures.

[5] 70% of medium kit recipients installed at least one showerhead, 49% of which installed both that came with the kit.

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The majority (84%) of respondents said they read the booklet, most of whom (80%) reported they found it highly helpful.[6] Additionally, Duke Energy Progress provides how-to videos on its website that demonstrate how to install the kit items. Only 7% of kit recipients watched these online videos, though most of those who watched them (67%) considered the videos highly helpful[7].

Additional Energy Saving Actions

Over one-quarter (39 of 131, or 30%) of participants reported purchasing and installing at least one additional energy efficiency measure since receiving their kit (Table 5-3). LEDs (18 mentions) and energy efficient appliances (13 mentions) were the most common purchases reported. Seven respondents reported getting a DEP incentive for their measure, and most (25 of 39) respondents said the DEP SEWKP at least partially influenced their decision to purchase and install additional energy-saving measures.

Table 5-2: Additional Energy Saving Measures Purchased by DEP Participants (Multiple Responses Allowed; n=131)

	Count of Respondents Reporting Purchases After Receiving the Kit	Count That Received Duke Incentives for the Purchase/Measure*	Count Reporting at Least Some DEP Program Influence on Purchase
At least one measure	39	7	25
LEDs	18	4	11
Efficient appliances	13	0	9
Air sealing	11	0	9
CFLs	9	1	8
Insulation	9	0	7
Efficient heating or cooling equipment	8	2	4
Energy efficient water heater	6	0	4
Efficient windows	2	0	0
Duct sealing or insulation	2	0	2
Other	7	0	5

* Includes respondents that indicated they got their LEDs and CFLs through the DEP buy-down program.

6 We asked respondents to rate the helpfulness of the instruction booklet on a scale from 0 (“not at all helpful”) to 10 (“very helpful”). 88 of the 110 (or 80%) respondents who reported reading the booklet gave a rating of 8 or higher.

7 We asked respondents to rate the helpfulness of the DEP online how-to videos on a scale from 0 “not at all helpful” to 10 (“very helpful”). Six of the nine (67%) respondents who reported watching the videos gave a rating of 8 or higher.

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5.3 DEC Process Evaluation Findings

Motivations for Requesting Kit

More than half of DEC participants requested the Save Energy and Water Kit to conserve water (56%) and/or electricity (55%) (Table 5-3). Less than half (41%) requested the kit because "it was free".

Table 5-3: DEC Participant Motivations for Requesting Kit (Multiple Responses Allowed; n=114)

Motivation	Percent Reporting
Wanted to conserve water	56%
Wanted to conserve electricity	55%
It was free	41%
It was offered by Duke Energy	36%
It was easy	17%
To save money	5%
Other	8%

Installation Rates

Most (76%) kit recipients installed at least one measure, installing an average of two measures from the kit. The majority of kit recipients initially installed at least one of the showerheads (62%), less than half (46%) initially installed at least one of the bathroom faucet aerators, with a smaller proportion reporting installing the other measures. Of the respondents who received a medium-sized kit, 53% installed both showerheads.[8] Regardless of kit size received, participants installed one bathroom aerator and one showerhead on average.

Of the respondents who installed at least one item from the kit, 12% said they later uninstalled at least one of the measures, but only three participants uninstalled everything they had installed. In total, 3% of all installed measure types were later uninstalled. Kitchen faucet aerators and showerheads had the highest uninstallation rates, with about one-tenth of respondents who initially installed them uninstalling them later. 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.

Eleven percent of respondents reported installing all measure types. Of the respondents who did not install all measure types, 43% 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 already had the item, they had not "gotten around to it", or the item did not fit on their fixture.

[8] 59% of medium kit recipients installed at least one showerhead, 53% of which installed both that came with the kit.

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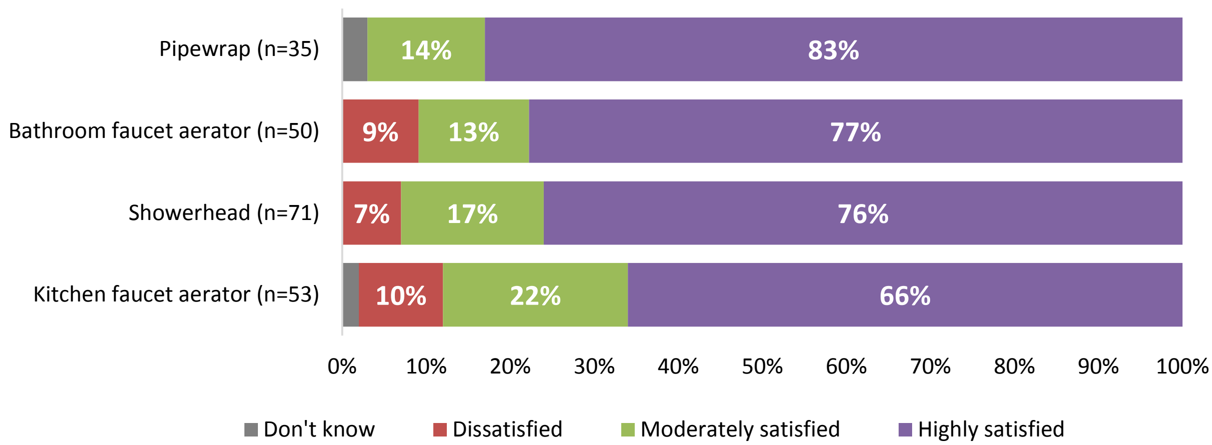
Measure Satisfaction

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 were most satisfied with the pipe tape and were least satisfied with the kitchen faucet aerator. Open-ended comments revealed respondents were dissatisfied with the water-saving measures due to water pressure being too low.

Figure 5-2: DEC 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 insert that provides information on how to install the provided measures. The majority (82%) of respondents said they read the insert, most of whom (70%) reported they found it highly helpful.[9] Additionally, Duke Energy provides how-to videos on its website that demonstrate how to install the kit items. Only 5% of kit recipients watched these online videos, though 83% of them considered the videos highly helpful.[10]

Additional Energy Saving Actions

One-third (37 of 114, or 33%) of participants reported purchasing and installing additional energy efficiency measures since receiving their kit (Table 5-4). Participants most commonly reported installing LEDs (14 respondents) or sealing air leaks in windows, walls, or doors (11 respondents). Eleven respondents reported getting a Duke Energy incentive for their measure, and most (29 of 37) respondents said DEC SEWKP at least partially influenced their decision to purchase and install additional energy-saving measures.

[9] We asked respondents to rate the helpfulness of the instruction booklet on a scale from 0 (“not at all helpful”) to 10 (“very helpful”). Sixty-five of the 93 (or 70%) respondents who reported reading the booklet gave a rating of 8 or higher.

[10] We asked respondents to rate the helpfulness of the DEC online how-to videos on a scale from 0 “not at all helpful” to 10 (“very helpful”). Five of the six (83%) respondents who reported watching the videos gave a rating of 8 or higher.

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Table 5-4: Additional Energy Saving Measures Purchased by DEC Participants (Multiple Responses Allowed; n=114)

	Count of Respondents Reporting Purchases After Receiving the Kit	Count That Received Duke Incentives for the Purchase/Measure*	Count Reporting at Least Some DEC Program Influence on Purchase
At least one measure	37	11	29
LEDs	14	5	12
Air sealing	11	0	10
CFLs	7	4	6
Efficient appliances	7	0	7
Efficient heating or cooling equipment	7	1	4
Efficient water heater	7	0	5
Insulation	6	0	6
Efficient windows	3	0	3
Duct sealing	2	0	1
Moved into ENERGY STAR home	1	0	1
Other	3	1	2

* Includes respondents that indicated they got their LEDs and CFLs through the Duke Energy buy-down program.

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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. Most participants installed at least one measure from the kit and the vast majority of measures, once installed, stayed installed. Participants were highly influenced by the program to install these kit measures, as demonstrated by low free ridership rates. Further, about one-third of respondents in either jurisdiction reported spillover actions.

> **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 satisfaction and uninstallation issues. Complaints of excessively low water pressure were the primary drivers of item dissatisfaction and uninstallation. However, only a minority of participants were dissatisfied with or uninstalled water saving items.

> **Recommendation**: Consider expanding participant-facing messaging around low-flow measures; water measure ISRs and satisfaction may increase if participants have better upfront expectations on the flow rates of the measures and better understand the energy saving benefits of low-flow fixtures.

> **Recommendation**: Consider investigating alternative products that provide the same GPM as the current aerator and showerhead offerings, but offer higher perceived water pressure.

Conclusion 3: Despite delivering a useable number of units to most homes, there may be cost- effectiveness benefits to reducing the number of items delivered. The kit size assignment algorithm works fairly well:

- Small and medium kit recipients largely got the appropriate number of kitchen and bathroom aerators, given the number of faucets in their home.
- However, more than half of small kit recipients have two or more showers in their home.

Nonetheless, many items do not get installed, especially multi-count measures:

- Recipients of either kit size installed one bathroom aerator and one showerhead on average.

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- Medium kits had lower ISRs on every measure, suggesting that delivering too many items may overwhelm participants and consequently hinder installations.

Recommendation: Consider if the there is a significant enough cost-effectiveness benefit to justify reducing the number of kit sizes and multi-count units offered. Reducing the number of items included in the kit, particularly the number of bathroom aerators provided, could increase ISRs and reduce program costs as the survey data reveals there is a negative relationship with number of kit items delivered and ISRs (that is, the more items Duke Energy provides, the lower the ISRs).

Conclusion 4: A high amount of non-electric water heater customers participated in the program. In total, the evaluation found that 18% of DEP and 29% of DEC customers in the program had non-electric water heaters. These saturations are comparable to the 2013 Duke Residential Appliance Saturation Survey non-electric water heat saturation of 25%.

Recommendation: For future program recruitment, Duke Energy should continue to review and refine its customer screening techniques to better filter non-electric water heater customers from the program's solicitation.

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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	January 1, 2017 – September 30, 2017
Region(s)	North Carolina, South Carolina
Evaluation Period	January 1, 2016 – December 31, 2016
Annual Gross MWh Savings	DEP: 11,153; DEC: 9,239
Per Kit kWh Savings	DEP: 396.1; DEC: 279.6
Annual Gross MW Savings	DEP: 3.7; DEC: 3.2
Net-to-Gross Ratio	DEP: 0.93; DEC: 0.93
Process Evaluation	Yes
Previous Evaluation(s)	DEC SEWKP; April 12, 2016, The Cadmus Group

Evaluation Methodology

Impact Evaluation Activities

- Telephone/web surveys (DEP n=131, DEC n=114) and analysis of 4 unique measures.

Impact Evaluation Findings

- Realization rate: DEP = 91.7%; DEC = 47.0%
- Net-to-gross ratio: DEP = 0.934; DEC = 0.932

Process Evaluation Activities

- Telephone/web surveys with SEWKP participants (DEP n=131, DEC n=114) and analysis of 4 unique measures.
- 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 a significant contributor to dissatisfaction among participants for water-saving kit items.
- Online how-to videos are viewed by a low proportion of SEWKP participants
- Pipe wrap is least popular measure; less than half of SEWKP participants installed pipe wrap.

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Appendix B Measure Impact Results

Table B-1: DEP Program Year 2016 per Unit Verified Impacts by Measure – Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Demand (kW)	Realization Rate (Energy)	Free Ridership	Spillover	Net to Gross Ratio	M&V Factor (Energy) (RR x NTG)	Measure Life
1.5 GPM Showerhead	291.6	0.093	203.9%	0.15	0.08	93.4%	190.5%	9
1.0 GPM Bathroom Faucet Aerator	5.4	0.003	7.4%				6.9%	10
1.5 GPM Kitchen Faucet Aerator	60.3	0.032	98.8%				92.3%	10
Insulating Pipe Tape	38.8	0.004	25.1%				23.4%	13
Total	**396.1**	**0.133**	**91.7%**	**0.15**	**0.08**	**93.4%**	**85.7%**	**-**

Table B-2: DEC Program Year 2016 per Unit Verified Impacts by Measure – Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Demand (kW)	Realization Rate (Energy)	Free Ridership	Spillover	Net to Gross Ratio	M&V Factor (Energy) (RR x NTG)	Measure Life
1.5 GPM Showerhead	195.4	0.063	66.5%	0.17	0.10	93.2%	61.9%	9
1.0 GPM Bathroom Faucet Aerator	4.5	0.002	70.2%				65.4%	10
1.5 GPM Kitchen Faucet Aerator	50.2	0.027	27.4%				25.5%	10
Insulating Pipe Tape	29.5	0.003	26.4%				24.6%	13
Total	**279.6**	**0.095**	**47.0%**	**0.17**	**0.10**	**93.2%**	**43.8%**	**-**

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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: DEP Program Experience PPIs

	Participants %	Participants n
Motivation PPIs		
Top motivating factors to request and install items from kit		
To conserve water	70%	131
To conserve electricity	60%	131
Because it was free	53%	131
Program experience & satisfaction PPIs		
Overall satisfaction with program	85%	111
Usefulness of kit instructions	80%	110
Usefulness of online how-to videos	67%	9
Satisfaction with kit measures		
Showerhead	76%	91
Kitchen faucet aerator	77%	64
Bathroom faucet aerator	74%	73
Pipe wrap	75%	52
Program influence on behavior PPIs		
Installed at least one kit measure	85%	131
Plan to install measure[s] (of those that did not install any measures)	60%	20
Most common measure installed: *showerhead*	69%	131
Adopted new energy and water saving behaviors	60%	131
Respondents reporting program attributable spillover	15%	131
Challenges and opportunities for improvement PPIs		
Measure with lowest installation rate: *bathroom aerator*	30%	131
Measure with highest uninstallation rate: *kitchen aerator*	9%	64
Measure with highest dissatisfaction: *showerhead*	6%	91

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Figure C-2: DEP Participant Demographics PPIs

Ownership Status	
Own	97%
Rent	2%

Household Size	
One to two	62%
Three	15%
Four	14%
Five+	8%

Education	
High school or less	14%
Some college	21%
Bachelors Degree	37%
Graduate Degree	23%
Refused / Don't know	5%

Income	
< $30k	11%
$30k to < $60k	24%
$60k to < $75k	7%
$75k to < $100k	12%
$100k+	20%
Refused / Don't know	27%

Figure 6-1: DEP Participant Household Characteristics PPIs

Housing Type	
Detached	87%
Attached	7%
Mobile	5%

Water Heater Fuel Type	
Electric	79%
Natural Gas	16%
Other	2%

Home Square Feet	Small Kit	Medium Kit
Less than 1,000	14%	0%
1,000-1,499	55%	24%
1,500-1,999	17%	32%
2,000-2,999	10%	31%
3,000+	3%	14%

Number of Showers	Small Kit	Medium Kit
1	30%	6%
2	57%	69%
3	13%	16%
4+	0%	9%

Number of Kitchen Faucets	Small Kit	Medium Kit
1	87%	88%
2	13%	12%
3	0%	0%

Number of Bathroom Faucets	Small Kit	Medium Kit
1-2	67%	28%
3-4	30%	53%
5+	3%	19%

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Figure C-3: DEC Program Experience PPIs

	Participants	
Motivation PPIs	**%**	**n**
Top motivating factors to request and install items from kit		
To conserve water	56%	114
To conserve electricity	55%	114
Because it was free	41%	114
Program experience & satisfaction PPIs		
Overall satisfaction with program	85%	87
Usefulness of kit instructions	70%	93
Usefulness of online how-to videos	83%	6
Satisfaction with kit measures		
Showerhead	76%	71
Kitchen faucet aerator	66%	50
Bathroom faucet aerator	77%	53
Pipe wrap	83%	35
Program influence on behavior PPIs		
Installed at least one kit measure	76%	114
Plan to install measure[s] (of those that did not install any measures)	59%	27
Most common measure installed: *showerhead*	62%	114
Adopted new energy and water saving behaviors	67%	114
Respondents reporting program attributable spillover	13%	114
Challenges and opportunities for improvement PPIs		
Measure with lowest installation rate: *bathroom aerator*	25%	114
Measure with highest uninstallation rate: *kitchen faucet aerator*	10%	50
Measure with highest dissatisfaction: *kitchen faucet aerator*	10%	50

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Figure 6-2: DEC Participant Demographics PPIs

Ownership Status	
Own	94%
Rent	6%

Household Size	
One to two	60%
Three	18%
Four	8%
Five +	5%

Education	
High school or less	20%
Some college	32%
Bachelor's degree	19%
Graduate degree	16%
Refused	13%

Income	
<$30k	20%
$30k to <$60k	26%
$60k to <$75k	5%
$75k to <$100k	9%
$100k+	11%
Refused	28%

Figure 6-3: DEC Participant Household Characteristics PPIs

Housing Type	
Detached	81%
Attached	4%
Mobile	13%

Water Heater Fuel Type	
Electric	70%
Natural Gas	28%

Home Square Feet	Small Kit	Medium Kit
Less than 1,000	23%	4%
1,000-1,499	52%	25%
1,500-1,999	16%	28%
2,000-2,999	10%	33%
3,000+	0%	10%

Number of Showers	Small Kit	Medium Kit
1	46%	11%
2	54%	72%
3	0%	15%
4+	0%	1%

Number of Kitchen Faucets	Small Kit	Medium Kit
1	97%	89%
2	3%	10%
3	0%	1%

Number of Bathroom Faucets	Small Kit	Medium Kit
1-2	80%	41%
3-4	20%	49%
5+	0%	10%

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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?

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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

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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?

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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.

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D.2 Implementer Staff In-Depth Interview Guide

Introduction

[*Note: Research Into Action 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?

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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.

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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.

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D.3 Participant Survey

Introduction/ Screening

[READ IF MODE=PHONE]

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 tape that can help you save water and energy in your home. Do you recall receiving this kit?

1. Yes
2. No [If no: Can I speak with someone who may know something about this kit?]
98. Don't know [If DK: Can I speak with someone who may know something about this kit?]

[INTERVIEWER INSTRUCTIONS: *If no adults are able to speak about the kit, thank and terminate.*]

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?

1. Yes
2. No [TERMINATE]
98. Don't know [TERMINATE]

Motivation and Collateral

Q3. What motivated you to request a free Save Energy and Water Kit from Duke Energy?

[MULTIPLE RESPONSE]

1. Wanted to conserve electricity
2. Wanted to conserve water
3. It was free
4. It was easy
5. It was offered by Duke Energy
6. Other – please specify: [OPEN-ENDED RESPONSE]
98. Don't know [*EXCLUSIVE ANSWER*]

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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 Q4 = 1]

Q5. 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. Did you watch any of Duke Energy's online how-to videos on how to install the items that came in the kit?

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

[ASK IF Q7 = 1]

Q8. On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were Duke Energy's online how-to videos on how to install the items that came in the kit?

0. Not at all helpful
1.
2.

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3.
4.
5.
6.
7.
8.
9.
10. Very helpful
98. Don't know

[ASK IF Q8<7]

Q9. What might have made the instructional videos more helpful?

[RECORD VERBATIM ANSWER]

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 tape.

[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 tape.

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.*]

[SINGLE RESPONSE]

1. Yes
2. No [→ 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.*]

Item

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a.	Showerhead
b.	Kitchen faucet aerator
c.	Bathroom faucet aerator
d.	Pipe tape
e.	I don’t remember which items were installed [→ TERMINATE]

[ASK IF Q11A = 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?

[SINGLE RESPONSE]

1. I installed both
2. I only installed one showerhead
98. Don't know

[ASK IF Q11C = 1]

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?

[SINGLE RESPONSE]

1. One
2. Two
3. Three [*DISPLAY IF KIT_SIZE=MEDIUM*]
4. Four [*DISPLAY IF KIT_SIZE=MEDIUM*]
98. Don't know

[ASK IF Q11D = 1]

Q14. Did you install all of the pipe insulation that was included with the kit?

[SINGLE RESPONSE]

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

[ASK IF Q14 IS DISPLAYED]

Q15. 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

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check.

[SINGLE RESPONSE]

1. About three feet or less
2. About five feet
3. About ten feet
4. About fifteen feet or more
98. Don't know

[ASK IF ANY PART OF Q11 = 1]

Q16. Overall, how satisfied are you with the item[s] you installed?
[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...

DISPLAY IF	Item	Rating
Q11a = 1	a. Showerhead	0-10 with DK
Q11b = 1	b. Kitchen faucet aerator	0-10 with DK
Q11c = 1	c. Bathroom faucet aerator	0-10 with DK
Q11d = 1	d. Pipe tape	0-10 with DK

[ASK IF ANY ITEMS IN Q16<7]

Q16a. Can you please explain any dissatisfaction you had with [DISPLAY ALL ITEMS IN Q16 THAT ARE <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.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
98.	Don’t Know

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[ASK IF ANY PART OF Q11 = 1]

Q18. Have you (or anyone in your home) uninstalled any of the items from the kit that you had previously installed?

[SINGLE RESPONSE]

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

[ASK IF Q18 = 1]

Q19. Which of the items did you uninstall?
[*Interviewer: Record the response, then prompt with the list items.*]

[MULTIPLE RESPONSE]

1. [DISPLAY IF Q11a = 1] Showerhead[s]
2. [DISPLAY IF Q11b = 1] Kitchen faucet aerator
3. [DISPLAY IF Q11c = 1] Bathroom faucet aerator[s]
4. [DISPLAY IF Q11d = 1] Pipe tape
98. Don't know [*EXCLUSIVE ANSWER*]

[ASK IF Q19.1 = 1 AND Q12 = 1]

Q20. Did you uninstall one or both of the showerheads you had previously installed?

[SINGLE RESPONSE]

1. I uninstalled both
2. I only uninstalled one of the showerheads
98. Don't know

[ASK IF Q19.3 = 1 AND Q13 = 2-4]

Q21. How many bathroom faucet aerators did you uninstall?

[SINGLE RESPONSE]

1. One [*DISPLAY IF Q13 = 1-4*]
2. Two [*DISPLAY IF Q13 = 2-4*]
3. Three [*DISPLAY IF Q13 = 3-4*]
4. Four [*DISPLAY IF Q13 = 4*]

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98. Don't know

[ASK IF ANY OF Q19.1-4 IS SELECTED]

Q22. Why were those items uninstalled?
[READ IF MODE=PHONE] Let's start with…
[*Interviewer: Read each item*]

[MULTIPLE RESPONSE]

DISPLAY ONLY THOSE 1-6 ITEMS THAT WERE SELECTED IN Q19	Item	Reason
	a. Showerhead	1. It was broken 2. I didn't like how it worked 3. I didn't like how it looked, or 96. Some other reason (specify: _______) 98. Don't know
	b. Kitchen faucet aerator	Repeat reason options
	c. Bathroom faucet aerator	Repeat reason options
	d. Pipe tape	Repeat reason options

[ASK IF ANY ITEMS NOT SELECTED IN Q11, OR Q10 = 2]

Q23. You said you haven't installed the following items. Which of the following do you plan to install in the next three months?
[*Interviewer: Record the response, then prompt with the list items.*]

[MULTIPLE RESPONSE] [DISPLAY ALL IF Q10 = 2]

1. [DISPLAY IF NOT SELECTED IN Q11] Showerhead
2. [DISPLAY IF NOT SELECTED IN Q11] Kitchen faucet aerator
3. [DISPLAY IF NOT SELECTED IN Q11] Bathroom faucet aerator
4. [DISPLAY IF NOT SELECTED IN Q11] Pipe tape
5. I'm not planning on installing any of these in the next three months [*EXCLUSIVE ANSWER*]
98. Don't know [*EXCLUSIVE ANSWER*]

[ASK IF ANY 1-6 OPTIONS WERE NOT SELECTED IN Q23 OR OPTION "NONE" WAS SELECTED]

Q24. What's preventing you from installing those items? Let's start with….
[*Interviewer: Read items*]

[MULTIPLE RESPONSE]

DISPLAY IF	Item	Reason
Q23a was not selected	a. Showerhead	Use multiple response options below
Q23b was not selected	b. Kitchen faucet aerator	Use multiple response options below

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Q23c was not selected	c. Bathroom faucet aerator	Use multiple response options below
Q23d was not selected	d. Pipe tape	Use multiple response options below

[MULTIPLE RESPONSE OPTIONS FOR Q24]

[PHONE CALLERS: DO NOT READ, CODE VERBATIM RESPONSES]

1. Didn't know what that was
2. Tried it, didn't fit [*DOES NOT DISPLAY FOR PIPE WRAP*]
3. Tried it, didn't work as intended (Please specify: ______________________________)
4. Haven't gotten around to it
5. Current one is still working [*DOES NOT DISPLAY FOR PIPE WRAP*]
6. Takes too much time to install it/No time/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. [DISPLAY IF Q23.1 was displayed but not selected] Already have efficient showerhead
    [DISPLAY IF Q23.2 was displayed but not selected] Already have efficient kitchen faucet aerator
    [DISPLAY IF Q23.3 was displayed but not selected] Already have efficient bathroom faucet aerators
    [DISPLAY IF Q23.4 was displayed but not selected] Already have pipe tape on my hot water pipe

96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know [*EXCLUSIVE ANSWER*]

[ASK IF Q11b = 1 AND Q19 KITCHEN FAUCET AERATOR OPTION WAS NOT SELECTED]

Q25. Your efficient kitchen faucet aerator has three settings to adjust the flow of water. Have you adjusted this setting?

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

Q26. [If Q25= Yes] What flow setting is the kitchen faucet aerator currently set at? Please go over to your kitchen sink if you need to check.

1. 0.5 GPM (lowest flow setting – "soaping mode")
2. 1.0 GPM (middle flow setting – "ecofriendly mode")

3. 1.5 GPM (highest flow setting – "power rinse mode")

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4. Don't Know

Q27. [If Q26 = 1,2, or 3] How often do you use that flow setting?

1. Not very often
2. About half the time
3. Most of the time
4. All the time
98. Don't Know

Q28. [If Q27= 1 or 2] What flow setting do you use most regularly?

1. 0.5 GPM (lowest flow setting – "soaping mode")
2. 1.0 GPM (middle flow setting – "ecofriendly mode")
3. 1.5 GPM (highest flow setting – "power rinse mode")
98. Don't Know

[ASK IF Q11a = 1 AND AT LEAST ONE SHOWERHEAD STILL INSTALLED]

Q29. On average, what is the typical shower length in your household?

[SINGLE RESPONSE]

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 AT LEAST ONE SHOWERHEAD STILL INSTALLED]

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?

[SINGLE RESPONSE]

1. Less than one
2. One
3. Two

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4. Three
5. Four
6. Five
7. Six
8. Seven
9. Eight or more
98. Don't know

[ASK IF TWO SHOWERHEADS STILL INSTALLED]

Q31. Thinking of the other efficient showerhead you installed…
On average, how many showers per day are taken in this shower?

[SINGLE RESPONSE]

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

[IF ANY PART OF Q11 = 1 AND IT'S NOT THE CASE THAT ALL PARTS OF Q19=SELECTED (THAT IS, THEY INSTALLED ANYTHING AND DID NOT UNINSTALL EVERYTHING THEY INSTALLED)]

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
98. Don't know

[If Q33 = 1]

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Q34. What items would you have purchased and installed within the next year?

[MULTIPLE RESPONSES]

1. [IF AT LEAST ONE SHOWERHEAD IS STILL INSTALLED] Energy-efficient showerhead[s]
2. [IF Q11b = 1 AND Q19.2 NOT SELECTED] Energy-efficient kitchen faucet aerator
3. [IF AT LEAST ONE BATHROOM AERATOR IS STILL INSTALLED] Energy-efficient bathroom faucet aerator[s]
4. [IF Q11d = 1 AND Q19.4 NOT SELECTED] Pipe tape
98. Don't know [EXCLUSIVE ANSWER]

[ASK IF Q34.1=1 AND TWO SHOWERHEADS ARE STILL INSTALLED]

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?

[SINGLE RESPONSE]

1. One
2. Two
98. Don't know

[ASK Q34.3=1 AND IF MORE THAN ONE BATHROOM AERATOR IS STILL INSTALLED]

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?

[SINGLE RESPONSE]

1. One
2. Two
3. Three [*DISPLAY IF AT LEAST THREE BATHROOM AERATORS ARE STILL INSTALLED*]
4. Four [*DISPLAY IF FOUR BATHROOM AERATORS ARE STILL INSTALLED*]
98. Don't know

[IF Q33 WAS DISPLAYED]

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…

[*Interviewer: If respondent says, “Not applicable - I didn’t get/use that,” then follow up with: “So would you say it was “not at all influential?” and probe to code.*]

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[MATRIX QUESTION: SCALE]

Elements	Responses
The fact that the items were free	0-10 scale with DK
The fact that the items were mailed to your house	0-10 scale with DK
Information provided by Duke Energy about how the items would save energy and water	0-10 scale with DK
Other information or advertisements from Duke Energy, including its website	0-10 scale with DK

Q38. Since receiving your kit from Duke Energy, what **new** behaviors has your household adopted to help save energy at home? Please only consider new **behaviors** that your household has adopted since receiving the kit.
[MULTIPLE RESPONSE] [*Interviewer: Do not read list. After each response ask, "Anything else?"*]

1. Not applicable - no new behaviors since receiving kit [EXCLUSIVE ANSWER]
2. Turn off lights when not in a room
3. Turn off furnace when not home
4. Turn off air conditioning when not home
5. Changed thermostat settings to use less energy
6. Used fans instead of air conditioning
7. Turn off electronics when we are not using them
8. Take shorter showers
9. Turned water heat thermostat down
10. Turn off water when brushing teeth
11. Other (specify: ____________)
98. Don't know [EXCLUSIVE ANSWER]

Q39. On a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how much influence did Duke Energy's kit and materials on saving energy have on your decision to [LIST ALL RESPONSES FROM Q38].

0 – Not at all influential	1	2	3	4	5	6	7	8	9	10 – Extremely influential	98 Don't know

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

[If Q40 = 1]

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Q41. What **products** have you purchased and installed to help save energy in your home? [*Do not read list. After each response, ask, "Anything else?"*] [MULTIPLE RESPONSE]

1. Bought energy efficient appliances
2. Moved into an ENERGY STAR home
3. Bought efficient heating or cooling equipment
4. Bought efficient windows
5. Added insulation
6. Sealed air leaks in windows, walls, or doors
7. Sealed or insulated ducts
8. Bought LEDs
9. Bought CFLs
10. Installed an energy efficient water heater
11. None – no other actions taken
96. Other, please specify: ____________________
98. Don't know [EXCLUSIVE ANSWER]

[If Q41 = 2]

Q42. Is Duke Energy still your gas or electricity utility?

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

[ASK IF Q41<>11, 98, OR 99]

Q43. Did you get a rebate from Duke Energy for any of those products or services? If so, which ones? Please select all products and services for which you received Duke Energy rebates. [MULTIPLE RESPONSE]

[LOGIC] Item
[IF Q41.1 IS SELECTED] 1. Bought energy efficient appliances
[IF Q41.2 IS SELECTED] 2. Moved into an ENERGY STAR home
[IF Q41.3 IS SELECTED] 3. Bought efficient heating or cooling equipment
[IF Q41.4 IS SELECTED] 4. Bought efficient windows
[IF Q41.5 IS SELECTED] 5. Added insulation
[IF Q41.6 IS SELECTED] 6. Sealed air leaks in windows, walls, or doors
[IF Q41.7 IS SELECTED] 7. Sealed or insulated ducts
[IF Q41.8 IS SELECTED] 8. Bought LEDs
[IF Q41.9 IS SELECTED] 9. Bought CFLs
IF Q41.10 IS SELECTED] 10. Installed an energy efficient water heater
[IF Q41.96 IS SELECTED] [**Q41 open ended response**]
I did not get any Duke rebates [*EXCLUSIVE ANSWER*]
Don't know [*EXCLUSIVE ANSWER*]

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[IF Q41.8 IS SELECTED]

Q44. Duke Energy's website has a tool that helps you find discounted LEDs in your area. Duke Energy's website also has an online store where you can purchase discounted LEDs and have them shipped directly to your home. Did you use either of these Duke Energy services to acquire your LEDs?

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

[IF Q41.9 IS SELECTED]

Q45. Duke Energy's website has a tool that helps you find discounted CFLs in your area. Duke Energy's website also has an online store where you can purchase discounted CFLs and have them shipped to your home. Did you use either of these Duke Energy services to acquire your CFLs?

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

[ASK IF ANY ITEM IN Q41 WAS SELECTED]

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…

[MATRIX QUESTION: SCALE]

[LOGIC] Item	Response
[IF Q41.1 IS SELECTED] 1. Buy energy efficient appliances	0-10 scale with DK
[IF Q41.2 IS SELECTED] 2. Move into an ENERGY STAR home	0-10 scale with DK
[IF Q41.3 IS SELECTED] 3. Buy efficient heating or cooling equipment	0-10 scale with DK
[IF Q41.4 IS SELECTED] 4. Buy efficient windows	0-10 scale with DK
[IF Q41.5 IS SELECTED] 5. Add insulation	0-10 scale with DK
[IF Q41.6 IS SELECTED] 6. Seal air leaks in windows, walls, or doors	0-10 scale with DK
[IF Q41.7 IS SELECTED] 7. Seal or insulate ducts	0-10 scale with DK
[IF Q41.8 IS SELECTED] 8. Buy LEDs	0-10 scale with DK
[IF Q41.9 IS SELECTED] 9. Buy CFLs	0-10 scale with DK
IF Q41.10 IS SELECTED] 10. Install an energy efficient water heater	0-10 scale with DK
[IF Q41.96 IS SELECTED] [**Q41 open ended response**]	0-10 scale with DK

[ASK IF Q41.1 IS SELECTED AND Q46.1 <> 0]

Q47. What kinds of appliance(s) did you buy?

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[*Do not read list*] [MULTIPLE RESPONSE]

1. Refrigerator
2. Stand-alone Freezer
3. Dishwasher
4. Clothes washer
5. Clothes dryer
6. Oven
7. Microwave
96. Other, please specify: ____________
98. Don't know
99. Refused

[ASK IF Q47 = 1-96]

Q48. Was the [INSERT Q47 RESPONSE] an ENERGY STAR or high-efficiency model?

[SINGLE RESPONSE]

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

[REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN Q47]

[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
99. Refused

[ASK IF Q41.3 IS SELECTED AND Q46.3 > 0]

Q50. What type of heating or cooling equipment did you buy?
[*Do not read list*] [MULTIPLE RESPONSE]

1. Central air conditioner
2. Window/room air conditioner unit
3. Wall air conditioner unit
4. Air source heat pump
5. Geothermal heat pump

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6. Boiler
7. Furnace
8. Wifi-enabled thermostat
96. Other, please specify: _______________
98. Don't know
99. Refused

[ASK IF Q50= 6-7]

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
99. Refused

[ASK IF Q50= 1-7, 96]

Q52. Was the [INSERT Q50 RESPONSE] an ENERGY STAR or high-efficiency model?

[SINGLE RESPONSE]

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

[REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN Q50, EXCLUDING wifi-enabled thermostat]

[ASK IF Q41.4 IS SELECTED AND Q46.4 > 0]

Q53. Do you know how many windows you installed??

1. Yes [*please specify how many you installed in the box below:* _______________]
2. No

[ASK IF Q41.5 IS SELECTED AND Q46.5 > 0]

Q54. 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%).

	Check here for each space you added insulation to	Use these boxes to type in the approximate proportion of each space you added insulation to

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Attic		
Walls		
Below the floor		

[ASK IF Q41.8 IS SELECTED AND Q46.8 > 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:* ________________]
2. No

[ASK IF Q41.9 IS SELECTED AND Q46.9 > 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:* ________________]
2. No

[ASK IF Q41.10 IS SELECTED AND Q46.10 > 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
99. Refused

[ASK IF Q41.10 IS SELECTED AND Q46.10 > 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
4. Other, please specify: ________________
98. Don’t know
99. Refused

[ASK IF Q41.10 IS SELECTED AND Q46.10 > 0]

Q59. Is the new water heater an ENERGY STAR model?

[SINGLE RESPONSE]

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

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99. Refused

Demographics

Lastly, we have some basic demographic questions for you. Please be assured that your responses are confidential and are for statistical purposes only.

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

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
6. Other _______________
98. Don't know
99. Prefer not to say

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?

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1. One
2. Two
3. Three
4. Four or more
98. Don't know

[Q32] What fuel type does your water heater use?

5. Electric
6. Natural Gas
7. Other, please specify: [OPEN-ENDED RESPONSE]
98. 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

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99. Prefer not to say

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

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Appendix E 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=94)
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=37)
Yes	100%
No	0%
Don't know	0%

Q3. What motivated you to request a free Save Energy and Water Kit from Duke Energy?

Response Option	Percent (n=131)*
Wanted to conserve water	70%
Wanted to conserve electricity	60%
It was free	53%
It was offered by Duke Energy	34%
It was easy	33%
Other	7%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim Response	Count (n=9)
The bill kept going up	1
To save money	1
savings	1

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The tone of the letter was "you need to do this right now"	1
Needed a new shower head-thank you	1
Needed to update things, old house	1
Save money	1
money	1
My husband wanted to try it out	1

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

Response Option	Percent (n=131)
Yes	84%
No	12%
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=110)
0- Not at all helpful	0%
1	0%
2	0%
3	0%
4	0%
5	4%
6	2%
7	11%
8	17%
9	16%
10 - Very helpful	47%
Don't Know	3%

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

Verbatim Response	Count (n=6)
Can't remember	1
comparison information to understand if the items included in the kit were superior/inferior to existing fixtures	1
its hard to say. I had a plumber install the shower head	1
More pictures on how to install	1
n/a	1
Specific applications	1

Q7. Did you watch any of Duke Energy's online how-to videos on how to install the items that came in the kit?

Response Option	Percent (n=131)

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Yes	7%
No	92%
Don't know	1%

Q8. [Ask if Q7 = YES] On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were Duke Energy's online how-to videos on how to install the items that came in the kit?

Response Option	Percent (n=9)
0- Not at all helpful	0%
1	0%
2	0%
3	0%
4	0%
5	22%
6	11%
7	0%
8	0%
9	11%
10 - Very helpful	56%
Don't know	0%

Q9. [Ask if Q8<7] What might have made the instructional videos more helpful?

Verbatim Response	Count (n=3)
I'm not good with computers.	1
shorter	1
They were ok	1

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=131)
Yes	85%
No	15%
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=111)*
Showerhead	82%
Bathroom faucet aerator	66%
Kitchen faucet aerator	58%
Pipe tape	47%

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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=71)
I installed both	49%
I only installed one showerhead	49%
Don't know	2%

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=73)
One	30%
Two	56%
Three	10%
Four	4%
Don't know	0%

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

Response Option	Percent (n=52)
Yes	81%
No	13%
Don't know	6%

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=52)
About three feet or less	42%
About five feet	15%
About ten feet	8%
About fifteen feet or more	0%
Don't know	35%

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

Showerhead

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Response Option	Percent (n=91)
0 - Very dissatisfied	2%
1	0%
2	2%
3	0%
4	1%
5	8%
6	2%
7	9%
8	21%
9	8%
10 - Very satisfied	47%
Don't know	0%

Kitchen Faucet Aerator

Response Option	Percent (n= 64)
0 – Very dissatisfied	0%
1	0%
2	0%
3	5%
4	0%
5	5%
6	5%
7	8%
8	19%
9	16%
10 - Very satisfied	42%
Don't know	2%

Bathroom Faucet Aerator

Response Option	Percent (n= 73)
0 – Very dissatisfied	1%
1	0%
2	0%
3	0%
4	3%
5	4%
6	4%
7	12%
8	15%
9	16%
10 - Very satisfied	43%
Don't know	1%

Pipe Tape

Response Option	Percent (n= 52)

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0 – Very dissatisfied	0%
1	0%
2	0%
3	0%
4	2%
5	6%
6	4%
7	4%
8	15%
9	4%
10 - Very satisfied	56%
Don't know	10%

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

Showerhead

Verbatim Response	Count (n=14)
could not get any water pressure	1
Has not really changed anything	1
I have kids and we really needed to switch back to the shower head that has a hose and handle in order to get their hair rinsed well.	1
I realize it's there to save water. It just doesnt have much pressure.	1
I wasn't really dissatisfied, I had to adjust to a different amount of water pressure.	1
Insufficient pressure when installed.	1
It takes time to get hot water	1
None	1
pressure not strong enough	1
The head itself is nice... I just prefer having the handheld on a hose type.	1
The water pressure is much too low. And due to that it takes even longer than usual to get hot. I'm probably wasting more water as a result.	1
There is nothing wrong with the shower head it's just that the flow/amount of water we get in the shower is substantially less. While it does conserve water it makes showering a lot less enjoyable.	1
Very basic showerhead	1
We have a Rinnai water heater. This shower head did not have enough power to activate the hot water consistently. The shower would suddenly go ice cold. After 2 months we put back our plain 10 years old shower head. This did not work for us. Very disappointed.	1

Kitchen Faucet Aerator

Verbatim Response	Count (n=9)
It didn't match the metal finish on my faucet and it made it look bad, plus we have a spray hose already so it was not really an improvement	1
It doesn't have enough pressure. It cuts the pressure a lot in the water.	1

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It is very splashy on the higher settings. On the lower setting it's okay, but it's harder to wash dishes on either setting.	1
On the lowest setting it doesn't produce a lot of water and turning it to a higher setting gets water everywhere when washing off the dishes.	1
pressure not strong enough	1
They all work pretty well...All in all I have no complaints.	1
Very low flow/pressure so unable to create soap for washing dishes.	1
Water pressure not strong enough	1
Water splashed everywhere	1

Bathroom Faucet Aerator

Verbatim Response	Count (n=8)
As I said, all in all, I really have no complaints.	1
Flow was too slow	1
it didn't work that well, leaking	1
It made the flow too weak...	1
Not enough water pressure.	1
pressure not strong enough	1
Same low pressure so took out in master bathroom, left in children bathroom.	1
Terribly thin and slow flow.	1

Pipe Tape

Verbatim Response	Count (n=6)
did not use it all	1
didn't see any difference	1
does not stay on	1
none	1
None	1
The pipe tape seemed to be of good quality, but it was hard for me to install in tight quarters. The split foam rubber type insulation that comes in long sections would have been easier to put in, but maybe harder to ship	1

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

Response Options	Percent (n=111)
0 - Very dissatisfied	2%
1	0%
2	0%
3	1%
4	2%
5	1%
6	5%
7	5%
8	15%
9	16%
10 - Very satisfied	53%

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Don't know	0%

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=111)
Yes	15%
No	82%
Don't know	3%

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

Response Option	Count (n=17)*
Showerhead	9
Kitchen faucet aerator	6
Bathroom faucet aerator	7
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?

Response Option	Percent (n=3)
One	67%
Two	33%
Three	0%
Four	0%
Don't know	0%

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

Showerhead

Response Option	Percent (n=9)*
It was broken	11%
Didn't like how it worked	78%

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Didn't like how it looked	0%
Other	44%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Responses	Count (n=4)
Didn't work with our Rinnai water heater. Not enough pressure to keep the hot water working. Suddenly ice cold showers.	1
didnt like lack of water pressure	1
I just prefer the handheld type on the hose.	1
It did not have enough water pressure.	1

Kitchen faucet aerator

Response Options	Percent (n=6)*
It was broken	0%
Didn't like how it worked	100%
Didn't like how it looked	17%
Other	0%
Don't know	0%

*Multiple responses were allowed for this question

Bathroom faucet aerator

Response Options	Percent (n=7)*
It was broken	0%
Didn't like how it worked	86%
Didn't like how it looked	0%
Other	14%
Don't know	14%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=1)
Extremely restricted flow	1

Pipe Tape

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

*Multiple responses were allowed for this question

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Verbatim "Other" Response	Count (n=1)
Kept falling off	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=131)*
Showerhead	35%
Kitchen faucet aerator	18%
Bathroom faucet aerator	31%
Pipe tape	20%
I'm not planning on installing any of these in the next three months	44%
Don't know	26%

*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=26)*
Already have an efficient showerhead	46%
Current one is still working	42%
Too difficult to install it, don't know how to do it	4%
Tried it, didn't fit	4%
Takes too much time to install it / No time / Too busy	4%
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	0%
Don't have the tools I need	0%
Didn't know what that was	0%
Other	19%
Don't know	4%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=5)
use handheld	1
I have a removable shower head with hose so it doesn't work	1
I have a hand held shower	1
I like the shower head I have better than this one	1
Expect to be moving in the next 6 months	1

Kitchen faucet aerator

Response Option	Percent (n=55)*

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Tried it, didn't fit	31%
Current one is still working	27%
Already have an efficient kitchen faucet aerator	16%
Haven't gotten around to it	7%
Too difficult to install it, don't know how to do it	7%
Tried it, didn't work as intended (please explain in the box below)	4%
Didn't know what that was	2%
Takes too much time to install it / No time / Too busy	2%
Don't have the items any longer (threw away, gave away)	0%
Don't have the tools I need	0%
Other	18%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=10)
since the shower didnt work, we figured the facuets	1
did not receive one	1
Just purchased a new kitchen and used a facet that did the same or better.	1
I have a counter water filter system	1
purchased a new faucet for kitchen	1
It is not designed for my new faucet	1
Expect to be moving in the next 6 months	1
Wrong size-they were too large for my 3 faucets	1
already have a good aerator	1
I just remember getting the shower head, not the others	1

Bathroom Faucet Aerator

Response Option	Percent(n=40)*
Tried it, didn't fit	38%
Current one is still working	23%
Already have an efficient bathroom faucet aerator	18%
Haven't gotten around to it	10%
Too difficult to install it, don't know how to do it	10%
Takes too much time to install it / No time / Too busy	3%
Don't have the items any longer (threw away, gave away)	0%
Don't have the tools I need	0%
Tried it, didn't work as intended (please explain in the box below)	0%
Didn't know what that was	0%
Other	20%
Don't know	0%

*Multiple responses were allowed for this question

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Verbatim "Other" Response	Count (n=7)
same as before	1
Husband did it; he has passed away	1
too low flow	1
Expect to be moving in the next 6 months	1
would not adapt to mine	1
wrong metal finish and stuck out too far	1
Don't remember receiving	1

Pipe Tape

Response Option	Percent (n=63)*
Already have pipetape	44%
Haven't gotten around to it	19%
Too difficult to install it, don't know how to do it	8%
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	2%
Don't have the tools I need	2%
Don't have the items any longer (threw away, gave away)	0%
Other	16%
Don't know	6%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=7)
Not sure that I need it	1
Didn't know which pipe to put it on	1
not necessary at the time	1
dont want tape on water heater	1
Really don't think it will make a difference given my house and current insulation, etc.	1
Expect to be moving in the next 6 months	1
water heater is inside	1
wont work in space needed - require more tape	1
Don't remember receiving	1
Hot water heater is inside hpuse	1

Q25. [Ask if Q11 = SHOWERHEAD and Q19 KITCHEN FAUCET AERATOR option was not selected] Your efficient kitchen faucet aerator has three settings to adjust the flow of water. Have you adjusted this setting?

