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Duke Energy Carolinas & Duke Energy Progress Retail Lighting Program

2022 Evaluation Report - Final

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1. Evaluation Summary

This report provides results of an impact and process evaluation of the Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) Retail Lighting Program. The program period under evaluation is January 1, 2021, through March 31, 2022. Throughout this report, we refer to this period as the evaluation period.

1.1 Program Summary

The Duke Energy Retail Lighting Program offers a range of point-of-sale (POS)-discounted LED lighting products. DEP launched its program in January 2010 with the goal of reducing energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. DEC adopted the program in early 2016 to supplement its existing energy-efficient residential lighting program offerings. As part of the Retail Lighting Program, Duke Energy partners with retailers and manufacturers across the DEC and DEP service territories to provide POS price markdowns on LED products available for customers to purchase. Participating stores reflect a variety of retail channels, including big box, do-it-yourself (DIY), hardware, thrift, and dollar stores. The program discounts a wide range of ENERGY STAR® LED bulbs and fixtures.[1]

1.2 Evaluation Objectives

This evaluation included process and impact assessments and had several key objectives:

- Assess the program's performance and estimate gross and net energy (kWh) and peak summer and winter demand (kW) savings for the evaluation period.
  - Review program tracking data for completeness and accuracy and discuss implications of any errors or inconsistencies for program savings estimates
  - Review deemed savings estimates used to track program performance and provide recommendations for updates to assumptions where necessary
  - Develop updated estimates of program leakage and determine appropriate in-service rate (ISR) assumptions
  - Develop net-to-gross ratios (NTGRs) based on sales data modeling and feedback from retailers and manufacturers
  - Estimate ex post gross and net energy (kWh) and peak summer and winter demand (kW) savings and realization rates
- Gauge current and anticipated market trends to provide recommendations for how future implementation strategies can maximize customer engagement and minimize free ridership.
- Assess the program's implementation processes and marketing strategies to identify key successes and opportunities for improvement.

[1] The ENERGY STAR® name and mark are registered trademarks owned by the United States Environmental Protection Agency.

1.3 High Level Findings

From January 1, 2021, through March 31, 2022, the Duke Energy Retail Lighting Program sold over 2.5 million discounted energy-efficient bulbs and fixtures in the DEC jurisdiction and 1.8 million in the DEP jurisdiction. The DEC program achieved ex ante gross energy savings of 94.5 GWh, and the DEP program achieved 60.6 GWh of gross savings. Sales and ex ante gross savings by jurisdiction and product category are reported in Table 1.

Table 1. Retail Lighting Program Performance Summary by Jurisdiction and Product Category

Jurisdiction	Product Category	Units	% of Sales	Ex Ante Gross Savings (kWh)	% of Savings
DEC	Reflector LEDs	726,421	29%	34,645,143	37%
	Specialty LEDs	696,192	28%	21,384,591	23%
	Standard LEDs	564,965	22%	16,999,797	18%
	LED Fixtures	537,395	21%	21,447,434	23%
	All Categories	**2,524,973**	**100%**	**94,476,965**	**100%**
DEP	Reflector LEDs	495,137	27%	21,421,623	35%
	Specialty LEDs	451,764	25%	14,248,159	24%
	Standard LEDs	534,719	30%	15,341,088	25%
	LED Fixtures	323,726	18%	9,592,001	16%
	All Categories	**1,805,346**	**100%**	**60,602,872**	**100%**

Note: Specialty LEDs include globe, decorative, and three-way bulbs; reflector LEDs include both indoor and outdoor bulbs; LED fixtures include both portable and direct-wire products.

1.3.1 Impact Evaluation

The DEC program realized 104.9 GWh in ex post gross energy savings, 17.2 MW in summer peak demand savings, and 7.3 MW in winter peak demand savings during the evaluation period. In the same period, the DEP program realized 71.2 GWh in ex post gross energy savings, 11.7 MW in summer peak demand savings, and 4.9 MW in winter peak demand savings.

Gross realization rates for the DEC program were 111% for energy savings, 111% for summer peak demand savings, and 105% for winter peak demand savings. The DEP program gross realization rates were 117% for energy savings, 117% for summer peak demand savings, and 111% for winter peak demand savings.

After applying NTGRs established by the current evaluation, the DEC program achieved 63.3 GWh in ex post net energy savings, 10.4 MW in summer peak demand savings, and 4.4 MW in winter peak demand ex post net savings. The DEP program achieved 45.2 GWh in ex post net energy savings, 7.4 MW in summer peak demand savings, and 3.1 MW in winter peak demand ex post net savings.

Table 2 summarizes total ex ante, ex post gross, and ex post net savings by jurisdiction.

Table 2. Retail Lighting Program Impact Evaluation Results by Jurisdiction

Jurisdiction	Metric	Ex Ante	Gross RR	Ex Post Gross	Effective NTGR	Ex Post Net
DEC	Energy Savings (kWh)	94,476,965	111%	104,940,087	0.604	63,383,847
	Summer Peak Demand Savings (kW)	15,586	111%	17,242		10,414
	Winter Peak Demand Savings (kW)	6,915	105%	7,278		4,395
DEP	Energy Savings (kWh)	60,602,872	117%	71,205,792	0.635	45,215,699
	Summer Peak Demand Savings (kW)	9,981	117%	11,670		7,410
	Winter Peak Demand Savings (kW)	4,439	111%	4,942		3,138

Note: NTGR values were developed by retail channel and jurisdiction.