Response Option	Percent (n=58)
Yes	60%
No	35%
Don't know	5%

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Q26. [Ask if Q25 = Yes] What flow setting is the kitchen faucet aerator currently set at? Please go over to your kitchen sink if you need to check.

Response Option	Percent (n=35)
0.5 GPM (lowest flow setting – "soaping mode")	26%
1.0 GPM (middle flow setting – "eco friendly mode")	46%
1.5 GPM (highest flow setting – "power rinse mode")	14%
Don't Know	14%

Q27. [Ask if Q26 = 0.5, 1.0, or 1.5 GPM] How often do you use that flow setting?

Response Option	Percent (n=30)
Not very often	10%
About half the time	10%
Most of the time	57%
All the time	23%
Don't know	0%

Q28. [If Q27 = NOT VERY OFTEN or ABOUT HALF THE TIME] What flow setting do you use most regularly?

Response Option	Percent (n=6)
0.5 GPM (lowest flow setting – "soaping mode")	33%
1.0 GPM (middle flow setting – "eco friendly mode")	50%
1.5 GPM (highest flow setting – "power rinse mode")	17%
Don't know	0%

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=82)
One minute or less	1%
Two to four minutes	11%
Five to eight minutes	38%
Nine to twelve minutes	34%
Thirteen to fifteen minutes	6%
Sixteen to twenty minutes	4%
Twenty-one to thirty minutes	4%
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…]

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[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=82)
Less than one	0%
One	11%
Two	32%
Three	35%
Four	13%
Six	9%
Seven	0%
Eight or more	0%
Don't know	0%

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=31)
Less than one	28%
One	31%
Two	34%
Three	3%
Four	3%
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=131)
Electric	79%
Natural gas	16%
Other (please specify in the box below)	2%
Don't know	3%

Verbatim "Other" Response	Count (n=2)
geo thermal	1
LP gas	1

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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=108)
Yes	19%
No	55%
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=21)*
Showerhead	16
Kitchen faucet aerator	4
Bathroom faucet aerator	10
Pipe tape	1
Don't know	2

*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=3)
One	33%
Two	33%
Don't know	33%

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=7)
One	0%
Two	43%
Three	0%
Four	14%
Don't know	43%

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=108)
0- Not at all influential	0%
1	0%

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2	1%
3	0%
4	1%
5	2%
6	1%
7	4%
8	9%
9	11%
10 - Extremely influential	70%
Don't know	1%

The fact that the items were mailed to your home

Response Option	Percent (n=108)
0- Not at all influential	2%
1	0%
2	0%
3	0%
4	0%
5	3%
6	1%
7	4%
8	12%
9	11%
10 - Extremely influential	66%
Don't know	2%

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

Response Option	Percent (n=108)
0- Not at all influential	0%
1	0%
2	1%
3	1%
4	0%
5	7%
6	7%
7	7%
8	15%
9	19%
10 - Extremely influential	39%
Don't know	4%

Other information or advertisements from Duke Energy, including its website

Response Option	Percent (n=108)
0- Not at all influential	9%
1	1%
2	5%

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3	2%
4	5%
5	11%
6	8%
7	8%
8	13%
9	8%
10 - Extremely influential	23%
Don't know	7%

Q38. Since receiving your kit from Duke Energy, what **new** behaviors has your household adopted to help save energy at home? Please only consider new **behaviors** that your household has adopted since receiving the kit.

Response Option	Percent (n=131)*
Not applicable - no new behaviors since receiving kit	33%
Turn off lights when not in a room	33%
Turn off furnace when not home	6%
Turn off air conditioning when not home	11%
Changed thermostat settings to use less energy	28%
Used fans instead of air conditioning	14%
Turn off electronics when we are not using them	18%
Take shorter showers	23%
Turned water heat thermostat down	8%
Turn off water when brushing teeth	32%
Other	11%
Don't know	3%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=15)
led lighting	1
We already had these behaviors prior to receiving kit	1
I none	1
Limit the flow at kitchen faucet unless necessary.	1
Unplugging items so no "ghost" current	1
Wait til midnight to do the laundry	1
buy led lights	1
We are already extremely energy conscious so have not adopted any new behaviors.	1
Already do all these things.	1
Replacing lightbulbs with LEDs	1
We did most of these already	1
I would have turned my water heater down but it is tapeped up and controls not accessible	1

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wash dishes more than using dishwasher	1
save water	1
I did these already	1

Q39. [Ask if Q38 <> DON'T KNOW or NOT APPLICABLE]. On a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how much influence did Duke Energy's kit and materials on saving energy have on your decision to [LIST ALL RESPONSES FROM Q38].

Response Option	Percent (n=84)
0 – Not at all influential	6%
1	2%
2	4%
3	1%
4	5%
5	8%
6	7%
7	13%
8	20%
9	11%
10 - Extremely influential	21%
Don't know	1%

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=131)
Yes	30%
No	68%
Don't know	2%

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

Response Option	Percent (n=39)*
Bought energy efficient appliances	33%
Moved into an ENERGY STAR home	0%
Bought efficient heating or cooling equipment	21%
Bought efficient windows	3%
Added insulation	23%
Sealed air leaks in windows, walls, or doors	28%
Sealed or insulated ducts	5%
Bought LEDs	46%
Bought CFLs	23%

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Installed an energy efficient water heater	15%
None – no other actions taken	0%
Other	18%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=7)
automated thermostats, lights with alexa.	1
siding, windows	1
more pipe insulation	1
received free lightbulbs from Duke	1
new faucet in bathroom and kitchen	1
Improved well liner and water purification system	1
Installed solar attic fans and solar tube in bathroom with solar nightlight	1

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

Response Option	Percent (n=131)
Not asked	100%

Q43. [Ask if Q41<> NONE, DON'T KNOW, or REFUSED] Did you get a rebate from Duke Energy for any of those products or services? If so, which ones? Please select all products and services for which you received Duke Energy rebates.

Response Option	Count (n=39)*
Bought energy efficient appliances	0
Moved into an ENERGY STAR home	0
Bought efficient heating or cooling equipment	2
Bought efficient windows	0
Added insulation	0
Sealed air leaks in windows, walls, or doors	0
Sealed or insulated ducts	0
Bought LEDs	1
Bought CFLs	0
Installed an energy efficient water heater	0
I did not get any Duke Rebates	34
Other	0
Don't know	2

*Multiple responses were allowed for this question.

Q44. [Ask if Q41 = BOUGHT LEDS] Duke Energy's website has a tool that helps you find discounted LEDs in your area. Duke Energy's website also has an online store where you

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can purchase discounted LEDs and have them shipped directly to your home. Did you use either of these Duke Energy services to acquire your LEDs?

Response Option	Percent (n=18)
Yes	17%
No	72%
Don't know	11%

Q45. [Ask if Q41 = BOUGHT CFLS] Duke Energy's website has a tool that helps you find discounted CFLs in your area. Duke Energy's website also has an online store where you can purchase discounted CFLs and have them shipped to your home. Did you use either of these Duke Energy services to acquire your CFLs?

Response Option	Percent (n=9)
Yes	11%
No	89%
Don't know	0

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	31%	0%	8%	0%	0%	15%	8%	0%	0%	0%	39%	0%	13
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	43%	14%	0%	0%	0%	0%	0%	0%	0%	29%	14%	0%	7
Buy efficient windows	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1
Add insulation	22%	11%	0%	0%	11%	11%	0%	%	11%	11%	22%	0%	9
Seal air leaks	9%	9%	9%	0%	9%	9%	0%	9%	0%	9%	27%	9%	11
Seal ducts	0%	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%	2
Buy LEDs	28%	6%	11%	0%	6%	6%	6%	0%	6%	0%	22%	11%	18
Buy CFLs	11%	0%	11%	11%	11%	11%	11%	0%	11%	11%	11%	0%	9
Install an energy efficient water heater	33%	0%	0%	17%	0%	0%	0%	0%	0%	0%	50%	0%	6
Other	29%	0%	0%	0%	14%	0%	14%	14%	14%	0%	14%	0%	7

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

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Response Option	Percent (n=9)*
Refrigerator	56%
Stand-alone freezer	0%
Dishwasher	22%
Clothes washer	44%
Clothes dryer	33%
Oven	33%
Microwave	33%
Other	11%
Don't know	0%
Refused	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	Oven	Other
Yes	1	5	0	2	4	3	3	1
No	0	0	0	0	0	0	0	0
Don't know	2	0	0	0	0	0	0	0
Total	3	5	0	2	4	3	3	1

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

Response Option	Percent (n=3)
Yes	67%
No	33%
Don't know	0%
Refused	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=4)*
Central air conditioner	50%
Window/room air conditioner unit	25%
Wall air conditioner unit	0%
Air source heat pump	0%
Geothermal heat pump	0%
Boiler	0%
Furnace	25%
Wifi thermostat	25%
Other	25%
Don't know	0%
Refused	0%

*Multiple responses were allowed for this question

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Verbatim "Other" Response	Count (n=1)
Blanket/Tape for hot water heater	1

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	0	2	1	0	0	0	0	1
No	0	0	0	0	0	0	0	0
Don't know	1	0	0	0	0	0	0	0
Total	1	2	1	0	0	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=131)
Yes	0%
No	0%
Don't know	0%
Not asked	100%

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=7)*
Attic	71%
Walls	14%
Below the floor	29%

*Multiple responses were allowed for this question

Attic

Verbatim Response	Count (n=4)

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100	3
1530	1

Walls

Verbatim Response	Count (n=1)
75	1

Below the floor

Verbatim Response	Count (n=2)
10	1
1530	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=13)
Yes	100%
No	0%

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

Verbatim Response	Count (n=13)
15	2
2	1
25	2
30	1
4	1
5	1
6	2
8	1
9	2

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=8)
Yes	100%
No	0%

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

Verbatim Response	Count (n=8)
10	1
12	1
15	1
16	2
5	1

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6	1
8	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	50%
No	50%
Don't know	0%
Refused	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=4)
A traditional water heater with a large tank that holds the hot water	75%
A tankless water heater that provides hot water on demand	25%
A solar water heater	0%
Other	0%
Don’t know	0%
Refused	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=4)
Yes	100%
No	0%
Don't know	0%
Refused	0%

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

Response Option	Percent (n=131)
Single-family detached house	87%
Single-family attached home (such as a townhouse or condo)	7%
Duplex, triplex or four-plex	1%
Apartment or condo with 5 units or more	0%
Manufactured or mobile home	5%
Other	0%
Prefer not to say	0%
Don't know	1%

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

Response Option	Percent (n=131)
One	12%
Two	66%
Three	15%
Four	7%
Five or more	0%
Don't know	0%

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=131)
One	5%
Two	32%
Three	34%
Four	15%
Five	10%
Six	5%
Seven	1%
Eight or more	0%
Don't know	0%

Q63. How many kitchen faucets are in your home?

Response Option	Percent (n=131)
One	88%
Two	12%
Three	0%
Four or more	0%
Don't know	0%

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=131)
500 to under 1,000 square feet	3%
1,000 to under 1,500 square feet	30%
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	11%
Greater than 3,000 square feet	11%
Prefer not to say	1%
Don't know	5%

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

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Response Option	Percent (n=131)
Own / buying	97%
Rent / lease	2%
Occupy rent-free	0%
Prefer not to say	1%
Don't know	1%

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

Response Option	Percent (n=131)
I live by myself	18%
Two people	44%
Three people	15%
Four people	14%
Five people	5%
Six people	2%
Seven people	1%
Eight or more people	0%
Prefer not to say	1%
Don't know	0%

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

Response Option	Percent (n=131)
Under $20,000	8%
$20,000 to under $30,000	3%
$30,000 to under $40,000	6%
$40,000 to under $50,000	12%
$50,000 to under $60,000	6%
$60,000 to under $75,000	7%
$75,000 to under $100,000	12%
$100,000 to under $150,000	12%
$150,000 to under $200,000	5%
$200,000 or more	3%
Prefer not to say	21%
Don't know	5%

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

Response Option	Percent (n=131)
Less than high school	0%
Some high school	1%
High school graduate or equivalent (such as GED)	13%
Trade or technical school	5%
Some college (including Associate degree)	17%
College degree (Bachelor's degree)	32%
Some graduate school	5%
Graduate degree, professional degree	21%

Doctorate	2%
Prefer not to say	5%
Don’t know	1%

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Appendix F 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.

Q69. [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=34)
Yes	100%
No	0%
Don’t know	0%

Q70. [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=80)
Yes	100%
No	0
Don’t know	0

Q71. What motivated you to request a free Save Energy and Water Kit from Duke Energy?

Response Option	Percent (n=114)*
Wanted to conserve water	56%
Wanted to conserve electricity	55%
It was free	41%
It was offered by Duke Energy	36%
It was easy	17%
Other	13%
Don't know	1%

*Multiple responses were allowed for this question

Verbatim Other Responses	Count (n=13)

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We already had one and it was beginning to stop up on us.	1
Wanted to save money	1
Saw it in a flyer	1
Save money	1
Save money	1
said something about 20x21 filters, but never got them	1
My Sister got one and it helped on her power bill	1
my bill is high	1
It was my daughter that did that.	1
Hip was broken, decided when I get that I can get to use the shower head, I thought i'd correct it.	1
cut expenses	1
brochure, save energy	1
a fresh pair of eyes looking at ways to improve our home	1

Q72. Did you read the included instructions on how to install the items that came in the kit?

Response Option	Percent (n=114)
Yes	82%
No	13%
Don't remember	4%

Q73. [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=93)
1- Not at all helpful	1%
1	1%
2	1%
3	0%
4	1%
5	7%
6	3%
7	10%
8	15%
9	8%
10 - Very helpful	47%
Don't Know	5%

Q74. [Ask if Q5<7] What might have made the instructions more helpful?

Verbatim Response	Count (n=10)
Didn't fit	1
I cant think of anything.	1
If the aerators would fit my faucets they would have worked	1
it it good	1
My son installed the shower head for me and I love it.	1
No product was fine for one of the sinks would not fit the others	1
nothing	2

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Nothing it was common sense instalation	1
The instructions were helpful	1

Q75. Did you watch any of Duke Energy's online how-to videos on how to install the items that came in the kit?

Response Option	Percent (n=114)
Yes	5%
No	93%
Don't remember	2%

Q76. [Ask if Q7 = YES] On a scale from 0 to 10, where 0 is not at all helpful and 10 is very helpful, how helpful were Duke Energy's online how-to videos on how to install the items that came in the kit?

Response Option	Percent (n=6)
1- Not at all helpful	0%
1	0%
2	0%
3	0%
4	0%
5	0%
6	17%
7	0%
8	33%
9	0%
10 - Very helpful	50%
Don't know	0%

Q77. [Ask if Q8<7] What might have made the instructional videos more helpful?

Verbatim Response	Count (n=1)
More detail	1

Q1. Have you or anyone else installed any of those items in your home, even if they were taken out later?

Response Option	Percent (n=114)
Yes	76%
No	24%
Don't Know	0%

Q2. [Ask if Q10 = YES] Which of the items did you install, even if they were taken out later?

Response Option	Percent (n=87)*
Showerhead	82%

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Kitchen faucet aerator	57%
Bathroom faucet aerator	61%
Pipe tape	40%
I don't remember	0%

*Multiple responses were allowed for this question

Q3. [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=47)
I installed both	53%
I only installed one showerhead	47%
Don't know	2%

Q4. [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=53)
One	42%
Two	42%
Three	11%
Four	5%
Don't know	0%

Q5. [Ask if Q11 = PIPEWRAP] Did you install all of the pipe insulation that was included with the kit?

Response Option	Percent (n=35)
Yes	66%
No	26%
Don't know	8%

Q6. [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=35)
About three feet or less	37%
About five feet	20%
About ten feet	20%
Don't know	23%

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Q7. [Ask if any part of Q11 = YES] Overall, how satisfied are you with the item[s] you installed?

Showerhead

Response Option	Percent (n=71)
0 - Very dissatisfied	3%
1	0%
2	1%
3	1%
4	1%
5	1%
6	7%
7	9%
8	16%
9	10%
10 - Very satisfied	51%
Don’t know	0%

Kitchen Faucet Aerator

Response Option	Percent (n=50)
0 – Very dissatisfied	6%
1	0%
2	2%
3	0%
4	2%
5	6%
6	2%
7	14%
8	8%
9	14%
10 - Very satisfied	44%
Don't know	2%

Bathroom Faucet Aerator

Response Option	Percent (n= 53)
0 – Very dissatisfied	4%
1	0%
2	0%
3	4%
4	2%
5	6%
6	2%
7	6%
8	8%
9	23%
10 - Very satisfied	47%
Don't know	0%

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Pipe Tape

Response Option	Percent (n= 35)
0 – Very dissatisfied	0%
1	0%
2	0%
3	0%
4	0%
5	3%
6	6%
7	6%
8	11%
9	11%
10 - Very satisfied	60%
Don't know	3%

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

Showerhead

Verbatim Response	Count (n=10)
Did not allow enough water pressure	1
It was very cheap made	1
Leaked	1
My son complains it doesn't wet his hair evenly.	1
No pressure	1
No water pressure	1
not enough water coming out, adjusted it every way, just not enough water	1
Pressure is low	1
Water source is much weaker	1
Water to slow	1

Kitchen Faucet Aerator

Verbatim Response	Count (n=8)
Could not tell much difference from what was there. Not necessarily dissatisfied.	1
It was good	1
It's just that I'm accustom to quite a bit more pressure coming out of my kitchen faucet.	1
kitchen aerator did not fit	1
No pressure	1
No water pressure	1
Splashed too much water because of the force.	1
worked for a couple weeks and then cracked down the side of it. had to go buy one for 11.00	1

Bathroom Faucet Aerator

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Verbatim Response	Count (n=9)
I never got this one	1
It restricted the pressure far too much than the previously installed aerators. I have thus far left them.	1
Low pressure	1
No pressure	1
Same as kitchen. I am on a well and have low water pressure.	1
The pressure was way too low. I ended up taking them off because I am listing my house for sale and don't want people to think there is an issue here with water pressure.	1
The same didn't help	1
the water just does not seem to flow right anymore	1
Very little water pressure but we still have these on	1

Pipe tape

Verbatim Response	Count (n=3)
Can't tell a difference	1
Don't see any differenence	1
No dissatisfaction just needed more	1

Q8. Overall, how satisfied are you with Duke Energy's Save Energy and Water Kit Program?

Response Options	DEP (n=87)
0 - Very dissatisfied	0%
1	0%
2	0%
3	0%
4	2%
5	2%
6	2%
7	6%
8	20%
9	12%
10 - Very satisfied	54%
Don't know	2%

Q9. [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	DEP (n=87)
Yes	12%
No	85%
Don't know	3%

Q10. [Ask if Q18 = YES] Which of the items did you uninstall?

Response Option	Count (n= 10)*

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Showerhead	6
Kitchen faucet aerator	5
Bathroom faucet aerator	4
Pipe tape	0
Don't know	1

*Multiple responses were allowed for this question

Q11. [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	100%
I only uninstalled one of the showerheads	0%
Don’t know	0%

Q12. [Ask if Q19 = BATHROOM FAUCET AERATOR and Q13 = 2-4] How many bathroom faucet aerators did you uninstall?

Response Option	Percent (n=1)
One	0%
Two	0%
Three	0%
Four	100%
Don’t know	0%

Q13. [Ask if any item of Q19 is selected] Why were those items uninstalled?

Showerhead

Response Option	Percent (n=6)*
It was broken	0%
Didn't like how it worked	83%
Didn't like how it looked	17%
Other	33%
Don’t know	0%

*Multiple responses were allowed for this question

Verbatim “Other” Responses	Count (n=2)
not enough water coming out	1
Put the Moen brand back on as I am selling the house.	1

Kitchen faucet aerator

Response Options	Percent (n=5)*
It was broken	20%

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Didn't like how it worked	60%
Didn't like how it looked	0%
Other	20%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=1)
We replaced our kitchen faucet with a faucet that was too big for the aerator.	1

Bathroom faucet aerator

Response Options	Percent (n=2)*
It was broken	0%
Didn't like how it worked	100%
Didn't like how it looked	0%
Other	0%
Don't know	0%

*Multiple responses were allowed for this question

Pipe tape

Response Options	Percent (n=0)*
It was broken	0%
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

Q14. [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=114)*
Showerhead	33%
Kitchen faucet aerator	28%
Bathroom faucet aerator	31%
Pipe tape	24%
I'm not planning on installing any of these in the next three months	32%
Don't know	25%

*Multiple responses were allowed for this question

Q15. [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=29)*

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Already have an efficient showerhead	28%
Current one is still working	24%
Tried it, didn't fit	14%
Too difficult to install it, don't know how to do it	7%
Takes too much time to install it / No time / Too busy	3%
Tried it, didn't work as intended (please explain in the box below)	3%
Don't have the items any longer (threw away, gave away)	3%
Haven't gotten around to it	3%
Don't have the tools I need	0%
Didn't know what that was	0%
Other	21%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=6)
Doesn't match our plumbing which is brushed nickel.	1
My shower head is a detachable one and this would just not help.	1
My husband likes the one we now have. He is very particular. I plan to give the showerhead to my son who just purchased a house.	1
The significant restriction on the bathroom aerator dissuaded me.... thus far.	1
I use a handheld showerhead.	1
health problems	1

Kitchen faucet aerator

Response Option	Percent (n=46)*
Tried it, didn't fit	26%
Current one is still working	20%
Already have an efficient kitchen faucet aerator	15%
Haven't gotten around to it	13%
Didn't know what that was	7%
Tried it, didn't work as intended (please explain in the box below)	4%
Too difficult to install it, don't know how to do it	2%
Takes too much time to install it / No time / Too busy	2%
Don't have the items any longer (threw away, gave away)	2%
Don't have the tools I need	0%
Other	17%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=8)
Already have aerators plus didn't match faucets.	1
will not work with my current faucet	1

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Lazy	1
need to include adapter, did not fit my faucet	1
didnt see this	1
Did not work with the faucet I have.	1
health problems	1
Dont recall receiving it	1

Bathroom Faucet Aerator

Response Option	Percent (n=42)*
Tried it, didn't fit	29%
Haven't gotten around to it	26%
Current one is still working	17%
Already have an efficient bathroom faucet aerator	14%
Didn't know what that was	5%
Takes too much time to install it / No time / Too busy	2%
Don't have the items any longer (threw away, gave away)	2%
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%
Don't have the tools I need	0%
Other	14%
Don't know	2%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=6)
i will put it on	1
need to include adapter, did not fit my faucet	1
didnt recall getting one of those	1
health problems	1
n/a	1
n/a	1

Pipe Tape

Response Option	Percent (n=60)*
Haven't gotten around to it	35%
Already have pipetape	25%
Didn't know what that was	13%
Too difficult to install it, don't know how to do it	10%
Takes too much time to install it / No time / Too busy	3%
Don't have the items any longer (threw away, gave away)	2%
Tried it, didn't work as intended (please explain in the box below)	2%
Don't have the tools I need	0%
Other	20%

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Don’t know	5%

*Multiple responses were allowed for this question

Verbatim “Other” Response	Count (n=12)
Pipes are inside the wall.	1
just like i said, lazy	1
I dont know if it would do any good to install it. I dont know if it would benefit me if I do install it. I dont know if it would cover all the pipes I have.	1
You're planning on installing a bath tub in the next little while and may install the pip tape then.	1
Bad back and crawl space install is difficult	1
Want to use it for my rental property	1
didnt recall getting this	1
health problems	1
Don't need it	1
just gave it away	1
Don't remember receiving pipe tape	1
because it is in the basement, dont need it	1

Q16. [Ask if Q11 = SHOWERHEAD and Q19 kitchen faucet aerator option was not selected] Your efficient kitchen faucet aerator has three settings to adjust the flow of water. Have you adjusted this setting?

Response Option	Percent (n=45)
Yes	64%
No	27%
Don't know	9%

Q17. [Ask if Q25 = Yes] What flow setting is the kitchen faucet aerator currently set at? Please go over to your kitchen sink if you need to check.

Response Option	Percent (n=29)
0.5 GPM (lowest flow setting – “soaping mode”)	10%
1.0 GPM (middle flow setting – “eco friendly mode”)	83%
1.5 GPM (highest flow setting – “power rinse mode”)	3%
Don’t Know	3%

Q18. [Ask if Q26 = 0.5, 1.0, or 1.5 GPM] How often do you use that flow setting?

Response Option	Percent (n=28)
Not very often	14%
About half the time	11%
Most of the time	46%
All the time	25%
Don't know	3%

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Q19. [If Q27 = NOT VERY OFTEN or ABOUT HALF THE TIME] What flow setting do you use most regularly?

Response Option	Percent (n=7)
0.5 GPM (lowest flow setting – “soaping mode”)	14%
1.0 GPM (middle flow setting – “eco friendly mode”)	86%
1.5 GPM (highest flow setting – “power rinse mode”)	0%
Don’t know	0%

Q20. [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=65)
One minute or less	0%
Two to four minutes	11%
Five to eight minutes	49%
Nine to twelve minutes	29%
Thirteen to fifteen minutes	5%
Sixteen to twenty minutes	2%
Twenty-one to thirty minutes	0%
More than thirty minutes	0%
Don’t know	5%

Q21. [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=65)
Less than one	5%
One	29%
Two	49%
Three	9%
Four	3%
Six	2%
Seven	2%
Eight or more	0%
Don’t know	2%

Q22. [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?

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Response Option	Percent (n=22)
Less than one	23%
One	36%
Two	27%
Three	0%
Four	5%
Five	0%
Six	0%
Seven	0%
Eight or more	0%
Don't know	9%

Q23. What fuel type does your water heater use?

Response Option	Percent (n=114)
Electric	70%
Natural gas	28%
Other (please specify in the box below)	0%
Don't know	2%

Q24. [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=84)
Yes	34%
No	50%
Don't know	16%

Q25. [Ask if Q33 = YES] What items would you have purchased and installed within the next year?

Response Option	Count (n=29)*
Showerhead	20
Kitchen faucet aerator	6
Bathroom faucet aerator	5
Pipe tape	3
Don't know	2

*Multiple responses were allowed for this question

Q26. [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=7)

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One	57%
Two	43%
Don't know	0%

Q27. [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=5)
One	20%
Two	20%
Three	20%
Four	0%
Don't know	40%

Q28. [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=84)
1- Not at all influential	1%
1	0%
2	0%
3	0%
4	0%
5	2%
6	2%
7	1%
8	10%
9	12%
10 - Extremely influential	71%
Don't know	0%

The fact that the items were mailed to your home

Response Option	Percent (n=84)
0- Not at all influential	1%
1	0%
2	0%
3	0%
4	0%
5	4%
6	2%
7	2%
8	5%
9	18%
10 - Extremely influential	68%

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Don't know	0%

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

Response Option	Percent (n=84)
0- Not at all influential	2%
1	0%
2	0%
3	0%
4	0%
5	8%
6	2%
7	7%
8	12%
9	16%
10 - Extremely influential	51%
Don't know	1%

Other information or advertisements from Duke Energy, including its website

Response Option	Percent (n=84)
0- Not at all influential	10%
1	0%
2	0%
3	0%
4	0%
5	7%
6	6%
7	6%
8	21%
9	14%
10 - Extremely influential	31%
Don't know	5%

Q29. Since receiving your kit from Duke Energy, what **new** behaviors has your household adopted to help save energy at home? Please only consider new **behaviors** that your household has adopted since receiving the kit.

Response Option	Percent (n=114)*
Not applicable - no new behaviors since receiving kit	28%
Turn off lights when not in a room	46%
Turn off furnace when not home	9%
Turn off air conditioning when not home	17%
Changed thermostat settings to use less energy	42%
Used fans instead of air conditioning	25%
Turn off electronics when we are not using them	35%
Take shorter showers	23%
Turned water heat thermostat down	9%

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Turn off water when brushing teeth	32%
Other	5%
Don't know	4%

*Multiple responses were allowed for this question

Verbatim "Other" Response	Count (n=6)
only used pipe tape	1
agree with duke enegy save energy	1
Installed new hi eff pool pump	1
replaced water lines with pvc	1
We are energy conscious so this probably made little difference........slight if any.	1
Shades, front and back, depending on time of day and season	1

Q30. [Ask if Q38 <> DON'T KNOW or NOT APPLICABLE]. On a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how much influence did Duke Energy's kit and materials on saving energy have on your decision to [LIST ALL RESPONSES FROM Q38].

Response Option	Percent (n=78)
0 – Not at all influential	5%
1	3%
2	4%
3	1%
4	0%
5	8%
6	12%
7	15%
8	13%
9	5%
10 - Extremely influential	33%
Don't know	1%

Q31. 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=114)
Yes	33%
No	62%
Don't know	5%

Q32. [If Q40 = YES] What **products** have you purchased and installed to help save energy in your home?

Response Option	Percent (n=37)*
Bought energy efficient appliances	19%
Moved into an ENERGY STAR home	3%
Bought efficient heating or cooling equipment	16%
Bought efficient windows	8%

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Added insulation	16%
Sealed air leaks in windows, walls, or doors	30%
Sealed or insulated ducts	5%
Bought LEDs	38%
Bought CFLs	19%
Installed an energy efficient water heater	19%
None – no other actions taken	3%
Other	11%
Don't know	0%

*Multiple responses were allowed for this question

Verbatim Other Responses	Count (n=4)
Aerators and shower head	1
New thermostat, cut down on my furnace running so long . Really helped.	1
Kitchen Faucet	1
generator	1

Q33. [If Q41 = MOVED INTO AN ENERGY STAR HOME] Is Duke Energy still your gas or electricity utility?

Response Option	Count (n=114)
Yes	1
Not asked	113

Q34. [Ask if Q41<> NONE, DON'T KNOW, or REFUSED] Did you get a rebate from Duke Energy for any of those products or services? If so, which ones? Please select all products and services for which you received Duke Energy rebates.

Response Option	Count (n=36)*
Bought energy efficient appliances	0
Moved into an ENERGY STAR home	0
Bought efficient heating or cooling equipment	1
Bought efficient windows	0
Added insulation	0
Sealed air leaks in windows, walls, or doors	0
Sealed or insulated ducts	0
Bought LEDs	1
Bought CFLs	2
Installed an energy efficient water heater	0
I did not get any Duke Rebates	29
Other	1
Don't know	2

*Multiple responses were allowed for this question.

Q35. [Ask if Q41 = BOUGHT LEDS] Duke Energy's website has a tool that helps you find discounted LEDs in your area. Duke Energy's website also has an online store where you can purchase discounted LEDs and have them shipped directly to your home. Did you use either of these Duke Energy services to acquire your LEDs?

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Response Option	Percent (n=14)
Yes	36%
No	64%
Don't know	0%

Q36. [Ask if Q41 = BOUGHT CFLS] Duke Energy's website has a tool that helps you find discounted CFLs in your area. Duke Energy's website also has an online store where you can purchase discounted CFLs and have them shipped to your home. Did you use either of these Duke Energy services to acquire your CFLs?

Response Option	Percent (n=7)
Yes	43%
No	57%
Don't know	0%

Q37. [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	0%	14%	0%	0%	0%	0%	0%	29%	57%	0%	0%	0%	7
Move into an ENERGY STAR home	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	1
Buy efficient heating or cooling equipment	17%	0%	0%	0%	0%	0%	17%	17%	0%	0%	33%	17%	6
Buy efficient windows	0%	0%	0%	0%	0%	0%	0%	33%	33%	0%	33%	0%	3
Add insulation	0%	0%	0%	0%	0%	0%	17%	33%	33%	0%	17%	0%	6
Seal air leaks	9%	0%	0%	0%	0%	18%	9%	9%	9%	0%	45%	0%	11
Seal ducts	50%	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%	0%	2
Buy LEDs	14%	0%	0%	0%	0%	7%	0%	14%	29%	7%	29%	0%	14
Buy CFLs	14%	0%	0%	0%	0%	0%	14%	14%	14%	14%	29%	0%	7

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Install an energy efficient water heater	29%	0%	0%	0%	0%	0%	0%	14%	0%	14%	43%	0%	7
Other	50%	0%	0%	0%	0%	0%	0%	0%	25%	0%	25%	0%	4

Q38. [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=7)*
Refrigerator	57%
Stand-alone freezer	0%
Dishwasher	29%
Clothes washer	86%
Clothes dryer	71%
Oven	29%
Microwave	29%
Other	0%
Don't know	0%
Refused	0%

*Multiple responses were allowed for this question

Q39. [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	2	2	0	2	5	4	1	0
No	0	0	0	0	0	0	0	0
Don't know	0	2	0	0	1	1	0	0
Total	2	4	0	2	6	5	2	0

Q40. [Ask if Q47 = CLOTHES DRYER] Does the new clothes dryer use natural gas?

Response Option	Percent (n=5)
Yes	0%
No	100%
Don't know	0%
Refused	0%

Q41. [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=5)*
Central air conditioner	60%
Window/room air conditioner unit	0%
Wall air conditioner unit	0%

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Air source heat pump	20%
Geothermal heat pump	0%
Boiler	0%
Furnace	20%
Wifi thermostat	20%
Other	0%
Don't know	0%
Refused	0%

*Multiple responses were allowed for this question

Q42. [Ask if Q50 = BOILER OR FURNACE] Does the new [INSERT Q50 RESPONSE] use natural gas?

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

Q43. [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	0	2	0	0	1	0	0	1
No	0	0	0	0	0	0	0	0
Don't know	0	1	0	0	0	0	0	0
Total	0	3	0	0	1	0	0	1

Q44. [Ask if Q41= BOUGHT EFFICIENT WINDOWS and Q46_BUY EFFICIENT WINDOWS >0] Do you know how many windows you installed?

Response Option	Percent (n=114)
Yes	1%
No	2%
Don't know	0%
Not asked	97%

Please specify how many you installed:

Verbatim Response	Percent (n=1)
11	100%

Q45. [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

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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=6)*
Attic	100%
Walls	17%
Below the floor	17%

*Multiple responses were allowed for this question

Attic

Verbatim Response	Count (n=2)
20	1
75	1

Q46. [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=12)
Yes	100%
No	0%

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

Verbatim Response	Count (n=12)
12	3
15	1
2	1
4	1
5	2
6	2
8	1
9	1

Q47. [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=6)
Yes	83%
No	17%

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

Verbatim Response	Count (n=5)
11	1
25	1
3	1
8	2

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Q48. [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=5)
Yes	20%
No	80%
Don't know	0%
Refused	0%

Q49. [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=5)
A traditional water heater with a large tank that holds the hot water	40%
A tankless water heater that provides hot water on demand	60%
A solar water heater	0%
Other	0%
Don’t know	0%
Refused	0%

Q50. [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=5)
Yes	80%
No	0%
Don't know	20%
Refused	0%

Q51. Which of the following types of housing units would you say best describes your home? It is . . .?

Response Option	Percent (n=114)
Single-family detached house	81%
Single-family attached home (such as a townhouse or condo)	4%
Duplex, triplex or four-plex	0%
Apartment or condo with 5 units or more	0%
Manufactured or mobile home	13%
Other	1%
Prefer not to say	0%
Don't know	1%

Verbatim Other Response	Count (n=1)
Tri level house	1

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Q52. How many showers are in your home? Please include both stand-up showers and bathtubs with showerheads.

Response Option	Percent (n=114)
One	22%
Two	67%
Three	11%
Four	1%
Five or more	0%
Don't know	0%

Q53. 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=114)
One	14%
Two	39%
Three	31%
Four	10%
Five	4%
Six	1%
Seven	2%
Eight or more	0%
Don't know	0%

Q54. How many kitchen faucets are in your home?

Response Option	Percent (n=114)
One	91%
Two	8%
Three	1%
Four or more	0%
Don't know	0%

Q55. 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=114)
500 to under 1,000 square feet	9%
1,000 to under 1,500 square feet	30%
1,500 to under 2,000 square feet	22%
2,000 to under 2,500 square feet	18%
2,500 to under 3,000 square feet	6%
Greater than 3,000 square feet	6%
Prefer not to say	1%
Don't know	9%

Q56. Do you or members of your household own your home, or do you rent it?

Response Option	Percent (n=114)

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Own / buying	94%
Rent / lease	6%
Occupy rent-free	0%
Prefer not to say	0%
Don't know	0%

Q57. Including yourself, how many people currently live in your home year-round?

Response Option	Percent (n=114)
I live by myself	15%
Two people	45%
Three people	18%
Four people	8%
Five people	3%
Six people	1%
Seven people	1%
Eight or more people	0%
Prefer not to say	10%
Don't know	0%

Q58. What was your total annual household income for 2016, before taxes?

Response Option	Percent (n=114)
Under $20,000	7%
$20,000 to under $30,000	13%
$30,000 to under $40,000	7%
$40,000 to under $50,000	8%
$50,000 to under $60,000	11%
$60,000 to under $75,000	5%
$75,000 to under $100,000	9%
$100,000 to under $150,000	6%
$150,000 to under $200,000	0%
$200,000 or more	1%
Prefer not to say	28%
Don't know	4%

Q59. What is the highest level of education achieved among those living in your household?

Response Option	Percent (n=114)
Less than high school	1%
Some high school	3%
High school graduate or equivalent (such as GED)	17%
Trade or technical school	10%
Some college (including Associate degree)	22%
College degree (Bachelor's degree)	17%
Some graduate school	3%
Graduate degree, professional degree	11%
Doctorate	4%

Prefer not to say	13%
Don’t know	0%

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Duke Energy Carolinas

Energy Efficient Appliances and Devices Program
Final Evaluation Report

December 8, 2017

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1. Evaluation Summary

1.1 Program Summary

Duke Energy Carolinas (DEC) launched the Energy Efficient Appliances and Devices program in 2010 with the goal of reducing energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. The Free LED program is a distinct component of the Energy Efficient Appliances and Devices program and is the focus of this evaluation report. The free LED program launched in 2010 and is a free giveaway program. Historically, Duke Energy offered up to 15 free general service CFL products in a variety of wattages and package configurations to DEC customers as part of this program. In January 2016, the program product mix shifted from CFLs to LEDs. The transition from CFLs to LEDs occurred in three phases:

- **Phase 0 (January–April 2016)[1]:** As part of this phase, Duke Energy offered 6-bulb LED kits to active residential customers who had not received their free bulb limit of 15 energy-efficient bulbs from Duke Energy. These included new DEC customers. The program targeted a select number of these eligible customers by sending them a business reply card (BRC) that they could send back to request the bulbs.
- **Phase 1 (June 2016–Present):** As part of this phase, the Free LED ordering platform was launched, allowing all eligible customers to order kits of various sizes (3, 6, 8, 12, and 15 bulbs), depending on the number of bulbs ordered in the past. This phase is available to the same customer cohort as Phase 0. Customer ordering channels include a dedicated website page, an online services (OLS) portal where customers can be intercepted with a pop-up offer if eligible, and an interactive voice response (IVR) phone system.
- **Phase 2 (March 2017–Present):** As part of this phase, Duke Energy is targeting customers who reached or exceeded their free bulb limit through the various free lighting programs with orders over 5 years or more since order date. Customers have a choice of 6- and 12-bulb kits. As with Phase 1 customers, eligible Phase 2 customers are able to order via a platform that will be incorporated into the Duke Energy public website, an OLS, and an IVR.[2]

To ensure that only DEC customers receive the LEDs, customers must provide their account number or the phone number associated with their account, as well as last four digits of their social security number. Once requested, program bulbs are shipped to the billing address associated with the customer's account.

This evaluation effort is focused on the program period February 29, 2016 through April 28, 2017.

1.2 Evaluation Objectives, Conclusions, and Recommendations

This evaluation of the Free LED program includes process and impact assessments, and addresses several major research objectives:

- Assess program performance and estimate gross and net annual energy (kWh) and peak demand (kW) savings associated with program activity

[1] Note that while the last drop of business reply cards informing customers of the program occurred in April 2016, participant requests for program bulbs continued through November 2016.

[2] Note that this evaluation covers less than two months of Phase 2.

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- Assess program implementation processes and marketing strategies and identify opportunities for improvement
- Understand participant lighting awareness, preferences, and purchasing behaviors, and obtain an insight into lighting market dynamics

To achieve these research objectives, the evaluation team completed a range of data collection and analytical activities, including interviews with program staff, a participant survey, program-tracking data analysis, a deemed savings review, an impact analysis, and an analysis of the survey results. Through the primary data collection, the evaluation team developed estimates of a first-year in-service rate (ISR) and net-to-gross ratio (NTGR). Table 1-1 provides an overview of the ex post gross savings parameters, the sample sizes used to develop those estimates, and the associated confidence and precision.

Table 1-1. Summary of Gross Savings Inputs

Estimate	Sample Size	Estimate	Relative Precision (at 90% Confidence)
First-year ISR*	180	59.9%	7%
NTGR	482	50%	8%

* Note that, due to the timing of the research activities, first-year ISR estimate is based on the participants from Phase 0 and Phase 1, while the NTGR is based on Phase 1 and Phase 2 participants.

Between February 29, 2016 and April 28, 2017, the Free LED program distributed 3,074,086 LEDs by sending 258,720 kits to 251,168 DEC customers. The program achieved 96,396 MWh in ex post gross energy savings, 14.2 MW in ex post gross summer peak demand savings, and 6.9 MW in winter peak demand savings across the three phases. The program realized 112% of energy savings, 127% of summer peak demand savings, and 171% of winter peak demand savings. High realization rates are primarily a result of the program using lower baseline wattage assumptions[3], first-year ISR, and coincidence factors when estimating savings for LEDs distributed during Phase 2 of the program.

While the overall ISR was high (91.1% for North Carolina and 91.0% for South Carolina), first-year ISR was low, at 59.9%. The low first-year ISR is driven primarily by the fact that customers were able to receive a large number of LEDs at once, up to 15 depending on the phase, and most took advantage of the offering and ordered the maximum number of bulbs allowable.

The overall program NTGR of 50% was low compared to the previous evaluation of this program, where CFLs were the program measure (84%)[4], and is a likely result of increased customer knowledge of energy-efficient lighting products and their benefits and positive results of the previous Free CFL program interventions. Program participant composition was disproportionately skewed toward higher-income customers and customers with higher levels of educational attainment; both of these cohorts had higher free-ridership (FR) and consequently lower NTGRs.

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[3] The program team used lower baseline wattage assumptions for Phase 2 participants to account for likely replacement of LEDs with CFLs.

[4] Opinion Dynamics Corporation. *Duke Energy Carolinas. Energy Efficient Appliances and Devices Program. Final Evaluation Report.* Prepared for Duke Energy Carolinas. November 2015.

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After applying the program NTGR to the ex post gross savings, the program achieved 48,476 MWh in energy savings, 7.2 MW in summer peak demand savings, and 3.5 MW in winter peak demand savings. Table 1-2 provides a summary of the program's gross and net impacts overall and by phase.

Table 1-2. Overview of Program Impacts

Phase	Total Savings	Ex Ante Results	Ex Post Gross Results	Gross Realization Rate	Ex Post Net Results	Net Realization Rate
0	Bulbs	343,848	343,848			
	Energy savings (MWh)	10,836	10,782	100%	5,422	60%
	Summer peak demand savings (MW)	1.4	1.6	113%	0.8	68%
	Winter peak demand savings (MW)	0.5	0.8	152%	0.4	92%
1	Bulbs	2,265,652	2,265,652			
	Energy savings (MWh)	71,398	71,046	100%	35,728	60%
	Summer peak demand savings (MW)	9.2	10.5	113%	5.3	68%
	Winter peak demand savings (MW)	3.3	5.1	152%	2.6	92%
2	Bulbs	464,586	464,586			
	Energy savings (MWh)	4,115	14,568	354%	7,326	213%
	Summer peak demand savings (MW)	0.5	2.2	404%	1.1	243%
	Winter peak demand savings (MW)	0.2	1.0	542%	0.5	327%
Total	Bulbs	3,074,086	3,074,086			
	Energy savings (MWh)	86,349	96,396	112%	48,476	67%
	Summer peak demand savings (MW)	11.2	14.2	127%	7.2	77%
	Winter peak demand savings (MW)	4.0	6.9	171%	3.5	103%

Table 1-3 provides per-bulb ex post gross and net savings. As can be seen in the table, across all phases per-bulb ex post gross energy savings are 31.4 kWh and peak demand savings are 0.0046 and 0.0022 for summer and winter respectively. Per-bulb ex post net energy savings are 15.8 kWh and peak demand savings are 0.0023 and 0.0011 for summer and winter respectively across all phases.

Table 1-3. Per-Unit Ex Post Savings

Per-Bulb Savings	Ex Post Gross Savings	Ex Post Net Savings
Energy savings (kWh)	31.4	15.8
Summer peak demand savings (kW)	0.0046	0.0023
Winter peak demand savings (kW)	0.0022	0.0011

The program implementation processes ran smoothly and effectively, resulting in high levels of customer satisfaction with the program. Program-tracking data were complete and accurate. Instances of products mailed and installed outside of the DEC jurisdiction were minimal. Instances of participants receiving more than the phase-based maximum number of bulbs through the program were also minimal.

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Recommendations

We recommend that program administrators calculate future savings from the Free LED program using the recommended per-bulb energy and summer peak savings presented in Table 1-3 above.

To increase program efficacy, we recommend that the program deploys targeted marketing and outreach strategies aimed at increasing participation among lower-income customers and customers with lower levels of educational attainment, while also continuing to reach out to renters and younger customers. Those customer cohorts are less likely to be free-riders and the program therefore will be able to effect change in their lighting preferences and behaviors. Such targeting can be achieved by overlaying census data over the customer data and targeting customers in geographic units (such as census block groups) with higher shares of the desired segment.

To improve its first-year ISR and subsequently the overall ISR, we recommend that the program includes collateral in the bulb kits urging customers to install as many program LEDs as possible by replacing working, less-efficient bulbs in their homes.

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2. Program Description

2.1 Program Design

Duke Energy Carolinas (DEC) launched the Energy Efficient Appliances and Devices program in 2010 with the goal of reducing energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. The Free LED program is a distinct component of the Energy Efficient Appliances and Devices program and is the focus of this evaluation report. The free LED program launched in 2010 and is a free giveaway program. Historically, Duke Energy offered up to 15 free general service CFL products in a variety of wattages and package configurations to DEC customers as part of this program. In January 2016, the program product mix shifted from CFLs to LEDs. The transition from CFLs to LEDs occurred in three phases:

- **Phase 0 (January–April 2016)[5]:** As part of this phase, Duke Energy offered 6-bulb LED kits to active residential customers who had not received their free bulb limit of 15 energy-efficient bulbs from Duke Energy. These included new DEC customers. The program targeted a select number of these eligible customers by sending them a business reply card (BRC) that they could send back to request the bulbs.
- **Phase 1 (June 2016-Present):** As part of this phase, the Free LED ordering platform was launched, allowing all eligible customers to order kits of various sizes (3, 6, 8, 12, and 15 bulb), depending on the number of bulbs ordered in the past. This phase is available to the same customer cohort as Phase 0. Customer ordering channels include a dedicated website page, an online services (OLS) portal where customers can be intercepted with a pop-up offer if eligible, and an interactive voice response (IVR) phone system.
- **Phase 2 (March 2017–Present):** As part of this phase, Duke Energy is targeting customers who reached or exceeded their free bulb limit through the various free lighting programs with orders over 5 years or more since order date. Depending upon bulb quantities from previous orders greater than 5 years, customers may have a choice of 6- or 12-bulb kits. As with Phase 1 customers, eligible Phase 2 customers are able to order via a platform that will be incorporated into the Duke Energy public website, an OLS, and an IVR.[6]

To ensure that only DEC customers receive the LEDs, customers must provide their account number or the phone number associated with their account, as well as last four digits of their social security number. Once requested, program bulbs are shipped to the billing address associated with the customer's account.

This evaluation effort is focused on the program period February 29, 2016 through April 28, 2017.

2.2 Program Implementation

DEC manages the Free LED program and is responsible for marketing the program to its customers, receiving customer orders, and maintaining the program-tracking database. AM Conservation Group (AMC) implements the Free LED program on behalf of DEC and handles fulfillment of customer orders. More specifically, AMC

[5] Note that while the last drop of business reply cards informing customers of the program occurred in April 2016, participant requests for program bulbs continued through November 2016.

[6] Note that this evaluation covers less than two months of Phase 2.

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handles packing, shipping, and tracking orders, as well as any shipment or product issues. AMC provides daily updates on fulfilled orders and monthly reports on performance metrics to DEC.

Free LED program marketing has been focused and phase-specific and included BRCs during Phase 0 and intercepts through OLS or direct mail during Phase 1 and Phase 2. DEC also offers a program-dedicated web page.

2.3 Program Performance

Between February 29, 2016 and April 28, 2017, AMC shipped 258,720 LED kits totaling 3,074,086 LEDs. Most of the packs shipped were 12-bulb or 15-bulb packs (86%). Program-estimated energy savings totaled 86,349 MWh. Table 2-1 provides a summary of shipments, bulbs, and energy and demand savings achieved during the program period.

Table 2-1. Summary of Program-Tracking Data for Program Period[a]

Kit Type Mailed	Kits Mailed	Bulbs Mailed	Ex Ante Gross Savings (MWh)	Ex Ante Gross Summer Coincident Savings (MW)	Ex Ante Gross Winter Coincident Savings (MW)
Phase 0	57,308	343,848	10,836	1.40	0.51
Phase 1	161,300	2,265,652	71,398	9.25	3.34
Phase 2	40,112	464,586	4,115	0.53	0.19
Total	258,720	3,074,086	86,349	11.18	4.04

[a] Savings may not add due to rounding.

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3. Key Research Objectives

This evaluation of the Free LED program includes process and impact assessments and addresses several major research objectives:

- Assess program performance and estimate gross and net annual energy (kWh) and peak demand (kW) savings associated with program activity
- Assess program implementation processes and marketing strategies and identify opportunities for improvement
- Understand participant lighting awareness, preferences, and purchasing behaviors, and obtain an insight into lighting market dynamics

This evaluation provides DEC with results required by the North Carolina Utilities Commission and the Public Service Commission of South Carolina. The results also provide inputs for system planning and future program design and delivery.

The North Carolina Utilities Commission requires the following for the evaluation of DEC's Free LED program:

- That DEC uses Carolinas-specific, both North and South Carolina, data in future evaluation, measurement, and verification (EM&V) reports
- That future EM&V reports include a discussion of the impacts of LEDs, 2007 Energy Independence and Security Act (EISA), and other innovations in lighting technology and relevant regulatory mandates on the calculations of measure impacts and the baseline measures used in those calculations

This evaluation satisfies commission requirements and provides certain Carolinas-specific updated inputs into savings calculations. The evaluation also provides process and market information that DEC can use to further tailor the Free LED program to a rapidly changing lighting market.

As part of the process assessment, we explored the following research questions:

- What are the sources of program information?
- How effective are the program implementation and data-tracking practices?
- Are participants satisfied with their program experiences?
- How effective are the program's marketing, outreach, and educational tactics?
- What is the program reach? What percentage of DEC's customer base has participated in the program?
- What customer segments should the program target to minimize free-ridership (FR)?
- What are the strengths, weaknesses, and opportunities for program improvement?
- What are participant lighting preferences and purchase behaviors?

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4. Overview of Evaluation Activities

To answer the research questions outlined in the previous section, the evaluation team performed a range of data collection and analytical activities. Table 4-1 provides a summary of evaluation activities and associated areas of inquiry. Following the table, we provide detail on each activity's scope, sampling approach (if applicable), and timing of the activity.

Table 4-1. Overview of Evaluation Research Activities

#	Evaluation Activity	Impact	Process/ Market	Purpose of Activity
1	Program staff interviews		X	• Provide insight into program design and delivery • Support process assessment
2	Materials review	X	X	• Provide insight into program design and delivery • Inform previously used and alternative savings assumptions
3	Deemed savings review	X		• Review accuracy and appropriateness of energy savings assumptions and determine alternative savings inputs
4	Impact analysis	X		• Calculate gross and net energy and demand savings
5	Participant survey	X	X	• Estimate in-service rate (ISR) • Estimate FR and spillover (SO) • Assess lighting market • Support process assessment

4.1.1 Program Staff Interviews

The evaluation team completed one interview with program staff at Duke Energy, in June 2016. The interview explored changes in program design and implementation, program performance, incentivized product specifications, and data tracking and communication processes, among other topics.

4.1.2 Materials Review

In support of the impact and process evaluations, the evaluation team reviewed program materials and data, including marketing materials, plans, and past evaluation reports and research studies. This information informed our research design, provided insight into program design and delivery, and supported the assessment of program impacts.

4.1.3 Deemed Savings Review

In support of the impact evaluation, the evaluation team reviewed program-tracking databases and energy savings assumptions. The objectives of the review were to identify the deemed savings values DEC used to calculate impacts; review the deemed savings values for reasonableness; verify their accurate application; and identify data gaps, omissions, inconsistencies, and errors.

To assess the reasonableness of the savings assumptions, we reviewed evaluation reports from previous evaluations of the Free CFL program, as well as other residential lighting programs that Duke Energy

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administers in the Carolinas.[7] We also drew on the primary research completed as part of the DEC's Retail LED program evaluation.[8] Finally, we consulted evaluation reports and Technical Reference Manuals (TRMs) from other jurisdictions.

As part of the deemed savings review process, we also checked program-tracking data for accuracy, consistency, and completeness.

4.1.4 Impact Analysis

The impact analysis included calculating ex post gross and net program savings using updated savings assumptions. We calculated savings using the Uniform Methods Project (UMP) protocols recommended approach.

4.1.5 Participant Survey

The evaluation team completed a mixed-mode (telephone and online) survey with a representative sample of DEC Free LED program participants. The key goals of the survey were to gather information to support the assessment of gross impacts, program attribution, program processes, and market dynamics. Specifically, we used the survey results to produce updated estimates of the first-year ISR, FR, SO, lighting knowledge and preferences, and participant experiences with the program.

Sample Design and Fielding

For most customers, lighting products are a low-cost and low-importance purchase. Therefore, when using the self-report method to estimate program FR, it is best to conduct interviews with participants as close to their participation as possible to facilitate accurate recall of the factors that affect bulb purchase or order decisions. On the other hand, it is best to let some time pass when measuring SO effects and first-year ISR so that participants have time to install the products and take additional program-induced actions.

To address these competing priorities, Opinion Dynamics conducted the participant survey in waves and staggered the timing of the interviews based on the survey objective. We drew one sample from the most recent participants to assess program processes and to estimate FR and a separate sample from earlier participants to estimate SO and ISR. The phased approach to survey administration is more accurate than if we relied just on the most recent participants and extrapolated the results to all participants regardless of when they participated.[9]

We completed a total of three waves of the participant survey equally timed over the course of the program period. We administered the first wave between December 2016 and January 2017, the second wave between March 2017 and April 2017, and the third wave between May 2017 and June 2017.

For each wave, we used two distinct sample frames from which we drew a random sample of program participants. The sample frame used to estimate FR and program processes included customers who participated in the program in the 3 months prior to the survey. The sample frame used to estimate SO and ISR included customers who participated in the program between 3 months and 6 months prior to the survey

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[7] These programs include the Duke Energy Progress (DEP) Energy Efficient Lighting (EEL) program and the DEC Online Store program.

[8] The DEC Retail LED report is undergoing review as of the writing of this report.

[9] Duke Energy anticipates to apply the evaluated (ex post) energy and demand savings values starting in May, 2017. The timing of the participant surveys (mostly in 2017) should provide an adequate perspective on the LED installation patterns and decision making processing of 2017 participants overall.

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fielding date. Due to the timing of the survey efforts, the FR sample included almost exclusively participants from Phases 1 and 2, while the SO and ISR sample only included Phase 0 and Phase 1 participants.

We completed a total of 482 interviews over the course of the three waves. Overall, 304 interviews supported the assessment of FR and program processes and 178 interviews supported the assessment of SO and ISR.

Table 4-2. Participant Survey Sample Sizes and Number of Completed Interviews by Sample Frame

Sample Frame	Sample Frame Size	Sample Size	Number of Completed Interviews
FR	185,058	1,257	304
SO	92,217	943	178
Total	**225,182**	**2,200**	**482[a]**

[a] Please note that nine additional participants completed the survey but did not receive either the FR or SO modules. Those participants did not verify their participation in the program. Their responses are used in our calculation of the ISR only.

We sent participants either mail or email invitations and reminders to take the survey depending on the availability of email addresses; participants could choose to take the survey online or call our phone center to take it over the telephone. Participants who did not have an email address on file received an invitation letter and two postcard reminders in the mail, while participants with email addresses received invitations and reminders via email. To increase response rates, we offered participants incentives in the form of several cash prize drawings.

Survey Dispositions and Response Rate

Table 4-3 provides the final survey dispositions.

Table 4-3. Participant Survey Disposition Summary

Disposition	Count
Completed Interviews (I)	**482**
Internet survey complete	463
Phone survey complete	19
Partial Interviews (N)	**43**
Household with Undetermined Survey Eligibility (U1)	**1,659**
Partial complete - survey eligibility unknown	26
Answering machine	8
Not available	2
Language problems	1
Non-specific callback	1
Initial refusal	4
No response	1,617
Undetermined if eligible household	**1**
No answer	1
Survey-ineligible household	**10**
Known ineligible (screened out)	10

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Disposition	Count
Not an eligible household	5
Bounced email	5
Total Participants in Sample	2,200

We calculated response rates using the Response Rate 3 (RR3) methodology specified by American Association of Public Opinion Research (AAPOR). We achieved a 22% survey response rate. We do not report a cooperation rate, because it is difficult to estimate it accurately with mailed and emailed survey invitations. The cooperation rate is the proportion of participants who *completed* the survey out of all eligible participants *contacted*. While we recorded returned mail invitations and bounce-back email invitations, we cannot say with certainty that the ones that were not returned were received and opened by qualified participants. Therefore, we do not have an accurate number of eligible contacted participants to calculate a cooperation rate.

Survey Data Weighting

The survey sample resembled the participant population across a range of known participant characteristics; therefore, there was no need to apply post-stratification weights.

Targeted and Achieved Confidence and Precision

The evaluation targeted 10% precision at a 90% confidence level for all data collection tasks that involved sampling. These precision goals were met (Table 4-4).

Table 4-4. Precision and Margin of Error at 90% Confidence

Metric of Interest	Relative Precision (At 90% Confidence)
First-year ISR	7%
Net-to-gross ratio (NTGR)	8%

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5. Impact Evaluation

This section describes the methodology for conducting the gross impact analysis and the results of the analysis. The evaluation team completed the following activities:

- Reviewed program-tracking data and savings assumptions for accuracy, completeness, and consistency
- Conducted engineering analysis of energy and demand savings and developed ex post gross savings estimates based on the Uniform Methods Project (UMP)

5.1 Methodology

The evaluation team reviewed reported savings assumptions and verified that the algorithms and inputs used to calculate those assumptions were in line with the previous evaluation's recommendations.

As part of the impact evaluation, we conducted a deemed savings review through which we identified the deemed savings values that DEC used to calculate program savings; reviewed the deemed savings values for reasonableness; verified their accurate application; and identified data gaps, omissions, inconsistencies, and errors. As part of the deemed savings review process, we also checked program-tracking data for accuracy, consistency, and completeness.

To assess the reasonableness of the savings assumptions, we reviewed evaluation reports from previous evaluations of the Free CFL program, as well as other residential lighting programs that Duke Energy administers in the Carolinas. We also drew on the primary research completed as part of the DEC's Retail LED program evaluation. Finally, as part of our review, we consulted evaluation reports and TRMs from other jurisdictions.

Using data collected as part of the participant survey, we developed an updated estimate of the first-year ISR.

We estimated savings using the UMP protocols recommended approach. Per the UMP protocols, energy savings calculations include delta watts and ISR. Equation 5-1 provides the formula that we used to estimate energy savings, while

Equation 5-2 provides the formula that we used to estimate demand savings.

Many upstream lighting programs[10] also account for leakage of discounted products outside of the utility service territory and for installation of program-discounted lighting in commercial applications. Leakage results in decreased savings, whereas installations in commercial applications lead to higher savings. Unlike upstream residential lighting programs that oftentimes have little control over who purchases discounted lighting products, DEC's Free LED program tightly controls who receives program LEDs and where customers can receive their LEDs, thus making leakage to non-DEC customers and installations in commercial applications unlikely. We explored the incidence of leakage and commercial installations through the participant survey and found that both are minimal (see Section 7.2.1 of this report). Therefore, we chose not to revise the equation to add a separate adjustment factor for leakage. However, we did account for program bulb leakage outside of the DEC service territory as part of the ISR by removing these bulbs from the installed base. This resulted in only a negligible change to ISR. We also did not apply a separate set of savings

[10] Upstream lighting programs provide incentives to retailers and manufacturers who, in turn, pass them on to customers in the form of price markdowns.

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assumptions to account for installations in commercial applications because of the minimal number of bulbs installed in such applications.

Equation 5-1. Algorithm for Energy Savings

$$\Delta kWh = ISR * \frac{(Watts * HOU)_{base} - (Watts * HOU)_{ee}}{1{,}000} * 365 * (1 + HVAC_c)$$

Equation 5-2. Algorithm for Peak Demand Savings

$$\Delta kW = ISR * \frac{Watts_{base} - Watts_{ee}}{1{,}000} * CF * (1 + HVAC_d)$$

Where:

ΔkWh = first-year electric energy savings
ΔkW = peak electric demand savings
ISR = in-service rate
$Watts_{base}$ = Baseline wattage
$Watts_{ee}$ = Efficient bulb wattage
HOU = residential annual operating hours
CF = peak coincidence factor
$HVAC_c$ = HVAC system interaction factor for energy
$HVAC_d$ = HVAC system interaction factor for demand

Table 5-1 presents a summary of the inputs used to calculate program gross energy and demand impacts and specifies the sources of the inputs. Following the table, we detail the source(s) behind each input and the rationale for the input selection. For reference purposes, Table 5-1 also provides savings assumptions used to estimate ex ante energy and demand savings.

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Table 5-1. Summary of Gross Savings Inputs

Assumption	Program Phase	Ex Ante Assumption	Ex Post Assumption	Ex Post Assumption Source
ISR	All Phases[a]	90.2%	91.1% (NC) 91.0% (SC)	• Free LED Participant Survey for first-year ISR • PY2013 Evaluation of the DEP EEL program for installation trajectory (Also consistent with the UMP) • DEC-specific discount rates to discount future savings
Baseline Wattage	0–1	47.7	43	2016 DEC Shelf Audit completed as part of the DEC Retail LED program evaluation[b]
	2	18.6		
LED Wattage	All Phases	9.0	9	Actual wattage
Average Daily Hours of Use (HOU)	All Phases	2.92	2.88	2016 DEP-DEC Residential Lighting Logger study completed as part of the DEC Retail LED program[a] and DEP EEL program evaluations
Summer CF	All Phases	0.114	0.128	
Winter CF	All Phases	0.096	0.145	
$HVAC_c$	All Phases	−0.037	−0.037	2012 DEC Smart $aver Program Evaluation
$HVAC_d$ – Summer	All Phases	0.168	0.168	
$HVAC_d$ – Winter	All Phases	−0.500	−0.500	PY2012 DEP EEL program evaluation

[a] Note that the first-year ISR estimate is based on Phase 0 and Phase 1 participants and excludes Phase 2 participants.
[b] As of the writing of this report, the Retail LED program evaluation report is undergoing review.

In-Service Rate

Although the first-year ISR is generally less than 100%, research studies across the country have found that customers eventually install nearly all bulbs received through a lighting program. Approaches to claiming savings from these later installations vary and include staggering the claiming of savings over time and claiming the savings from all expected installations in the program year but discounting them by a societal or utility discount rate. While the "staggered" approach allows program administrators to more accurately capture the timing of the realized savings, the "discounted" savings approach allows for simplicity of claiming all costs and benefits during the program year and eliminates the need to keep track of and claim savings from future installations. We chose to use the "discounted" savings approach for this evaluation.

To allocate installations over time, we used the installation trajectory from the recently completed lighting storage log study conducted for DEP (discussed as part of the 2013 evaluation report of DEP Energy Efficient Lighting Program[11]). This study is the most recent and Carolina's specific effort and is therefore appropriate for use. Furthermore, the installation rate trajectory from this study is recommended for use in the UMP. The DEP study estimates that participants install 97% of bulbs within 4 years of purchase. Table 5-2 presents the approach to developing installation rates over the 4 years following purchase based on the study.

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[11] Navigant Consulting, Inc. and Apex Analytics, LLC. *EM&V Report for the 2013 Energy Efficient Lighting Program.* Prepared for Duke Energy Progress. August 13, 2014.

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Table 5-2. Installation Trajectory

Year	Installation Trajectory Formula
Year 1	First-Year ISR
Year 2	((1 – First-Year ISR) * 41%) + First-Year ISR)
Year 3	((1 – First-Year ISR) * 69%) + First-Year ISR)
Year 4	97%

We estimated the first-year ISR through the participant survey and discounted future savings by the utility discount rate using the net present value (NPV) formula (Equation 5-3).

Equation 5-3. Net Present Value Formula

$$NPV = \frac{R_t}{(1+i)^t}$$

Where:

R = savings
T = number of years in the future savings take place
I = discount rate

We used different discount rates by state. Table 5-3 provides a summary of the discount rates that we used to discount the future savings.

Table 5-3. Discount Rate Summary

State	Discount Rate
North Carolina	7.09%
South Carolina	7.25%

We made an additional adjustment to the installation trajectory to account for bulbs that participants never received. This adjustment was necessary because the installation rate trajectory assumes that light bulbs were acquired (purchased), and we found that not all program bulbs were received (and therefore could not be considered acquired). We further made an additional adjustment to account for the program LEDs installed outside of the DEC jurisdiction (leakage) as part of the in-service rate. We assessed leakage through the participant survey and determined it to be minimal at 1.7%.

The first-year ISR is calculated by dividing the total number of program LEDs reported in service by the total number of LEDs reported in the program-tracking database. We incorporated the receipt, installation, and persistence of program LEDs into the first-year ISR.

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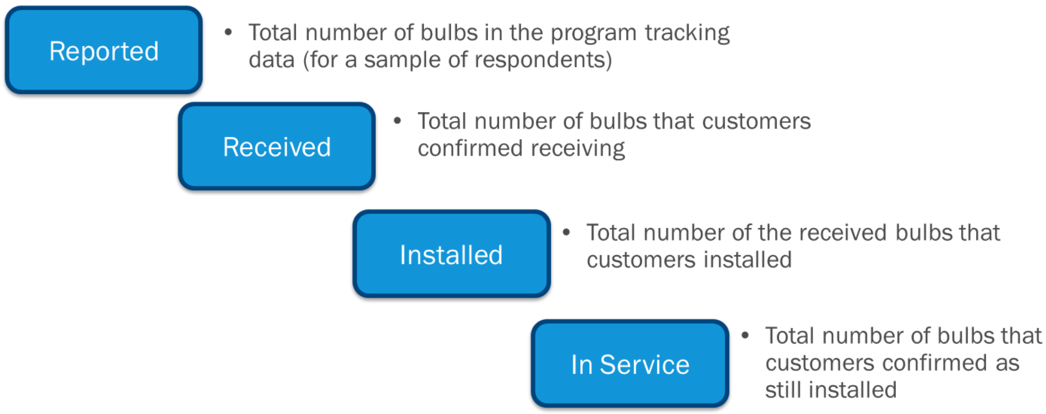
Figure 5-1. Installation Rate Components



The evaluation resulted in a first-year ISR of 59.9%. Relative precision around this point estimate is 7% at 90% confidence. Table 5-4 shows that the first-year ISR is lower for Phase 1 than Phase 0, likely due to the larger number of bulbs offered in Phase 1. The overall first-year ISR is weighted more towards the Phase 1 value due to a greater number of bulbs distributed in Phase 1 compared to Phase 0.

Table 5-4. First-Year ISR

Metric	Phase 0	Phase 1	Total
n	53	125	180
First-year ISR	72.4%	58.4%	59.9%
Relative precision (at 90% confidence)	9%	8%	7%

Note that due to the survey administration time frame, participants from Phase 2 were not part of the sample to calculate ISR.

Table 5-5 provides the installation rate trajectory that we used to allocate savings over time. After discounting the future installations by the DEC utility discount rate, the overall ISR decreased from 97.0% to 92.7% for NC and from 97.0% to 92.6% for SC.

Table 5-5. DEC Cumulative Installation Rate Trajectory

Program Year	Installation Trajectory before Discounting Future Installations by Utility Discount Rate		Installation Trajectory after Discounting Future Installations by Utility Discount Rate	
	NC	SC	NC	SC
Year 1	59.9%	59.9%	59.9%	59.9%
Year 2	76.3%	76.3%	75.3%	75.2%
Year 3	87.5%	87.5%	85.1%	85.0%
Year 4	97.0%	97.0%	92.7%	92.6%

After accounting for the leakage rate of 1.7%, the overall ISR is 91.1% for NC and 91.0% for SC.[12]

[12] Note that the leakage rate was applied first, followed by the cumulative net present value adjusted ISR.

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Baseline Wattage

The kits distributed through the program contained LEDs that are the equivalent of 60-watt incandescents in terms of lumen output. The 2007 EISA required a gradual phase out of general service incandescent products, which impacts the baseline wattage that can be used to estimate energy savings. Manufacturers complied with EISA by creating a halogen bulb that met the efficiency requirements, effectively making halogens the new baseline. The EISA regulations affected 60-watt incandescent products in January 2014. However, manufacturers and retailers were allowed to sell their existing inventory of incandescents so products did not immediately disappear from the market. Because some incandescent products may still have been available for purchase in 2016, assuming a halogen baseline may be too punitive.

To assess incandescent product availability and determine if any upward adjustments to the baseline wattage are warranted, Opinion Dynamics completed lighting shelf audits at a sample of 15 retail stores in DEC territory as part of the most recent DEC Retail LED program evaluation. The sample of 15 stores included 10 stores participating in the DEC Retail LED program and 5 non-participating stores. As part of the audits, we collected data on general service lighting products (including incandescents), including the number of products by wattage category.

Of the 15 stores, none carried 60-watt incandescents and most carried halogen products. Based on these findings, we will use the equivalent halogen wattage of 43 watts as the baseline wattage for LEDs distributed through the program.

LED Wattage

LED wattage was based on the wattage of the actual bulbs distributed by the program during the evaluation period. Program kits exclusively featured 9-watt LEDs.

Hours of Use and Coincidence Factors

The industry standard to estimate HOU is to conduct lighting logger studies. Opinion Dynamics recently completed an LED-specific HOU study as part of the evaluation of the DEC Retail LED and DEP EEL programs. As part of this study, we metered LED usage across a representative sample of 107 homes across DEP and DEC jurisdictions[13] with 61 homes located in the DEC jurisdiction specifically. The study yielded updated LED-specific and Carolinas-specific HOU and CF estimates. Table 5-6 provides LED HOU and CF estimates from the study.

Table 5-6. LED HOU and CF Assumptions

Statistic	LED Value
HOU	2.881
Summer CF	0.128
Winter CF	0.145

Interactive Effects

The evaluation team chose to use HVAC system interaction factors for energy, summer, and winter demand estimated as part of two recent studies:

[13] Of 107 homes, 61 were in DEC jurisdiction.

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- 2012 TecMarket Works Process and Impact Evaluation of the Residential Smart $aver Energy Efficiency Products (CFLs) Program in the Carolina System
- 2012 DEP EEL program evaluation for winter peak demand interactive effects

Based on these studies, we used HVAC system interaction factors of −0.037 for energy savings, 0.168 for summer peak demand savings, and −0.500 for winter peak demand savings.

Due to differences in technologies, interactive effects caused by CFLs and LEDs are likely different. The difference in these effects is unclear, especially as it pertains to the DEC jurisdiction. We are unaware of any existing modeling or simulation efforts to estimate LED-specific interactive effects. In our professional judgment, the difference between CFL and LED interactive effects is likely to have only a marginal impact on energy and peak demand savings. Given the small anticipated change in energy and peak demand savings estimates due to LED-specific interactive effects, and the relatively high cost of conducting the modeling and simulation needed to estimate those interactive effects, the evaluation team believes that the interactive effect estimates for CFLs in the studies listed above are appropriate to use.

5.2 Gross Impact Results

The evaluation team received program-tracking data in two extracts. One extract contained product and shipment information and the other contained customer contact information. The shipment data extract did not contain participant contact information (phone numbers and email addresses) that is critical for conducting a participant survey. As such, we merged shipment information with customer information using customer account number as the linking unique identifier.

Upon merging the program-tracking data files, the evaluation team analyzed the data for any gaps and inconsistencies. As part of the analysis, we performed the following steps:

- Checked the core data fields for missing values[14]
- Checked the data for temporal gaps (due to missing invoices, transactions, or other data gaps) by exploring reasonable variation in monthly invoiced sales

We found that necessary data fields were clean, fully populated, and contained all necessary information to proceed with the impact analysis.

Using the equations and inputs discussed in Section 5.1, we calculated gross energy and peak demand savings achieved by the program during the evaluation period. Table 5-7 presents the results of the analysis. The Free LED program realized 112% of the reported gross energy savings, 127% of the reported summer peak demand savings, and 171% of the reported winter peak demand savings.

[14] This excludes the email address data field as we expect that not every participant would have provided his or her email address.

Table 5-7. Gross Impact Results

Phase	Total Savings	Ex Ante Savings	Ex Post Gross Savings	Gross Realization Rate
0	Bulbs	343,848	343,848	
	Energy savings (MWh)	10,836	10,782	100%
	Summer peak demand savings (MW)	1.4	1.6	113%
	Winter peak demand savings (MW)	0.5	0.8	152%
1	Bulbs	2,265,652	2,265,652	
	Energy savings (MWh)	71,398	71,046	100%
	Summer peak demand savings (MW)	9.2	10.5	113%
	Winter peak demand savings (MW)	3.3	5.1	152%
2	Bulbs	464,586	464,586	
	Energy savings (MWh)	4,115	14,568	354%
	Summer peak demand savings (MW)	0.5	2.2	404%
	Winter peak demand savings (MW)	0.2	1.0	542%
Total	Bulbs	3,074,086	3,074,086	
	Energy savings (MWh)	86,349	96,396	112%
	Summer peak demand savings (MW)	11.2	14.2	127%
	Winter peak demand savings (MW)	4.0	6.9	171%

The key driver of the higher-than-program-reported energy savings is the use of a higher ex post baseline wattage for Phase 2 bulbs in our evaluation. The ex ante savings assumed a baseline wattage of 18.6 for LEDs distributed during Phase 2 of evaluation. The program team used lower baseline wattage assumptions for Phase 2 participants to account for likely replacement of LEDs with CFLs. However, the evaluation team recommends using a halogen-equivalent baseline wattage of 43. Higher ex post savings were also driven by our use of a slightly higher ISR. The reduction in HOU drove energy savings downward, but did not outweigh the effect of the higher baseline wattage for Phase 2 LEDs and ISR. Higher summer and winter peak demand savings are a result of higher ex post CFs.

Using total ex post gross energy and demand savings, the evaluation team calculated per-bulb savings (Table 5-8). We recommend that the program applies these per-unit savings values to calculate program impacts moving forward.

Table 5-8. Ex Post Total and Per-Bulb Gross Impacts

Savings Type	Number of Bulbs	Ex Post Gross Savings	Ex Post Gross Per-Bulb Savings
Energy savings (kWh)	3,074,086	96,396,086	31.4
Summer peak demand savings (kW)		14,236	0.0046
Winter peak demand savings (kW)		6,904	0.0022

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5.3 References

Navigant Consulting, Inc. and Apex Analytics, LLC. *EM&V Report for the 2013 Energy Efficient Lighting Program.* Prepared for Duke Energy Progress. August 13, 2014.

Navigant Consulting, Inc. and Apex Analytics, LLC. *EM&V Report for the 2012 Energy Efficient Lighting Program.* Prepared for Duke Energy Progress. July 12, 2013.

TecMarket Works. *Process and Impact Evaluation of the Residential Smart $aver Energy Efficiency Products (CFLs) Program in the Carolina System.* Prepared for Duke Energy Carolinas. September 2012.

Opinion Dynamics Corporation. *Duke Energy Progress & Duke Energy Carolinas Energy Efficient Lighting & Retail LED Programs.* Prepared for Duke Energy Progress and Duke Energy Carolinas. (Currently in Draft Phase).

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6. Net-to-Gross Analysis

This section describes our approach for estimating the NTGR for the Free LED program and presents the resulting NTGR and the program net impacts.

6.1 Methodology

The NTGR represents the portion of the gross energy savings associated with a program-supported measure or behavior change that would not have been realized in the absence of the program. In other words, the NTGR represents the share of program-induced savings. The NTGR consists of FR and SO and is calculated as $(1 - FR + SO)$. FR is the proportion of the program-achieved verified gross savings that would have been realized absent the program. There are two types of SO: participant and non-participant. Participant SO occurs when participants take additional energy-saving actions that are influenced by program interventions but did not receive program support. Non-participant SO is the reduction in energy consumption and/or demand by non-participants because of the influence of the program.

As part of this evaluation, the evaluation team estimated FR and participant SO. Quantifying savings from non-participant SO activities is a challenging task that warrants a separate study and was outside of the scope of this evaluation effort. In addition, the Free LED program design is less likely to result in significant amounts of non-participant SO than upstream lighting programs that exist in the larger market. Both FR and SO components of the NTGR were derived from self-reported information from telephone interviews with program participants.

The final NTGR is the percentage of gross program savings that can reliably be attributed to the program. We estimate a separate NTGR for each participant, which we weighted to reflect the relative contribution of each participant's ex post gross savings to the overall program estimate.

Below is a general overview of the method for developing FR and SO estimates. **Error! Reference source not found.** of this report contains the participant survey instrument. **Error! Reference source not found.** provides a detailed overview of the FR and SO algorithms.

6.1.1 Free-Ridership

Free-riders are program participants who would have installed high efficiency light bulbs on their own without the program. FR represents the percent of savings that would have been achieved in the absence of the program. Through participant surveys, we asked program participants a series of structured and open-ended questions about the influence of the program on their decision to order and install program LEDs. The survey questions measured the following areas of program influence:

- **Influence efficiency:** We asked participants what type of light bulbs they would have purchased the next time they needed light bulbs if they had not received free LEDs through the program.
- **Influence on timing:** We asked participants who replaced working incandescent bulbs if they would have replaced working light bulbs on their own if they had not received free LEDs, of if they would have waited for the bulbs to burn out.
- **Influence on quantity:** We asked participants whether they would have purchased fewer LEDs if they had purchased the bulbs on their own instead of receiving them for free through the program.

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As part of the FR survey module, we referenced retail bulb pricing to ground participant responses.[15] To reduce measurement error, we included follow-up questions to check participant responses for consistency. We also compared participant FR scores to the other survey responses and made the necessary adjustments.

6.1.2 Spillover

SO represents energy savings from additional actions (expressed as a percent of total program savings) that were due to the program but that did not receive program financial support. While SO can result from a variety of measures, it is not possible to ask about a large number of potential SO measures on a survey due to the need to limit the length of the survey. The evaluation team chose to focus on the measures that participants would reasonably take following their program participation and would do so without additional program support. As such, we focused SO questions on CFLs and LEDs. We asked participants if they purchased any CFLs or LEDs after receiving program LEDs.[16] We asked those who purchased additional bulbs about the degree to which the program influenced their decision to purchase high-efficiency bulbs as opposed to less-efficient alternatives. We asked participants to rate the degree to which the program influenced their purchase decision, as well as to provide a rationale for their rating. We carefully reviewed participant responses to establish eligibility for SO participants and purchases.

To estimate the SO rate, we estimated savings for each SO measure using the standard savings equation and a set of engineering assumptions. We determined the program-level SO rate by dividing the sum of SO savings by the ex post gross savings achieved by the sample of participants who received SO questions.

Equation 6-1. SO Rate Formula

$$Spillover\ Rate = \frac{Spillover\ Savings}{Evaluated\ Gross\ Savings\ in\ the\ Respondent\ Sample}$$

6.2 NTG Results

We estimate the overall FR to be 51% and SO to be 1%. The resulting program NTGR for the evaluation period is 50%. Relative precision around this point estimate is 8% at 90% confidence. Table 6-1 provides FR results by phase, as well as overall across all three phases, along with SO and final program-level NTGR. As can be seen in the table, FR for Phase 2 is considerably higher than FR for Phase 1 (64% vs. 50%). Phase 2 participants include customers who reached or exceeded their free CFL bulb limit through the various free lighting programs with orders over 5 years or more since order date, which may suggest that these individuals are at the forefront of energy-efficient product adoption and had a considerable amount of time to learn and experience the benefits from energy-efficient lighting products, such as CFLs and LEDs. It should be noted that, while we were able to achieve better than 10% precision at 90% confidence for the overall program-level FR estimate, as well as for Phase 1, relative precision is quite high (19%) for Phase 2. We applied the overall program level NTG of 50% to ex post gross impacts to arrive at the ex post net impacts.

[15] We used a per-bulb price of $2 for CFLs and $4 for LEDs. CFL pricing is based on the current market data, while retail LED pricing was supplied by the program team.

[16] Note that the assessment of program SO is based on Phase 0 and Phase 1 participants.

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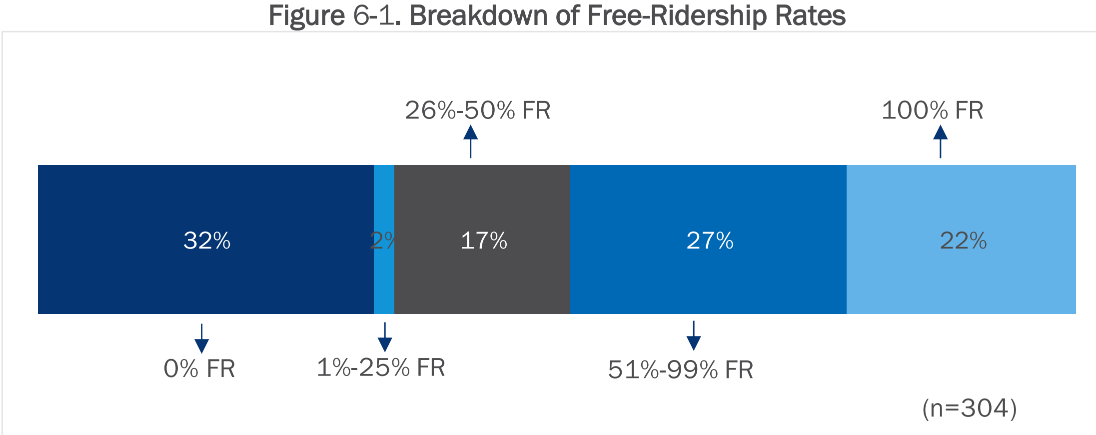
Table 6-1. NTG Results

NTG Component	n	Value	Relative Precision
FR – Phase 0	1	44%	N/A
FR – Phase 1	272	50%	8%
FR – Phase 2	31	64%	19%
FR – Total	**304**	**51%**	**7%**
SO	**178**	**1%**	**9%**
NTGR	**482**	**50%**	**8%**

6.2.1 Free-Ridership

Our results show that free-ridership rates varied across participants (see Figure 6-1). Three in 10 participants (32%) are complete non-free-riders. That is, in the absence of the program's free LEDs, they would have purchased less-efficient alternatives, namely, halogens. At the opposite end of the FR spectrum, 22% are complete free-riders who reported that they would have purchased all of the LEDs that they received through the program on their own.[17] A combined 46% of respondents are partial free-riders (FR between 1% and 99%). Participants could be partial free-riders for several reasons. Some of the partial free-riders are participants who reported that in the absence of receiving the program's free LEDs, they would have purchased a mix of LEDs or CFLs and halogens the next time they needed to purchase light bulbs. Other partial free-riders are customers who reported that they would have purchased efficient bulbs (CFLs or LEDs) on their own but reported that the program motivated them to replace their working incandescent or halogen light bulbs with efficient bulbs, which they would not have done on their own. In essence, the program sped up their installation of energy efficient bulbs.

Figure 6-1. Breakdown of Free-Ridership Rates



The program NTGR of 50% was low compared to the previous evaluation of this program, where CFLs were the program measure (84%), and is a likely result of increased customer knowledge of energy-efficient lighting products and their benefits and positive results of the previous Free CFL program interventions. As compared to the general population of DEC customers, program participants had higher-incomes and higher levels of educational attainment, and both of these cohorts had higher FR and consequently lower NTGRs. We discuss the differences in participant composition and their effect on FR in greater detail in Section 7.2 of this report.

[17] This cohort also includes rare cases of respondents reporting that in the absence of the program they would have purchased CFLs.

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6.2.2 Spillover

A quarter of the Free LED program participants (25%) purchased additional light bulbs since participating in the program. Of those, 7 in 10 (71%) purchased CFLs or LEDs, either exclusively or along with incandescents or halogens. Of those, 81% reported that their purchases were influenced by the program so that overall, 10% of all participants qualified for SO. The average SO participant purchased 5.1 bulbs that qualified for SO, most of those being LEDs.

6.3 Net Impact Results

Table 6-2 presents ex post gross and net savings along with the net realization rates for the program period under evaluation. We developed net realization rates by dividing ex post net savings by program-reported net savings. We present net impact results by program phase as well as overall. Overall, the program achieved 48,476 MWh in ex post net energy savings, 7.2 MW in ex post net summer peak demand savings, and 3.5 MW in ex post net winter peak demand savings, achieving 67%, 77%, and 103% net realization rates, respectively.

Table 6-2. Net Impact Results for 2012–2015 Evaluation Period

Phase	Total Savings[a]	Ex Post Gross Savings	Ex Post Net Savings	Net Realization Rate[b]
0	Energy savings (MWh)	10,782	5,422	60%
	Summer peak demand savings (MW)	1.6	0.8	68%
	Winter peak demand savings (MW)	0.8	0.4	92%
1	Energy savings (MWh)	71,046	35,728	60%
	Summer peak demand savings (MW)	10.5	5.3	68%
	Winter peak demand savings (MW)	5.1	2.6	92%
2	Energy savings (MWh)	14,568	7,326	213%
	Summer peak demand savings (MW)	2.2	1.1	243%
	Winter peak demand savings (MW)	1.0	0.5	327%
Total	Energy savings (MWh)	96,396	48,476	67%
	Summer peak demand savings (MW)	14.2	7.2	77%
	Winter peak demand savings (MW)	6.9	3.5	103%

[a] Savings were calculated using unrounded assumptions, including NTGR.
[b] Denominator is ex ante net savings.

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7. Process Evaluation

7.1 Methodology

Process assessment leveraged the following data collection methods and research activities:

- Program staff interviews (n=1)
- Materials review
- Program-tracking data analysis
- Participant survey (n=482)

We provide a detailed overview of each data collection method, as well as achieved confidence and precision in Section 4 of this report.

7.2 Key Findings

7.2.1 Program Performance

Between February 29, 2016 and April 28, 2017, 3,074,086 LED were distributed through the Free LED program in the DEC jurisdiction. During this period, the program touched 251,168 residential customers[18] and distributed an average of 12 bulbs per participant.

Table 7-1 shows participation by program phase. As can be seen in the table, the Free LED program reached 23% of participants during Phase 0. However, because the maximum number of LEDs during that phase was capped at six and was increased to 15 and 12 bulbs (for Phase 1 and 2, respectively), the number of LEDs distributed as part of Phase 0 accounts for just 11% of all LED distributed during the program period under evaluation. Phase 1 was the most prominent for the period, accounting for 63% of participants and 74% of all LEDs.

Table 7-1. Participation by Program Phase

Phase	% of Participants (n=251,168)	% of Bulbs (n=3,074,086)
0	23%	11%
1	63%	74%
2	16%	15%
Total	100%	100%

Program participation over time was well distributed, with participation spikes occurring at the starts of Phases 1 and 2, likely in response to the marketing efforts promoting each phase. Figure 7-1 shows participation trends over the course of the program period under evaluation and marks the start and duration of each phase.

[18] For the purposes of this analysis, we defined residential customers as unique accounts.

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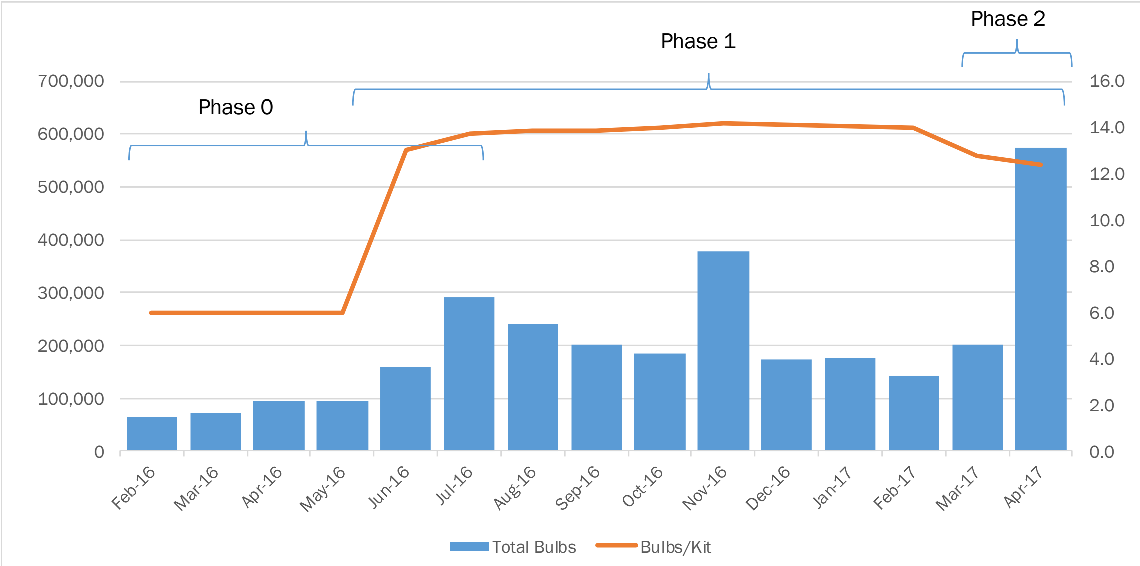
Figure 7-1. Participation Trends over Time



Program participants tend to participate in the program just once and order the maximum number of LEDs allowable. Only 3% of participants requested program LEDs more than once. Table 7-2 provides a percent distribution of program-distributed kits and bulbs by phase and kit size. Phase 0 participants could receive up to six LEDs, and all of the kits distributed during this phase were 6-bulb kits. Phase 1 participants were offered a range of kit configurations, including 3-bulb, 6-bulb, 8-bulb, 12-bulb, and 15-bulb kits, with a maximum of 15 LEDs per account. Close to 9 in 10 kits (87%) distributed during this phase were 15-bulb kits. Phase 2 participants were offered 6-bulb and 12-bulb kits, with 93% of all kits distributed during that phase being 12-bulb kits.

Table 7-2. Kit Size Distribution by Phase

	Phase 0		Phase 1		Phase 2	
Kit Size	% of Kits (n=57,308)	% of Bulbs (n=343,848)	% of Kits (n=161,300)	% of Bulbs (n=2,265,652)	% of Kits (n=40,112)	% of Bulbs (n=464,586)
3-bulb kit	0%	0%	2%	<1%	N/A	N/A
6-bulb kit	100%	100%	6%	2%	7%	4%
8-bulb kit	N/A	N/A	<1%	<1%	N/A	N/A
12-bulb kit	N/A	N/A	4%	4%	93%	96%
15-bulb kit	N/A	N/A	87%	93%	N/A	N/A
Total	100%	100%	100%	100%	100%	100%
Average number of kits/bulbs	1.0	6.0	1.0	14.2	1.0	11.6

To be eligible for the program, customers must have an active DEC account. Program participation is controlled, wherein customers must provide their account number or the phone number associated with their account, as well as the last four digits of their social security number. Once requested, program bulbs are shipped to the billing address associated with the customer's account. Such controlled program design resulted in minimal leakage of program bulbs outside of the DEC jurisdiction. Fewer than 1% of bulbs (0.7%) were shipped outside of North and South Carolina and fewer than 1% of participants (0.6%) reported installing program bulbs in homes not serviced by DEC.

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7.2.2 Participant Composition

Participant composition analysis included comparing participant sociodemographic and household characteristics gathered as part of the participant survey effort and comparing them to the DEC population. We obtained population characteristics from the U.S. Census's 2013–2015 American Community Survey (ACS). As part of the analysis, we examined FR rates by each of the sociodemographic subgroups. The analysis allowed us to identify the customer types that the program is reaching and future targeting opportunities to improve the efficacy of the program in advancing energy efficiency in the jurisdiction. Table 7-3 provides the results of the analysis. As can be seen in the table, during the program period under evaluation, program participant composition skews disproportionately toward younger customers (29% of participants are 18–34 vs. 18% of the DEC customer base), renters (39% of program participants vs. 29% of the DEC customer base), customers with higher levels of education (50% of participants have a college degree+ vs. 27% of the DEC customer base), and customers with higher income levels (56% of participants have an annual income of $50,000+ vs. 48% of the DEC customer base).

Disproportionate participation of higher-income customers and customers with higher education levels had a negative impact on program's net impacts, because FR among those two customer cohorts is much higher than their respective counterparts. As can be seen in Table 7-3, FR among customers without higher education is 32%, compared to the FR of 57% among those with some college, and 58% among college graduates+. Similarly, FR among those with annual household incomes of less than $50,000 is 44%, while FR among those with incomes of $50,000 to less than $100,000 and $100,000+ is 60% and 59%, respectively. As described further in this section of the report, OLS portal is the primary mechanism through which participants ordered program LEDs. As a channeling mechanism, the OLS portal does offer the ability to target certain customer segments but rather allows everyone who is eligible for the program to order program LEDs.

Conversely, the disproportionate presence of renters helped drive program FR down. FR for renters is 43%, much lower than for those who own their homes (61%). These findings suggest that focusing program efforts on targeting customers in rental properties, lower-income customers, and customers with lower levels of educational attainment will help reduce the program FR rate, thus ensuring a more efficacious program. To avoid possible overlap with Duke Energy's Multi-Family program, which targets multi-family apartment complexes, the program should consider prioritizing rental single-family properties and rental units in smaller multi-family properties (less than 10 units, for example). One way to achieve that is through geographic targeting of the census block groups with high concentrations of rental units and high concentration of 1-10 unit properties.

Table 7-3. Participant Composition Analysis

Characteristics	Free-Ridership Rate	Participant Characteristics	DEC Population Estimates
Age		n=462	Census Data
18–34	50%	29%	18%
35–54	55%	35%	40%
55+	52%	36%	41%
Homeownership		n=479	Census Data
Own	61%	61%	71%
Rent	43%	39%	29%
Education		n=475	Census Data
High school or less	32%	16%	64%
Some college	57%	34%	9%
College graduate+	58%	50%	27%

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Characteristics	Free-Ridership Rate	Participant Characteristics	DEC Population Estimates
Income		**n=452**	**Census Data**
Less than $50,000	44%	44%	52%
$50,000 to less than $100,000	60%	36%	30%
$100,000+	59%	20%	18%
Housing type		**n=481**	**Census Data**
Single-family	55%	66%	69%
Non-single-family (townhouse, mobile home, multifamily)	51%	34%	31%

7.2.3 Participant Lighting Knowledge and Experience

The participant survey explored participants' existing knowledge and experience with a variety of lighting products, along with their use of the various technologies. As can be seen in Figure 7-2, participants are knowledgeable and experienced with energy-efficient technologies. More specifically, nearly all participants had heard of CFLs (98%) and 89% had used CFLs prior to participating in the program. Such high levels of previous CFL use are not surprising given the past efforts, both programmatic and non-programmatic, to advance CFL adoption in the jurisdiction. Based on the Opinion Dynamics estimates presented in the most recent 2015 evaluation of the Free CFL program, since 2010 and through the March 2015 implementation of the Free CFL program, the program had reached more than three-quarters (76%) of DEC's residential customers.

Nearly all participants had heard of LEDs prior to participating in the program (93%) and almost half (49%) had used LEDs. Not surprisingly, previous experience with LEDs drives FR rates; participants with LED experience have much higher FR rates than those who are aware of the technology, but have not used it (65% FR vs. 50% FR, respectively). Prior LED usage is disproportionately lower among customers residing in multifamily homes, customers who rent their homes, younger customers, and customers with lower levels of education and lower income levels. Targeting these customers will help ensure program reach into the underserved segment and drive FR down.

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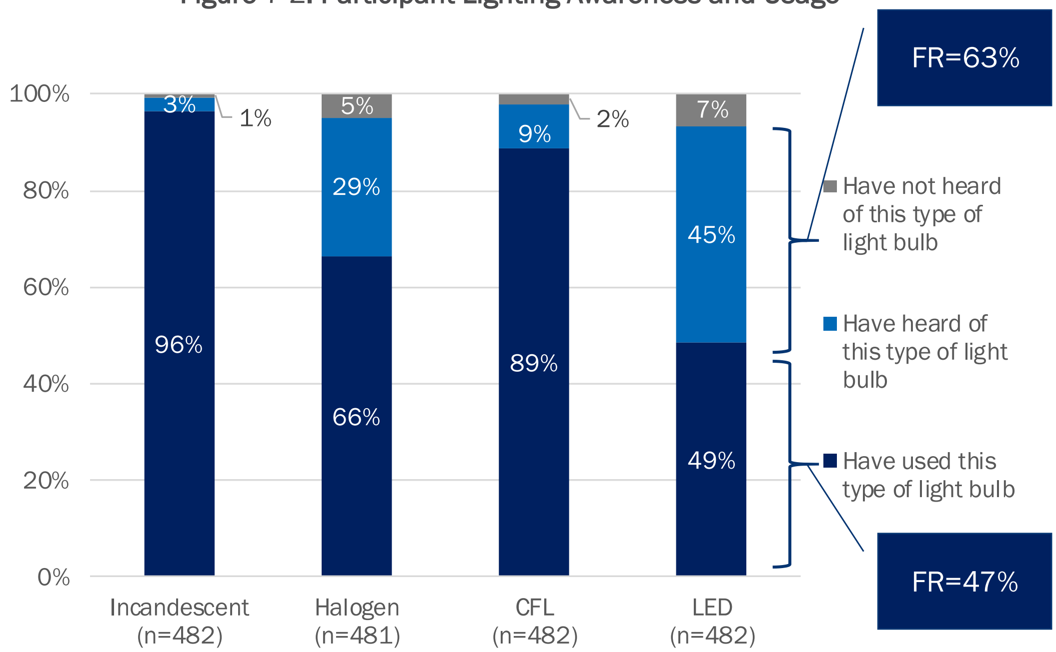
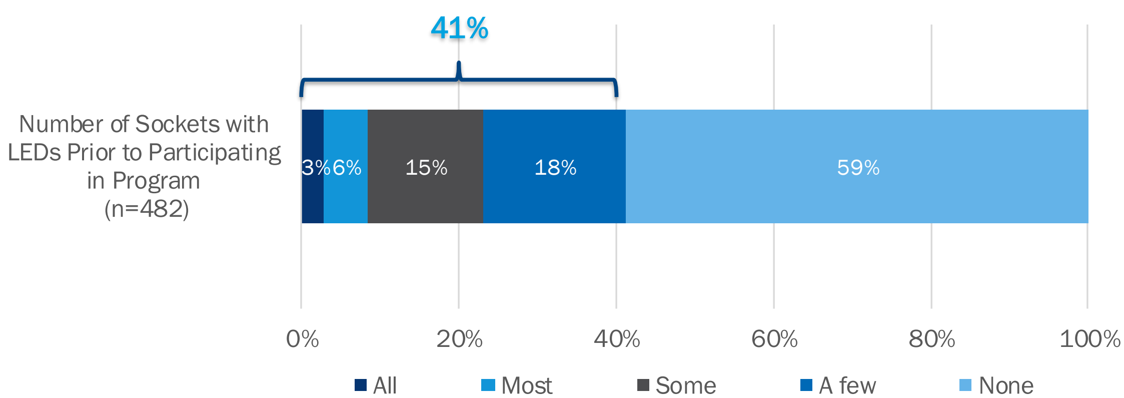
Figure 7-2. Participant Lighting Awareness and Usage



As part of the survey, we asked participants to estimate the number of light sockets in their homes that had LEDs prior to participating in the program. As shown in Figure 7-3, 41% had LEDs in at least a few of their sockets prior to participating in the program, and 9% had LEDs in most or all of their sockets.[19]

Figure 7-3. Pre-Program LED Saturation



With participants having used CFLs, many are replacing CFLs with program LEDs. More specifically, more than half of participants (57%) replaced CFLs or LEDs with program LEDs, and more than a fifth of participants (22%) installed all program LEDs in place of CFLs or LEDs.

[19] The 41% reporting having LEDs in at least some of the sockets is seemingly inconsistent with 49% reporting having used LEDs in the past in Figure 7-1. However, it is feasible that some participants had used LEDs at some point but has since removed them.

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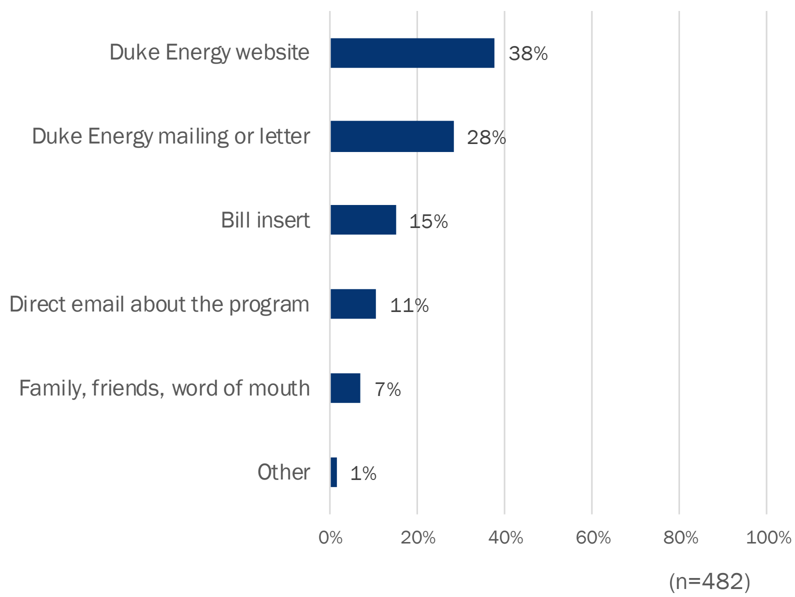
7.2.4 Program Marketing and Outreach

Program marketing efforts during the program period under evaluation were focused and targeted. Program marketing varied depending on the program phase. Phase 0 marketing relied almost exclusively on a BRC mailing, while Phase 1 and Phase 2 marketing efforts made use of a dedicated program website, an OLS portal with a pop-up intercept, and mailers. As part of the participant survey, we asked participants how they first learned about the Free LED program. Consistent with program marketing, the Duke Energy website and mailings were the primary sources of program awareness (Figure 7-4).

Figure 7-4. Sources of Program Awareness



DEC customers could participate in the program through several modes, including mailing back their BRC, making an order through the OLS portal or on Duke Energy's website, the IVR phone system, or ordering bulbs through a customer service representative (CSR), along with a manual reorder. Figure 7-5 summarizes program LED shipments (in terms of bulbs) by order mode. As can be seen in the figure, 70% of the program LEDs were ordered through the OLS portal.

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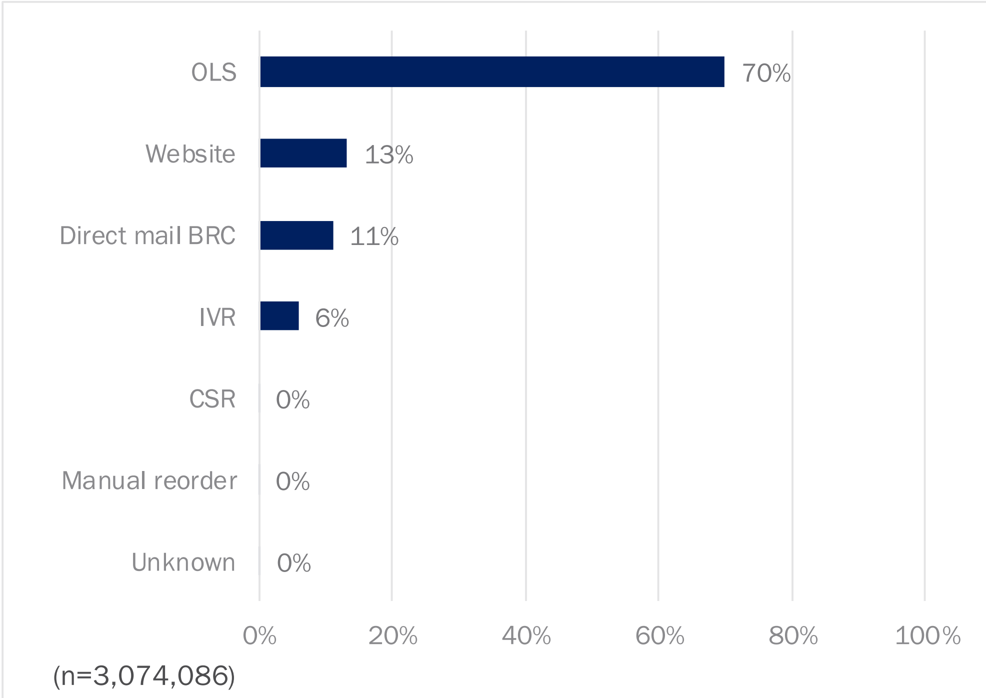
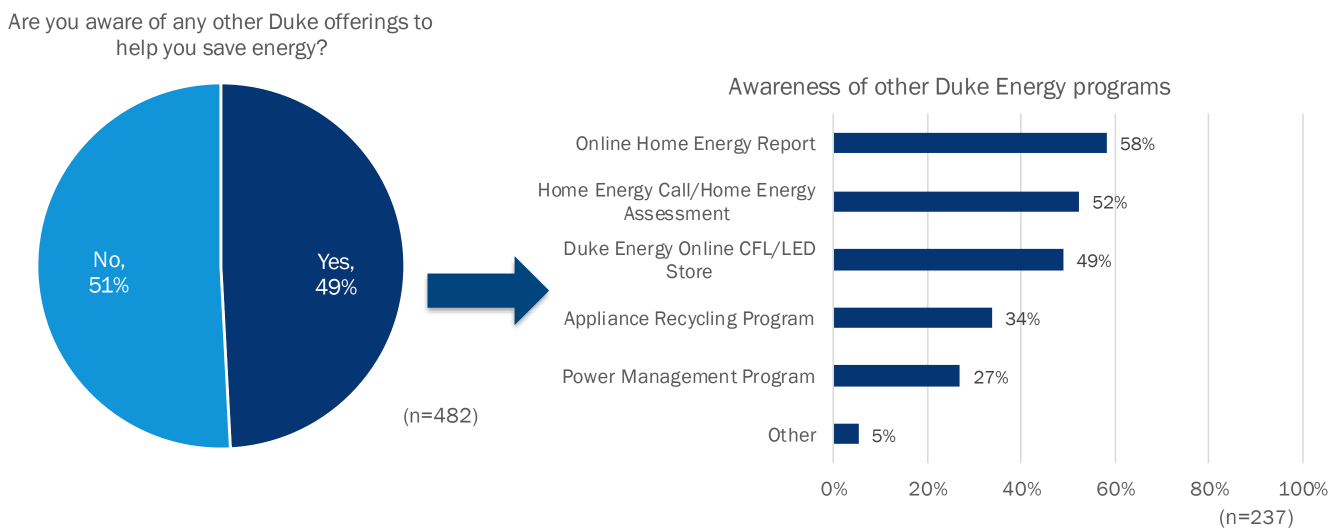
Figure 7-5. Program Participation Mode



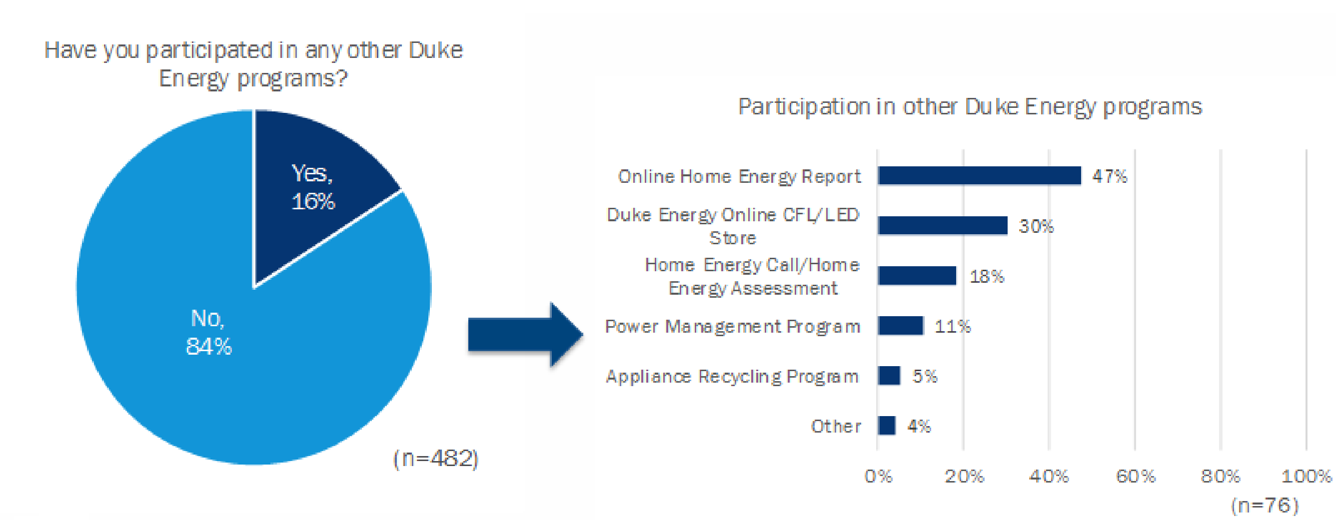
In addition to sources of the Free LED program awareness and modes of participant intake, our process evaluation explored participant knowledge of the other energy efficiency programs that Duke Energy offered. As part of the participant survey, we asked respondents about their awareness of and previous participation in DEC's other energy efficiency programs. Almost half of program participants (49%) were aware of other Duke Energy programs, including the Online Home Energy Report, the Home Energy Assessment, and the Online Store programs (Figure 7-6).

Figure 7-6. Cross-Program Awareness



A relatively small percentage of Free LED program participants also participated in the other Duke Energy programs. As can be seen in Figure 7-7, 16% of Free LED program participants also participated in other programs offered by DEC. Of those, close to half (47%) received an online home energy report, 30% purchased energy-efficient lighting products from DEC's Online Store, 18% received home energy assessments, 11% participated in the Power Management program, and 5% in the Appliance Recycling program.

Figure 7-7. Cross-Program Participation



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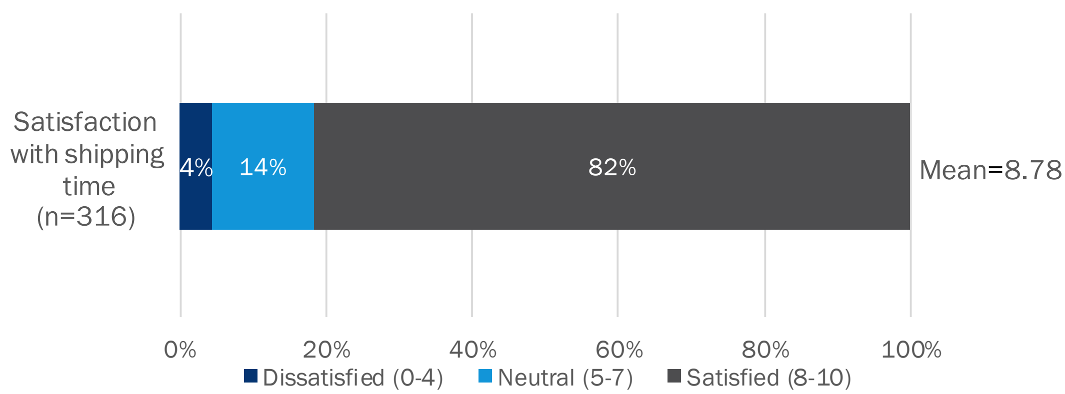
7.2.5 Program Delivery and Participant Satisfaction

Program delivery processes were smooth and well managed. Program-tracking data were clean and well maintained. The program implementer worked hard to control maximum LED ordering caps. Our analysis of the program tracking found a very small percent of cases where participants received more than phase-specific bulb limits. The rare cases where that occurred were justified by the previously ordered LED counts and available kit configurations.

The program implementer also worked hard to ensure prompt delivery of the ordered LED kits. Based on the participant survey results, 9 in 10 participants (90%) reported receiving their LEDs in the mail within 3 weeks and more than a quarter (29%) reported receiving their LEDs within 1 week. More than 8 in 10 (82%) reported being satisfied[20] with the time it took to receive their order; 59% of respondents reported being extremely satisfied[21] (Figure 7-8).

Figure 7-8. Satisfaction with Shipping Timelines



Program-related inquiries from program participants were rare. Only 4% of participants reported contacting Duke Energy or program staff after receiving their bulbs. Most of those inquiries were focused on non-program-related questions or questions about other programs. Nearly three-quarters of those who contacted Duke Energy (74%) reported that they were satisfied[22] with their communication with the Duke Energy staff.

Participants expressed high levels of satisfaction with the program, which is another indication that program processes are effective and well run. As can be seen in **Error! Reference source not found.**, 94% of participants are satisfied with their program experiences overall and 90% are satisfied with the program LEDs.

[20] A rating of 8, 9, and 10 on a scale from 0 to 10, where 0 is very dissatisfied and 10 is very satisfied.

[21] A rating of 10 on a scale from 0 to 10, where 0 is very dissatisfied and 10 is very satisfied.

[22] A rating of 8, 9, and 10 on a scale from 0 to 10, where 0 is very dissatisfied and 10 is very satisfied.

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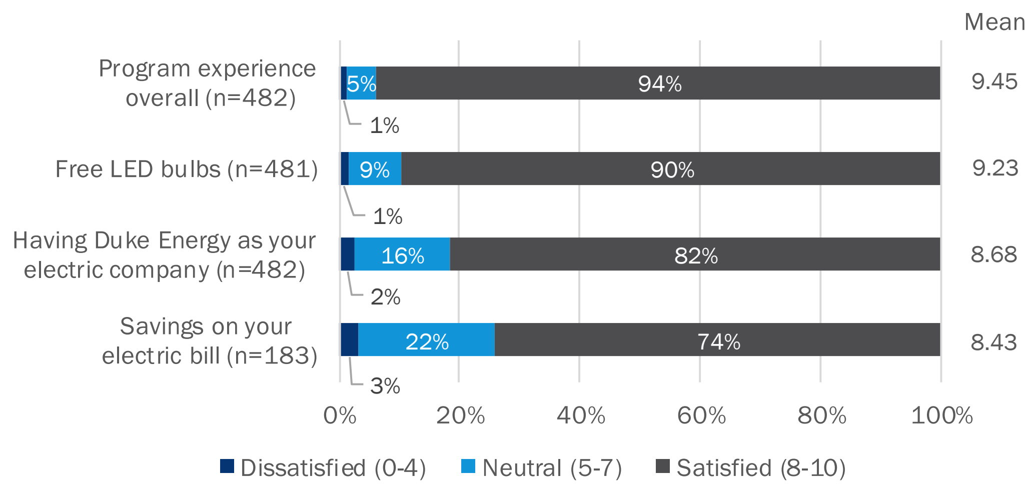
Figure 7-9. Satisfaction Ratings



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8. Conclusions and Recommendations

This section presents conclusions and recommendations resulting from the process and impact evaluations of the Free LED program.

8.1 Conclusions

Between February 29, 2016 and April 28, 2017, the Free LED program distributed 3,074,086 LEDs across 258,720 kits to 251,168 DEC customers. The program relied on a phased approach to program delivery with a total of three phases, each featuring distinct design and delivery elements. The program achieved 96,396 MWh in ex post gross energy savings, 14.2 MW in ex post summer peak demand savings, and 6.9 MW in winter peak demand savings across the three phases. The program realized 112% of energy savings, 127% of summer peak demand savings, and 171% of winter peak demand savings. High realization rates are primarily a result of the program using lower baseline wattage assumptions[23], first-year ISR, and coincidence factors when estimating savings for LEDs distributed during Phase 2 of the program.

While the overall ISR was high (91.1% for North Carolina and 91.0% for South Carolina), first-year ISR was low, at 59.9%. The low first-year ISR is driven primarily by the fact that customers were able to receive up to 15 LEDs at once, depending on the phase, and most took advantage of the offering and ordered the maximum number of bulbs allowable.

The program NTGR of 50% was low compared to the previous evaluation of this program, where CFLs were the program measure (84%), and is a likely result of increased customer knowledge of energy-efficient lighting products and their benefits and positive results of the previous Free CFL program interventions. Program participant composition was disproportionately skewed toward higher-income customers and customers with higher levels of educational attainment, and both of these cohorts had higher FR and consequently lower NTGRs.

After applying program NTGR to the ex post savings, the program achieved 48,476 MWh in energy savings, 7.2 MW in summer peak demand savings, and 3.5 MW in winter peak demand savings. Table 8-1 provides a summary of the program's gross and net impacts overall and by phase.

[23] The program team used lower baseline wattage assumptions for Phase 2 participants to account for likely replacement of LEDs with CFLs.

Table 8-1. Overview of Program Impacts

Phase	Total Savings	Ex Ante Results	Ex Post Gross Results	Gross Realization Rate	Ex Post Net Results	Net Realization Rate
0	Bulbs	343,848	343,848			
	Energy savings (MWh)	10,836	10,782	100%	5,422	60%
	Summer peak demand savings (MW)	1.4	1.6	113%	0.8	68%
	Winter peak demand savings (MW)	0.5	0.8	152%	0.4	92%
1	Bulbs	2,265,652	2,265,652			
	Energy savings (MWh)	71,398	71,046	100%	35,728	60%
	Summer peak demand savings (MW)	9.2	10.5	113%	5.3	68%
	Winter peak demand savings (MW)	3.3	5.1	152%	2.6	92%
2	Bulbs	464,586	464,586			
	Energy savings (MWh)	4,115	14,568	354%	7,326	213%
	Summer peak demand savings (MW)	0.5	2.2	404%	1.1	243%
	Winter peak demand savings (MW)	0.2	1.0	542%	0.5	327%
Total	Bulbs	3,074,086	3,074,086			
	Energy savings (MWh)	86,349	96,396	112%	48,476	67%
	Summer peak demand savings (MW)	11.2	14.2	127%	7.2	77%
	Winter peak demand savings (MW)	4.0	6.9	171%	3.5	103%

Table 8-2 provides per-unit ex post gross and net savings.

Table 8-2. Per-Unit Ex Post Gross Savings

Per-Bulb Savings	Ex Post Gross Savings	Ex Post Net Savings
Energy savings (kWh)	31.4	15.8
Summer peak demand savings (kW)	0.0046	0.0023
Winter peak demand savings (kW)	0.0022	0.0011

The program implementation processes ran smoothly and effectively, resulting in high levels of customer satisfaction with the program. Program-tracking data were complete and accurate. Instances of products mailed and installed outside of the DEC jurisdiction were minimal. Instances of participants receiving more than the phase-based maximum number of bulbs through the program were also minimal.

8.2 Recommendations

We recommend that program administrators calculate future savings from the Free LED program using the recommended per-bulb energy and summer peak savings presented in Table 8-2 above.

To increase program efficacy, we recommend that the program deploys targeted marketing and outreach strategies aimed at increasing participation among lower-income customers and customer with lower levels of educational attainment, while also continuing to reach out to renters and younger customers. Those customer cohorts are less likely to be free-riders and the program therefore will be able to effect change in their lighting preferences and behaviors. Such targeting can be achieved by overlaying census data over the

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customer data and targeting customers in geographic units (such as census block groups) with higher shares of the desired segment.

To improve its first-year ISR and subsequently the overall ISR, we recommend that the program includes collateral urging customers to install as many program LEDs as possible by replacing working, less-efficient bulbs in their homes.

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9. Summary Form

DEC Free LED Program

Completed EMV Fact Sheet

Duke Energy Carolinas' Free LED program is a continuation of the Free CFL program. The transition from CFLs to LEDs occurred in three phases with each phase targeting different customers and featuring differing program design and delivery components.

Date	August 18, 2017
Region(s)	Duke Energy Carolinas
Evaluation Period	February 2016 through April 2017
Gross Annual kWh impact	96,396 kWh 112% realization rate
Coincident kW impact	127% realization rate (summer) 171% realization rate (winter)
Measure life	12 years
Net to Gross	50%
Process Evaluation	Yes
Previous Evaluation(s)	November 10, 2015

Evaluation Methodology

The Evaluation Team reviewed reported savings assumptions and verified that the inputs used to calculate those assumptions were in line with the previous evaluation's recommendations. The Evaluation Team also performed an engineering analysis of energy and demand savings to develop ex post savings estimates, including estimation of a net-to-gross ratio (NTGR) and first-year in-service rate (ISR) through a participant survey. The Evaluation Team also conducted a program process evaluation including results from participant and general population surveys.

Impact Evaluation Details

- North Carolina Utilities Commission requires that evaluations of DEC's Energy Efficient Lighting program include Carolinas-specific data
- North Carolina Utilities Commission requires that evaluations of DEC's Energy Efficient Lighting program include a discussion of the impacts of LEDs, the Energy Independence and Security Act (EISA), and other innovations in lighting technology on the calculations of measure impacts and the baseline measures used in those calculations
- The Evaluation Team estimates baseline wattages using the equivalent baseline wattage approach and recent regionally specific research
- The Evaluation Team estimates hours of use (HOU) and coincidence factors (CF) for program LEDs through metering of a representative sample of the DEC and DEP customers
- The Evaluation Team uses the Uniform Methods Project (UMP) recommended approach to estimate gross energy savings, and incorporates additional adjustments as necessary
- The Evaluation team relied on a participant research to estimate first-year in-service rate (ISR) and net-to-gross ratio (NTGR)
- The Evaluation Team used discounted approach to claiming savings from future LED installations which includes claiming the savings from all expected installations in the program year but discounting them by a utility discount rate

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Duke Energy Carolinas

Energy Efficient Appliances and Devices Program Appendices

December 8, 2017

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Appendix A. Detailed Analysis Tables

The Excel spreadsheet is provided as a separate submission and contains detailed analysis of program gross and net impacts. The data in the file are at the kit configuration and month and year of shipment levels. The file contains ex ante savings, all of the gross savings assumptions, ex post gross savings, NTGR, ex post net savings, and recommended gross savings.

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Appendix B. Chart with Measure-Level Inputs for Duke Energy Analytics

The Excel spreadsheet is provided as a separate submission and contains measure-level inputs for Duke Energy Analytics. Note that Duke Energy plans to apply the measure-level inputs starting in May, 2017.

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Appendix C. Detailed Survey Results

This Appendix contains detailed survey results from the participant survey effort. We provide results in the form of the Wincross tables with a breakdown of the survey results across core customer demographic and household characteristics.

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DEC Free LED Detailed Participant Survey Results

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Appendix C. Detailed Survey Results

Table qiv1 Page 1

DEC Free LED Detailed Participant Survey Results

Our records indicate that in <MONTH> of <YEAR>, you received [IF DUP=0: a free LED bulb kit] [IF DUP>0: free LED bulb kits] with <LED_QTY> LED light bulbs from Duke Energy. Is that correct?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes, both quantity and date are correct	474	358	27	86	289	182	118	172	175	300	87	34	129	158	167	234	233	194	160	88
	98.3	98.4	96.4	98.9	99.0	97.3	100.0 I	98.9	96.7	98.7	98.9	97.1	97.7	98.1	98.8	97.9	98.7	97.5	98.8	98.9
No, quantity is correct but the date is wrong	1	-	-	1	-	1	-	-	1	1	-	-	-	1	-	-	1	-	1	-
	0.2			1.1		0.5			0.6	0.3				0.6			0.4		0.6	
No, date is correct, but quantity is wrong	7	6	1	-	3	4	-	2	5	3	1	1	3	2	2	5	2	5	1	1
	1.5	1.6	3.6		1.0	2.1		1.1	2.8	1.0	1.1	2.9	2.3	1.2	1.2	2.1	0.8	2.5	0.6	1.1
No, both quantity and date are wrong	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No, I did not receive any LEDs from Duke Energy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv1b Page 2

DEC Free LED Detailed Participant Survey Results

How many LEDs did you receive from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	7	6	1	-	3	4	-	2	5	3	1	1	3	2	2	5	2	5	1	1
	100.0	100.0	100.0		100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
6	1	1	-	-	1	-	-	-	1	1	-	-	-	1	-	1	-	1	-	-
	14.3	16.7			33.3				20.0	33.3				50.0		20.0		20.0		
8	2	2	-	-	1	1	-	-	2	-	1	1	-	1	1	1	1	1	-	1
	28.6	33.3			33.3	25.0			40.0		100.0	100.0		50.0	50.0	20.0	50.0	20.0		100.0
10	1	1	-	-	-	1	-	1	-	-	-	-	1	-	-	1	-	1	-	-
	14.3	16.7				25.0		50.0					33.3			20.0		20.0		
12	1	1	-	-	1	-	-	-	1	-	-	-	-	-	1	-	1	1	-	-
	14.3	16.7			33.3				20.0						50.0		50.0	20.0		
15	1	-	1	-	-	1	-	-	1	1	-	-	1	-	-	1	-	1	-	-
	14.3		100.0			25.0			20.0	33.3			33.3			20.0		20.0		
18	1	1	-	-	-	1	-	1	-	1	-	-	1	-	-	1	-	-	1	-
	14.3	16.7				25.0		50.0		33.3			33.3			20.0			100.0	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	11.00	10.33	15.00	-	8.67	12.75	-	14.00	9.80	13.00	8.00	8.00	14.33	7.00	10.00	11.40	10.00	10.20	18.00	8.00

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qb1pa Page 3

DEC Free LED Detailed Participant Survey Results

An incandescent bulb is a traditional light bulb that has been available for 100 years. Would you say you...

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482 100.0	364 100.0	28 100.0	87 100.0	292 100.0	187 100.0	118 100.0	174 100.0	181 100.0	304 100.0	88 100.0	35 100.0	132 100.0	161 100.0	169 100.0	239 100.0	236 100.0	199 100.0	162 100.0	89 100.0
Have used or currently use this type of light bulb?	465 96.5	353 97.0	28 100.0 BD	81 93.1	288 98.6 F	174 93.0	113 95.8	168 96.6	175 96.7	293 96.4	85 96.6	35 100.0 JK	127 96.2	157 97.5	162 95.9	228 95.4	230 97.5	189 95.0	157 96.9	88 98.9 R
Have heard of this type of light bulb but have never used it?	14 2.9	9 2.5	-	5 5.7	4 1.4	10 5.3 E	5 4.2	4 2.3	5 2.8	9 3.0	3 3.4	-	5 3.8	3 1.9	5 3.0	8 3.3	6 2.5	8 4.0	5 3.1	1 1.1
Or have not heard of this type of light bulb before today?	3 0.6	2 0.5	-	1 1.1	-	3 1.6	-	2 1.1	1 0.6	2 0.7	-	-	-	1 0.6	2 1.2	3 1.3	-	2 1.0	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qb1pb Page 4

DEC Free LED Detailed Participant Survey Results

A halogen bulb looks similar to an incandescent light bulb. The exterior of a halogen bulb looks like an incandescent bulb but the interior contains a little capsule that produces the light.

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482 100.0	364 100.0	28 100.0	87 100.0	292 100.0	187 100.0	118 100.0	174 100.0	181 100.0	304 100.0	88 100.0	35 100.0	132 100.0	161 100.0	169 100.0	239 100.0	236 100.0	199 100.0	162 100.0	89 100.0
Have used or currently use this type of light bulb?	320 66.4	257 70.6 D	16 57.1	46 52.9	212 72.6 F	105 56.1	65 55.1	118 67.8 G	130 71.8 G	201 66.1	63 71.6	27 77.1	81 61.4	113 70.2	111 65.7	155 64.9	160 67.8	106 53.3	124 76.5 R	66 74.2 R
Have heard of this type of light bulb but have never used it?	138 28.6	89 24.5	12 42.9 B	35 40.2 B	71 24.3	67 35.8 E	45 38.1 HI	46 26.4	45 24.9	90 29.6 L	23 26.1	6 17.1	45 34.1	42 26.1	47 27.8	67 28.0	70 29.7	76 38.2 ST	36 22.2	21 23.6
Or have not heard of this type of light bulb before today?	23 4.8	18 4.9	-	5 5.7	9 3.1	14 7.5 E	7 5.9	10 5.7	6 3.3	12 3.9	2 2.3	2 5.7	6 4.5	6 3.7	10 5.9	16 6.7 Q	6 2.5	16 8.0 ST	2 1.2	2 2.2
Don't know/Not sure	1 0.2	-	-	1 1.1	-	1 0.5	1 0.8	-	-	1 0.3	-	-	-	-	1 0.6	1 0.4	-	1 0.5	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qb1pc Page 5

DEC Free LED Detailed Participant Survey Results

A CFL bulb, also known as a compact fluorescent lamp, is commonly made with a glass tube bent into a spiral shape resembling soft-serve ice cream. Some CFLs may have a plastic or glass cover over the spiral tube.

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482 100.0	364 100.0	28 100.0	87 100.0	292 100.0	187 100.0	118 100.0	174 100.0	181 100.0	304 100.0	88 100.0	35 100.0	132 100.0	161 100.0	169 100.0	239 100.0	236 100.0	199 100.0	162 100.0	89 100.0
Have used or currently use this type of light bulb?	428 88.8	331 90.9 D	23 82.1	72 82.8	269 92.1 F	156 83.4	100 84.7	153 87.9	166 91.7 G	272 89.5	81 92.0	32 91.4	114 86.4	146 90.7	149 88.2	208 87.0	213 90.3	164 82.4	151 93.2 R	82 92.1 R
Have heard of this type of light bulb but have never used it?	44 9.1	26 7.1	4 14.3	13 14.9 B	20 6.8	24 12.8 E	15 12.7 I	19 10.9 I	10 5.5	25 8.2	7 8.0	2 5.7	14 10.6	10 6.2	19 11.2	26 10.9	18 7.6	28 14.1 ST	9 5.6	7 7.9
Or have not heard of this type of light bulb before today?	10 2.1	7 1.9	1 3.6	2 2.3	3 1.0	7 3.7 E	3 2.5	2 1.1	5 2.8	7 2.3	-	1 2.9	4 3.0	5 3.1 O	1 0.6	5 2.1	5 2.1	7 3.5	2 1.2	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qb2p Page 6

DEC Free LED Detailed Participant Survey Results

The free light bulbs you received from Duke Energy are called LEDs. An LED bulb often has a plastic base, sometimes with ridges. LEDs are the newest type of light bulb on the market. Prior to receiving the free LEDs from Duke Energy, had you..?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Used this type of light bulb	234	189	9	34	155	77	47	87	98	139	51	22	59	82	83	102	130	75	81	61
	48.5	51.9	32.1	39.1	53.1	41.2	39.8	50.0	54.1	45.7	58.0	62.9	44.7	50.9	49.1	42.7	55.1	37.7	50.0	68.5
		CD			F			G	G		J	J					P		R	RS
Heard of this type of light bulb but had never used it	216	157	14	44	129	86	63	73	73	147	35	11	63	69	74	114	97	101	76	25
	44.8	43.1	50.0	50.6	44.2	46.0	53.4	42.0	40.3	48.4	39.8	31.4	47.7	42.9	43.8	47.7	41.1	50.8	46.9	28.1
							HI			L								T	T	
Or had you not heard of this type of light bulb	32	18	5	9	8	24	8	14	10	18	2	2	10	10	12	23	9	23	5	3
	6.6	4.9	17.9	10.3	2.7	12.8	6.8	8.0	5.5	5.9	2.3	5.7	7.6	6.2	7.1	9.6	3.8	11.6	3.1	3.4
			B			E				K						Q		ST		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qb3 Page 7

DEC Free LED Detailed Participant Survey Results

Thinking about all of the light sockets in your home in which you could use a LED, how many of them contained LEDs before you received the free ones from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	234	189	9	34	155	77	47	87	98	139	51	22	59	82	83	102	130	75	81	61
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All of them	14	11	-	3	10	4	3	3	8	9	3	1	2	6	6	9	5	7	3	4
	6.0	5.8		8.8	6.5	5.2	6.4	3.4	8.2	6.5	5.9	4.5	3.4	7.3	7.2	8.8	3.8	9.3	3.7	6.6
Most of them	27	21	-	6	16	11	8	8	11	15	5	3	4	7	12	16	11	9	6	7
	11.5	11.1		17.6	10.3	14.3	17.0	9.2	11.2	10.8	9.8	13.6	6.8	8.5	14.5	15.7	8.5	12.0	7.4	11.5
																Q				
Some of them	70	59	1	9	52	17	11	31	27	40	17	10	18	25	24	24	45	23	23	19
	29.9	31.2	11.1	26.5	33.5	22.1	23.4	35.6	27.6	28.8	33.3	45.5	30.5	30.5	28.9	23.5	34.6	30.7	28.4	31.1
		C			F												P			
A few of them	88	71	7	10	59	28	21	31	35	51	21	6	24	29	32	32	55	24	35	23
	37.6	37.6	77.8	29.4	38.1	36.4	44.7	35.6	35.7	36.7	41.2	27.3	40.7	35.4	38.6	31.4	42.3	32.0	43.2	37.7
			BD														P			
None of them	35	27	1	6	18	17	4	14	17	24	5	2	11	15	9	21	14	12	14	8
	15.0	14.3	11.1	17.6	11.6	22.1	8.5	16.1	17.3	17.3	9.8	9.1	18.6	18.3	10.8	20.6	10.8	16.0	17.3	13.1
						E										Q				
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv2 Page 8

DEC Free LED Detailed Participant Survey Results

Have you installed all, some, or none of the LEDs you received from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482 100.0	364 100.0	28 100.0	87 100.0	292 100.0	187 100.0	118 100.0	174 100.0	181 100.0	304 100.0	88 100.0	35 100.0	132 100.0	161 100.0	169 100.0	239 100.0	236 100.0	199 100.0	162 100.0	89 100.0
All of them	169 35.1	127 34.9	15 53.6 BD	27 31.0	107 36.6	62 33.2	29 24.6	65 37.4 G	73 40.3 G	101 33.2	41 46.6 J	12 34.3	48 36.4	61 37.9	55 32.5	95 39.7 Q	73 30.9	66 33.2	63 38.9	31 34.8
Some of them	291 60.4	217 59.6	13 46.4	58 66.7 C	169 57.9	119 63.6	86 72.9 HI	97 55.7	102 56.4	189 62.2 K	44 50.0	21 60.0	77 58.3	94 58.4	107 63.3	138 57.7	147 62.3	126 63.3	90 55.6	55 61.8
None of them	21 4.4	19 5.2	-	2 2.3	15 5.1	6 3.2	3 2.5	11 6.3	6 3.3	13 4.3	3 3.4	2 5.7	7 5.3	6 3.7	6 3.6	6 2.5	15 6.4 P	7 3.5	9 5.6	2 2.2
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	1 0.2	1 0.3	-	-	1 0.3	-	-	1 0.6	-	1 0.3	-	-	-	-	1 0.6	-	1 0.4	-	-	1 1.1

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv2a Page 9

DEC Free LED Detailed Participant Survey Results

How many of the LEDs that you had received from Duke Energy did you install?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	291	217	13	58	169	119	86	97	102	189	44	21	77	94	107	138	147	126	90	55
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	12	9	-	3	8	4	6	5	1	8	2	1	3	3	6	5	7	6	4	1
	4.1	4.1		5.2	4.7	3.4	7.0	5.2	1.0	4.2	4.5	4.8	3.9	3.2	5.6	3.6	4.8	4.8	4.4	1.8
							I	I												
2	26	17	-	9	14	12	10	7	9	18	4	1	10	6	10	10	16	14	8	4
	8.9	7.8		15.5	8.3	10.1	11.6	7.2	8.8	9.5	9.1	4.8	13.0	6.4	9.3	7.2	10.9	11.1	8.9	7.3
3	34	23	3	8	22	12	11	13	10	24	5	1	10	9	14	20	14	16	11	5
	11.7	10.6	23.1	13.8	13.0	10.1	12.8	13.4	9.8	12.7	11.4	4.8	13.0	9.6	13.1	14.5	9.5	12.7	12.2	9.1
4	38	31	-	7	24	14	11	19	6	28	6	3	9	8	19	20	17	16	12	6
	13.1	14.3		12.1	14.2	11.8	12.8	19.6	5.9	14.8	13.6	14.3	11.7	8.5	17.8	14.5	11.6	12.7	13.3	10.9
								I							N					
5	33	26	-	7	16	17	11	10	12	21	3	7	10	11	10	12	20	9	13	8
	11.3	12.0		12.1	9.5	14.3	12.8	10.3	11.8	11.1	6.8	33.3	13.0	11.7	9.3	8.7	13.6	7.1	14.4	14.5
												JK							R	
6	38	29	5	3	25	13	9	9	20	25	5	3	9	15	11	20	18	17	8	9
	13.1	13.4	38.5	5.2	14.8	10.9	10.5	9.3	19.6	13.2	11.4	14.3	11.7	16.0	10.3	14.5	12.2	13.5	8.9	16.4
		D	BD						GH											
7	17	11	1	5	9	8	8	7	2	10	4	-	3	3	10	11	6	12	3	2
	5.8	5.1	7.7	8.6	5.3	6.7	9.3	7.2	2.0	5.3	9.1		3.9	3.2	9.3	8.0	4.1	9.5	3.3	3.6
							I	I							N			S		
8	35	27	1	5	20	14	4	12	18	24	5	1	8	17	9	17	17	13	12	8
	12.0	12.4	7.7	8.6	11.8	11.8	4.7	12.4	17.6	12.7	11.4	4.8	10.4	18.1	8.4	12.3	11.6	10.3	13.3	14.5
								G	G					O						
9	13	12	-	1	8	4	2	4	6	6	4	-	4	6	2	4	8	3	5	3
	4.5	5.5		1.7	4.7	3.4	2.3	4.1	5.9	3.2	9.1		5.2	6.4	1.9	2.9	5.4	2.4	5.6	5.5
		D																		

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv2a Page 10
(Continued)
DEC Free LED Detailed Participant Survey Results

How many of the LEDs that you had received from Duke Energy did you install?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
10	24	16	1	7	12	11	8	3	11	12	3	3	4	11	8	11	11	10	8	4
	8.2	7.4	7.7	12.1	7.1	9.2	9.3 H	3.1	10.8 H	6.3	6.8	14.3	5.2	11.7	7.5	8.0	7.5	7.9	8.9	7.3
11	7	6	-	1	4	3	2	3	2	3	2	-	3	2	2	1	6	4	1	2
	2.4	2.8		1.7	2.4	2.5	2.3	3.1	2.0	1.6	4.5		3.9	2.1	1.9	0.7	4.1 P	3.2	1.1	3.6
12	9	6	1	2	4	5	2	4	3	6	1	-	3	3	3	4	5	3	4	2
	3.1	2.8	7.7	3.4	2.4	4.2	2.3	4.1	2.9	3.2	2.3		3.9	3.2	2.8	2.9	3.4	2.4	4.4	3.6
13	2	2	-	-	1	1	-	1	1	2	-	-	1	-	1	2	-	1	1	-
	0.7	0.9			0.6	0.8		1.0	1.0	1.1			1.3		0.9	1.4		0.8	1.1	
14	1	-	1	-	1	-	1	-	-	1	-	-	-	-	1	-	1	1	-	-
	0.3		7.7		0.6		1.2			0.5					0.9		0.7	0.8		
15	1	1	-	-	-	1	1	-	-	1	-	-	-	-	1	1	-	1	-	-
	0.3	0.5				0.8	1.2			0.5					0.9	0.7		0.8		
20	1	1	-	-	1	-	-	-	1	-	-	1	-	-	-	-	1	-	-	1
	0.3	0.5			0.6				1.0			4.8					0.7			1.8
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	5.93	5.99	6.92	5.43	5.81	6.03	5.50	5.60	6.53 GH	5.71	5.95	6.14	5.66	6.36 O	5.61	5.83	5.97	5.79	5.87	6.42

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

Appendix C. Detailed Survey Results

Table qiv3 Page 11

DEC Free LED Detailed Participant Survey Results

Where did you install the bulbs that you received from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	460	344	28	85	276	181	115	162	175	290	85	33	125	155	162	233	220	192	153	86
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
On the inside of your home	455	339	28	85	272	180	114	159	174	287	83	33	125	153	159	230	218	190	152	84
	98.9	98.5	100.0	100.0	98.6	99.4	99.1	98.1	99.4	99.0	97.6	100.0	100.0	98.7	98.1	98.7	99.1	99.0	99.3	97.7
			B	B								J	O							
On the outside of your home	85	73	6	5	60	25	21	27	36	45	18	9	19	30	32	46	37	37	23	18
	18.5	21.2	21.4	5.9	21.7	13.8	18.3	16.7	20.6	15.5	21.2	27.3	15.2	19.4	19.8	19.7	16.8	19.3	15.0	20.9
		D	D		F															
Someplace else	5	5	-	-	4	1	2	1	2	5	-	-	1	2	2	3	2	3	2	-
	1.1	1.5			1.4	0.6	1.7	0.6	1.1	1.7			0.8	1.3	1.2	1.3	0.9	1.6	1.3	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv3a Page 12

DEC Free LED Detailed Participant Survey Results

Does Duke Energy provide service at your home?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	459	343	28	85	275	181	115	161	175	289	85	33	125	154	162	233	219	192	152	86
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	450	338	28	81	271	176	113	158	171	284	85	33	121	151	161	229	214	186	151	85
	98.0	98.5	100.0	95.3	98.5	97.2	98.3	98.1	97.7	98.3	100.0	100.0	96.8	98.1	99.4	98.3	97.7	96.9	99.3	98.8
			BD								J	J							R	
No	4	2	-	2	1	3	1	1	2	3	-	-	1	2	-	2	2	2	1	-
	0.9	0.6		2.4	0.4	1.7	0.9	0.6	1.1	1.0			0.8	1.3		0.9	0.9	1.0	0.7	
Don't know/Not sure	5	3	-	2	3	2	1	2	2	2	-	-	3	1	1	2	3	4	-	1
	1.1	0.9		2.4	1.1	1.1	0.9	1.2	1.1	0.7			2.4	0.6	0.6	0.9	1.4	2.1		1.2
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv3b Page 13

DEC Free LED Detailed Participant Survey Results

Where else did you install the bulbs that you received from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	5	5	-	-	4	1	2	1	2	5	-	-	1	2	2	3	2	3	2	-
	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0	100.0	
Where you work	3	3	-	-	3	-	1	1	1	3	-	-	1	2	-	1	2	2	1	-
	60.0	60.0			75.0		50.0	100.0	50.0	60.0			100.0	100.0		33.3	100.0	66.7	50.0	
																	P			
In someone else's home	1	1	-	-	-	1	1	-	-	1	-	-	-	-	1	1	-	1	-	-
	20.0	20.0				100.0	50.0			20.0					50.0	33.3		33.3		
Someplace else, specify	2	2	-	-	2	-	1	-	1	2	-	-	-	1	1	1	1	1	1	-
	40.0	40.0			50.0		50.0		50.0	40.0				50.0	50.0	33.3	50.0	33.3	50.0	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv3c Page 14

DEC Free LED Detailed Participant Survey Results

Does Duke Energy provide service at the other location(s) that you installed your bulb(s)?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	5	5	-	-	4	1	2	1	2	5	-	-	1	2	2	3	2	3	2	-
	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0	100.0	
Yes	3	3	-	-	2	1	1	-	2	3	-	-	1	-	2	3	-	2	1	-
	60.0	60.0			50.0	100.0	50.0		100.0	60.0			100.0		100.0	100.0		66.7	50.0	
No	1	1	-	-	1	-	-	1	-	1	-	-	-	1	-	-	1	-	1	-
	20.0	20.0			25.0			100.0		20.0				50.0			50.0		50.0	
Duke Energy provides service to some locations (please specify)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	1	1	-	-	1	-	1	-	-	1	-	-	-	1	-	-	1	1	-	-
	20.0	20.0			25.0		50.0			20.0				50.0			50.0	33.3		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv4 Page 15

DEC Free LED Detailed Participant Survey Results

Why haven't you installed all of the free LEDs you received?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	311	235	13	60	183	125	89	107	108	201	47	23	84	100	112	144	161	133	98	57
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Haven't had the need to install bulbs	105	74	3	27	53	51	37	35	28	75	14	2	40	27	33	55	48	52	28	15
	33.8	31.5	23.1	45.0	29.0	40.8	41.6	32.7	25.9	37.3	29.8	8.7	47.6	27.0	29.5	38.2	29.8	39.1	28.6	26.3
				B		E	I			L	L		NO					ST		
I am waiting for light bulbs to burn out	194	156	5	31	119	73	47	65	78	122	29	19	54	70	59	84	106	77	63	41
	62.4	66.4	38.5	51.7	65.0	58.4	52.8	60.7	72.2	60.7	61.7	82.6	64.3	70.0	52.7	58.3	65.8	57.9	64.3	71.9
		CD							GH			JK	O	O						R
I don't have a light socket where I use that wattage	14	10	1	2	6	8	4	8	2	10	1	1	7	1	6	5	9	7	2	5
	4.5	4.3	7.7	3.3	3.3	6.4	4.5	7.5	1.9	5.0	2.1	4.3	8.3	1.0	5.4	3.5	5.6	5.3	2.0	8.8
								I					N		N					S
I don't like LEDs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other, specify	48	33	4	10	26	22	16	16	16	32	6	2	11	12	24	23	24	25	17	4
	15.4	14.0	30.8	16.7	14.2	17.6	18.0	15.0	14.8	15.9	12.8	8.7	13.1	12.0	21.4	16.0	14.9	18.8	17.3	7.0
															N			T	T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv5 Page 16

DEC Free LED Detailed Participant Survey Results

What did you do with the LED(s) you did not install?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	311 100.0	235 100.0	13 100.0	60 100.0	183 100.0	125 100.0	89 100.0	107 100.0	108 100.0	201 100.0	47 100.0	23 100.0	84 100.0	100 100.0	112 100.0	144 100.0	161 100.0	133 100.0	98 100.0	57 100.0
Placed them in storage for later use	303 97.4	230 97.9	12 92.3	58 96.7	180 98.4	120 96.0	85 95.5	105 98.1	106 98.1	197 98.0	46 97.9	23 100.0 J	83 98.8	98 98.0	107 95.5	139 96.5	159 98.8	126 94.7	97 99.0 R	57 100.0 R
Threw them away	3 1.0	2 0.9	-	1 1.7	1 0.5	2 1.6	-	1 0.9	2 1.9	2 1.0	-	-	1 1.2	1 1.0	1 0.9	2 1.4	1 0.6	3 2.3	-	-
Gave them away	3 1.0	1 0.4	-	2 3.3	1 0.5	2 1.6	3 3.4	-	-	2 1.0	1 2.1	-	1 1.2	-	2 1.8	1 0.7	1 0.6	2 1.5	1 1.0	-
Other, specify	4 1.3	2 0.9	1 7.7	1 1.7	1 0.5	3 2.4	2 2.2	1 0.9	1 0.9	2 1.0	-	-	-	2 2.0	2 1.8	2 1.4	2 1.2	3 2.3	1 1.0	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv6 Page 17

DEC Free LED Detailed Participant Survey Results

Have you removed any of the free LEDs that you installed?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	460	344	28	85	276	181	115	162	175	290	85	33	125	155	162	233	220	192	153	86
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	30	23	1	6	16	14	5	6	18	17	4	3	9	14	7	18	12	17	5	8
	6.5	6.7	3.6	7.1	5.8	7.7	4.3	3.7	10.3	5.9	4.7	9.1	7.2	9.0	4.3	7.7	5.5	8.9	3.3	9.3
									GH					O				S		S
No	430	321	27	79	260	167	110	156	157	273	81	30	116	141	155	215	208	175	148	78
	93.5	93.3	96.4	92.9	94.2	92.3	95.7	96.3	89.7	94.1	95.3	90.9	92.8	91.0	95.7	92.3	94.5	91.1	96.7	90.7
							I	I							N				RT	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv6a Page 18

DEC Free LED Detailed Participant Survey Results

How many of the <INSTALLED QUANTITY> LEDs have you removed?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	29	22	1	6	16	13	4	6	18	16	4	3	8	14	7	17	12	16	5	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	8	8	-	-	6	2	2	2	4	5	3	-	1	5	2	5	3	4	2	2
	27.6	36.4			37.5	15.4	50.0	33.3	22.2	31.2	75.0 J		12.5	35.7	28.6	29.4	25.0	25.0	40.0	25.0
2	4	3	-	1	2	2	-	-	4	3	-	1	1	2	1	2	2	-	2	2
	13.8	13.6		16.7	12.5	15.4			22.2	18.8		33.3	12.5	14.3	14.3	11.8	16.7		40.0	25.0
3	2	1	1	-	2	-	-	1	1	-	-	1	-	-	2	1	1	1	-	1
	6.9	4.5	100.0		12.5			16.7	5.6			33.3			28.6	5.9	8.3	6.2		12.5
5	2	2	-	-	-	2	-	1	1	1	-	-	2	-	-	2	-	2	-	-
	6.9	9.1				15.4		16.7	5.6	6.2			25.0			11.8		12.5		
6	1	-	-	1	-	1	-	-	1	-	-	-	1	-	-	1	-	1	-	-
	3.4			16.7		7.7			5.6				12.5			5.9		6.2		
8	1	1	-	-	-	1	-	-	1	-	-	-	-	1	-	1	-	1	-	-
	3.4	4.5				7.7			5.6					7.1		5.9		6.2		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	11	7	-	4	6	5	2	2	6	7	1	1	3	6	2	5	6	7	1	3
	37.9	31.8		66.7	37.5	38.5	50.0	33.3	33.3	43.8	25.0	33.3	37.5	42.9	28.6	29.4	50.0	43.8	20.0	37.5
Mean	2.56	2.33	3.00	4.00	1.60	3.75 E	1.00	2.50	2.83 G	1.78	1.00	2.50	3.80	2.12	2.00	3.00	1.67	3.44 S	1.50	1.80

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qiv7aa Page 19

DEC Free LED Detailed Participant Survey Results

Was the free LED that you removed working or was it broken?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	1 100.0	1 100.0	-	-	-	1 100.0	1 100.0	-	-	1 100.0	-	-	1 100.0	-	-	1 100.0	-	1 100.0	-	-
Working	1 100.0	1 100.0	-	-	-	1 100.0	1 100.0	-	-	1 100.0	-	-	1 100.0	-	-	1 100.0	-	1 100.0	-	-
Broken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv7ab Page 20

DEC Free LED Detailed Participant Survey Results

Were the free LEDs that you removed working or were they broken?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	29	22	1	6	16	13	4	6	18	16	4	3	8	14	7	17	12	16	5	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All were working	14	9	1	4	7	7	1	3	9	8	-	3	4	6	4	6	8	8	2	4
	48.3	40.9	100.0	66.7	43.8	53.8	25.0	50.0	50.0	50.0		100.0	50.0	42.9	57.1	35.3	66.7	50.0	40.0	50.0
												J					P			
All were broken	8	7	-	1	5	3	2	1	5	6	1	-	1	5	2	6	2	4	3	1
	27.6	31.8		16.7	31.2	23.1	50.0	16.7	27.8	37.5	25.0		12.5	35.7	28.6	35.3	16.7	25.0	60.0	12.5
																			T	
Some were working and some were broken	7	6	-	1	4	3	1	2	4	2	3	-	3	3	1	5	2	4	-	3
	24.1	27.3		16.7	25.0	23.1	25.0	33.3	22.2	12.5	75.0		37.5	21.4	14.3	29.4	16.7	25.0		37.5
											J									
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv7b Page 21

DEC Free LED Detailed Participant Survey Results

What did you do with the working LED(s) you removed?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	22	16	1	5	11	11	3	5	13	11	3	3	8	9	5	12	10	13	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Placed them in storage for later use	14	10	1	3	6	8	1	3	9	8	2	1	6	6	2	9	5	8	2	4
	63.6	62.5	100.0	60.0	54.5	72.7	33.3	60.0	69.2	72.7	66.7	33.3	75.0	66.7	40.0	75.0	50.0	61.5	100.0	57.1
																			RT	
Threw them away	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gave them away	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Installed them somewhere besides my home	3	3	-	-	3	-	-	-	3	2	-	1	-	2	1	-	3	2	-	1
	13.6	18.8			27.3				23.1	18.2		33.3		22.2	20.0		30.0	15.4		14.3
Installed elsewhere in my home	4	3	-	1	3	1	-	2	2	-	1	2	2	1	1	1	3	1	-	3
	18.2	18.8		20.0	27.3	9.1		40.0	15.4		33.3	66.7	25.0	11.1	20.0	8.3	30.0	7.7		42.9
																				R
Other, specify	3	2	-	1	1	2	2	-	1	2	-	-	-	2	1	2	1	3	-	-
	13.6	12.5		20.0	9.1	18.2	66.7		7.7	18.2				22.2	20.0	16.7	10.0	23.1		
							I													
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qiv8 Page 22

DEC Free LED Detailed Participant Survey Results

Why did you remove the bulbs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	30	23	1	6	16	14	5	6	18	17	4	3	9	14	7	18	12	17	5	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Do not like light quality, not bright enough, too bright	8	6	-	2	3	5	1	2	4	6	-	2	4	3	1	2	6	3	2	3
	26.7	26.1		33.3	18.8	35.7	20.0	33.3	22.2	35.3		66.7	44.4	21.4	14.3	11.1	50.0	17.6	40.0	37.5
																	P			
Do not like appearance of bulb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulbs stopped working, burned out	15	12	1	2	7	8	2	4	9	9	2	-	4	6	5	12	3	10	3	2
	50.0	52.2	100.0	33.3	43.8	57.1	40.0	66.7	50.0	52.9	50.0		44.4	42.9	71.4	66.7	25.0	58.8	60.0	25.0
																Q		T		
Bulbs never worked	2	1	-	1	1	1	-	-	2	-	-	1	1	-	1	1	1	1	-	1
	6.7	4.3		16.7	6.2	7.1			11.1			33.3	11.1		14.3	5.6	8.3	5.9		12.5
Other, specify	7	6	-	1	6	1	2	-	5	3	2	1	1	6	-	4	3	4	-	3
	23.3	26.1		16.7	37.5	7.1	40.0		27.8	17.6	50.0	33.3	11.1	42.9		22.2	25.0	23.5		37.5
					F									M						
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr1 Page 23

DEC Free LED Detailed Participant Survey Results

I am interested in the types of bulbs that were in the sockets before you installed the free LEDs in them. Did you have any CFLs or LEDs in any of those sockets?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	424	322	25	74	261	160	102	148	166	269	79	32	111	146	150	212	205	166	146	83
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	238	185	16	35	155	80	56	89	88	147	46	21	60	78	87	111	122	82	85	51
	56.1	57.5	64.0	47.3	59.4	50.0	54.9	60.1	53.0	54.6	58.2	65.6	54.1	53.4	58.0	52.4	59.5	49.4	58.2	61.4
					F															R
No	185	137	9	38	106	79	45	59	78	121	33	11	51	68	62	100	83	83	61	32
	43.6	42.5	36.0	51.4	40.6	49.4	44.1	39.9	47.0	45.0	41.8	34.4	45.9	46.6	41.3	47.2	40.5	50.0	41.8	38.6
						E												T		
Don't know/Not sure	1	-	-	1	-	1	1	-	-	1	-	-	-	-	1	1	-	1	-	-
	0.2			1.4		0.6	1.0			0.4					0.7	0.5		0.6		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr2 Page 24

DEC Free LED Detailed Participant Survey Results

How many of the <INSTALLED QUANTITY> sockets where you installed the free LEDs had CFLs or LEDs in them?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	238	185	16	35	155	80	56	89	88	147	46	21	60	78	87	111	122	82	85	51
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	22	18	2	2	15	7	6	11	5	14	3	3	4	7	10	7	15	7	9	5
	9.2	9.7	12.5	5.7	9.7	8.8	10.7	12.4	5.7	9.5	6.5	14.3	6.7	9.0	11.5	6.3	12.3	8.5	10.6	9.8
2	36	27	1	8	26	9	10	15	10	22	7	5	8	13	14	9	27	12	10	11
	15.1	14.6	6.2	22.9	16.8	11.2	17.9	16.9	11.4	15.0	15.2	23.8	13.3	16.7	16.1	8.1	22.1	14.6	11.8	21.6
				C													P			
3	35	28	3	4	26	9	8	16	11	22	6	4	5	14	14	14	21	10	12	10
	14.7	15.1	18.8	11.4	16.8	11.2	14.3	18.0	12.5	15.0	13.0	19.0	8.3	17.9	16.1	12.6	17.2	12.2	14.1	19.6
														M						
4	31	23	2	6	20	10	12	10	8	22	4	2	9	8	11	19	10	12	11	4
	13.0	12.4	12.5	17.1	12.9	12.5	21.4	11.2	9.1	15.0	8.7	9.5	15.0	10.3	12.6	17.1	8.2	14.6	12.9	7.8
							I									Q				
5	22	18	-	3	13	9	2	7	13	10	8	1	8	7	5	7	14	4	9	6
	9.2	9.7		8.6	8.4	11.2	3.6	7.9	14.8	6.8	17.4	4.8	13.3	9.0	5.7	6.3	11.5	4.9	10.6	11.8
									G		JL									
6	21	16	3	2	16	5	6	7	8	11	5	1	4	7	9	12	9	7	5	7
	8.8	8.6	18.8	5.7	10.3	6.2	10.7	7.9	9.1	7.5	10.9	4.8	6.7	9.0	10.3	10.8	7.4	8.5	5.9	13.7
7	5	3	-	2	2	3	3	2	-	3	1	-	1	-	4	3	2	3	2	-
	2.1	1.6		5.7	1.3	3.8	5.4	2.2		2.0	2.2		1.7		4.6	2.7	1.6	3.7	2.4	
8	17	10	1	5	5	11	1	5	9	12	2	1	7	6	2	9	7	7	6	2
	7.1	5.4	6.2	14.3	3.2	13.8	1.8	5.6	10.2	8.2	4.3	4.8	11.7	7.7	2.3	8.1	5.7	8.5	7.1	3.9
						E			G				O							
9	8	6	-	2	5	3	2	2	4	6	1	-	4	2	2	5	3	3	3	1
	3.4	3.2		5.7	3.2	3.8	3.6	2.2	4.5	4.1	2.2		6.7	2.6	2.3	4.5	2.5	3.7	3.5	2.0

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr2 Page 25
(Continued)
DEC Free LED Detailed Participant Survey Results

How many of the <INSTALLED QUANTITY> sockets where you installed the free LEDs had CFLs or LEDs in them?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
10	9 3.8	8 4.3	1 6.2	-	6 3.9	3 3.8	-	4 4.5	4 4.5	4 2.7	3 6.5	1 4.8	3 5.0	1 1.3	4 4.6	6 5.4	2 1.6	2 2.4	3 3.5	3 5.9
11	2 0.8	1 0.5	1 6.2	-	2 1.3	-	1 1.8	-	1 1.1	1 0.7	-	1 4.8	-	1 1.3	1 1.1	-	2 1.6	1 1.2	1 1.2	-
12	9 3.8	9 4.9	-	-	6 3.9	3 3.8	3 5.4	2 2.2	4 4.5	6 4.1	1 2.2	1 4.8	2 3.3	4 5.1	3 3.4	5 4.5	4 3.3	3 3.7	6 7.1	-
14	2 0.8	1 0.5	-	1 2.9	1 0.6	1 1.2	-	-	2 2.3	2 1.4	-	-	-	2 2.6	-	2 1.8	-	1 1.2	1 1.2	-
15	18 7.6	16 8.6	2 12.5	-	12 7.7	6 7.5	2 3.6	7 7.9	9 10.2	11 7.5	5 10.9	1 4.8	4 6.7	6 7.7	8 9.2	12 10.8 Q	6 4.9	10 12.2 T	6 7.1	2 3.9
18	1 0.4	1 0.5	-	-	-	1 1.2	-	1 1.1	-	1 0.7	-	-	1 1.7	-	-	1 0.9	-	-	1 1.2	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	5.62	5.73	6.12	4.77	5.37	6.14	4.79	5.22	6.51 GH	5.67	5.87	4.76	6.10	5.60	5.43	6.61 Q	4.70	6.17 T	5.98 T	4.51

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr3 Page 26

DEC Free LED Detailed Participant Survey Results

Were any of the sockets where you installed the free LEDs empty at the time you installed the free LEDs in them?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	352	252	23	75	203	147	85	117	144	224	62	25	100	126	113	174	174	148	118	66
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	57	37	8	12	25	32	17	14	25	30	9	4	22	17	15	34	23	34	14	7
	16.2	14.7	34.8	16.0	12.3	21.8	20.0	12.0	17.4	13.4	14.5	16.0	22.0	13.5	13.3	19.5	13.2	23.0	11.9	10.6
			BD			E							NO					ST		
No	295	215	15	63	178	115	68	103	119	194	53	21	78	109	98	140	151	114	104	59
	83.8	85.3	65.2	84.0	87.7	78.2	80.0	88.0	82.6	86.6	85.5	84.0	78.0	86.5	86.7	80.5	86.8	77.0	88.1	89.4
		C		C	F									M	M				R	R
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr3a Page 27

DEC Free LED Detailed Participant Survey Results

How many of the sockets where you installed the free LEDs were empty?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	57	37	8	12	25	32	17	14	25	30	9	4	22	17	15	34	23	34	14	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	14	11	-	3	5	9	4	5	5	11	1	2	6	3	5	5	9	8	3	3
	24.6	29.7		25.0	20.0	28.1	23.5	35.7	20.0	36.7	11.1	50.0	27.3	17.6	33.3	14.7	39.1	23.5	21.4	42.9
										K							P			
2	19	12	2	5	8	11	6	4	8	9	3	1	7	6	4	11	8	11	4	2
	33.3	32.4	25.0	41.7	32.0	34.4	35.3	28.6	32.0	30.0	33.3	25.0	31.8	35.3	26.7	32.4	34.8	32.4	28.6	28.6
3	11	7	3	1	6	5	2	2	7	5	1	1	5	3	3	9	2	7	4	-
	19.3	18.9	37.5	8.3	24.0	15.6	11.8	14.3	28.0	16.7	11.1	25.0	22.7	17.6	20.0	26.5	8.7	20.6	28.6	
																Q				
4	6	1	2	3	-	6	-	2	4	2	1	-	2	3	1	5	1	4	2	-
	10.5	2.7	25.0	25.0		18.8		14.3	16.0	6.7	11.1		9.1	17.6	6.7	14.7	4.3	11.8	14.3	
				B																
6	3	2	1	-	2	1	2	1	-	3	-	-	2	-	1	3	-	3	-	-
	5.3	5.4	12.5		8.0	3.1	11.8	7.1		10.0			9.1		6.7	8.8		8.8		
10	2	2	-	-	2	-	1	-	1	-	2	-	-	1	-	-	2	-	1	1
	3.5	5.4			8.0		5.9		4.0		22.2			5.9			8.7		7.1	14.3
11	1	1	-	-	1	-	1	-	-	-	1	-	-	-	1	-	1	-	-	1
	1.8	2.7			4.0		5.9				11.1				6.7		4.3			14.3
Don't know/Not sure	1	1	-	-	1	-	1	-	-	-	-	-	-	1	-	1	-	1	-	-
	1.8	2.7			4.0		5.9							5.9		2.9		2.9		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	2.82	2.86	3.38	2.33	3.42	2.38	3.44	2.36	2.72	2.33	5.00	1.75	2.50	2.88	2.87	2.79	2.87	2.58	2.93	4.00
			D								JL									

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qr4 Page 28

DEC Free LED Detailed Participant Survey Results

At the time that you installed the free LED(s), were any of the bulbs you replaced with free LEDs still working or had all of them burnt out?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	460	344	28	85	276	181	115	162	175	290	85	33	125	155	162	233	220	192	153	86
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All were still working	205	154	16	35	130	75	50	76	75	125	43	17	49	66	83	111	91	85	67	38
	44.6	44.8	57.1	41.2	47.1	41.4	43.5	46.9	42.9	43.1	50.6	51.5	39.2	42.6	51.2	47.6	41.4	44.3	43.8	44.2
															M					
Some were still working	139	103	5	29	77	59	29	49	58	86	28	6	45	49	39	73	63	57	52	23
	30.2	29.9	17.9	34.1	27.9	32.6	25.2	30.2	33.1	29.7	32.9	18.2	36.0	31.6	24.1	31.3	28.6	29.7	34.0	26.7
				C							L		O							
All of them had burnt out	116	87	7	21	69	47	36	37	42	79	14	10	31	40	40	49	66	50	34	25
	25.2	25.3	25.0	24.7	25.0	26.0	31.3	22.8	24.0	27.2	16.5	30.3	24.8	25.8	24.7	21.0	30.0	26.0	22.2	29.1
										K							P			
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr1 Page 29

DEC Free LED Detailed Participant Survey Results

When you purchase light bulbs, do you generally purchase the lowest priced bulb, or do you consider other factors, such as energy efficiency, quality of light, or longevity of the bulb a factor in your decision?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482 100.0	364 100.0	28 100.0	87 100.0	292 100.0	187 100.0	118 100.0	174 100.0	181 100.0	304 100.0	88 100.0	35 100.0	132 100.0	161 100.0	169 100.0	239 100.0	236 100.0	199 100.0	162 100.0	89 100.0
I purchase the lowest-priced bulb	118 24.5	80 22.0	8 28.6	28 32.2 B	51 17.5	66 35.3 E	24 20.3	42 24.1	50 27.6	78 25.7 KL	12 13.6	2 5.7	39 29.5	38 23.6	39 23.1	72 30.1 Q	44 18.6	69 34.7 ST	31 19.1	13 14.6
I consider other factors	362 75.1	282 77.5 D	20 71.4	59 67.8	239 81.8 F	121 64.7	94 79.7	130 74.7	131 72.4	224 73.7	76 86.4 J	33 94.3 J	93 70.5	123 76.4	128 75.7	165 69.0	192 81.4 P	130 65.3	131 80.9 R	75 84.3 R
Don't know/Not sure	2 0.4	2 0.5	-	-	2 0.7	-	-	2 1.1	-	2 0.7	-	-	-	-	2 1.2	2 0.8	-	-	-	1 1.1
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr2 Page 30

DEC Free LED Detailed Participant Survey Results

If you had not received the <RECEIVED QUANTITY> LEDs from Duke Energy, what would you have purchased the next time you needed to buy light bulbs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Incandescent or halogen light bulbs	50	39	4	7	33	17	21	15	13	32	9	1	8	16	24	26	23	29	11	6
	10.4	10.7	14.3	8.0	11.3	9.1	17.8	8.6	7.2	10.5	10.2	2.9	6.1	9.9	14.2	10.9	9.7	14.6	6.8	6.7
							HI			L	L				M			ST		
CFLs	47	36	4	7	31	16	10	18	18	27	12	3	16	16	12	22	23	15	20	8
	9.8	9.9	14.3	8.0	10.6	8.6	8.5	10.3	9.9	8.9	13.6	8.6	12.1	9.9	7.1	9.2	9.7	7.5	12.3	9.0
LEDs	163	129	6	26	118	43	40	60	60	99	37	14	31	56	68	72	89	53	61	34
	33.8	35.4	21.4	29.9	40.4	23.0	33.9	34.5	33.1	32.6	42.0	40.0	23.5	34.8	40.2	30.1	37.7	26.6	37.7	38.2
		C			F									M	M		P		R	R
A mix of bulbs	133	104	6	23	78	54	25	54	51	84	23	16	41	43	43	58	73	46	47	32
	27.6	28.6	21.4	26.4	26.7	28.9	21.2	31.0	28.2	27.6	26.1	45.7	31.1	26.7	25.4	24.3	30.9	23.1	29.0	36.0
								G				JK								R
The lowest cost bulbs	88	56	7	24	31	57	22	26	39	61	7	1	36	30	21	60	28	56	22	9
	18.3	15.4	25.0	27.6	10.6	30.5	18.6	14.9	21.5	20.1	8.0	2.9	27.3	18.6	12.4	25.1	11.9	28.1	13.6	10.1
				B		E				KL			NO			Q		ST		
Don't know/Not sure	1	-	1	-	1	-	-	1	-	1	-	-	-	-	1	1	-	-	1	-
	0.2		3.6		0.3			0.6		0.3					0.6	0.4			0.6	
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr3 Page 31

DEC Free LED Detailed Participant Survey Results

Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would you have still purchased CFLs, or would you have purchased a different type of light bulb?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	47	36	4	7	31	16	10	18	18	27	12	3	16	16	12	22	23	15	20	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Still would have purchased CFLs	47	36	4	7	31	16	10	18	18	27	12	3	16	16	12	22	23	15	20	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Would have purchased a different type of light bulb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qfr4 Page 32

DEC Free LED Detailed Participant Survey Results

Would you have purchased all <RECEIVED QUANTITY> LEDs or just some at full retail price of $<LEDBULBCOST> per bulb?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	163	129	6	26	118	43	40	60	60	99	37	14	31	56	68	72	89	53	61	34
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All of them	69	55	3	9	54	14	18	23	25	43	15	5	10	25	28	32	35	25	22	13
	42.3	42.6	50.0	34.6	45.8	32.6	45.0	38.3	41.7	43.4	40.5	35.7	32.3	44.6	41.2	44.4	39.3	47.2	36.1	38.2
Some of them	93	73	3	17	63	29	22	36	35	55	22	9	21	31	39	40	53	28	39	20
	57.1	56.6	50.0	65.4	53.4	67.4 E	55.0	60.0	58.3	55.6	59.5	64.3	67.7	55.4	57.4	55.6	59.6	52.8	63.9	58.8
Don't know/Not sure	1	1	-	-	1	-	-	1	-	1	-	-	-	-	1	-	1	-	-	1
	0.6	0.8			0.8			1.7		1.0					1.5		1.1			2.9
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr5 Page 33

DEC Free LED Detailed Participant Survey Results

How many of the <RECEIVED QUANTITY> LEDs would you have purchased at the full retail price of $<LEDBULBCOST> per bulb?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	93	73	3	17	63	29	22	36	35	55	22	9	21	31	39	40	53	28	39	20
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	2	1	-	1	1	1	-	2	-	2	-	-	1	-	1	-	2	1	1	-
	2.2	1.4		5.9	1.6	3.4		5.6		3.6			4.8		2.6		3.8	3.6	2.6	
2	11	8	-	3	8	3	4	6	1	7	1	1	3	1	7	4	7	4	3	3
	11.8	11.0		17.6	12.7	10.3	18.2	16.7	2.9	12.7	4.5	11.1	14.3	3.2	17.9	10.0	13.2	14.3	7.7	15.0
							I	I							N					
3	4	3	-	1	2	2	1	-	3	3	1	-	1	1	2	1	3	3	1	-
	4.3	4.1		5.9	3.2	6.9	4.5		8.6	5.5	4.5		4.8	3.2	5.1	2.5	5.7	10.7	2.6	
4	11	8	1	2	7	4	1	5	5	3	7	-	3	5	3	3	8	2	7	1
	11.8	11.0	33.3	11.8	11.1	13.8	4.5	13.9	14.3	5.5	31.8		14.3	16.1	7.7	7.5	15.1	7.1	17.9	5.0
											J								T	
5	13	11	-	2	9	4	2	5	6	10	1	2	3	5	5	6	7	3	6	4
	14.0	15.1		11.8	14.3	13.8	9.1	13.9	17.1	18.2	4.5	22.2	14.3	16.1	12.8	15.0	13.2	10.7	15.4	20.0
										K										
6	8	7	1	-	7	1	1	2	5	3	4	1	1	4	3	4	4	-	7	1
	8.6	9.6	33.3		11.1	3.4	4.5	5.6	14.3	5.5	18.2	11.1	4.8	12.9	7.7	10.0	7.5		17.9	5.0
																			T	
7	3	3	-	-	3	-	1	2	-	2	1	-	-	-	2	2	1	2	1	-
	3.2	4.1			4.8		4.5	5.6		3.6	4.5				5.1	5.0	1.9	7.1	2.6	
8	8	6	-	2	4	4	2	2	4	4	1	2	1	5	1	4	4	3	2	2
	8.6	8.2		11.8	6.3	13.8	9.1	5.6	11.4	7.3	4.5	22.2	4.8	16.1	2.6	10.0	7.5	10.7	5.1	10.0
														O						
9	4	3	-	1	2	2	2	2	-	3	1	-	2	-	2	1	3	1	2	-
	4.3	4.1		5.9	3.2	6.9	9.1	5.6		5.5	4.5		9.5		5.1	2.5	5.7	3.6	5.1	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qfr5 Page 34
(Continued)
DEC Free LED Detailed Participant Survey Results

How many of the <RECEIVED QUANTITY> LEDs would you have purchased at the full retail price of $<LEDBULBCOST> per bulb?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
10	13	10	-	3	8	4	2	4	7	8	2	2	5	4	4	7	6	4	5	4
	14.0	13.7		17.6	12.7	13.8	9.1	11.1	20.0	14.5	9.1	22.2	23.8	12.9	10.3	17.5	11.3	14.3	12.8	20.0
11	1	1	-	-	1	-	1	-	-	-	1	-	-	-	1	-	1	-	-	1
	1.1	1.4			1.6		4.5				4.5				2.6		1.9			5.0
12	3	3	-	-	3	-	3	-	-	3	-	-	-	1	2	1	2	1	2	-
	3.2	4.1			4.8		13.6			5.5				3.2	5.1	2.5	3.8	3.6	5.1	
15	9	6	1	2	6	3	1	4	4	4	2	1	1	4	4	4	5	2	2	3
	9.7	8.2	33.3	11.8	9.5	10.3	4.5	11.1	11.4	7.3	9.1	11.1	4.8	12.9	10.3	10.0	9.4	7.1	5.1	15.0
Don't know/Not sure	3	3	-	-	2	1	1	2	-	3	-	-	-	1	2	3	-	2	-	1
	3.2	4.1			3.2	3.4	4.5	5.6		5.5				3.2	5.1	7.5		7.1		5.0
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	6.96	6.97	8.33	6.65	6.98	6.79	7.33	6.44	7.23	6.81	6.68	7.67	6.38	7.53	6.78	7.41	6.64	6.54	6.54	7.79

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr6 Page 35

DEC Free LED Detailed Participant Survey Results

Just to make sure I recorded everything accurately, you are telling me that of the <RECEIVED QUANTITY> LEDs that you received from Duke Energy, you would have purchased <FR5 ANSWER> LEDs, which means that you would not have purchased <RECEIVED QUANTITY-FR5 ANSWER>. Is that correct?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	78	61	2	15	52	25	17	30	31	45	20	8	20	25	31	32	46	23	35	16
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	78	61	2	15	52	25	17	30	31	45	20	8	20	25	31	32	46	23	35	16
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr7 Page 36

DEC Free LED Detailed Participant Survey Results

For these <RECEIVED QUANTITY-FR5 ANSWER> bulbs, would you have still purchased LEDs but have done it later, or would you have purchased a different type of light bulb instead of LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	78	61	2	15	52	25	17	30	31	45	20	8	20	25	31	32	46	23	35	16
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Purchased LEDs later	72	56	2	14	47	24	17	29	26	41	18	8	19	21	30	30	42	23	30	15
	92.3	91.8	100.0	93.3	90.4	96.0	100.0	96.7	83.9	91.1	90.0	100.0	95.0	84.0	96.8	93.8	91.3	100.0	85.7	93.8
			B				I	I				J						S		
Purchased a different type of light bulb	6	5	-	1	5	1	-	1	5	4	2	-	1	4	1	2	4	-	5	1
	7.7	8.2		6.7	9.6	4.0		3.3	16.1	8.9	10.0		5.0	16.0	3.2	6.2	8.7		14.3	6.2
									H											
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr7a Page 37

DEC Free LED Detailed Participant Survey Results

What type(s) of light bulbs would you have purchased instead of LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	6 100.0	5 100.0	-	1 100.0	5 100.0	1 100.0	-	1 100.0	5 100.0	4 100.0	2 100.0	-	1 100.0	4 100.0	1 100.0	2 100.0	4 100.0	-	5 100.0	1 100.0
Incandescent or halogen bulbs	2 33.3	2 40.0	-	-	2 40.0	-	-	-	2 40.0	-	2 100.0	-	-	2 50.0	-	-	2 50.0	-	2 40.0	-
CFLs	2 33.3	2 40.0	-	-	2 40.0	-	-	1 100.0	1 20.0	2 50.0	-	-	-	1 25.0	1 100.0	1 50.0	1 25.0	-	1 20.0	1 100.0
Other	2 33.3	1 20.0	-	1 100.0	1 20.0	1 100.0	-	-	2 40.0	2 50.0	-	-	1 100.0	1 25.0	-	1 50.0	1 25.0	-	2 40.0	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr7b Page 38

DEC Free LED Detailed Participant Survey Results

Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would CFLs still have been a part of the mix?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	2 100.0	2 100.0	-	-	2 100.0	-	-	1 100.0	1 100.0	2 100.0	-	-	-	1 100.0	1 100.0	1 100.0	1 100.0	-	1 100.0	1 100.0
Yes	2 100.0	2 100.0	-	-	2 100.0	-	-	1 100.0	1 100.0	2 100.0	-	-	-	1 100.0	1 100.0	1 100.0	1 100.0	-	1 100.0	1 100.0
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr8 Page 39

DEC Free LED Detailed Participant Survey Results

What types of bulbs would likely have been in the mix?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	133	104	6	23	78	54	25	54	51	84	23	16	41	43	43	58	73	46	47	32
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Incandescent or halogen bulbs	90	72	3	15	55	35	18	37	33	57	19	9	31	25	31	35	54	29	31	25
	67.7	69.2	50.0	65.2	70.5	64.8	72.0	68.5	64.7	67.9	82.6	56.2	75.6	58.1	72.1	60.3	74.0	63.0	66.0	78.1
											L		N				P			
CFLs	68	58	2	8	42	25	13	29	25	45	7	11	21	22	21	31	36	25	25	15
	51.1	55.8	33.3	34.8	53.8	46.3	52.0	53.7	49.0	53.6	30.4	68.8	51.2	51.2	48.8	53.4	49.3	54.3	53.2	46.9
		D								K		K								
LEDs	88	70	4	14	51	36	16	30	40	54	17	11	29	32	21	35	51	28	31	25
	66.2	67.3	66.7	60.9	65.4	66.7	64.0	55.6	78.4	64.3	73.9	68.8	70.7	74.4	48.8	60.3	69.9	60.9	66.0	78.1
									H				O	O						R
Other, specify	2	2	-	-	-	2	-	1	1	1	-	-	1	1	-	2	-	1	-	1
	1.5	1.9				3.7		1.9	2.0	1.2			2.4	2.3		3.4		2.2		3.1
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr9 Page 40

DEC Free LED Detailed Participant Survey Results

Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would CFLs still have been a part of the mix?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	68 100.0	58 100.0	2 100.0	8 100.0	42 100.0	25 100.0	13 100.0	29 100.0	25 100.0	45 100.0	7 100.0	11 100.0	21 100.0	22 100.0	21 100.0	31 100.0	36 100.0	25 100.0	25 100.0	15 100.0
Yes	68 100.0	58 100.0	2 100.0	8 100.0	42 100.0	25 100.0	13 100.0	29 100.0	25 100.0	45 100.0	7 100.0	11 100.0	21 100.0	22 100.0	21 100.0	31 100.0	36 100.0	25 100.0	25 100.0	15 100.0
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qfr10 Page 41

DEC Free LED Detailed Participant Survey Results

Earlier, you indicated that you replaced working light bulbs with the LEDs you received for free from Duke Energy. If you had not received the free LEDs from Duke Energy, would you have still replaced these working light bulbs with LEDs, or would you have waited until they burnt out?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	242	183	15	43	160	79	51	93	92	143	58	21	61	78	92	121	116	79	94	50
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Would have replaced working bulbs with LEDs	66	47	3	15	45	19	15	25	24	39	18	4	12	21	28	30	35	19	25	15
	27.3	25.7	20.0	34.9	28.1	24.1	29.4	26.9	26.1	27.3	31.0	19.0	19.7	26.9	30.4	24.8	30.2	24.1	26.6	30.0
Would have waited until working bulbs burned out	176	136	12	28	115	60	36	68	68	104	40	17	49	57	64	91	81	60	69	35
	72.7	74.3	80.0	65.1	71.9	75.9	70.6	73.1	73.9	72.7	69.0	81.0	80.3	73.1	69.6	75.2	69.8	75.9	73.4	70.0
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso1 Page 42

DEC Free LED Detailed Participant Survey Results

Besides the free LEDs you received from Duke Energy, have you or anyone in your household purchased light bulbs in the past year?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	253	201	13	38	170	82	48	102	100	149	61	22	61	92	91	124	125	90	84	62
	52.5	55.2	46.4	43.7	58.2	43.9	40.7	58.6	55.2	49.0	69.3	62.9	46.2	57.1	53.8	51.9	53.0	45.2	51.9	69.7
		D			F			G	G		J			M						RS
No	229	163	15	49	122	105	70	72	81	155	27	13	71	69	78	115	111	109	78	27
	47.5	44.8	53.6	56.3	41.8	56.1	59.3	41.4	44.8	51.0	30.7	37.1	53.8	42.9	46.2	48.1	47.0	54.8	48.1	30.3
				B		E	HI			K			N					T	T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso2 Page 43

DEC Free LED Detailed Participant Survey Results

Did you purchase these light bulbs before or after you received the free LEDs from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	253	201	13	38	170	82	48	102	100	149	61	22	61	92	91	124	125	90	84	62
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Before receiving LEDs from Duke Energy	162	128	7	27	104	57	35	58	66	103	36	10	32	63	61	83	76	63	55	31
	64.0	63.7	53.8	71.1	61.2	69.5	72.9	56.9	66.0	69.1	59.0	45.5	52.5	68.5	67.0	66.9	60.8	70.0	65.5	50.0
							H			L				M	M			T	T	
After receiving LEDs from Duke Energy	43	36	4	3	33	10	6	19	18	25	10	6	14	13	15	16	26	13	16	11
	17.0	17.9	30.8	7.9	19.4	12.2	12.5	18.6	18.0	16.8	16.4	27.3	23.0	14.1	16.5	12.9	20.8	14.4	19.0	17.7
		D	D														P			
Both before and after receiving the free LEDs from Duke Energy	47	36	2	8	32	15	7	24	16	20	15	6	15	16	14	25	22	14	13	19
	18.6	17.9	15.4	21.1	18.8	18.3	14.6	23.5	16.0	13.4	24.6	27.3	24.6	17.4	15.4	20.2	17.6	15.6	15.5	30.6
											J									RS
Don't know/Not sure	1	1	-	-	1	-	-	1	-	1	-	-	-	-	1	-	1	-	-	1
	0.4	0.5			0.6			1.0		0.7					1.1		0.8			1.6
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso3 Page 44

DEC Free LED Detailed Participant Survey Results

What types of light bulbs did you purchase in the past year?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	254	202	13	38	170	83	48	102	101	149	62	22	61	93	91	125	125	90	85	62
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Incandescent or halogen bulbs	117	93	5	18	74	43	19	51	46	67	26	10	30	41	42	57	58	41	37	30
	46.1	46.0	38.5	47.4	43.5	51.8	39.6	50.0	45.5	45.0	41.9	45.5	49.2	44.1	46.2	45.6	46.4	45.6	43.5	48.4
CFL bulb	84	65	5	14	55	28	13	36	33	53	16	9	14	40	25	40	43	28	37	14
	33.1	32.2	38.5	36.8	32.4	33.7	27.1	35.3	32.7	35.6	25.8	40.9	23.0	43.0	27.5	32.0	34.4	31.1	43.5	22.6
														MO					RT	
LED bulb	119	98	5	16	90	28	20	46	51	63	36	15	28	42	42	49	68	32	37	40
	46.9	48.5	38.5	42.1	52.9	33.7	41.7	45.1	50.5	42.3	58.1	68.2	45.9	45.2	46.2	39.2	54.4	35.6	43.5	64.5
					F						J	J					P			RS
Other, specify	16	13	2	1	11	5	6	6	4	10	4	-	4	5	7	10	6	10	4	1
	6.3	6.4	15.4	2.6	6.5	6.0	12.5	5.9	4.0	6.7	6.5		6.6	5.4	7.7	8.0	4.8	11.1	4.7	1.6
							I											T		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso4 Page 45

DEC Free LED Detailed Participant Survey Results

Approximately how many CFLs or LEDs did you purchase after you received the free LEDs from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	63	51	3	9	47	16	7	31	25	29	20	11	17	23	20	26	36	14	21	25
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	1	1	-	-	1	-	1	-	-	1	-	-	-	1	-	-	1	1	-	-
	1.6	2.0			2.1		14.3			3.4				4.3			2.8	7.1		
2	8	4	-	4	3	5	1	4	3	5	1	1	4	2	1	3	5	3	3	2
	12.7	7.8		44.4	6.4	31.2	14.3	12.9	12.0	17.2	5.0	9.1	23.5	8.7	5.0	11.5	13.9	21.4	14.3	8.0
				B		E														
3	6	5	-	1	4	2	1	1	4	4	2	-	2	1	3	1	5	1	3	2
	9.5	9.8		11.1	8.5	12.5	14.3	3.2	16.0	13.8	10.0		11.8	4.3	15.0	3.8	13.9	7.1	14.3	8.0
4	10	8	1	1	8	2	1	4	5	4	5	1	1	6	3	4	6	2	2	5
	15.9	15.7	33.3	11.1	17.0	12.5	14.3	12.9	20.0	13.8	25.0	9.1	5.9	26.1	15.0	15.4	16.7	14.3	9.5	20.0
														M						
5	3	2	-	1	2	1	-	2	1	1	1	1	-	1	2	2	1	1	1	1
	4.8	3.9		11.1	4.3	6.2		6.5	4.0	3.4	5.0	9.1		4.3	10.0	7.7	2.8	7.1	4.8	4.0
6	12	11	1	-	11	1	1	11	-	5	4	2	5	1	4	6	5	4	5	1
	19.0	21.6	33.3		23.4	6.2	14.3	35.5		17.2	20.0	18.2	29.4	4.3	20.0	23.1	13.9	28.6	23.8	4.0
					F								N					T	T	
7	1	1	-	-	1	-	-	1	-	-	-	1	-	-	1	-	1	-	-	1
	1.6	2.0			2.1			3.2				9.1			5.0		2.8			4.0
8	6	4	-	2	2	4	2	3	1	4	1	-	1	4	1	4	2	1	3	2
	9.5	7.8		22.2	4.3	25.0	28.6	9.7	4.0	13.8	5.0		5.9	17.4	5.0	15.4	5.6	7.1	14.3	8.0
						E														
9	1	1	-	-	1	-	-	-	1	1	-	-	-	1	-	1	-	1	-	-
	1.6	2.0			2.1				4.0	3.4				4.3		3.8		7.1		

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso4 Page 46
(Continued)
DEC Free LED Detailed Participant Survey Results

Approximately how many CFLs or LEDs did you purchase after you received the free LEDs from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
10	6	6	-	-	5	1	-	3	3	2	1	3	1	5	-	1	5	-	2	4
	9.5	11.8			10.6	6.2		9.7	12.0	6.9	5.0	27.3	5.9	21.7		3.8	13.9		9.5	16.0
12	3	2	1	-	3	-	-	1	2	2	1	-	2	-	1	2	1	-	2	1
	4.8	3.9	33.3		6.4			3.2	8.0	6.9	5.0		11.8		5.0	7.7	2.8		9.5	4.0
20	1	1	-	-	1	-	-	1	-	-	1	-	-	-	1	1	-	-	-	1
	1.6	2.0			2.1			3.2			5.0				5.0	3.8				4.0
25	1	1	-	-	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	1
	1.6	2.0			2.1				4.0		5.0				5.0		2.8			4.0
30	1	1	-	-	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	1
	1.6	2.0			2.1				4.0		5.0				5.0		2.8			4.0
32	1	1	-	-	1	-	-	-	1	-	1	-	-	1	-	1	-	-	-	1
	1.6	2.0			2.1				4.0		5.0			4.3		3.8				4.0
40	1	1	-	-	1	-	-	-	1	-	-	1	1	-	-	-	1	-	-	1
	1.6	2.0			2.1				4.0			9.1	5.9				2.8			4.0
50	1	1	-	-	1	-	-	-	1	-	-	1	-	-	1	-	1	-	-	1
	1.6	2.0			2.1				4.0			9.1			5.0		2.8			4.0
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.24	9.04	7.33	4.00	9.40	4.81	4.57	6.32	11.64	5.48	9.70	13.64	7.65	7.22	10.45	7.62	8.75	4.57	6.00	12.52
		D			F				GH		J									RS

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qso5 Page 47

DEC Free LED Detailed Participant Survey Results

Did your experience with the free LEDs you received from Duke Energy encourage you IN ANY WAY to purchase the additional CFLs or LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	63	51	3	9	47	16	7	31	25	29	20	11	17	23	20	26	36	14	21	25
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	51	40	3	8	37	14	6	25	20	24	15	9	15	18	15	21	29	13	17	19
	81.0	78.4	100.0	88.9	78.7	87.5	85.7	80.6	80.0	82.8	75.0	81.8	88.2	78.3	75.0	80.8	80.6	92.9	81.0	76.0
			B																	
No	12	11	-	1	10	2	1	6	5	5	5	2	2	5	5	5	7	1	4	6
	19.0	21.6		11.1	21.3	12.5	14.3	19.4	20.0	17.2	25.0	18.2	11.8	21.7	25.0	19.2	19.4	7.1	19.0	24.0
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso6 Page 48

DEC Free LED Detailed Participant Survey Results

How influential was your experience with the free LEDs you received from Duke Energy on your decision to purchase the additional CFLs or LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	51 100.0	40 100.0	3 100.0	8 100.0	37 100.0	14 100.0	6 100.0	25 100.0	20 100.0	24 100.0	15 100.0	9 100.0	15 100.0	18 100.0	15 100.0	21 100.0	29 100.0	13 100.0	17 100.0	19 100.0
Net 0-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0 - Not at all influential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net 5-6	5 9.8	4 10.0	-	1 12.5	4 10.8	1 7.1	-	4 16.0	1 5.0	1 4.2	2 13.3	2 22.2	2 13.3	1 5.6	2 13.3	2 9.5	3 10.3	2 15.4	1 5.9	2 10.5
5	1 2.0	1 2.5	-	-	1 2.7	-	-	-	1 5.0	-	-	1 11.1	-	1 5.6	-	1 4.8	-	-	-	1 5.3
6	4 7.8	3 7.5	-	1 12.5	3 8.1	1 7.1	-	4 16.0	-	1 4.2	2 13.3	1 11.1	2 13.3	-	2 13.3	1 4.8	3 10.3	2 15.4	1 5.9	1 5.3
Net 7-10	46 90.2	36 90.0	3 100.0 B	7 87.5	33 89.2	13 92.9	6 100.0 H	21 84.0	19 95.0	23 95.8	13 86.7	7 77.8	13 86.7	17 94.4	13 86.7	19 90.5	26 89.7	11 84.6	16 94.1	17 89.5

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qso6 Page 49
(Continued)
DEC Free LED Detailed Participant Survey Results

How influential was your experience with the free LEDs you received from Duke Energy on your decision to purchase the additional CFLs or LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
7	9 17.6	7 17.5	-	2 25.0	6 16.2	3 21.4	1 16.7	6 24.0	2 10.0	4 16.7	1 6.7	3 33.3	2 13.3	5 27.8	-	3 14.3	6 20.7	1 7.7	3 17.6	5 26.3
8	11 21.6	9 22.5	1 33.3	1 12.5	9 24.3	2 14.3	1 16.7	5 20.0	5 25.0	4 16.7	6 40.0 L	1 11.1	4 26.7	2 11.1	5 33.3	4 19.0	7 24.1	2 15.4	4 23.5	5 26.3
9	2 3.9	2 5.0	-	-	2 5.4	-	-	1 4.0	1 5.0	-	1 6.7	1 11.1	2 13.3	-	-	-	2 6.9	-	1 5.9	1 5.3
10 - Very influential	24 47.1	18 45.0	2 66.7	4 50.0	16 43.2	8 57.1	4 66.7	9 36.0	11 55.0	15 62.5 KL	5 33.3	2 22.2	5 33.3	10 55.6	8 53.3	12 57.1	11 37.9	8 61.5 T	8 47.1	6 31.6
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.59	8.55	9.33	8.50	8.51	8.79	9.17	8.20	8.90	9.00 L	8.40	7.67	8.40	8.67	8.80	8.76	8.41	8.85	8.71	8.16

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi1 Page 50

DEC Free LED Detailed Participant Survey Results

How did you first learn you could receive free LEDs from Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Duke Energy mailing or letter	136	101	9	24	89	46	33	51	49	84	23	9	28	44	57	67	64	57	43	19
	28.2	27.7	32.1	27.6	30.5	24.6	28.0	29.3	27.1	27.6	26.1	25.7	21.2	27.3	33.7	28.0	27.1	28.6	26.5	21.3
															M					
Bill insert	72	51	5	16	47	25	17	30	24	46	13	8	11	20	38	45	27	33	22	13
	14.9	14.0	17.9	18.4	16.1	13.4	14.4	17.2	13.3	15.1	14.8	22.9	8.3	12.4	22.5	18.8	11.4	16.6	13.6	14.6
															MN	Q				
Duke Energy website	182	138	11	32	102	78	51	56	72	120	33	12	59	66	51	95	85	73	69	33
	37.8	37.9	39.3	36.8	34.9	41.7	43.2	32.2	39.8	39.5	37.5	34.3	44.7	41.0	30.2	39.7	36.0	36.7	42.6	37.1
							H						O	O						
Family, friends, word of mouth	34	27	-	7	20	14	6	14	14	19	7	3	16	10	8	10	24	16	13	4
	7.1	7.4		8.0	6.8	7.5	5.1	8.0	7.7	6.2	8.0	8.6	12.1	6.2	4.7	4.2	10.2	8.0	8.0	4.5
													NO				P			
Direct email about the program	51	40	3	8	29	22	10	22	17	30	11	3	14	21	12	19	32	16	14	18
	10.6	11.0	10.7	9.2	9.9	11.8	8.5	12.6	9.4	9.9	12.5	8.6	10.6	13.0	7.1	7.9	13.6	8.0	8.6	20.2
														O			P			RS
Or some other way? (please specify)	7	7	-	-	5	2	1	1	5	5	1	-	4	-	3	3	4	4	1	2
	1.5	1.9			1.7	1.1	0.8	0.6	2.8	1.6	1.1		3.0		1.8	1.3	1.7	2.0	0.6	2.2
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi2 Page 51

DEC Free LED Detailed Participant Survey Results

Have you ever logged into your online residential account with Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	399	299	24	74	240	157	92	145	154	252	77	30	125	132	124	188	206	155	142	79
	82.8	82.1	85.7	85.1	82.2	84.0	78.0	83.3	85.1	82.9	87.5	85.7	94.7	82.0	73.4	78.7	87.3	77.9	87.7	88.8
													NO	O			P		R	R
No	59	44	4	10	37	22	19	26	14	38	7	3	2	18	38	38	20	34	13	5
	12.2	12.1	14.3	11.5	12.7	11.8	16.1	14.9	7.7	12.5	8.0	8.6	1.5	11.2	22.5	15.9	8.5	17.1	8.0	5.6
							I	I						M	MN	Q		ST		
Don't know/Not sure	24	21	-	3	15	8	7	3	13	14	4	2	5	11	7	13	10	10	7	5
	5.0	5.8		3.4	5.1	4.3	5.9	1.7	7.2	4.6	4.5	5.7	3.8	6.8	4.1	5.4	4.2	5.0	4.3	5.6
							H		H											
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi3 Page 52

DEC Free LED Detailed Participant Survey Results

Have you ever received a notification that free LEDs were available while you were logged into your online account?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	399	299	24	74	240	157	92	145	154	252	77	30	125	132	124	188	206	155	142	79
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	282	203	19	59	157	123	64	103	111	187	52	18	98	100	72	133	147	107	107	55
	70.7	67.9	79.2	79.7	65.4	78.3	69.6	71.0	72.1	74.2	67.5	60.0	78.4	75.8	58.1	70.7	71.4	69.0	75.4	69.6
				B		E							O	O						
No	37	31	2	4	26	11	9	15	13	21	8	4	12	7	18	22	15	16	11	9
	9.3	10.4	8.3	5.4	10.8	7.0	9.8	10.3	8.4	8.3	10.4	13.3	9.6	5.3	14.5	11.7	7.3	10.3	7.7	11.4
															N					
Don't know/Not sure	80	65	3	11	57	23	19	27	30	44	17	8	15	25	34	33	44	32	24	15
	20.1	21.7	12.5	14.9	23.8	14.6	20.7	18.6	19.5	17.5	22.1	26.7	12.0	18.9	27.4	17.6	21.4	20.6	16.9	19.0
					F										M					
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi4 Page 53

DEC Free LED Detailed Participant Survey Results

Did you request free LEDs as a result of this notification?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	282	203	19	59	157	123	64	103	111	187	52	18	98	100	72	133	147	107	107	55
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	249	178	18	52	137	111	57	91	98	167	47	16	88	85	65	119	128	91	96	50
	88.3	87.7	94.7	88.1	87.3	90.2	89.1	88.3	88.3	89.3	90.4	88.9	89.8	85.0	90.3	89.5	87.1	85.0	89.7	90.9
No	17	13	-	4	10	7	4	7	6	9	3	1	6	9	2	9	8	8	7	2
	6.0	6.4		6.8	6.4	5.7	6.2	6.8	5.4	4.8	5.8	5.6	6.1	9.0	2.8	6.8	5.4	7.5	6.5	3.6
														O						
Don't know/Not sure	16	12	1	3	10	5	3	5	7	11	2	1	4	6	5	5	11	8	4	3
	5.7	5.9	5.3	5.1	6.4	4.1	4.7	4.9	6.3	5.9	3.8	5.6	4.1	6.0	6.9	3.8	7.5	7.5	3.7	5.5
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi5 Page 54

DEC Free LED Detailed Participant Survey Results

Before ordering your LEDs, did you receive any materials from Duke Energy about the cost savings on your energy bill from installing more energy efficient lighting?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	287	216	18	51	179	106	71	104	107	182	50	23	78	92	104	142	140	121	94	51
	59.5	59.3	64.3	58.6	61.3	56.7	60.2	59.8	59.1	59.9	56.8	65.7	59.1	57.1	61.5	59.4	59.3	60.8	58.0	57.3
No	68	44	5	18	31	37	17	27	24	47	12	1	29	20	18	38	29	36	22	7
	14.1	12.1	17.9	20.7	10.6	19.8	14.4	15.5	13.3	15.5	13.6	2.9	22.0	12.4	10.7	15.9	12.3	18.1	13.6	7.9
				B		E				L	L		NO					T		
Don't know/Not sure	127	104	5	18	82	44	30	43	50	75	26	11	25	49	47	59	67	42	46	31
	26.3	28.6	17.9	20.7	28.1	23.5	25.4	24.7	27.6	24.7	29.5	31.4	18.9	30.4	27.8	24.7	28.4	21.1	28.4	34.8
														M	M					R
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi6 Page 55

DEC Free LED Detailed Participant Survey Results

Did you request the free LEDs from Duke Energy as a result of what you learned from these materials?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	287	216	18	51	179	106	71	104	107	182	50	23	78	92	104	142	140	121	94	51
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	195	140	13	40	112	81	44	70	76	134	28	14	49	64	73	109	83	94	59	27
	67.9	64.8	72.2	78.4	62.6	76.4	62.0	67.3	71.0	73.6	56.0	60.9	62.8	69.6	70.2	76.8	59.3	77.7	62.8	52.9
				B		E				K						Q		ST		
No	65	53	3	9	46	19	21	25	19	33	16	7	21	22	19	24	39	20	25	18
	22.6	24.5	16.7	17.6	25.7	17.9	29.6	24.0	17.8	18.1	32.0	30.4	26.9	23.9	18.3	16.9	27.9	16.5	26.6	35.3
							I				J						P		R	R
Don't know/Not sure	27	23	2	2	21	6	6	9	12	15	6	2	8	6	12	9	18	7	10	6
	9.4	10.6	11.1	3.9	11.7	5.7	8.5	8.7	11.2	8.2	12.0	8.7	10.3	6.5	11.5	6.3	12.9	5.8	10.6	11.8
		D			F												P			
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi7 Page 56

DEC Free LED Detailed Participant Survey Results

Besides providing you free LEDs to use in your home, are you aware of any offerings from Duke Energy that can help you save energy in your home?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	237	182	15	37	156	79	56	86	88	143	45	24	55	76	92	104	128	84	88	46
	49.2	50.0	53.6	42.5	53.4	42.2	47.5	49.4	48.6	47.0	51.1	68.6	41.7	47.2	54.4	43.5	54.2	42.2	54.3	51.7
					F							JK			M		P		R	
No	213	158	12	43	120	93	55	75	82	139	36	9	65	78	65	115	96	100	63	37
	44.2	43.4	42.9	49.4	41.1	49.7	46.6	43.1	45.3	45.7	40.9	25.7	49.2	48.4	38.5	48.1	40.7	50.3	38.9	41.6
						E				L	L		O	O				S		
Don't know/Not sure	32	24	1	7	16	15	7	13	11	22	7	2	12	7	12	20	12	15	11	6
	6.6	6.6	3.6	8.0	5.5	8.0	5.9	7.5	6.1	7.2	8.0	5.7	9.1	4.3	7.1	8.4	5.1	7.5	6.8	6.7
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi8 Page 57

DEC Free LED Detailed Participant Survey Results

What offerings were you aware of?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	237	182	15	37	156	79	56	86	88	143	45	24	55	76	92	104	128	84	88	46
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Duke Energy online CFL/ LED store	116	95	4	16	83	32	30	41	42	70	23	15	28	36	44	48	66	29	55	23
	48.9	52.2	26.7	43.2	53.2	40.5	53.6	47.7	47.7	49.0	51.1	62.5	50.9	47.4	47.8	46.2	51.6	34.5	62.5	50.0
		C			F														R	R
Home energy call/home energy assessment	124	100	6	18	90	34	35	44	43	78	27	16	25	36	57	50	73	35	54	27
	52.3	54.9	40.0	48.6	57.7	43.0	62.5	51.2	48.9	54.5	60.0	66.7	45.5	47.4	62.0	48.1	57.0	41.7	61.4	58.7
					F										MN				R	R
Power manager program	64	44	4	15	43	21	20	27	17	37	12	8	15	16	31	27	37	20	29	14
	27.0	24.2	26.7	40.5	27.6	26.6	35.7	31.4	19.3	25.9	26.7	33.3	27.3	21.1	33.7	26.0	28.9	23.8	33.0	30.4
				B			I	I							N					
Appliance recycling program	80	57	7	16	53	27	26	29	23	52	17	5	14	25	39	37	42	26	36	12
	33.8	31.3	46.7	43.2	34.0	34.2	46.4	33.7	26.1	36.4	37.8	20.8	25.5	32.9	42.4	35.6	32.8	31.0	40.9	26.1
							I			L					M				T	
Online home energy report	138	110	5	22	94	43	30	54	48	90	24	12	36	45	47	57	77	41	57	26
	58.2	60.4	33.3	59.5	60.3	54.4	53.6	62.8	54.5	62.9	53.3	50.0	65.5	59.2	51.1	54.8	60.2	48.8	64.8	56.5
		C		C									O						R	
Other, specify	13	10	2	-	9	4	3	3	7	6	1	3	1	5	7	7	6	7	3	3
	5.5	5.5	13.3		5.8	5.1	5.4	3.5	8.0	4.2	2.2	12.5	1.8	6.6	7.6	6.7	4.7	8.3	3.4	6.5
															M					
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi10 Page 58

DEC Free LED Detailed Participant Survey Results

When did you find out about these offerings?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	237	182	15	37	156	79	56	86	88	143	45	24	55	76	92	104	128	84	88	46
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Before ordering free LEDs	134	106	7	18	94	39	34	46	52	75	33	13	25	46	56	63	68	46	50	27
	56.5	58.2	46.7	48.6	60.3	49.4	60.7	53.5	59.1	52.4	73.3	54.2	45.5	60.5	60.9	60.6	53.1	54.8	56.8	58.7
											J			M	M					
After ordering free LEDs	51	36	7	8	27	23	8	19	22	32	6	4	16	15	16	21	28	23	16	8
	21.5	19.8	46.7	21.6	17.3	29.1	14.3	22.1	25.0	22.4	13.3	16.7	29.1	19.7	17.4	20.2	21.9	27.4	18.2	17.4
			BD			E														
Found out about some programs before and some programs after ordering LEDs	50	39	1	10	34	16	14	19	14	34	6	7	13	15	19	20	30	14	22	10
	21.1	21.4	6.7	27.0	21.8	20.3	25.0	22.1	15.9	23.8	13.3	29.2	23.6	19.7	20.7	19.2	23.4	16.7	25.0	21.7
		C		C						K										
Both before and after	1	-	-	1	-	1	-	1	-	1	-	-	1	-	-	-	1	1	-	-
	0.4			2.7		1.3		1.2		0.7			1.8				0.8	1.2		
Don't know/Not sure	1	1	-	-	1	-	-	1	-	1	-	-	-	-	1	-	1	-	-	1
	0.4	0.5			0.6			1.2		0.7					1.1		0.8			2.2
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi11 Page 59

DEC Free LED Detailed Participant Survey Results

Did you participate in any of these offerings?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	237	182	15	37	156	79	56	86	88	143	45	24	55	76	92	104	128	84	88	46
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	76	62	4	8	58	16	15	27	30	43	15	11	13	22	36	32	40	24	29	16
	32.1	34.1	26.7	21.6	37.2	20.3	26.8	31.4	34.1	30.1	33.3	45.8	23.6	28.9	39.1	30.8	31.2	28.6	33.0	34.8
					F										M					
No	161	120	11	29	98	63	41	59	58	100	30	13	42	54	56	72	88	60	59	30
	67.9	65.9	73.3	78.4	62.8	79.7	73.2	68.6	65.9	69.9	66.7	54.2	76.4	71.1	60.9	69.2	68.8	71.4	67.0	65.2
						E							O							
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi12 Page 60

DEC Free LED Detailed Participant Survey Results

In which offering(s) did you participate?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	76	62	4	8	58	16	15	27	30	43	15	11	13	22	36	32	40	24	29	16
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Duke Energy online CFL/ LED store	23	19	2	2	17	5	4	10	8	12	5	4	3	7	11	13	8	6	8	7
	30.3	30.6	50.0	25.0	29.3	31.2	26.7	37.0	26.7	27.9	33.3	36.4	23.1	31.8	30.6	40.6	20.0	25.0	27.6	43.8
																Q				
Home energy call/home energy assessment	14	14	-	-	13	1	1	6	7	9	2	3	1	6	7	3	11	3	7	3
	18.4	22.6			22.4	6.2	6.7	22.2	23.3	20.9	13.3	27.3	7.7	27.3	19.4	9.4	27.5	12.5	24.1	18.8
					F				G								P			
Power manager program	8	8	-	-	7	1	3	2	3	2	6	-	-	3	5	4	4	-	5	3
	10.5	12.9			12.1	6.2	20.0	7.4	10.0	4.7	40.0			13.6	13.9	12.5	10.0		17.2	18.8
											J									
Appliance recycling program	4	3	1	-	3	1	2	1	1	2	2	-	-	2	2	2	2	1	2	1
	5.3	4.8	25.0		5.2	6.2	13.3	3.7	3.3	4.7	13.3			9.1	5.6	6.2	5.0	4.2	6.9	6.2
Online home energy report	36	28	1	6	25	10	11	11	11	25	6	2	9	9	15	17	17	14	14	5
	47.4	45.2	25.0	75.0	43.1	62.5	73.3	40.7	36.7	58.1	40.0	18.2	69.2	40.9	41.7	53.1	42.5	58.3	48.3	31.2
				BC			HI			L			NO					T		
Other, specify	9	8	-	-	7	2	1	3	5	3	1	3	1	3	5	2	7	3	2	3
	11.8	12.9			12.1	12.5	6.7	11.1	16.7	7.0	6.7	27.3	7.7	13.6	13.9	6.2	17.5	12.5	6.9	18.8
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qmi13 Page 61

DEC Free LED Detailed Participant Survey Results

Prior to taking this survey, were you aware that Duke Energy has an online store where customers can purchase LED bulbs at discounted prices?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	366	269	24	71	209	155	88	133	139	234	65	20	104	125	125	191	170	170	107	66
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	128	96	10	20	83	44	28	52	47	76	26	9	35	41	47	77	50	53	41	26
	35.0	35.7	41.7	28.2	39.7	28.4	31.8	39.1	33.8	32.5	40.0	45.0	33.7	32.8	37.6	40.3	29.4	31.2	38.3	39.4
					F											Q				
No	228	167	14	47	121	106	58	77	89	152	37	10	69	82	70	108	116	112	64	38
	62.3	62.1	58.3	66.2	57.9	68.4	65.9	57.9	64.0	65.0	56.9	50.0	66.3	65.6	56.0	56.5	68.2	65.9	59.8	57.6
						E											P			
Don't know/Not sure	10	6	-	4	5	5	2	4	3	6	2	1	-	2	8	6	4	5	2	2
	2.7	2.2		5.6	2.4	3.2	2.3	3.0	2.2	2.6	3.1	5.0		1.6	6.4	3.1	2.4	2.9	1.9	3.0
															N					
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs1 Page 62

DEC Free LED Detailed Participant Survey Results

From the time you requested free LEDs from Duke Energy, approximately how long did it take for you to receive your bulbs in the mail?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1 week	93	70	5	18	48	44	21	33	38	62	13	7	28	34	29	45	47	44	30	15
	19.3	19.2	17.9	20.7	16.4	23.5	17.8	19.0	21.0	20.4	14.8	20.0	21.2	21.1	17.2	18.8	19.9	22.1	18.5	16.9
						E														
2 weeks	137	103	13	20	87	48	35	50	47	95	24	6	37	46	49	80	54	61	44	24
	28.4	28.3	46.4	23.0	29.8	25.7	29.7	28.7	26.0	31.2	27.3	17.1	28.0	28.6	29.0	33.5	22.9	30.7	27.2	27.0
			BD							L						Q				
3 weeks	53	43	4	6	31	22	12	24	17	31	12	6	14	18	20	24	29	17	22	10
	11.0	11.8	14.3	6.9	10.6	11.8	10.2	13.8	9.4	10.2	13.6	17.1	10.6	11.2	11.8	10.0	12.3	8.5	13.6	11.2
4 weeks	25	18	-	7	10	15	8	7	9	19	3	1	5	8	10	13	12	13	7	3
	5.2	4.9		8.0	3.4	8.0	6.8	4.0	5.0	6.2	3.4	2.9	3.8	5.0	5.9	5.4	5.1	6.5	4.3	3.4
						E														
5 weeks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 weeks	4	3	-	1	3	1	1	2	1	2	1	-	1	1	1	2	2	1	2	1
	0.8	0.8		1.1	1.0	0.5	0.8	1.1	0.6	0.7	1.1		0.8	0.6	0.6	0.8	0.8	0.5	1.2	1.1
7 weeks	1	-	-	1	-	1	1	-	-	1	-	-	-	-	1	-	1	-	-	1
	0.2			1.1		0.5	0.8			0.3					0.6		0.4			1.1
8 weeks	2	2	-	-	1	1	1	-	1	1	1	-	1	1	-	1	1	1	1	-
	0.4	0.5			0.3	0.5	0.8		0.6	0.3	1.1		0.8	0.6		0.4	0.4	0.5	0.6	
More than 8 weeks	1	-	-	1	-	1	-	-	1	1	-	-	-	1	-	-	1	-	1	-
	0.2			1.1		0.5			0.6	0.3				0.6			0.4		0.6	
Cannot remember how long it took	166	125	6	33	112	54	39	58	67	92	34	15	46	52	59	74	89	62	55	35
	34.4	34.3	21.4	37.9	38.4	28.9	33.1	33.3	37.0	30.3	38.6	42.9	34.8	32.3	34.9	31.0	37.7	31.2	34.0	39.3
				C	F															

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs1 Page 63
(Continued)
DEC Free LED Detailed Participant Survey Results

From the time you requested free LEDs from Duke Energy, approximately how long did it take for you to receive your bulbs in the mail?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	2.16	2.14	1.95	2.33	2.12	2.23	2.28	2.11	2.12	2.16	2.28	2.05	2.07	2.16	2.18	2.12	2.22	2.07	2.25	2.19

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs2 Page 64

DEC Free LED Detailed Participant Survey Results

How satisfied were you with how long it took to receive the free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	15	12	1	2	9	6	4	5	6	7	3	1	3	6	5	7	8	6	6	3
	3.1	3.3	3.6	2.3	3.1	3.2	3.4	2.9	3.3	2.3	3.4	2.9	2.3	3.7	3.0	2.9	3.4	3.0	3.7	3.4
0 - Extremely dissatisfied	4	4	-	-	3	1	2	-	2	1	1	1	-	1	3	1	3	2	-	2
	0.8	1.1			1.0	0.5	1.7		1.1	0.3	1.1	2.9		0.6	1.8	0.4	1.3	1.0		2.2
1	2	2	-	-	1	1	-	1	1	-	1	-	-	1	1	2	-	2	-	-
	0.4	0.5			0.3	0.5		0.6	0.6		1.1			0.6	0.6	0.8		1.0		
2	3	2	-	1	2	1	-	2	1	1	1	-	1	1	-	1	2	-	3	-
	0.6	0.5		1.1	0.7	0.5		1.1	0.6	0.3	1.1		0.8	0.6		0.4	0.8		1.9	
3	3	2	-	1	1	2	-	2	1	3	-	-	1	2	-	1	2	1	1	1
	0.6	0.5		1.1	0.3	1.1		1.1	0.6	1.0			0.8	1.2		0.4	0.8	0.5	0.6	1.1
4	3	2	1	-	2	1	2	-	1	2	-	-	1	1	1	2	1	1	2	-
	0.6	0.5	3.6		0.7	0.5	1.7		0.6	0.7			0.8	0.6	0.6	0.8	0.4	0.5	1.2	
Net 5-6	41	33	2	6	29	12	4	20	14	19	13	5	14	11	12	12	28	16	12	7
	8.5	9.1	7.1	6.9	9.9	6.4	3.4	11.5	7.7	6.2	14.8	14.3	10.6	6.8	7.1	5.0	11.9	8.0	7.4	7.9
								G	G		J						P			
5	25	18	2	5	17	8	1	10	12	10	9	3	7	6	9	6	19	8	7	5
	5.2	4.9	7.1	5.7	5.8	4.3	0.8	5.7	6.6	3.3	10.2	8.6	5.3	3.7	5.3	2.5	8.1	4.0	4.3	5.6
								G	G		J						P			
6	16	15	-	1	12	4	3	10	2	9	4	2	7	5	3	6	9	8	5	2
	3.3	4.1		1.1	4.1	2.1	2.5	5.7	1.1	3.0	4.5	5.7	5.3	3.1	1.8	2.5	3.8	4.0	3.1	2.2
		D						I												
Net 7-10	426	319	25	79	254	169	110	149	161	278	72	29	115	144	152	220	200	177	144	79
	88.4	87.6	89.3	90.8	87.0	90.4	93.2	85.6	89.0	91.4	81.8	82.9	87.1	89.4	89.9	92.1	84.7	88.9	88.9	88.8
							H			K						Q				

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs2 Page 65
(Continued)
DEC Free LED Detailed Participant Survey Results

How satisfied were you with how long it took to receive the free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
7	34	21	3	9	18	16	11	15	8	25	5	1	13	6	14	16	18	14	11	5
	7.1	5.8	10.7	10.3	6.2	8.6	9.3	8.6	4.4	8.2	5.7	2.9	9.8	3.7	8.3	6.7	7.6	7.0	6.8	5.6
										L			N		N					
8	66	51	-	15	38	28	14	30	20	41	9	6	24	12	27	29	36	25	19	18
	13.7	14.0		17.2	13.0	15.0	11.9	17.2	11.0	13.5	10.2	17.1	18.2	7.5	16.0	12.1	15.3	12.6	11.7	20.2
								I					N		N					S
9	61	52	2	7	40	20	14	24	22	37	13	6	10	24	24	32	28	20	19	19
	12.7	14.3	7.1	8.0	13.7	10.7	11.9	13.8	12.2	12.2	14.8	17.1	7.6	14.9	14.2	13.4	11.9	10.1	11.7	21.3
		D												M	M					RS
10 - Extremely satisfied	265	195	20	48	158	105	71	80	111	175	45	16	68	102	87	143	118	118	95	37
	55.0	53.6	71.4	55.2	54.1	56.1	60.2	46.0	61.3	57.6	51.1	45.7	51.5	63.4	51.5	59.8	50.0	59.3	58.6	41.6
			B				H		H					MO		Q		T	T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.74	8.72	9.04	8.76	8.71	8.79	8.95	8.52	8.87	8.91	8.48	8.46	8.63	8.99	8.69	8.97	8.51	8.82	8.84	8.54
							H		H	K				M		Q				

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs3 Page 66

DEC Free LED Detailed Participant Survey Results

After you received your free LEDs from Duke Energy, how often did you contact Duke Energy or program staff with questions?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Never	462	350	26	83	279	180	113	167	174	290	84	34	128	156	159	228	227	188	158	85
	95.9	96.2	92.9	95.4	95.5	96.3	95.8	96.0	96.1	95.4	95.5	97.1	97.0	96.9	94.1	95.4	96.2	94.5	97.5	95.5
Once	15	11	2	2	11	4	3	6	5	10	3	1	4	3	7	8	7	8	3	3
	3.1	3.0	7.1	2.3	3.8	2.1	2.5	3.4	2.8	3.3	3.4	2.9	3.0	1.9	4.1	3.3	3.0	4.0	1.9	3.4
2 or 3 times	3	2	-	1	2	1	-	1	2	2	1	-	-	2	1	1	2	1	1	1
	0.6	0.5		1.1	0.7	0.5		0.6	1.1	0.7	1.1			1.2	0.6	0.4	0.8	0.5	0.6	1.1
4 times or more	1	-	-	1	-	1	1	-	-	1	-	-	-	-	1	1	-	1	-	-
	0.2			1.1		0.5	0.8			0.3					0.6	0.4		0.5		
Don't know/Not sure	1	1	-	-	-	1	1	-	-	1	-	-	-	-	1	1	-	1	-	-
	0.2	0.3				0.5	0.8			0.3					0.6	0.4		0.5		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs4 Page 67

DEC Free LED Detailed Participant Survey Results

How did you contact them?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	19	13	2	4	13	6	4	7	7	13	4	1	4	5	9	10	9	10	4	4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Phone	16	11	2	3	12	4	3	7	5	11	3	1	4	3	8	8	8	8	3	4
	84.2	84.6	100.0	75.0	92.3	66.7	75.0	100.0	71.4	84.6	75.0	100.0	100.0	60.0	88.9	80.0	88.9	80.0	75.0	100.0
								I					N							
Email or fax	3	2	-	1	1	2	1	-	2	2	1	-	-	2	1	2	1	2	1	-
	15.8	15.4		25.0	7.7	33.3	25.0		28.6	15.4	25.0			40.0	11.1	20.0	11.1	20.0	25.0	
Letter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
In person	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qs4a Page 68

DEC Free LED Detailed Participant Survey Results

Why did you contact Duke Energy?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	19 100.0	13 100.0	2 100.0	4 100.0	13 100.0	6 100.0	4 100.0	7 100.0	7 100.0	13 100.0	4 100.0	1 100.0	4 100.0	5 100.0	9 100.0	10 100.0	9 100.0	10 100.0	4 100.0	4 100.0
Bulbs were broken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Didn't like the light bulbs I received	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I received the wrong bulbs	1 5.3	1 7.7	-	-	-	1 16.7	-	-	1 14.3	1 7.7	-	-	-	1 20.0	-	1 10.0	-	1 10.0	-	-
Other, specify	17 89.5	12 92.3	1 50.0	4 100.0	12 92.3	5 83.3	3 75.0	7 100.0	6 85.7	11 84.6	4 100.0	1 100.0	4 100.0	4 80.0	8 88.9	9 90.0	8 88.9	8 80.0	4 100.0	4 100.0
Don't know/Not sure	1 5.3	-	1 50.0	-	1 7.7	-	1 25.0	-	-	1 7.7	-	-	-	-	1 11.1	-	1 11.1	1 10.0	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs5 Page 69

DEC Free LED Detailed Participant Survey Results

And how satisfied were you with your communications with Duke Energy and program staff?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	19	13	2	4	13	6	4	7	7	13	4	1	4	5	9	10	9	10	4	4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	2	1	-	1	1	1	1	-	1	1	1	-	-	-	2	1	1	1	-	1
	10.5	7.7		25.0	7.7	16.7	25.0		14.3	7.7	25.0				22.2	10.0	11.1	10.0		25.0
0 - Extremely dissatisfied	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	1	1	1	1	-	1	1	1	-	-	-	2	1	1	1	-	1
	10.5	7.7		25.0	7.7	16.7	25.0		14.3	7.7	25.0				22.2	10.0	11.1	10.0		25.0
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net 5-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net 7-10	17	12	2	3	12	5	3	7	6	12	3	1	4	5	7	9	8	9	4	3
	89.5	92.3	100.0	75.0	92.3	83.3	75.0	100.0	85.7	92.3	75.0	100.0	100.0	100.0	77.8	90.0	88.9	90.0	100.0	75.0
7	3	2	1	-	2	1	-	-	2	1	1	1	-	1	1	1	2	-	1	1
	15.8	15.4	50.0		15.4	16.7			28.6	7.7	25.0	100.0		20.0	11.1	10.0	22.2		25.0	25.0

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs5 Page 70
(Continued)
DEC Free LED Detailed Participant Survey Results

And how satisfied were you with your communications with Duke Energy and program staff?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
8	2 10.5	1 7.7	-	1 25.0	1 7.7	1 16.7	-	2 28.6	-	2 15.4	-	-	-	-	2 22.2	1 10.0	1 11.1	1 10.0	-	1 25.0
9	1 5.3	1 7.7	-	-	1 7.7	-	-	1 14.3	-	1 7.7	-	-	-	-	1 11.1	1 10.0	-	-	1 25.0	-
10 - Extremely satisfied	11 57.9	8 61.5	1 50.0	2 50.0	8 61.5	3 50.0	3 75.0	4 57.1	4 57.1	8 61.5	2 50.0	-	4 100.0 O	4 80.0 O	3 33.3	6 60.0	5 55.6	8 80.0 T	2 50.0	1 25.0
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.42	8.69	8.50	7.50	8.69	7.83	8.00	9.29	8.00	8.77	7.25	7.00	10.00 O	9.40	7.33	8.60	8.22	9.00	9.00	6.75

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs7 Page 71

DEC Free LED Detailed Participant Survey Results

Have you noticed any savings on your electric bill since installing your free LED(s)?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	460	344	28	85	276	181	115	162	175	290	85	33	125	155	162	233	220	192	153	86
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes	189	133	12	42	94	93	45	67	74	121	23	12	56	62	63	111	74	99	56	21
	41.1	38.7	42.9	49.4	34.1	51.4	39.1	41.4	42.3	41.7	27.1	36.4	44.8	40.0	38.9	47.6	33.6	51.6	36.6	24.4
				B		E				K						Q		ST	T	
No	263	206	15	41	176	86	66	91	101	164	61	20	67	91	95	119	141	88	95	65
	57.2	59.9	53.6	48.2	63.8	47.5	57.4	56.2	57.7	56.6	71.8	60.6	53.6	58.7	58.6	51.1	64.1	45.8	62.1	75.6
		D			F						J						P		R	RS
Don't know/Not sure	1	-	1	-	1	-	1	-	-	1	-	-	-	-	1	-	1	1	-	-
	0.2		3.6		0.4		0.9			0.3					0.6		0.5	0.5		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing Response	7	5	-	2	5	2	3	4	-	4	1	1	2	2	3	3	4	4	2	-
	1.5	1.5		2.4	1.8	1.1	2.6	2.5		1.4	1.2	3.0	1.6	1.3	1.9	1.3	1.8	2.1	1.3	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs8 Page 72

DEC Free LED Detailed Participant Survey Results

How satisfied are you with any savings you noticed on your electric bill since installing your free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	189	133	12	42	94	93	45	67	74	121	23	12	56	62	63	111	74	99	56	21
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	6	3	-	3	3	3	1	2	3	4	1	1	4	-	2	1	5	4	1	1
	3.2	2.3		7.1	3.2	3.2	2.2	3.0	4.1	3.3	4.3	8.3	7.1		3.2	0.9	6.8	4.0	1.8	4.8
																	P			
0 - Extremely dissatisfied	2	1	-	1	1	1	1	-	1	1	-	1	1	-	1	-	2	1	-	1
	1.1	0.8		2.4	1.1	1.1	2.2		1.4	0.8		8.3	1.8		1.6		2.7	1.0		4.8
1	1	1	-	-	1	-	-	1	-	-	1	-	-	-	1	1	-	1	-	-
	0.5	0.8			1.1			1.5			4.3				1.6	0.9		1.0		
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	-	2	1	2	-	1	2	3	-	-	3	-	-	-	3	2	1	-
	1.6	0.8		4.8	1.1	2.2		1.5	2.7	2.5			5.4				4.1	2.0	1.8	
Net 5-6	22	16	-	6	10	12	6	7	9	13	1	4	8	9	5	14	8	9	9	3
	11.6	12.0		14.3	10.6	12.9	13.3	10.4	12.2	10.7	4.3	33.3	14.3	14.5	7.9	12.6	10.8	9.1	16.1	14.3
												K								
5	12	10	-	2	7	5	3	3	6	7	1	3	4	5	3	8	4	5	6	1
	6.3	7.5		4.8	7.4	5.4	6.7	4.5	8.1	5.8	4.3	25.0	7.1	8.1	4.8	7.2	5.4	5.1	10.7	4.8
6	10	6	-	4	3	7	3	4	3	6	-	1	4	4	2	6	4	4	3	2
	5.3	4.5		9.5	3.2	7.5	6.7	6.0	4.1	5.0		8.3	7.1	6.5	3.2	5.4	5.4	4.0	5.4	9.5
Net 7-10	155	110	12	31	81	72	36	56	60	102	20	6	43	51	53	91	60	81	45	17
	82.0	82.7	100.0	73.8	86.2	77.4	80.0	83.6	81.1	84.3	87.0	50.0	76.8	82.3	84.1	82.0	81.1	81.8	80.4	81.0
			BD							L	L									

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs8 Page 73
(Continued)
DEC Free LED Detailed Participant Survey Results

How satisfied are you with any savings you noticed on your electric bill since installing your free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
7	19	10	2	7	8	11	2	7	10	11	4	-	7	7	5	12	7	8	8	2
	10.1	7.5	16.7	16.7	8.5	11.8	4.4	10.4	13.5	9.1	17.4		12.5	11.3	7.9	10.8	9.5	8.1	14.3	9.5
									G											
8	29	20	2	7	10	19	5	11	12	20	4	-	9	11	8	16	12	18	8	1
	15.3	15.0	16.7	16.7	10.6	20.4	11.1	16.4	16.2	16.5	17.4		16.1	17.7	12.7	14.4	16.2	18.2	14.3	4.8
						E												T		
9	25	20	2	2	19	6	8	11	6	14	5	2	6	5	10	12	13	12	5	5
	13.2	15.0	16.7	4.8	20.2	6.5	17.8	16.4	8.1	11.6	21.7	16.7	10.7	8.1	15.9	10.8	17.6	12.1	8.9	23.8
		D			F															
10 - Extremely satisfied	82	60	6	15	44	36	21	27	32	57	7	4	21	28	30	51	28	43	24	9
	43.4	45.1	50.0	35.7	46.8	38.7	46.7	40.3	43.2	47.1	30.4	33.3	37.5	45.2	47.6	45.9	37.8	43.4	42.9	42.9
I didn't notice any savings	6	4	-	2	-	6	2	2	2	2	1	1	1	2	3	5	1	5	1	-
	3.2	3.0		4.8		6.5	4.4	3.0	2.7	1.7	4.3	8.3	1.8	3.2	4.8	4.5	1.4	5.1	1.8	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.43	8.53	9.00	7.88	8.56	8.25	8.58	8.46	8.28	8.54	8.23	7.18	8.02	8.52	8.62	8.56	8.19	8.47	8.31	8.29
			D																	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs9 Page 74

DEC Free LED Detailed Participant Survey Results

How satisfied are you with your new free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	7	7	-	-	6	1	1	2	4	3	1	2	1	2	4	5	2	3	1	1
	1.5	1.9			2.1	0.5	0.8	1.1	2.2	1.0	1.1	5.7	0.8	1.2	2.4	2.1	0.8	1.5	0.6	1.1
0 - Extremely dissatisfied	4	4	-	-	3	1	1	-	3	1	1	1	1	1	2	2	2	3	-	1
	0.8	1.1			1.0	0.5	0.8		1.7	0.3	1.1	2.9	0.8	0.6	1.2	0.8	0.8	1.5		1.1
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	1	-	-	1	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-
	0.2	0.3			0.3			0.6		0.3					0.6	0.4				
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	2	-	-	1	1	1	-	1	-	1	1	2	-	-	1	-
	0.4	0.5			0.7			0.6	0.6	0.3		2.9		0.6	0.6	0.8			0.6	
Net 5-6	22	17	1	4	12	10	3	9	8	12	4	2	9	6	4	8	14	9	6	5
	4.6	4.7	3.6	4.6	4.1	5.3	2.5	5.2	4.4	3.9	4.5	5.7	6.8	3.7	2.4	3.3	5.9	4.5	3.7	5.6
													O							
5	12	10	1	1	6	6	3	4	4	7	1	1	3	3	4	5	7	6	3	2
	2.5	2.7	3.6	1.1	2.1	3.2	2.5	2.3	2.2	2.3	1.1	2.9	2.3	1.9	2.4	2.1	3.0	3.0	1.9	2.2
6	10	7	-	3	6	4	-	5	4	5	3	1	6	3	-	3	7	3	3	3
	2.1	1.9		3.4	2.1	2.1		2.9	2.2	1.6	3.4	2.9	4.5	1.9		1.3	3.0	1.5	1.9	3.4
Net 7-10	452	339	27	83	273	176	113	163	169	289	83	31	122	152	161	225	220	186	155	83
	93.8	93.1	96.4	95.4	93.5	94.1	95.8	93.7	93.4	95.1	94.3	88.6	92.4	94.4	95.3	94.1	93.2	93.5	95.7	93.3
7	21	12	1	8	8	13	4	7	10	14	1	-	9	7	5	9	12	12	8	1
	4.4	3.3	3.6	9.2	2.7	7.0	3.4	4.0	5.5	4.6	1.1		6.8	4.3	3.0	3.8	5.1	6.0	4.9	1.1
				B		E				K								T	T	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs9 Page 75
(Continued)
DEC Free LED Detailed Participant Survey Results

How satisfied are you with your new free LEDs?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
8	41	32	-	9	24	17	8	15	17	24	9	4	14	10	13	15	24	11	14	10
	8.5	8.8		10.3	8.2	9.1	6.8	8.6	9.4	7.9	10.2	11.4	10.6	6.2	7.7	6.3	10.2	5.5	8.6	11.2
9	66	50	3	13	38	27	14	29	21	31	22	8	13	21	27	25	40	21	21	21
	13.7	13.7	10.7	14.9	13.0	14.4	11.9	16.7	11.6	10.2	25.0	22.9	9.8	13.0	16.0	10.5	16.9	10.6	13.0	23.6
											J	J					P			RS
10 - Extremely satisfied	324	245	23	53	203	119	87	112	121	220	51	19	86	114	116	176	144	142	112	51
	67.2	67.3	82.1	60.9	69.5	63.6	73.7	64.4	66.9	72.4	58.0	54.3	65.2	70.8	68.6	73.6	61.0	71.4	69.1	57.3
			BD				H			KL						Q		T	T	
Don't know/Not sure	1	1	-	-	1	-	1	-	-	-	-	-	-	1	-	1	-	1	-	-
	0.2	0.3			0.3		0.8							0.6		0.4		0.5		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	9.23	9.21	9.61	9.17	9.26	9.17	9.43	9.23	9.13	9.34	9.20	8.83	9.11	9.34	9.28	9.33	9.12	9.24	9.35	9.15
			BD																	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs11 Page 76

DEC Free LED Detailed Participant Survey Results

Finally, how satisfied with your experience receiving free LEDs from Duke Energy are you overall?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	6	5	1	-	4	2	2	-	4	2	1	1	1	2	3	4	2	4	1	1
	1.2	1.4	3.6		1.4	1.1	1.7		2.2	0.7	1.1	2.9	0.8	1.2	1.8	1.7	0.8	2.0	0.6	1.1
0 - Extremely dissatisfied	3	3	-	-	2	1	1	-	2	-	1	1	-	1	2	1	2	2	-	1
	0.6	0.8			0.7	0.5	0.8		1.1		1.1	2.9		0.6	1.2	0.4	0.8	1.0		1.1
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	-	1	-	-	1	1	-	-	-	-	-	-	-	1	1	-	1	-	-
	0.2		3.6			0.5	0.8								0.6	0.4		0.5		
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	2	-	-	-	2	2	-	-	1	1	-	2	-	1	1	-
	0.4	0.5			0.7				1.1	0.7			0.8	0.6		0.8		0.5	0.6	
Net 5-6	8	6	1	1	3	5	-	5	2	5	-	-	3	3	1	4	4	6	1	1
	1.7	1.6	3.6	1.1	1.0	2.7		2.9	1.1	1.6			2.3	1.9	0.6	1.7	1.7	3.0	0.6	1.1
																		S		
5	3	3	-	-	-	3	-	2	1	1	-	-	2	1	-	3	-	3	-	-
	0.6	0.8				1.6		1.1	0.6	0.3			1.5	0.6		1.3		1.5		
6	5	3	1	1	3	2	-	3	1	4	-	-	1	2	1	1	4	3	1	1
	1.0	0.8	3.6	1.1	1.0	1.1		1.7	0.6	1.3			0.8	1.2	0.6	0.4	1.7	1.5	0.6	1.1
Net 7-10	468	353	26	86	285	180	116	169	175	297	87	34	128	156	165	231	230	189	160	87
	97.1	97.0	92.9	98.9	97.6	96.3	98.3	97.1	96.7	97.7	98.9	97.1	97.0	96.9	97.6	96.7	97.5	95.0	98.8	97.8
																			R	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Table qs11 Page 77
(Continued)
DEC Free LED Detailed Participant Survey Results

Finally, how satisfied with your experience receiving free LEDs from Duke Energy are you overall?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
7	16	10	-	6	7	9	2	4	9	11	2	2	5	6	4	4	12	4	8	2
	3.3	2.7		6.9	2.4	4.8	1.7	2.3	5.0	3.6	2.3	5.7	3.8	3.7	2.4	1.7	5.1	2.0	4.9	2.2
																	P			
8	35	26	-	9	22	13	6	14	14	19	6	4	17	7	8	13	21	12	11	8
	7.3	7.1		10.3	7.5	7.0	5.1	8.0	7.7	6.2	6.8	11.4	12.9	4.3	4.7	5.4	8.9	6.0	6.8	9.0
													NO							
9	64	50	2	12	42	21	12	30	20	27	21	8	15	19	23	23	39	23	17	18
	13.3	13.7	7.1	13.8	14.4	11.2	10.2	17.2	11.0	8.9	23.9	22.9	11.4	11.8	13.6	9.6	16.5	11.6	10.5	20.2
								GI			J	J					P			RS
10 - Extremely satisfied	353	267	24	59	214	137	96	121	132	240	58	20	91	124	130	191	158	150	124	59
	73.2	73.4	85.7	67.8	73.3	73.3	81.4	69.5	72.9	78.9	65.9	57.1	68.9	77.0	76.9	79.9	66.9	75.4	76.5	66.3
			BD				HI			KL						Q			T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	9.45	9.45	9.50	9.40	9.48	9.39	9.59	9.47	9.36	9.57	9.44	9.09	9.36	9.50	9.51	9.54	9.35	9.40	9.55	9.39

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs13 Page 78

DEC Free LED Detailed Participant Survey Results

Based on your overall experience with Duke Energy's service, how satisfied are you with having them as your electric company?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net 0-4	12	9	1	2	7	5	3	3	6	5	3	2	2	4	4	7	4	5	4	1
	2.5	2.5	3.6	2.3	2.4	2.7	2.5	1.7	3.3	1.6	3.4	5.7	1.5	2.5	2.4	2.9	1.7	2.5	2.5	1.1
0 - Extremely dissatisfied	3	3	-	-	2	1	-	-	3	1	1	1	-	2	1	1	2	1	1	1
	0.6	0.8			0.7	0.5			1.7	0.3	1.1	2.9		1.2	0.6	0.4	0.8	0.5	0.6	1.1
1	2	1	-	1	1	1	1	1	-	1	-	1	1	-	1	1	1	-	1	-
	0.4	0.3		1.1	0.3	0.5	0.8	0.6		0.3		2.9	0.8		0.6	0.4	0.4		0.6	
2	2	2	-	-	2	-	1	1	-	1	1	-	1	-	1	2	-	2	-	-
	0.4	0.5			0.7		0.8	0.6		0.3	1.1		0.8		0.6	0.8		1.0		
3	1	1	-	-	1	-	-	-	1	1	-	-	-	1	-	1	-	1	-	-
	0.2	0.3			0.3				0.6	0.3				0.6		0.4		0.5		
4	4	2	1	1	1	3	1	1	2	1	1	-	-	1	1	2	1	1	2	-
	0.8	0.5	3.6	1.1	0.3	1.6	0.8	0.6	1.1	0.3	1.1			0.6	0.6	0.8	0.4	0.5	1.2	
Net 5-6	37	26	1	10	18	19	11	14	11	25	5	2	16	9	10	11	26	14	12	9
	7.7	7.1	3.6	11.5	6.2	10.2	9.3	8.0	6.1	8.2	5.7	5.7	12.1	5.6	5.9	4.6	11.0	7.0	7.4	10.1
													NO				P			
5	19	10	-	9	6	13	7	7	4	13	1	1	7	2	8	5	14	9	3	5
	3.9	2.7		10.3	2.1	7.0	5.9	4.0	2.2	4.3	1.1	2.9	5.3	1.2	4.7	2.1	5.9	4.5	1.9	5.6
				B		E				K			N		N		P			
6	18	16	1	1	12	6	4	7	7	12	4	1	9	7	2	6	12	5	9	4
	3.7	4.4	3.6	1.1	4.1	3.2	3.4	4.0	3.9	3.9	4.5	2.9	6.8	4.3	1.2	2.5	5.1	2.5	5.6	4.5
		D											O	O						
Net 7-10	433	329	26	75	267	163	104	157	164	274	80	31	114	148	155	221	206	180	146	79
	89.8	90.4	92.9	86.2	91.4	87.2	88.1	90.2	90.6	90.1	90.9	88.6	86.4	91.9	91.7	92.5	87.3	90.5	90.1	88.8
																Q				

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qs13 Page 79
(Continued)
DEC Free LED Detailed Participant Survey Results

Based on your overall experience with Duke Energy's service, how satisfied are you with having them as your electric company?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
7	39	31	1	7	24	15	4	17	18	24	10	1	16	12	10	14	25	13	17	7
	8.1	8.5	3.6	8.0	8.2	8.0	3.4	9.8	9.9	7.9	11.4	2.9	12.1	7.5	5.9	5.9	10.6	6.5	10.5	7.9
								G	G		L		O				P			
8	87	71	2	14	50	37	15	34	35	53	15	10	26	37	21	33	53	28	31	22
	18.0	19.5	7.1	16.1	17.1	19.8	12.7	19.5	19.3	17.4	17.0	28.6	19.7	23.0	12.4	13.8	22.5	14.1	19.1	24.7
		C											O	O			P			R
9	83	63	4	16	49	33	17	32	31	54	17	5	26	23	28	38	43	30	30	15
	17.2	17.3	14.3	18.4	16.8	17.6	14.4	18.4	17.1	17.8	19.3	14.3	19.7	14.3	16.6	15.9	18.2	15.1	18.5	16.9
10 - Extremely satisfied	224	164	19	38	144	78	68	74	80	143	38	15	46	76	96	136	85	109	68	35
	46.5	45.1	67.9	43.7	49.3	41.7	57.6	42.5	44.2	47.0	43.2	42.9	34.8	47.2	56.8	56.9	36.0	54.8	42.0	39.3
			BD				HI							M	MN	Q		ST		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	8.68	8.66	9.25	8.52	8.78	8.51	8.87	8.64	8.61	8.73	8.61	8.40	8.38	8.73	8.93	8.96	8.40	8.85	8.61	8.53
			BD											M	M	Q				

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd1 Page 80

DEC Free LED Detailed Participant Survey Results

Which of the following best describes your home/residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Single family detached home	317	317	-	-	240	76	58	114	140	172	81	34	73	115	115	159	152	110	112	72
	65.8	87.1			82.2	40.6	49.2	65.5	77.3	56.6	92.0	97.1	55.3	71.4	68.0	66.5	64.4	55.3	69.1	80.9
					F			G	GH		J	J		M	M				R	RS
Single family attached home	47	47	-	-	30	16	21	13	12	38	5	-	14	16	16	19	28	18	15	12
	9.8	12.9			10.3	8.6	17.8	7.5	6.6	12.5	5.7		10.6	9.9	9.5	7.9	11.9	9.0	9.3	13.5
							HI			K										
Mobile home	28	-	28	-	18	10	7	14	7	19	2	1	6	7	14	23	5	22	5	-
	5.8		100.0		6.2	5.3	5.9	8.0	3.9	6.2	2.3	2.9	4.5	4.3	8.3	9.6	2.1	11.1	3.1	
								I		K						Q		S		
Apartment or condominium	87	-	-	87	3	84	32	32	21	75	-	-	38	23	24	37	50	48	30	5
	18.0			100.0	1.0	44.9	27.1	18.4	11.6	24.7			28.8	14.3	14.2	15.5	21.2	24.1	18.5	5.6
						E	HI	I					NO					T	T	
Other, specify	2	-	-	-	1	1	-	1	1	-	-	-	1	-	-	1	1	1	-	-
	0.4				0.3	0.5		0.6	0.6				0.8			0.4	0.4	0.5		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.2																			

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd1a Page 81

DEC Free LED Detailed Participant Survey Results

Is your home a factory manufactured or modular home?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	317	317	-	-	240	76	58	114	140	172	81	34	73	115	115	159	152	110	112	72
	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yes, factory manufactured or modular	19	19	-	-	10	9	1	5	13	11	2	1	8	6	4	13	6	13	3	2
	6.0	6.0			4.2	11.8	1.7	4.4	9.3	6.4	2.5	2.9	11.0	5.2	3.5	8.2	3.9	11.8	2.7	2.8
						E			G				O					ST		
No, conventionally built	296	296	-	-	229	67	57	108	127	161	78	33	65	109	110	145	146	97	109	69
	93.4	93.4			95.4	88.2	98.3	94.7	90.7	93.6	96.3	97.1	89.0	94.8	95.7	91.2	96.1	88.2	97.3	95.8
					F		I										P		R	R
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	2	2	-	-	1	-	-	1	-	-	1	-	-	-	1	1	-	-	-	1
	0.6	0.6			0.4			0.9			1.2				0.9	0.6				1.4

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd1b Page 82

DEC Free LED Detailed Participant Survey Results

How many housing units/apartments are in your building?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	87 100.0	-	-	87 100.0	3 100.0	84 100.0	32 100.0	32 100.0	21 100.0	75 100.0	-	-	38 100.0	23 100.0	24 100.0	37 100.0	50 100.0	48 100.0	30 100.0	5 100.0
1	1 1.1	-	-	1 1.1	-	1 1.2	-	1 3.1	-	1 1.3	-	-	-	-	1 4.2	1 2.7	-	1 2.1	-	-
2-3	6 6.9	-	-	6 6.9	-	6 7.1	2 6.2	3 9.4	1 4.8	4 5.3	-	-	2 5.3	1 4.3	3 12.5	3 8.1	3 6.0	4 8.3	1 3.3	-
4-9	31 35.6	-	-	31 35.6	2 66.7	29 34.5	14 43.8 H	6 18.8	10 47.6 H	26 34.7	-	-	13 34.2	9 39.1	8 33.3	17 45.9 Q	14 28.0	17 35.4	11 36.7	2 40.0
10 or more	44 50.6	-	-	44 50.6	1 33.3	43 51.2	15 46.9	21 65.6 I	8 38.1	41 54.7	-	-	21 55.3	12 52.2	11 45.8	14 37.8	30 60.0 P	23 47.9	17 56.7	3 60.0
Don't know/Not sure	5 5.7	-	-	5 5.7	-	5 6.0	1 3.1	1 3.1	2 9.5	3 4.0	-	-	2 5.3	1 4.3	1 4.2	2 5.4	3 6.0	3 6.2	1 3.3	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd2 Page 83

DEC Free LED Detailed Participant Survey Results

Do you own or rent this residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Own	292	270	18	3	292	-	61	115	111	160	79	33	56	95	126	130	158	85	108	75
	60.6	74.2	64.3	3.4	100.0		51.7	66.1	61.3	52.6	89.8	94.3	42.4	59.0	74.6	54.4	66.9	42.7	66.7	84.3
		D	D					G	G		J	J		M	MN		P		R	RS
Rent	187	92	10	84	-	187	56	59	70	143	9	2	76	66	42	109	77	113	54	14
	38.8	25.3	35.7	96.6		100.0	47.5	33.9	38.7	47.0	10.2	5.7	57.6	41.0	24.9	45.6	32.6	56.8	33.3	15.7
				BC			H			KL			NO	O		Q		ST	T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	3	2	-	-	-	-	1	-	-	1	-	-	-	-	1	-	1	1	-	-
	0.6	0.5					0.8			0.3					0.6		0.4	0.5		

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd2a Page 84

DEC Free LED Detailed Participant Survey Results

Do you pay your own electric bill or is it included in your rent?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	187	92	10	84	-	187	56	59	70	143	9	2	76	66	42	109	77	113	54	14
	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Pay bill	186	91	10	84	-	186	56	59	69	142	9	2	76	66	41	108	77	112	54	14
	99.5	98.9	100.0	100.0		99.5	100.0	100.0	98.6	99.3	100.0	100.0	100.0	100.0	97.6	99.1	100.0	99.1	100.0	100.0
Included in rent	1	1	-	-	-	1	-	-	1	1	-	-	-	-	1	1	-	1	-	-
	0.5	1.1				0.5			1.4	0.7					2.4	0.9		0.9		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd3 Page 85

DEC Free LED Detailed Participant Survey Results

How long have you lived in this residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 1 year	219	155	10	53	115	104	59	79	77	143	41	12	83	73	56	101	116	101	63	41
	45.4	42.6	35.7	60.9	39.4	55.6	50.0	45.4	42.5	47.0	46.6	34.3	62.9	45.3	33.1	42.3	49.2	50.8	38.9	46.1
				BC		E							NO	O				S		
1-3 years	140	106	5	29	71	68	27	54	58	93	19	11	42	53	40	72	66	51	60	23
	29.0	29.1	17.9	33.3	24.3	36.4	22.9	31.0	32.0	30.6	21.6	31.4	31.8	32.9	23.7	30.1	28.0	25.6	37.0	25.8
				C		E			G	K				O					RT	
4-10 years	42	34	3	5	35	7	5	14	22	28	8	3	6	17	17	17	24	13	16	8
	8.7	9.3	10.7	5.7	12.0	3.7	4.2	8.0	12.2	9.2	9.1	8.6	4.5	10.6	10.1	7.1	10.2	6.5	9.9	9.0
					F				G					M	M					
11-20 years	37	32	4	-	31	5	13	9	15	16	13	4	1	10	22	17	19	11	14	9
	7.7	8.8	14.3		10.6	2.7	11.0	5.2	8.3	5.3	14.8	11.4	0.8	6.2	13.0	7.1	8.1	5.5	8.6	10.1
					F		H				J			M	MN					
More than 20 years	42	36	6	-	39	3	14	18	8	24	7	4	-	8	33	32	10	23	9	7
	8.7	9.9	21.4		13.4	1.6	11.9	10.3	4.4	7.9	8.0	11.4		5.0	19.5	13.4	4.2	11.6	5.6	7.9
					F		I	I							N	Q		S		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	2	1	-	-	1	-	-	-	1	-	-	1	-	-	1	-	1	-	-	1
	0.4	0.3			0.3				0.6			2.9			0.6		0.4			1.1

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd4 Page 86

DEC Free LED Detailed Participant Survey Results

Including yourself, how many people currently live in your residence year-round?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	118	79	7	32	61	56	118	-	-	91	12	2	24	32	59	64	53	66	35	14
	24.5	21.7	25.0	36.8	20.9	29.9	100.0			29.9	13.6	5.7	18.2	19.9	34.9	26.8	22.5	33.2	21.6	15.7
				B		E				KL					MN			ST		
2	174	127	14	32	115	59	-	174	-	109	35	13	56	35	76	84	89	64	57	38
	36.1	34.9	50.0	36.8	39.4	31.6		100.0		35.9	39.8	37.1	42.4	21.7	45.0	35.1	37.7	32.2	35.2	42.7
					F								N		N					R
3	75	59	3	12	40	35	-	-	75	45	12	8	25	26	23	39	36	33	25	13
	15.6	16.2	10.7	13.8	13.7	18.7			41.4	14.8	13.6	22.9	18.9	16.1	13.6	16.3	15.3	16.6	15.4	14.6
4	70	60	2	8	50	20	-	-	70	34	19	9	18	47	5	27	43	19	35	14
	14.5	16.5	7.1	9.2	17.1	10.7			38.7	11.2	21.6	25.7	13.6	29.2	3.0	11.3	18.2	9.5	21.6	15.7
		CD			F						J	J	O	MO			P		R	
5 or more	36	33	2	1	21	15	-	-	36	19	10	3	9	20	5	24	11	16	9	10
	7.5	9.1	7.1	1.1	7.2	8.0			19.9	6.2	11.4	8.6	6.8	12.4	3.0	10.0	4.7	8.0	5.6	11.2
		D												MO		Q				
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	9	6	-	2	5	2	-	-	-	6	-	-	-	1	1	1	4	1	1	-
	1.9	1.6		2.3	1.7	1.1				2.0				0.6	0.6	0.4	1.7	0.5	0.6	
Mean	2.47	2.59	2.29	1.99	2.52	2.39	1.00	2.00	3.88	2.29	2.86	2.94	2.51	3.00	1.93	2.48	2.44	2.31	2.57	2.66
		D							GH		J	J	O	MO					R	R

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd5 Page 87

DEC Free LED Detailed Participant Survey Results

How many people under the age of 18 live in your residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0	317	232	19	65	195	121	118	156	42	210	53	22	87	70	151	158	158	138	103	58
	65.8	63.7	67.9	74.7	66.8	64.7	100.0	89.7	23.2	69.1	60.2	62.9	65.9	43.5	89.3	66.1	66.9	69.3	63.6	65.2
				B			HI	I					N		MN					
1	49	37	2	9	27	22	-	10	39	27	10	5	14	24	9	26	23	20	18	9
	10.2	10.2	7.1	10.3	9.2	11.8		5.7	21.5	8.9	11.4	14.3	10.6	14.9	5.3	10.9	9.7	10.1	11.1	10.1
									H				O	O						
2	69	58	2	9	42	27	-	-	69	39	17	6	18	46	3	30	38	27	26	13
	14.3	15.9	7.1	10.3	14.4	14.4			38.1	12.8	19.3	17.1	13.6	28.6	1.8	12.6	16.1	13.6	16.0	14.6
		C											O	MO						
3	20	17	2	1	14	6	-	-	20	10	5	1	10	10	-	12	8	8	6	6
	4.1	4.7	7.1	1.1	4.8	3.2			11.0	3.3	5.7	2.9	7.6	6.2		5.0	3.4	4.0	3.7	6.7
		D																		
4	7	6	1	-	3	4	-	-	7	5	2	-	1	5	1	5	2	2	4	1
	1.5	1.6	3.6		1.0	2.1			3.9	1.6	2.3		0.8	3.1	0.6	2.1	0.8	1.0	2.5	1.1
														O						
5 or more	2	2	-	-	1	1	-	-	2	-	1	1	-	1	1	1	1	1	-	1
	0.4	0.5			0.3	0.5			1.1		1.1	2.9		0.6	0.6	0.4	0.4	0.5		1.1
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	18	12	2	3	10	6	-	8	2	13	-	-	2	5	4	7	6	3	5	1
	3.7	3.3	7.1	3.4	3.4	3.2		4.6	1.1	4.3			1.5	3.1	2.4	2.9	2.5	1.5	3.1	1.1
								I												

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd5 Page 88
(Continued)
DEC Free LED Detailed Participant Survey Results

How many people under the age of 18 live in your residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Mean	0.60	0.66	0.62	0.36	0.59	0.64	0.00	0.06	1.52	0.53	0.82	0.59	0.65	1.10	0.12	0.63	0.57	0.57	0.66	0.66
		D						G	GH		J		O	MO						

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd6 Page 89

DEC Free LED Detailed Participant Survey Results

Approximately when was your residence first built?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Before 1950	42	34	-	8	25	17	11	14	15	28	6	2	9	15	18	14	28	21	14	5
	8.7	9.3		9.2	8.6	9.1	9.3	8.0	8.3	9.2	6.8	5.7	6.8	9.3	10.7	5.9	11.9	10.6	8.6	5.6
																	P			
1950-1959	30	28	-	2	17	13	9	13	8	19	4	2	7	11	12	19	11	15	9	5
	6.2	7.7		2.3	5.8	7.0	7.6	7.5	4.4	6.2	4.5	5.7	5.3	6.8	7.1	7.9	4.7	7.5	5.6	5.6
		D																		
1960-1969	25	24	1	-	20	5	5	9	11	13	7	1	4	7	13	17	7	10	11	2
	5.2	6.6	3.6		6.8	2.7	4.2	5.2	6.1	4.3	8.0	2.9	3.0	4.3	7.7	7.1	3.0	5.0	6.8	2.2
					F										M	Q			T	
1970-1979	38	34	2	2	31	7	11	13	14	29	7	1	9	13	15	21	17	13	13	9
	7.9	9.3	7.1	2.3	10.6	3.7	9.3	7.5	7.7	9.5	8.0	2.9	6.8	8.1	8.9	8.8	7.2	6.5	8.0	10.1
		D			F					L										
1980-1989	66	54	5	7	45	21	11	26	27	47	11	6	20	18	26	32	34	22	25	15
	13.7	14.8	17.9	8.0	15.4	11.2	9.3	14.9	14.9	15.5	12.5	17.1	15.2	11.2	15.4	13.4	14.4	11.1	15.4	16.9
		D																		
1990-1999	60	45	11	4	46	14	17	19	24	41	13	4	18	16	26	34	25	30	20	8
	12.4	12.4	39.3	4.6	15.8	7.5	14.4	10.9	13.3	13.5	14.8	11.4	13.6	9.9	15.4	14.2	10.6	15.1	12.3	9.0
		D	BD		F															
2000-2005	41	27	6	8	27	12	8	15	16	23	10	3	7	20	9	17	22	15	11	10
	8.5	7.4	21.4	9.2	9.2	6.4	6.8	8.6	8.8	7.6	11.4	8.6	5.3	12.4	5.3	7.1	9.3	7.5	6.8	11.2
			B											MO						
2006-2009	39	31	-	8	24	15	12	14	13	25	10	3	11	13	12	16	22	9	19	9
	8.1	8.5		9.2	8.2	8.0	10.2	8.0	7.2	8.2	11.4	8.6	8.3	8.1	7.1	6.7	9.3	4.5	11.7	10.1
																			R	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd6 Page 90
(Continued)
DEC Free LED Detailed Participant Survey Results

Approximately when was your residence first built?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
2010 or later	63 13.1	58 15.9 D	-	5 5.7	52 17.8 F	11 5.9	12 10.2	25 14.4	25 13.8	27 8.9	20 22.7 J	13 37.1 J	17 12.9	22 13.7	20 11.8	22 9.2	40 16.9 P	12 6.0	24 14.8 R	21 23.6 RS
Don't know/Not sure	77 16.0	29 8.0	3 10.7	43 49.4 BC	5 1.7	72 38.5 E	22 18.6	26 14.9	28 15.5	52 17.1	-	-	30 22.7 O	26 16.1	18 10.7	47 19.7 Q	30 12.7	52 26.1 ST	16 9.9	5 5.6
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	1 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd7 Page 91

DEC Free LED Detailed Participant Survey Results

Approximately how many square feet is your residence?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 1,001 sqft	45	15	6	24	11	34	24	15	5	45	-	-	15	14	16	19	26	26	15	3
	9.3	4.1	21.4	27.6	3.8	18.2	20.3	8.6	2.8	14.8			11.4	8.7	9.5	7.9	11.0	13.1	9.3	3.4
			B	B		E	HI	I										T	T	
Between 1,001 and 2,000 sqft	189	161	7	21	136	52	44	77	65	189	-	-	60	59	67	97	91	68	83	29
	39.2	44.2	25.0	24.1	46.6	27.8	37.3	44.3	35.9	62.2			45.5	36.6	39.6	40.6	38.6	34.2	51.2	32.6
		CD			F														RT	
Between 2,001 and 3,000 sqft	82	81	1	-	77	5	12	34	36	-	82	-	12	34	33	29	52	10	36	32
	17.0	22.3	3.6		26.4	2.7	10.2	19.5	19.9		93.2		9.1	21.1	19.5	12.1	22.0	5.0	22.2	36.0
		C			F			G	G					M	M		P		R	RS
Between 3,001 and 4,000 sqft	24	24	-	-	23	1	1	10	13	-	-	24	1	9	11	6	18	1	5	16
	5.0	6.6			7.9	0.5	0.8	5.7	7.2			68.6	0.8	5.6	6.5	2.5	7.6	0.5	3.1	18.0
					F			G	G					M	M		P		R	RS
Between 4,001 and 5,000 sqft	4	4	-	-	4	-	-	1	3	-	-	4	-	2	2	-	4	1	-	2
	0.8	1.1			1.4			0.6	1.7			11.4		1.2	1.2		1.7	0.5		2.2
Greater than 5,000 sqft	2	2	-	-	2	-	-	-	2	-	-	2	-	1	1	-	2	-	-	2
	0.4	0.5			0.7				1.1			5.7		0.6	0.6		0.8			2.2
Don't know/Not sure	131	73	14	42	37	94	36	37	56	70	6	5	43	41	39	88	41	91	23	5
	27.2	20.1	50.0	48.3	12.7	50.3	30.5	21.3	30.9	23.0	6.8	14.3	32.6	25.5	23.1	36.8	17.4	45.7	14.2	5.6
			B	B		E	H		H	K			O			Q		ST	T	
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	5	4	-	-	2	1	1	-	1	-	-	-	1	1	-	-	2	2	-	-
	1.0	1.1			0.7	0.5	0.8		0.6				0.8	0.6			0.8	1.0		

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd8 Page 92

DEC Free LED Detailed Participant Survey Results

Would you estimate the square footage of your residence to be...

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	131	73	14	42	37	94	36	37	56	70	6	5	43	41	39	88	41	91	23	5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 1,000 sq. ft.	21	9	3	9	3	18	9	3	8	21	-	-	10	6	5	17	4	16	5	-
	16.0	12.3	21.4	21.4	8.1	19.1	25.0	8.1	14.3	30.0			23.3	14.6	12.8	19.3	9.8	17.6	21.7	
						E	H													
Between 1,001 and 2,000 sq. ft.	49	25	3	21	10	39	14	14	20	49	-	-	16	16	15	32	17	33	10	2
	37.4	34.2	21.4	50.0	27.0	41.5	38.9	37.8	35.7	70.0			37.2	39.0	38.5	36.4	41.5	36.3	43.5	40.0
				BC																
Between 2,001 and 3,000 sq. ft.	6	5	1	-	2	4	-	1	5	-	6	-	-	5	-	3	2	2	3	-
	4.6	6.8	7.1		5.4	4.3		2.7	8.9		100.0			12.2		3.4	4.9	2.2	13.0	
Between 3,001 and 4,000 sq. ft.	5	4	1	-	4	1	1	2	2	-	-	5	-	1	4	2	3	2	-	2
	3.8	5.5	7.1		10.8	1.1	2.8	5.4	3.6			100.0		2.4	10.3	2.3	7.3	2.2		40.0
					F															R
Between 4,001 and 5,000 sq. ft.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater than 5,000 sq. ft.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Don't know/Not sure	50	30	6	12	18	32	12	17	21	-	-	-	17	13	15	34	15	38	5	1
	38.2	41.1	42.9	28.6	48.6	34.0	33.3	45.9	37.5				39.5	31.7	38.5	38.6	36.6	41.8	21.7	20.0
																		S		
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd9 Page 93

DEC Free LED Detailed Participant Survey Results

In what year were you born?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Before 1950	55	45	5	5	44	10	23	25	6	29	13	6	-	-	55	34	20	29	13	7
	11.4	12.4	17.9	5.7	15.1	5.3	19.5	14.4	3.3	9.5	14.8	17.1			32.5	14.2	8.5	14.6	8.0	7.9
		D			F		I	I								Q		ST		
1950-1959	89	65	9	15	63	26	28	42	19	55	17	9	-	-	89	57	32	42	24	20
	18.5	17.9	32.1	17.2	21.6	13.9	23.7	24.1	10.5	18.1	19.3	25.7			52.7	23.8	13.6	21.1	14.8	22.5
					F		I	I								Q				
1960-1969	73	59	2	12	49	24	18	26	28	44	16	7	-	48	25	40	33	24	25	18
	15.1	16.2	7.1	13.8	16.8	12.8	15.3	14.9	15.5	14.5	18.2	20.0		29.8	14.8	16.7	14.0	12.1	15.4	20.2
		C												O						R
1970-1979	85	69	4	12	45	40	15	14	56	51	19	8	-	85	-	37	48	28	36	18
	17.6	19.0	14.3	13.8	15.4	21.4	12.7	8.0	30.9	16.8	21.6	22.9		52.8		15.5	20.3	14.1	22.2	20.2
									GH										R	
1980-1989	111	83	6	21	64	47	18	41	52	83	18	2	83	28	-	48	63	44	44	23
	23.0	22.8	21.4	24.1	21.9	25.1	15.3	23.6	28.7	27.3	20.5	5.7	62.9	17.4		20.1	26.7	22.1	27.2	25.8
								G	G	L	L		N				P			
1990 or later	49	28	1	20	12	37	13	19	17	37	1	-	49	-	-	18	31	30	17	1
	10.2	7.7	3.6	23.0	4.1	19.8	11.0	10.9	9.4	12.2	1.1		37.1			7.5	13.1	15.1	10.5	1.1
				BC		E				K							P	T	T	
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	20	15	1	2	15	3	3	7	3	5	4	3	-	-	-	5	9	2	3	2
	4.1	4.1	3.6	2.3	5.1	1.6	2.5	4.0	1.7	1.6	4.5	8.6				2.1	3.8	1.0	1.9	2.2
					F															

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd10 Page 94

DEC Free LED Detailed Participant Survey Results

What is your highest level of education?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than a high school degree	13	10	1	2	6	7	5	3	5	8	-	-	1	5	7	13	-	12	1	-
	2.7	2.7	3.6	2.3	2.1	3.7	4.2	1.7	2.8	2.6			0.8	3.1	4.1	5.4		6.0	0.6	
															M			S		
High school degree	64	39	9	15	26	38	15	29	20	40	7	1	18	16	30	64	-	49	10	3
	13.3	10.7	32.1	17.2	8.9	20.3	12.7	16.7	11.0	13.2	8.0	2.9	13.6	9.9	17.8	26.8		24.6	6.2	3.4
			B			E				L					N			ST		
Technical/trade school program	37	27	5	5	20	17	9	14	14	30	6	1	6	17	14	37	-	20	14	3
	7.7	7.4	17.9	5.7	6.8	9.1	7.6	8.0	7.7	9.9	6.8	2.9	4.5	10.6	8.3	15.5		10.1	8.6	3.4
										L				M				T	T	
Associates degree or some college	125	102	8	15	78	47	35	38	51	87	19	6	28	36	56	125	-	61	41	13
	25.9	28.0	28.6	17.2	26.7	25.1	29.7	21.8	28.2	28.6	21.6	17.1	21.2	22.4	33.1	52.3		30.7	25.3	14.6
		D								L					MN			T	T	
Bachelor's degree	130	104	2	23	95	34	31	49	48	77	27	15	50	42	35	-	130	37	51	37
	27.0	28.6	7.1	26.4	32.5	18.2	26.3	28.2	26.5	25.3	30.7	42.9	37.9	26.1	20.7		55.1	18.6	31.5	41.6
		C		C	F							J	NO						R	R
Graduate / professional degree, e.g., J.D., MBA, MD, Ph.D.	106	76	3	27	63	43	22	40	42	61	27	12	29	45	26	-	106	20	44	33
	22.0	20.9	10.7	31.0	21.6	23.0	18.6	23.0	23.2	20.1	30.7	34.3	22.0	28.0	15.4		44.9	10.1	27.2	37.1
				BC							J	J		O					R	R
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	7	6	-	-	4	1	1	1	1	1	2	-	-	-	1	-	-	-	1	-
	1.5	1.6			1.4	0.5	0.8	0.6	0.6	0.3	2.3				0.6				0.6	

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd11 Page 95

DEC Free LED Detailed Participant Survey Results

What best describes your current employment status?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Employed full-time	306	231	12	62	182	124	63	109	131	202	57	20	111	130	57	130	176	96	127	67
	63.5	63.5	42.9	71.3	62.3	66.3	53.4	62.6	72.4	66.4	64.8	57.1	84.1	80.7	33.7	54.4	74.6	48.2	78.4	75.3
		C		C					GH				O	O			P		R	R
Employed part-time	35	21	4	9	17	18	11	14	10	23	4	2	6	11	16	21	14	26	4	4
	7.3	5.8	14.3	10.3	5.8	9.6	9.3	8.0	5.5	7.6	4.5	5.7	4.5	6.8	9.5	8.8	5.9	13.1	2.5	4.5
															M			ST		
Retired	92	75	10	7	71	20	31	46	13	48	22	11	-	6	82	60	31	47	22	15
	19.1	20.6	35.7	8.0	24.3	10.7	26.3	26.4	7.2	15.8	25.0	31.4		3.7	48.5	25.1	13.1	23.6	13.6	16.9
		D	D		F		I	I			J	J			N	Q		S		
Not employed, but actively looking	15	11	-	4	6	9	4	3	8	9	2	1	4	5	6	8	7	11	2	2
	3.1	3.0		4.6	2.1	4.8	3.4	1.7	4.4	3.0	2.3	2.9	3.0	3.1	3.6	3.3	3.0	5.5	1.2	2.2
																		S		
Not employed, and not looking	27	21	1	5	12	15	8	1	18	20	2	1	11	9	7	20	7	19	7	1
	5.6	5.8	3.6	5.7	4.1	8.0	6.8	0.6	9.9	6.6	2.3	2.9	8.3	5.6	4.1	8.4	3.0	9.5	4.3	1.1
						E	H		H	K						Q		ST		
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missing response	7	5	1	-	4	1	1	1	1	2	1	-	-	-	1	-	1	-	-	-
	1.5	1.4	3.6		1.4	0.5	0.8	0.6	0.6	0.7	1.1				0.6		0.4			

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix C. Detailed Survey Results

Table qd12 Page 96

DEC Free LED Detailed Participant Survey Results

Which category best represents your total annual pre-tax household income in <Last Whole Year>?

	Total	Housing Type			Housing Ownership Status		Number of Individuals in Residence			House Size (sqft)			Age			Education		Income		
		SF	Mobile	MF	Own	Rent	One	Two	Three +	<2,001	2,001-3,000	>3,000	<35	35-54	55+	<Coll	Coll+	<50K	50K-100K	100K+
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
Total	482	364	28	87	292	187	118	174	181	304	88	35	132	161	169	239	236	199	162	89
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
less than $25,000	79	49	7	22	25	54	33	20	26	54	4	2	24	19	36	60	19	79	-	-
	16.4	13.5	25.0	25.3	8.6	28.9	28.0	11.5	14.4	17.8	4.5	5.7	18.2	11.8	21.3	25.1	8.1	39.7		
				B		E	HI			KL					N	Q				
$25,000 to just under $50,000	120	79	15	26	60	59	33	44	42	89	8	2	40	34	44	82	38	120	-	-
	24.9	21.7	53.6	29.9	20.5	31.6	28.0	25.3	23.2	29.3	9.1	5.7	30.3	21.1	26.0	34.3	16.1	60.3		
			BD			E				KL			N			Q				
$50,000 to just under $75,000	97	73	5	19	66	31	26	27	44	72	20	2	31	38	28	44	53	-	97	-
	20.1	20.1	17.9	21.8	22.6	16.6	22.0	15.5	24.3	23.7	22.7	5.7	23.5	23.6	16.6	18.4	22.5		59.9	
					F				H	L	L									
$75,000 to just under $100,000	65	54	-	11	42	23	9	30	25	41	19	3	19	29	14	22	42	-	65	-
	13.5	14.8		12.6	14.4	12.3	7.6	17.2	13.8	13.5	21.6	8.6	14.4	18.0	8.3	9.2	17.8		40.1	
								G	G		JL			O			P			
$100,000 to just under $150,000	50	48	-	2	42	8	8	25	17	21	16	12	14	12	22	13	37	-	-	50
	10.4	13.2		2.3	14.4	4.3	6.8	14.4	9.4	6.9	18.2	34.3	10.6	7.5	13.0	5.4	15.7			56.2
		D			F			G			J	JK			N		P			
$150,000 or more	39	36	-	3	33	6	6	13	20	13	16	10	3	24	12	6	33	-	-	39
	8.1	9.9		3.4	11.3	3.2	5.1	7.5	11.0	4.3	18.2	28.6	2.3	14.9	7.1	2.5	14.0			43.8
		D			F				G		J	J		MO	M		P			
Don't know/Not sure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	2	2	-	-	1	1	-	2	-	1	-	-	-	-	2	2	-	-	-	-
	0.4	0.5			0.3	0.5		1.1		0.3					1.2	0.8				
Missing response	30	23	1	4	23	5	3	13	7	13	5	4	1	5	11	10	14	-	-	-
	6.2	6.3	3.6	4.6	7.9	2.7	2.5	7.5	3.9	4.3	5.7	11.4	0.8	3.1	6.5	4.2	5.9			
					F			G							M					

Comparison Groups: BCD/EF/GHI/JKL/MNO/PQ/RST
T-Test for Means, Z-Test for Percentages
Uppercase letters indicate significance at the 90% level.

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Appendix D. Participant Survey Instrument

Duke Energy Ohio & Duke Energy Carolinas

DEC Free LED Program and DEO Residential LED Program

Participant Survey

FINAL

February 14, 2017

Background

The main goals of the survey are to estimate the first-year in-service rate, free-ridership and participant spillover. Additionally, this survey collects data to support an assessment of program processes.

We will administer the survey on a rolling basis online and via phone. We will offer participants monetary incentives in the form of cash prize drawings to further improve survey response rate.

Introduction

[FOR INBOUND PHONE SURVEY]

Thank you for calling to complete the survey. My name is <NAME>. This survey is about the free LED bulbs you received from Duke Energy. We are trying to better understand your experience with the bulbs that Duke Energy provided, and your feedback will help Duke Energy better tailor its offerings. All of your responses are confidential.

[FOR WEB SURVEY]

Thank you for taking the time to complete this survey. This survey is about the free LED bulbs you received from Duke Energy. We are trying to better understand your experience with the bulbs that Duke Energy provided, and your feedback will help Duke Energy better tailor its offerings.

[FOR BOTH]

The survey will take about 10 minutes to complete. Your participation is very important, and as a token of appreciation, once you complete the survey, you will be entered into a drawing to win one of two $100 Visa gift cards. You will be one of <COMPLETES> customers eligible to win.

[FOR INBOUND PHONE SURVEY]

For quality control purposes this call may be monitored or recorded.

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Screening

I3. Are you the person who is most knowledgeable about the [IF DUP=0: free LED bulb kit] [IF DUP>0: free LED bulb kits] your household received from Duke Energy?
1. Yes
2. No [FOR INBOUND PHONE SURVEY: ASK TO SPEAK WITH THE DECISION MAKER]

[ASK FOR INBOUND PHONE SURVEY]

C1. Are you currently talking to me on a regular landline phone or a cell phone?
1. Regular landline phone
2. Cell phone
8. (Don’t know)
9. (Refused)

[ASK IF C1=2]
CI2. Are you currently in a place where you can talk safely and answer my questions?
1. Yes
2. No [SCHEDULE CALL BACK]
8. (Don’t know) [SCHEDULE CALL BACK]
9. (Refused) [TERMINATE]

[ASK FOR WEB SURVEY ONLY]
[ASK IF I3=2]
INT81. For the purposes of this survey, we are looking to gather feedback from the person most knowledgeable about the [IF DUP=0: free LED bulb kit] [IF DUP>0: free LED bulb kits] your household received from Duke Energy. Please have that person complete the survey using the same five-digit PIN that was provided in the survey invitation letter. [TERMINATE]

Participation Verification

IV1. [READ IF <MULTIORD>=1: Our records indicate that you have placed multiple orders for free LED bulbs. For the purposes of this survey, we will focus just on your most recent order.] Our records indicate that in <MONTH> of <YEAR>, you received [IF DUP=0: a free LED bulb kit] [IF DUP>0: free LED bulb kits] with <LED_QTY> LED light bulbs from Duke Energy. Is that correct?
1. (Yes, both quantity and date are correct) [SHOW FOR WEB SURVEY]
2. (No, quantity is correct but the date is wrong) [SHOW FOR WEB SURVEY]
3. (No, date is correct, but quantity is wrong) [SHOW FOR WEB SURVEY]
4. (No, both quantity and date are wrong) [SHOW FOR WEB SURVEY]
5. (No, I did not receive any LEDs from Duke Energy) [TERMINATE]
8. (Don’t know) [TERMINATE]
9. (Refused) [TERMINATE]

[ASK IF IV1=3,4]
IV1B. How many LEDs did you receive from Duke Energy?
00. (Open-end, [ALLOW RESPONSES OF 1-97, SHOW FOR WEB SURVEY]
98. (Don’t know) [TERMINATE]
99. (Refused) [TERMINATE]

[CALCULATE RECEIVED QUANTITY=IV1B IF IV1=3,4, ELSE=<LED_QTY>]

[ASK IF IV1=2,4]
IV1C_MO. When did you receive your LED kit(s)? [[FOR WEB SURVEY: Please provide the month and the year.]
01. January
02. February
03. March
04. April
05. May
06. June
07. July
08. August
09. September
10. October
11. November
12. December
98. (Don't know)
99. (Refused)

IV1C_YR. [FOR WEB: Please enter the year in which you received your free LED kit(s).] [RECORD YEAR; 9998= DK; 9999=REF]

Lighting Awareness and Purchase Behaviors

[ASK FOR INBOUND PHONE SURVEY ONLY]
Duke Energy is interested in learning more about the types of light bulbs that their customers use. I would like to learn about your experience with different types of light bulbs. After I describe each type of light bulb, please tell me if you have used or heard of this type light bulb before.

[ASK FOR INBOUND PHONE SURVEY ONLY]
B1P
A. An incandescent bulb is a traditional light bulb that has been available for 100 years. Would you say you... (IF NEEDED: For many years, this was the most common household lightbulb. This bulb may also be known as the Edison bulb.)
1. Have used or currently use this type of light bulb
2. Have heard of this type of light bulb but have never used it
3. Have not heard of this type of light bulb before today
8. (Don't know)
9. (Refused)

B. A halogen bulb looks similar to an incandescent light bulb. The exterior of a halogen bulb looks like an incandescent bulb but the interior contains a little capsule that produces the light.
1. Have used or currently use this type of light bulb
2. Have heard of this type of light bulb but have never used it
3. Have not heard of this type of light bulb before today
8. (Don't know)
9. (Refused)

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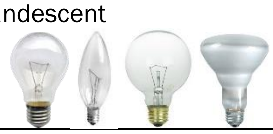
C. CFLs, also known as compact fluorescent lamps, are commonly made with a glass tube bent into a spiral shape resembling soft-serve ice cream. Some CFLs may have a plastic or glass cover over the spiral tube.
1. Have used or currently use this type of light bulb
2. Have heard of this type of light bulb but have never used it
3. Have not heard of this type of light bulb before today
8. (Don't know)
9. (Refused)

B2P. The free light bulbs you received from Duke Energy are called LEDs. An LED bulb often has a plastic base, sometimes with ridges. LEDs are the newest type of light bulb on the market. **Prior to receiving** the free LEDs from Duke Energy, had you..?
1. Used this type of light bulb
2. Heard of this type of light bulb but had never used it
3. Or had you not heard of this type of light bulb
8. (Don't know)
9. (Refused)

[ASK FOR WEB SURVEY ONLY]
Duke Energy is interested in learning more about the types of light bulbs you used before you received your free LED bulb(s).

[ASK FOR WEB SURVEY ONLY]
B1W. Please indicate your level of experience with each type of light bulb shown below. For each product, please think about a bulb with a screw base similar to what you see in the pictures.
1. Have used this type of light bulb
2. Have heard of this type of light bulb but have never used it
3. Have not heard of this type of light bulb before today

Bulb Type	Description
A. Incandescent 	An incandescent bulb is a traditional light bulb that has been available for 100 years.
B. Halogen 	A halogen bulb looks similar to an incandescent light bulb. The exterior of a halogen bulb looks like an incandescent bulb but the interior contains a little capsule that produces the light.
C. CFL (otherwise known as compact fluorescent lamp) 	A CFL bulb, also known as a compact fluorescent lamp, is commonly made with a glass tube bent into a spiral shape resembling soft-serve ice cream. Some CFLs may have a plastic or glass cover over the spiral tube.

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B2W. The free light bulbs you received from Duke Energy are called LEDs. An LED bulb often has a plastic base, sometimes with ridges. LEDs are the newest type of light bulb on the market. They may look like the following bulbs:

Prior to receiving the free LEDs from Duke Energy, have you..?

1. Used this type of light bulb
2. Heard of this type of light bulb but have never used it
3. Or have you not heard of this type of light bulb

[ASK IF B2P=1 OR B2W=1]

B3. Thinking about ALL of the light sockets in your home in which you could use a LED, how many of them contained LEDs **before** you received the free ones from Duke Energy?

1. All of them
2. Most of them
3. Some of them
4. A few of them
5. None of them
8. (Don't know)
9. (Refused)

Installation Verification

IV2. Have you installed all, some, or none of the <RECEIVED QUANTITY> LED(s) you received from Duke Energy?

1. (All of them) [SHOW FOR WEB SURVEY]
2. (Some of them) [SHOW FOR WEB SURVEY]
3. (None of them) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

[ASK IF IV2=2]

IV2A. How many of the <RECEIVED QUANTITY> LEDs that you had received from Duke Energy did you install? [NUMERIC OPEN END; 1 TO 97, 98=DON'T KNOW, 99=REFUSED]

[CALCULATE INSTALLED QUANTITY=RECEIVED QUANTITY IF IV2=1
INSTALLED QUANTITY=IV2A IF IV2=2 AND IV2A<98
INSTALLED QUANTITY=0 IF IV2=3, ELSE INSTALLED QUANTITY=MISSING]

[ASK IF INSTALLED_QUANTITY>0]

IV3. Where did you install the bulb(s) that you received from Duke Energy? [FOR WEB: Please select all that apply.] [FOR PHONE: Did you install the bulb(s) in any of the following places?] [READ LIST]

1. On the inside of my home
2. On the outside of my home (please count garage as outside)
3. Someplace else

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[ASK IF IV3=1,2]
IV3A. Does Duke Energy provide service at your home?
1. (Yes)
2. (No)
8. (Not sure) [SHOW FOR WEB SURVEY]

[ASK IF IV3=3]
IV3B. Where else did you install the bulb(s) that you received from Duke Energy? [MULTIPLE RESPONSE]
01. Where I work
02. In someone else's home
00. Some other place (specify____________)
98. (Don't know)
99. (Refused)

[ASK IF IV3=3]
IV3C. Does Duke Energy provide service at the other location(s) that you installed your bulb(s)?
01. (Yes)
02. (No)
00. Duke Energy provides service to some locations (please specify those locations below)
98. (Not sure) [SHOW FOR WEB SURVEY]

[ASK IF (IV2=2 OR IV2=3) AND RECEIVED_QTY<>INSTALLED_QTY, ELSE SKIP TO IV6]
IV4. [READ IF IV2=2] Why haven't you installed all of the free LEDs you received?
[READ IF IV2=3] "Why haven't you installed any of the free LEDs you received?"
[MULTIPLE RESPONSE UP TO 4, RANDOMIZE]
01. Haven't had the need to install bulbs
02. I am waiting for light bulbs to burn out
03. I don't have a light socket where I use that wattage
04. I don't like LEDs
00. (Other, specify) [SHOW FOR WEB SURVEY]
98. (Don't know)
99. (Refused)

IV5. What did you do with the LED(s) you did not install? [MULTIPLE RESPONSE UP TO 4, RANDOMIZE]
01. Placed them in storage for later use
02. Threw them away
03. Gave them away
00. (Other, specify) [SHOW FOR WEB SURVEY]
98. (Don't know)
99. (Refused)

[ASK IF IV2=1 OR IV2=2]
IV6. [READ IF INSTALLED QUANTITY=1] Have you removed the free LED that you installed?
[READ IF INSTALLED QUANTITY>1] Have you removed any of the free LEDs that you installed?
1. Yes
2. No
8 (Don't know)
9. (Refused)

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[ASK IF IV6=1 AND INSTALLED QUANTITY>1]

IV6A. How many of the <INSTALLED QUANTITY> LEDs have you removed? [NUMERIC OPEN END; 1 TO 97, 98=DON'T KNOW, 99=REFUSED, RESPONSE MUST BE LESS THAN INSTALLED QUANTITY]

[ASK IF IV6=1 AND INSTALLED QUANTITY=1]

IV7aa. Was the free LED that you removed working or was it broken?

1. Working
2. Broken
8 (Don't know)
9. (Refused)

[ASK IF IV6=1 AND INSTALLED QUANTITY>1]

IV7ab. Were the free LEDs that you removed working or were they broken?

1. All were working
2. All were broken
3. Some were working and some were broken
8 (Don't know)
9. (Refused)

[ASK IF IV7AA=1 OR IV7AB=1 OR 3]

IV7b. What did you do with the **working** LED(s) you removed? [MULTIPLE RESPONSE UP TO 5, RANDOMIZE]

01. Placed them in storage for later use
02. Threw them away
03. Gave them away
04. Installed them somewhere besides my home
05. Installed elsewhere in my home
00. (Other, specify) [SHOW FOR WEB SURVEY]
98. (Don't know)
99. (Refused)

[ASK IF IV6=1]

IV8. [SHOW FOR WEB SURVEY: It looks like you removed some of the bulbs that you ordered from the Duke Energy Free LED program.] Why did you remove the bulbs? [RANDOMIZE] [READ LIST]

01. Do not like light quality/not bright enough/too bright
02. Do not like appearance of bulb
03. Bulbs stopped working/burned out
04. Bulbs never worked
00. Other, specify
98. (Don't know)
99. (Refused)

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Replacement Behaviors

[ASK IF INSTALLED QUANTITY>0 AND B1PC=1 OR B1WC=1 OR B2P=1 OR B2W=1]

R1. [ASK FOR INBOUND PHONE: I am] [ASK FOR WEB: We are] interested in the types of bulbs that were in the sockets before you installed the free LEDs in them. Did you have any CFLs or LEDs in any of those sockets?
(READ IF NEEDED FOR INBOUND PHONEY SURVEY: CFLs are "twisty" bulbs that are made with a glass tube bent into a spiral, resembling self-serve ice-cream. Very often they look just like the bulbs that were installed through the program.
An LED bulb often has a plastic base, sometimes with ridges. LEDs are the newest type of light bulb on the market. They typically cost more than the other types of light bulbs.)

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF R1=1]

R2. How many of the <INSTALLED QUANTITY> sockets where you installed the free LEDs had CFLs or LEDs in them? [NUMERIC OPEN END 1-<INSTALLED QUANTITY>, 98=DON'T KNOW; 99=REFUSED]

[ASK IF INSTALLED QUANTITY>0, ELSE SKIP TO NEXT SECTION]
[SKIP IF R2=INSTALLED QUANTITY]

R3. Were any of the sockets where you installed the free LEDs empty at the time you installed the free LEDs in them?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF R3=1]

R3A. How many of the sockets where you installed the free LEDs were empty? [NUMERIC OPEN END 1-<INSTALLED QUANTITY>, 98=DON'T KNOW; 99=REFUSED]

R4. At the time that you installed the free LED(s), were any of the bulbs you replaced with free LEDs still working or had all of them burnt out? [RANDOMIZE]

1. All were still working
2. Some were still working
3. All of them had burnt out
8. (Don't know)
9. (Refused)

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Free Ridership

For this next set of questions, please think about **all** <RECEIVED QUANTITY> of the LEDs that you received for free from Duke Energy.

FR1. When you purchase light bulbs, do you generally purchase the lowest priced bulb, or do you consider other factors, such as energy efficiency, quality of light, or longevity of the bulb a factor in your decision? (IF PARTICIPANT SAYS THAT THEY CONSIDER BOTH PRICE AND OTHER FACTORS, RECORD RESPONSE AS 2)

1. I purchase the lowest-priced bulb
2. I consider other factors
8. (Don't know)
9. (Refused)

[CALCULATE LEDKITCOST=LEDBULBCOST * RECEIVED QUANTITY]

FR2. The <RECEIVED QUANTITY> LED bulbs you received from Duke Energy cost about $<LEDBULBCOST> per bulb at a retail store, for a total cost of $<LEDKITCOST>.

If you had not received the <RECEIVED QUANTITY> LEDs from Duke Energy, what would you have purchased the next time you needed to buy light bulbs? [RANDOMIZE]

1. Incandescent or halogen bulbs
2. CFLs
3 LEDs
4. A mix of bulbs
5. The lowest cost bulbs
8. (Don't know)
9. (Refused)

[ASK IF FR2=2]

FR3. Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would you have still purchased CFLs, or would you have purchased a different type of light bulb?

1. Still would have purchased CFLs [SKIP TO FR10]
2. Would have purchased a different type of light bulb [RETURN TO FR2, DO NOT GIVE CFLs AS AN OPTION IN FR2]
8. (Don't know) [SKIP TO FR10]
9. (Refused) [SKIP TO FR10]

[ASK IF FR2=3]

FR4. Would you have purchased all <RECEIVED QUANTITY> LEDs or just some at full retail price of $<LEDBULBCOST> per bulb?

1. All of them
2. Some of them
3. (None of them)
8. (Don't know)
9. (Refused)

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[ASK IF FR4=2]

FR5. How many of the <RECEIVED QUANTITY> LEDs would you have purchased at the full retail price of $<LEDBULBCOST> per bulb? [NUMERIC OPEN END, 1 TO <RECEIVED QUANTITY>, 98=DON'T KNOW; 99=REFUSED]

[CALCULATE FR_QTY=FR5 IF FR4=2 OR FR_QTY=RECEIVED QUANTITY IF FR4=1]
[CALCULATE PROG_QTY=RECEIVED QUANTITY - FR_QTY>

[ASK IF FR4=2 AND FR5<98 AND PROG_QTY>0]

FR6. Just to make sure I recorded everything accurately, you are telling me that of the <RECEIVED QUANTITY> LEDs that you received from Duke Energy, you would have purchased <FR5 ANSWER> LEDs, which means that you would not have purchased <RECEIVED QUANTITY-FR5 ANSWER>. Is that correct?

1. Yes
2. No [RETURN TO FR5]
8. (Don't know)
9. (Refused)

[ASK IF FR4=2 AND FR5<98 AND PROG_QTY>0]

FR7. For these <RECEIVED QUANTITY-FR5 ANSWER> bulbs, would you have still purchased LEDs but have done it later, or would you have purchased a different type of light bulb instead of LEDs?

1. Purchased LEDs later
2. Purchased a different type of light bulb
8. (Don't know)
9. (Refused)

[ASK IF FR7=2]

FR7A. What type(s) of light bulbs would you have purchased instead of LEDs? [MULTIPLE RESPONSE]

1. Incandescent or halogen bulbs
2. CFLs
4. (Other)
8. (Don't know)
9. (Refused)

[ASK IF FR7A=2]

FR7B. Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would CFLs still have been a part of the mix?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[IF FR7B=2, GO BACK TO FR7A AND RECORD UPDATED RESPONSES]

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[ASK IF FR2=4]

FR8. What types of bulbs would likely have been in the mix? [MULTIPLE RESPONSE]

1. Incandescent or halogen bulbs
2. CFLs
3 LEDs
00. (Other: Specify)
8. (Don't know)
9. (Refused)

[ASK IF FR8=2]

FR9. Similar CFL bulbs cost about $<CFLBULBCOST> per bulb at a retail store. Knowing this, would CFLs still have been a part of the mix?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[IF FR9=2, GO BACK TO FR8 AND RECORD UPDATED RESPONSES]

[ASK IF R4=1 OR R4=2 AND FR2<>1 AND 5]

FR10. Earlier, you indicated that you replaced working light bulbs with the LEDs you received for free from Duke Energy. If you had not received the free LEDs from Duke Energy, would you have still replaced these working light bulbs with LEDs, or would you have waited until they burnt out?

1. Would have replaced working bulbs with LEDs
2. Would have waited until working bulbs had burnt out
8. (Don't know)
9. (Refused)

Spillover

SO1. Besides the free LEDs you received from Duke Energy, have you or anyone in your household purchased light bulbs in the past year?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF SO1=1; ELSE SKIP TO MI1]

SO2. Did you purchase these light bulbs before or after you received the free LEDs from Duke Energy?

1. (Before receiving the free LEDs from Duke Energy) [SHOW FOR WEB SURVEY]
2. (After receiving the free LEDs from Duke Energy) [SHOW FOR WEB SURVEY]
3. (Both before and after receiving the free LEDs from Duke Energy) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

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SO3. What types of light bulbs did you purchase in the past year? [MULTIPLE RESPONSE UP TO 5]
- 01. Incandescent or halogen bulbs
- 03. CFL bulbs
- 04. LED bulbs
- 00. (Other, specify) [SHOW FOR WEB SURVEY]
- 98. (Don't know)
- 99. (Refused)

[ASK IF SO2=2 OR 3 AND SO3=3 OR 4, ELSE SKIP TO MI1]
SO4. Approximately how many CFLs or LEDs did you purchase **after** you received the free LEDs from Duke Energy?
[NUMERIC OPEN END; 0-997, 998=DON'T KNOW, 999=REFUSED]

[ASK IF SO4>0]
SO5. Did your experience with the **free** LEDs you received from Duke Energy encourage you IN ANY WAY to purchase the additional CFLs or LEDs?
- 1. Yes
- 2. No
- 8. (Don't know)
- 9. (Refused)

[ASK IF SO5=1]
SO6. How influential was your experience with the free LEDs you received from Duke Energy on your decision to purchase the additional CFLs or LEDs? [CATI ONLY:] Please answer using a scale of 0 to 10, where 0 is "not at all influential" and 10 is "very influential",
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF SO6>6]
SO7. How, specifically, did receiving the free LEDs from Duke Energy influence your decision to purchase the additional CFLs or LEDs?
[OPEN END, 98=DON'T KNOW, 99=REFUSED]

Program Marketing and Interactions

MI1. How did you first learn you could receive free LEDs from Duke Energy? [READ LIST] [RANDOMIZE]
- 01. Duke Energy mailing or letter
- 02. Bill insert
- 03. Duke Energy website
- 04. Family, friends, word of mouth
- 05 Direct email about the program
- 00. Or some other way? (Please specify)
- 98. (Don't know)
- 99. (Refused)

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MI2. Have you ever logged into your online residential account with Duke Energy?
1. Yes
2. No
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

[ASK IF MI2=1]
MI3. Have you ever received a notification that free LEDs were available while you were logged into your online account?
1. Yes
2. No
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

[ASK IF MI3=1]
MI4. Did you request free LEDs as a result of this notification?
1. Yes
2. No
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

MI5. Before ordering your LEDs, did you receive any materials from Duke Energy about the cost savings on your energy bill from installing more energy efficient lighting?
1. Yes
2. No
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

[ASK IF MI5=1]
MI6. Did you request the free LEDs from Duke Energy as a result of what you learned from these materials?
1. Yes
2. No
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

MI7. Besides providing you free LEDs to use in your home, are you aware of any offerings from Duke Energy that can help you save energy in your home?
1. Yes
2. No
8. (Don't know)
9. (Refused)

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[ASK IF MI7=1]
MI8. What offerings were you aware of? [READ LIST] [MULTIPLE RESPONSE, RANDOMIZE]
- 01. Duke Energy online CFL/LED store
- 02. Home Energy Call/Home Energy Assessment
- 03. Power Manager Program
- 04. Appliance Recycling Program
- 05. Online Home Energy Report
- 00. Other, specify
- 98. (Don't know)
- 99. (Refused)

[ASK IF MI7=1]
MI10. When did you find out about these offerings?
- 1. Before ordering free LED(s)
- 2. After ordering free LED(s)

[SHOW ANSWER OPTION 3 IF MORE THAN ONE RESPONSE TO MI8]
- 3. Found out about some programs before and some programs after ordering LED(s)
- 8. (Don't know)
- 9. (Refused)

[ASK IF MI7=1]
MI11. Did you participate in any of these offerings?
- 1. Yes
- 2. No
- 8. (Don't know)
- 9. (Refused)

[ASK IF MI11=1] [MULTIPLE RESPONSE UP TO 6] [READ ONLY RESPONSES SELECTED IN MI8]
MI12. In which offering(s) did you participate?
- 01. Duke Energy online CFL/LED store
- 02. Home Energy Call/Home Energy Assessment
- 03. Power Manager Program
- 04. Appliance Recycling Program
- 05. Online Home Energy Report
- 06. <OPEN END FROM MI8>
- 00. (Other, specify)
- 98. (Don't know)
- 99. (Refused)

[SKIP IF MI8=1]
MI13. Prior to taking this survey, were you aware that Duke Energy has an online store where customers can purchase LED bulbs at discounted prices?
- 1. Yes
- 2. No
- 8. (Don't know)
- 9. (Refused)

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Residential Program Satisfaction

I'd like to ask you a few questions about your experience receiving free LEDs from Duke Energy.

S1. From the time you requested free LEDs from Duke Energy, approximately how long did it take for you to receive your bulbs in the mail?
- 01. 1 week
- 02. 2 weeks
- 03. 3 weeks
- 04. 4 weeks (a month)
- 05. 5 weeks
- 06. 6 weeks
- 07. 7 weeks
- 08. 8 weeks (2 months)
- 09. More than 8 weeks
- 98. Cannot remember how long it took

S2. How satisfied were you with how long it took to receive the free LEDs? [FOR INBOUND PHONEY SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

S3. After you received your free LEDs from Duke Energy, how often did you contact Duke Energy or program staff with questions?
- 1. Never
- 2. Once
- 3. 2 or 3 times
- 4. 4 times or more
- 8. (Don't know)
- 9. (Refused)

[ASK IF S3=2,3,4]
S4. How did you contact them? [MULTIPLE RESPONSES]
- 1. Phone
- 2. Email or fax
- 3. Letter
- 4. In person
- 8. (Don't know)
- 9. (Refused)

[ASK IF S3=2,3,4]
S4A. Why did you contact Duke Energy? [MULTIPLE RESPONSES] [ROTATE]
- 1. Bulbs were broken
- 2. Didn't like the light bulbs I received
- 3. I received the wrong bulbs
- 0. (Other, please specify) [OPEN-ENDED RESPONSE, SHOW FOR WEB SURVEY]
- 8. (Don't know)
- 9. (Refused)

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[ASK IF S3=2,3,4]

S5. And how satisfied were you with your communications with Duke Energy and program staff? [FOR INBOUND PHONE SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF S5<5]

S6. Why were you dissatisfied?
[OPEN-ENDED RESPONSE 98=DON'T KNOW, 99=REFUSED]

[ASK IF FINAL INSTALLED QUANTITY>0]

S7. Have you noticed any savings on your electric bill since installing your free LED(s)?
1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF S7=1]

S8. How satisfied are you with any savings you noticed on your electric bill since installing your free LEDs? [FOR INBOUND PHONE SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 96="I DIDN'T NOTICE ANY SAVINGS," 98=DON'T KNOW, 99=REFUSED]

S9. How satisfied are you with your new free LEDs? [FOR INBOUND PHONE SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF S9<5]

S10. Why aren't you satisfied?
00. [OPEN END]
98. (Don't know)
99. (Refused)

S11. Finally, how satisfied with your experience receiving free LEDs from Duke Energy are you overall? [FOR INBOUND PHONE SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF S11<>98, 99]

S12. Do you have any suggestions to improve Duke Energy's free LED offering?
00. (Open end, specify) [SHOW FOR WEB SURVEY]
96. (No suggestions/None) [SHOW FOR WEB SURVEY]
98. (Don't know)
99. (Refused)

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S13. Based on your overall experience with Duke Energy's service, how satisfied are you with having them as your electric company? [FOR INBOUND PHONE SURVEY: Please answer on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."]
[SCALE 0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF S13<5]
S14. Why did you rate it that way? [OPEN END]

Demographics

These last few questions are about your home and your household.

D1. Which of the following best describes your home/residence?
- 01. Single-family detached home (If needed: Not a duplex, townhome, or apartment; attached garage is OK)
- 02. Single family attached home (If needed: townhouse)
- 03. Mobile home
- 04. Apartment or condominium (If needed: multifamily)
- 00. (Other, specify) [SHOW FOR WEB SURVEY]
- 98. (Don't know)
- 99. (Refused)

[ASK IF D1=1]
D1a. Is your home a factory manufactured or modular home?
1. (Yes, factory manufactured or modular) [SHOW FOR WEB SURVEY]
2. (No, conventionally built) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

[ASK IF D1=4]
D1b. How many housing units (If needed: apartments) are in your building? (READ RESPONSES IF NECESSARY)
1. (1) (Interviewer note: Do not read even if other responses are read) [SHOW FOR WEB SURVEY]
2. (2-3) [SHOW FOR WEB SURVEY]
3. (4-9) [SHOW FOR WEB SURVEY]
4. (10 or more) [SHOW FOR WEB SURVEY]
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

D2. Do you own or rent this residence?
1. (Own) [SHOW FOR WEB SURVEY]
2. (Rent) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

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[ASK IF D2=2]
D2a. Do you pay your own electric bill or is it included in your rent?
1. (Pay bill) [SHOW FOR WEB SURVEY]
2. (Included in rent) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

D3. How long have you lived in this residence? (READ RESPONSES IF NECESSARY)
1. (Less than 1 year) [SHOW FOR WEB SURVEY]
2. (1-3 years) [SHOW FOR WEB SURVEY]
3. (4-10 years) [SHOW FOR WEB SURVEY]
4. (11-20 years) [SHOW FOR WEB SURVEY]
5. (More than 20 years) [SHOW FOR WEB SURVEY]
8. (Don't know)
9. (Refused)

D4. Including yourself, how many people currently live in your residence year-round?
[NUMERIC OPEN END 0-97, 98=DON'T KNOW, 99=REFUSED]

[SKIP IF D4=1]
D5. How many people under the age of 18 live in your residence?
[NUMERIC OPEN END 0-97, 98=DON'T KNOW, 99=REFUSED]

D6. Approximately when was your residence first built?
01. (Before 1950) [SHOW FOR WEB SURVEY]
02. (1950-1959) [SHOW FOR WEB SURVEY]
03. (1960-1969) [SHOW FOR WEB SURVEY]
04. (1970-1979) [SHOW FOR WEB SURVEY]
05. (1980-1989) [SHOW FOR WEB SURVEY]
06. (1990-1999) [SHOW FOR WEB SURVEY]
07. (2000-2005) [SHOW FOR WEB SURVEY]
08. (2006-2009) [SHOW FOR WEB SURVEY]
09. (2010 or later) [SHOW FOR WEB SURVEY]
98. (Don't know) [SHOW FOR WEB SURVEY]
99. (Refused)

D7. Approximately how many square feet is your residence?
[NUMERIC OPEN END 1-50000; 99998=DON'T KNOW[SHOW FOR WEB SURVEY], 99999=REFUSED]

[ASK IF D7=99998]
D8. Would you estimate the square footage of your residence to be:
1. Less than 1,000 sq. ft.
2. Between 1,001 and 2,000 sq. ft.
3. Between 2,001 and 3,000 sq. ft.
4. Between 3,001 and 4,000 sq. ft.
5. Between 4,001 and 5,000 sq. ft.
6. Greater than 5,000 sq. ft.
8. (Don't know) [SHOW FOR WEB SURVEY]
9. (Refused)

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D9. In what year were you born? [NUMERIC OPEN END 1900-2015, 9998=DON'T KNOW, 9999=REFUSED]

D10. What is your highest level of education?
1. Less than a high school degree
2. High school degree
3. Technical/trade school program
4. Associates degree or some college
5. Bachelor's degree
6. Graduate / professional degree, e.g., J.D., MBA, MD, Ph.D.
8. (Don't know)
9. (Refused)

D11. What best describes your current employment status?
1. Employed full-time
2. Employed part-time
3. Retired
4. Not employed, but actively looking
5. Not employed, and not looking
8. (Don't know)
9. (Refused)

D12. [FOR INBOUND PHONE SURVEY: Please stop me when I reach the category that best represents your total annual pre-tax household income in <last whole year, i.e., 2015>.]

[FOR WEB SURVEY: Which category best represents your total annual pre-tax household income in <last whole year, i.e., 2015>?]

1. Less than $25,000
2. $25,000 to just under $50,000
3. $50,000 to just under $75,000
4. $75,000 to just under $100,000
5. $100,000 to just under $150,000
6. $150,000 or more
8. (Don't know)
9. (Refused)

D13. Thank you for completing our survey! Your name will be entered into our drawing for two $100 cash prizes. [FOR INBOUND PHONE SURVEY: What would be the best phone number and email address to reach you at if you win the drawing?] [FOR WEB SURVEY: Please enter the phone number and email address to contact you at if you win the drawing.]

A. Phone: [OPEN-END NUMERIC REQUIRING 10 DIGITS]
B. Email: [OPEN-END]

Those are all the questions I have. Thank you so much for your participation!

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Appendix E. Detailed Overview of the Net-to-Gross Algorithm

This appendix contains a detailed overview of the free ridership (FR) and spillover algorithms.

Free Ridership Algorithm

Participants of the Free LED program received free LED kits via mail. As such, we asked participants questions about their purchase behaviors and decisions **in the absence** of the free LED kit offering. Figure E-1 provides a detailed overview of the FR algorithm. Blue boxes in the graphic are questions used in the calculation of the FR score, grey boxes are validation and consistency check questions and green boxes are FR calculations.

We first asked participants what they would have purchased the next time they needed light bulbs if they had not received their free LED kit. We included retail LED pricing as part of the question to make sure that participants provide responses with consideration of the LED costs. Participants who said they would have purchased incandescents, halogens, or the lowest cost light bulb option, were classified as non-free-riders. Participants who said they would have purchased LEDs received follow-up questions asking about the timing and the quantity of the counterfactual LED purchase. Participants who reported purchasing CFLs in the absence of the program, received a follow-up question validating their response. As part of the question, we provided retail prices for CFLs and asked participants to confirm their counterfactual product choice. Participants who reported purchasing a mix of products in the absence of the program received follow-up questions exploring the mix and validating respondent choices of the products in the mix.

As part of the FR algorithm we accounted for the differences in efficiency between CFLs and LEDs. In cases where participants would have purchased CFLs in the absence of the program, we adjusted the FR downward to give the program the credit for increasing the efficiency as compared to the counterfactual choice. We developed an adjustment rate based on the differences in delta watts between LEDs and CFLs and applied it to all instances of counterfactual CFL purchases, scaling it as needed, depending on the counterfactual product mix.

Finally, as part of the FR algorithm, we explored participant installation patterns of program LEDs and give the program additional credit in cases where it motivated customers to replace **working** less efficient products instead of waiting for those bulbs to burn out. By encouraging participants to replace working light bulbs, the program accelerates energy savings and therefore deserves a credit. In cases where participants said that in the absence of the program they would have waited for their bulbs to burn out, we gave the program the credit depending on the number of **working** light bulbs that program LEDs replaced.

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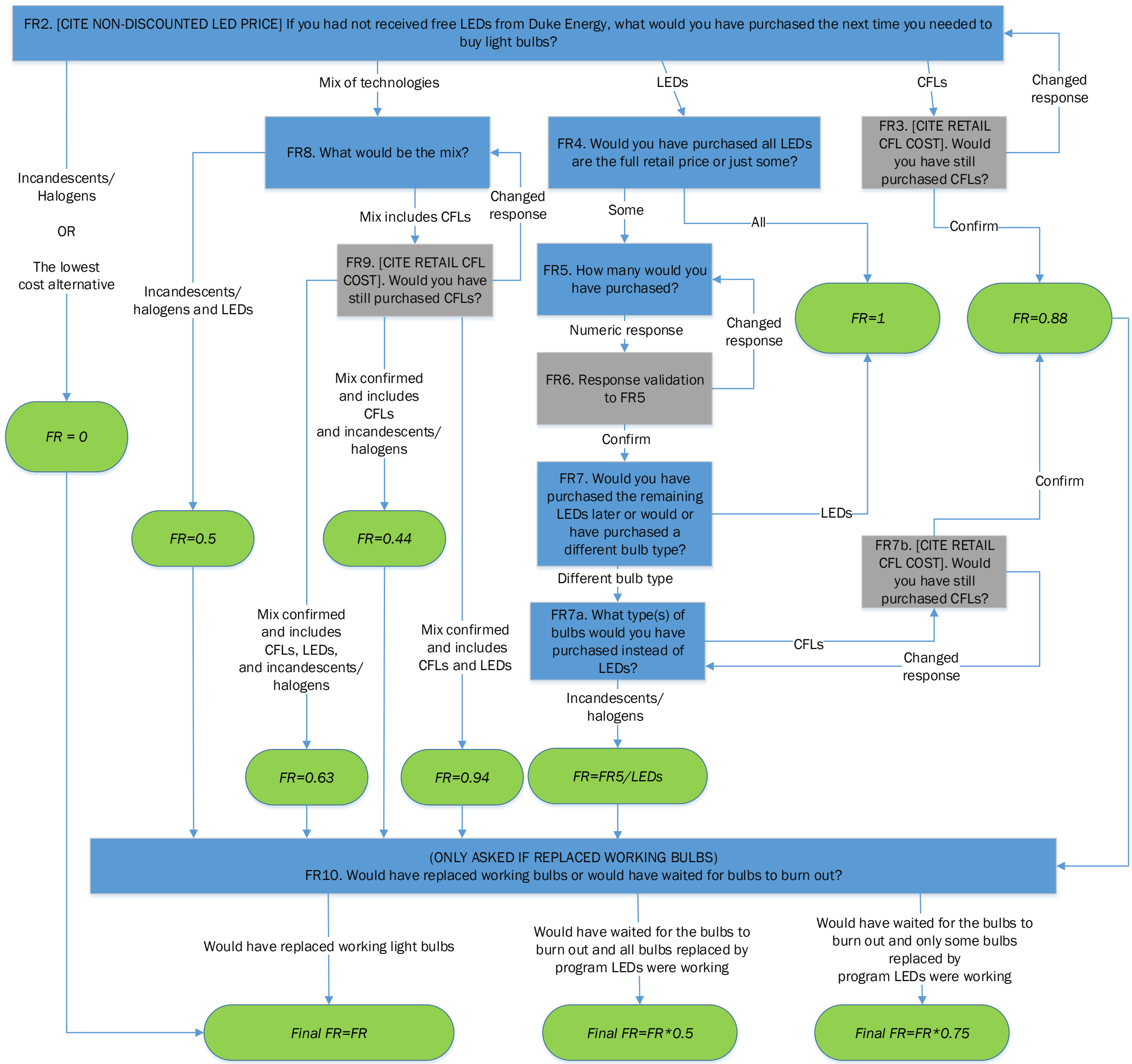
Figure E-1. Free LED Program Free-Ridership Algorithm



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As part of calculating the FR, we made reasonable imputations where participant responses were missing or contradictory. For instance, in cases where respondents reported that they would have purchased LEDs in the absence of the program, yet earlier in the survey they reported that they had not heard of LEDs prior to the survey, we reset participant FR to zero (non-free riders).

Using the above-outlined algorithm, we calculated a FR rate for each respondent. We aggregated respondent results to the program level by weighting individual participant responses by the energy savings associated with the technology purchased.

Spillover Algorithm

We limited the exploration of spillover effects to lighting products. Exploration of the presence and magnitude of spillover from other end uses would require a much longer survey. Given the nature of the Free LED program, the Evaluation Team does not believe that spillover effects from other end uses are likely enough to justify the additional respondent burden.

We explored non-program CFL and LED purchases and the degree of program influence on those purchases through the participant survey. Participants were asked whether they purchased any CFLs or LEDs after receiving program discounted CFLs and/or LEDs from the program and, if so, how many additional bulbs they had purchased. We did not ask participants to report bulb wattages because customers typically have difficulty recalling wattage information, especially if they purchased bulbs across a range of wattages. Due to survey length, we also did not ask questions about bulb type (standard or specialty). Respondents who reported purchasing additional products received follow-up questions about the impact of the program on their purchase of the energy efficient products. Respondents who reported that the program influenced their decision were asked to provide a quantitative rating of the level of program influence as well as a qualitative explanation of the way(s) the program influenced their purchase decisions. Figure E-2 graphically depicts the spillover algorithm we will deploy as part of the participant surveys to establish the presence of participant spillover and obtain the total number of spillover bulbs.

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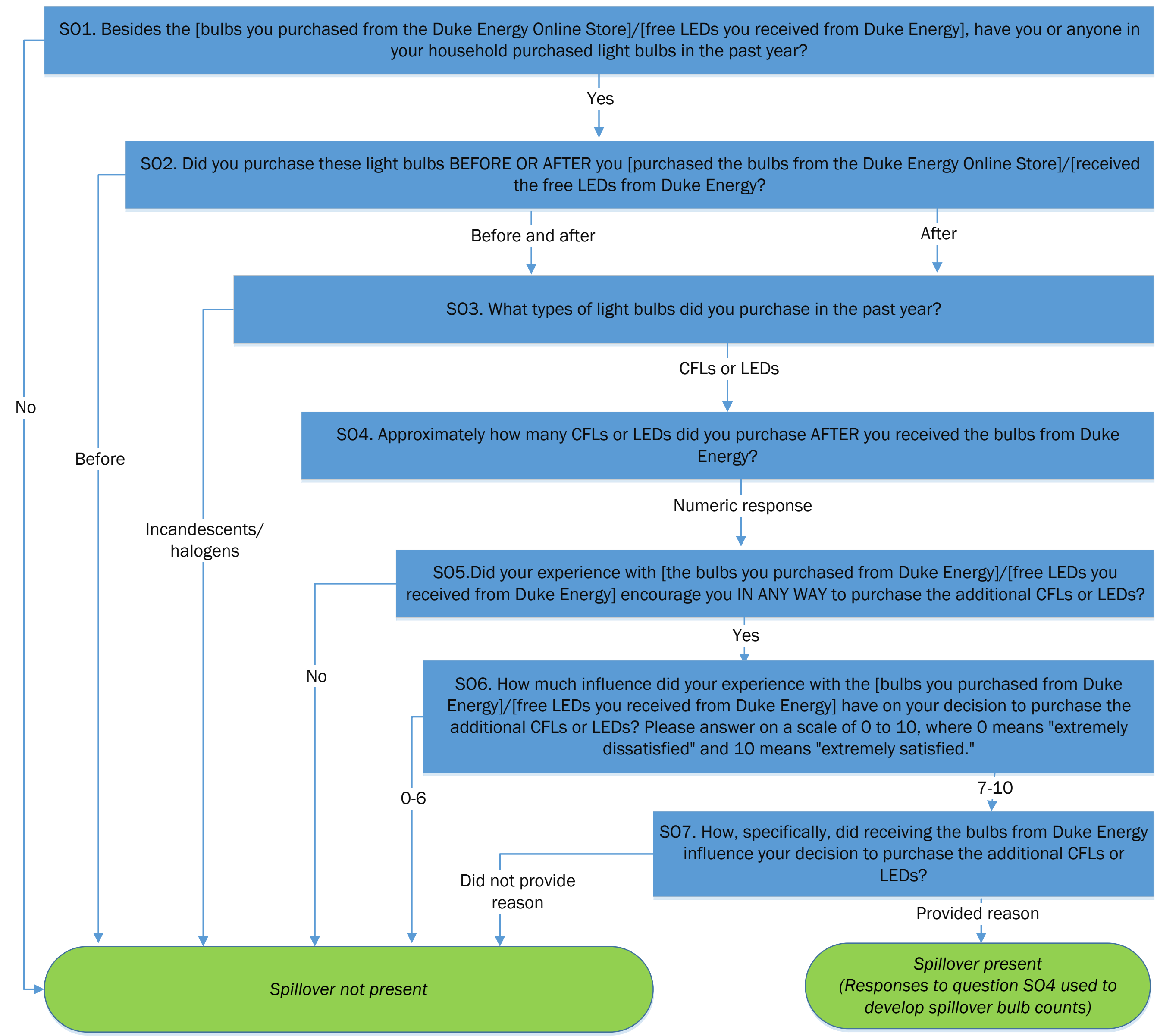
Figure E-2. Spillover Algorithm



Equation E-1 shows the formula that we used to estimate SO energy savings, and Equation E-2 shows the formula that we used to estimate SO peak demand savings.

Equation E-1. SO Energy Savings Formula

$$\Delta kWh = \frac{(Watts * HOU)_{base} - (Watts * HOU)_{ee}}{1{,}000} * 365 * (1 + HVAC_c)$$

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Equation E-2. SO Peak Demand Savings Formula

$$\Delta kW = \frac{Watts_{base} - Watts_{ee}}{1{,}000} * CF * (1 + HVAC_d)$$

Where:

ΔkWh = first-year electric energy savings
ΔkW = peak electric demand savings
$Watts_{base}$ = Baseline wattage
$Watts_{ee}$ = Efficient bulb wattage
HOU = residential annual operating hours
CF = peak coincidence factor
$HVAC_c$ = HVAC system interaction factor for energy
$HVAC_d$ = HVAC system interaction factor for demand

Table E-1 shows the savings assumptions that we used to estimate SO energy and demand savings and details the sources of those assumptions. We assumed that SO bulbs were standard bulbs and assumed an efficient wattage of 13 watts for CFLs and 9 watts for LEDs. These wattages represent typical wattages of the standard CFL and LED. We used the EISA-adjusted baseline wattages for 60-watt incandescent equivalents. All other savings assumptions mirror the ones we used to estimate energy and demand savings for program LEDs.

Table E-1. SO Savings Assumptions

Assumption Type	Assumption Value	Assumption Source
Efficient bulb wattage – CFL	13	Typical standard CFL wattage
Efficient bulb wattage – LED	9	Actual program LED wattage
Baseline wattage	43	2017 DEC Shelf Audit
HOU – LED	2.88 hours/day	2017 DEC/DEP Residential Lighting Hours of Use Study
Summer CF – LED	0.128	
Winter CF – LED	0.145	
HOU – CFL	2.92 hours/day	2012 DEP EEL Program Evaluation
Summer CF – CFL	0.114	
Winter CF – CFL	0.096	
$HVAC_c$	−0.037	2012 DEC Smart $aver Program Evaluation
$HVAC_d$ – Summer	0.168	
$HVAC_d$ – Winter	−0.500	2012 DEP EEL Program Evaluation

Using the savings formula and the savings assumptions above, we estimated per-bulb kWh savings of 34.42 for LEDs and 30.79 for CFLs. We then multiplied the per-bulb savings by the total quantity of SO CFLs and LEDs. Overall, the program achieved SO savings of 2,949 kWh, 0.4339 summer peak kW, and 0.2089 winter peak kW.

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Table E-2. SO Savings Summary

Product Type	Total Number of SO Bulbs	Total Per-Bulb Savings			Total SO Savings		
		kWh	Summer Peak kW	Winter Peak kW	kWh	Summer Peak kW	Winter Peak kW
CFLs	3	30.79	0.0040	0.0014	92	0.0120	0.0043
LEDs	83	34.42	0.0051	0.0025	2,857	0.4219	0.2046
Total	86	-	-	-	2,949	0.4339	0.2089

Note that the values have been rounded.

We estimated the program SO rate by dividing the SO savings by the ex post gross savings for the survey respondents who received SO questions.

Equation E-3. SO Rate Formula

$$Spillover\ Rate = \frac{Spillover\ Savings}{Evaluated\ Gross\ Savings\ in\ the\ Respondent\ Sample}$$

The resulting SO rate is 1.4% (Table E-3).

Table E-3. SO Rate Estimate

	kWh	Summer Peak kW	Winter Peak kW
SO savings	2,949	0.4339	0.2089
Ex post gross savings in the respondent sample	213,400	31.5	15.1
SO rate	1.4%	1.4%	1.4%

Note that the values have been rounded.

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Appendix F. Participant Survey Data Package

We provide the final participant survey data package as a separate submission. As part of the package, we provide final participant survey data file in Stata and Excel as well as a data dictionary.

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Appendix G. In-Service Rate, Free-Ridership, and Spillover Calculations

The Stata syntax code is provided as a separate submission and contains detailed calculations of the program's first-year in-service rate, free-ridership, and spillover.

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Duke Energy Carolinas

Smart Energy in Offices
Evaluation Report

December 15, 2017

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1. Evaluation Summary

1.1 Program Summary

Smart Energy in Offices (SEiO) is a Duke Energy Carolinas (DEC) behavioral demand-side management program targeting electricity conservation in mid- to large-sized office buildings. The program takes a holistic approach to energy management within office buildings by offering multiple interventions, including (1) engaging building operators with training and campaigns related to energy efficient building operations and maintenance; (2) engaging tenants through community-wide challenges related to energy efficiency within office spaces; and (3) providing building operators and other building stakeholders with detailed data on their buildings' energy consumption and automated building energy benchmarking. Participating operators and tenants earn points for their engagement, providing positive feedback, social norms, and/or competition between individuals, teams, buildings, and communities, all of which may contribute to motivating energy-saving actions and behaviors. The program is designed to complement Duke Energy's existing equipment-based rebate programs by focusing on behavioral and operational savings.

1.2 Evaluation Objectives

The evaluation had three primary components: a gross impact evaluation, a net-to-gross analysis, and a process evaluation. The key objectives of each of the components of the research are described below.

Gross Impact Evaluation

- Estimate program impacts, including gross and net energy (kWh) and summer and winter peak demand (kW) savings at the program level, as well by sub-groups of interest (such as participants that also participated in the Smart Energy Now pilot program, participants that participated in various types of campaigns, etc.).

Net-to-Gross Analysis

- Assess the relative success of the program's components in terms of increasing participant engagement and generating energy savings.

Process Evaluation

- Identify barriers to participation by eligible customers and how these barriers can be addressed by the program.
- Identify program strengths and the potential for introducing additional measures.
- Assess program processes and satisfaction.
- Identify ways in which the program can be improved.

To achieve these research objectives, the evaluation team completed a range of data collection and analytical activities, including interviews with program staff, in-depth interviews with building operators and

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coaches, surveys with coaches and tenant participants, and analysis of the results.[1] Through the primary data collection, the evaluation team developed estimates of average gross and net consumption savings, peak demand savings, as well as a program-level net-to-gross ratio (NTGR). For the purposes of the impact evaluation, the evaluation team used customer data from accounts enrolled between September 2014 and February 2016, and analyzed energy consumption data from one year before enrollment through February 2017.

1.3 High-Level Findings

This evaluation measured the gross and net savings achieved by the 199 accounts that enrolled in Duke Energy's SEiO program between September 2014 and February 2016. While each of these accounts enrolled in a three-year participation period, this evaluation was designed to estimate savings achieved as of February 2017. This means that we estimated savings over varying participation periods depending on when customers enrolled, from 30 months of participation for the earliest enrollees to 12 months for the most recent ones. Because many of the participants may go on to engage in more program campaigns after our February 2017 cut-off, this evaluation provides a very specific measure of the program's impacts: savings through February 2017 from accounts that enrolled between program inception and February 2016. To the extent that program offerings have changed or participants have engaged more deeply since February 2017, our average annual savings estimates may not reflect the savings participants realize over their entire three-year enrollment period. This is important to consider when interpreting the results in this evaluation since (1) the effects of the program are expected to continue to accrue over the three-year participation period that participants commit to when they enroll and, more importantly, (2) the program has continued to improve the offerings available to enrollees since its launch in fall 2014. If changes make the program more effective, if program engagement increases over time (as outreach staff work with participants), or if savings from program interventions persist and accumulate over time, then the estimates from this evaluation under-estimate program savings. Indeed, the program has made a number of changes that are not captured in the results from this evaluation, such as engaging University of North Carolina Charlotte students to complete building audits and help customize operator campaigns for each participant. While we cannot be sure that savings are under-estimated, it will be important to evaluate this program in the future to determine full savings from a mature version of the program (incorporating early changes to program design) with participants who have completed their three-year participation period.

This evaluation estimated gross savings separately for customers that were and were not part of the precursor Smart Energy Now (SEN) pilot program because of two key differences between these groups. First, SEN participants started engaging with Duke Energy earlier, during the SEN pilot, and have continued this engagement through SEiO. Second, for the most part, SEN participants are also participants in the public private collaborative in Charlotte, Envision Charlotte.[2] While Envision Charlotte does not directly target energy savings, there are synergies between SEiO and Envision Charlotte, with staff from both efforts

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[1] Each participating organization designates a lead building operator to engage with the program and a "coach," who serves as the primary stakeholder for tenant engagement and is responsible for promoting challenges to the building's tenants. The same individual can fill both roles. Coaches help recruit team "captains" who organize and encourage teams of tenants, the individuals working within the office building, to participate.

[2] Envision Charlotte is a public-private program implemented in Charlotte that promotes sustainability more broadly, including areas like water and waste efficiency. As part of their partnership with Duke Energy, Envision Charlotte does not focus on energy efficiency but rather leaves energy savings interventions to the SEiO program. Duke Energy did not have a complete list of Envision Charlotte participants, so SEN participation was the best available proxy for Envision Charlotte participation.