The DEC program NTGR was 0.604 and the DEP program NTGR was 0.635 based on market actor interview feedback and sales data modeling outputs. We developed separate estimates for discount (thrift and dollar stores) and non-discount (big box, DIY, and hardware stores) retail channels. Table 3 reports NTGR by jurisdiction, retail channel, and research activity.

Table 3. NTGR Results by Jurisdiction and Retail Channel

Jurisdiction	Retail Channel	Market Actor Interview NTGR	Sales Data Modeling NTGR	% of Sales	Final NTGR
DEC	Discount	0.845	N/A	66%	0.845
	Non-Discount	0.137	0.134	34%	0.135
	All Channels	**N/A**	**N/A**	**100%**	**0.604**
DEP	Discount	0.852	N/A	68%	0.852
	Non-Discount	0.215	0.130	32%	0.172
	All Channels	**N/A**	**N/A**	**100%**	**0.635**

1.3.2 Process Evaluation

The evaluation team identified the following high-level process findings based on research conducted as part of the current evaluation:

- Participating manufacturer and retailer contacts express high satisfaction with key program elements and the program overall.
- Program tracking data is clean and comprehensive, contained fully populated and internally consistent data fields, and included all necessary information to support core evaluation activities.
- The program team's ongoing efforts to prioritize dollar and thrift stores and reach low-income customer segments has been a success with these retail channels accounting for 64% of all DEC sales and 67% of DEP sales during the evaluation period.
- Several discount retailers that do not fall into traditional thrift or dollar store categories, such as Ollie's Bargain Outlet and Maxway, share key characteristics (i.e., stocking practices and customer demographics) and are therefore strong candidates for future program engagement.
- LED market share continues to increase aided by ongoing decreases in manufacturing costs and by the availability of utility program discounts. Non-ENERGY STAR LEDs, which are energy-efficient

but often have shorter lifespans and lower light quality, are emerging as a more prevalent lower-cost alternative to ENERGY STAR LEDs.

- The COVID-19 pandemic affected the residential lighting supply chain, store traffic, and customer demand, but these patterns started to subside in late 2021 and early 2022.
- Participating retailer and manufacturer staff expect to halt production of halogen and incandescent products by the end of 2022 and sell through any existing inventory of those products by the end of Q2 2023 to comply with new federal lighting efficiency standards announced in April 2022.
- In light of anticipated market developments, Duke Energy staff plan to end POS lighting discounts by July 2023 and will begin offering POS discounts for non-lighting energy-efficient consumer electronics.

1.4 Evaluation Recommendations

Based on the findings of this evaluation, the evaluation team identified the following opportunities for program improvement:

- Continue to prioritize retailers that disproportionally serve low-income customers, such as thrift, dollar, and other discount stores, given this customer segment is less likely to purchase energy-efficient lighting in the absence of incentives (i.e., exhibit lower free ridership).
- Continue to provide discounts on LED bulbs and fixtures through the end of 2022, and potentially the first half of 2023 at retailers that continue to stock incandescent or halogen lighting products. Anticipate that LED products will be the only lighting available on most store shelves by July 2023 at the latest.
- Given the new federal lighting efficiency standards and associated market changes, we support Duke Energy's plans to end POS lighting discounts by July 2023 and diversify upstream program offerings to include non-lighting energy-efficient products.

2. Program Description

This section provides an overview of the design, implementation, and performance of the DEC and DEP Retail Lighting programs. The program period under evaluation is January 1, 2021, to March 31, 2022.

2.1 Program Design

Duke Energy launched the DEP Retail Lighting Program in January 2010 with the goal of reducing electric energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. The program was expanded to the DEC territory in early 2016 to supplement existing energy-efficient residential lighting program offerings there. As part of the Retail Lighting Program, Duke Energy partners with retailers and manufacturers across the DEC and DEP service territories to provide POS price markdowns on customer purchases of LED products. The program promotes customer awareness and purchase of program-discounted products through a range of marketing and outreach strategies, including in-store collateral and events, mail and email marketing, and community events. The program also provides training to store staff on current program offerings and benefits to customers.

The product mix includes a wide range of standard, specialty, and reflector ENERGY STAR LED bulbs and fixtures,[2] and participating retailers include a variety of store types. Notably, the program has made efforts in recent years to prioritize thrift and dollar stores, targeting 65% of program sales through these retailers for the 2021 calendar year. Moving forward, program staff anticipate introducing POS discounts for non-lighting energy-efficient consumer electronics at many of the same retailers and plan to end POS lighting discounts by July 2023 in acknowledgment of new federal lighting efficiency standards and associated lighting market developments discussed later in this report.

2.2 Program Implementation

Duke Energy staff manages the DEC and DEP Retail Lighting programs and is responsible for overseeing program design, marketing, and operations. CLEAResult is responsible for communicating directly with participating manufacturers and retailers, obtaining and processing program sales data, training retailer staff, and promoting program products through in-store events and point-of-purchase (POP) marketing materials. Duke Energy and CLEAResult staff maintained close communication throughout the evaluation period to monitor market changes and adjust program offerings when needed.

[2] Standard LEDs were discontinued in non-discount retailers after May 2021.

2.3 Program Performance

From January 1, 2021, to March 31, 2022, the Duke Energy Retail Lighting Program sold over 2.5 million discounted energy-efficient bulbs and fixtures in the DEC service territory and 1.8 million in the DEP territory. The DEC program achieved ex ante gross energy savings of 94.5 GWh, and the DEP program realized ex ante gross energy savings of 60.6 GWh. Over the course of the evaluation period, the DEC and DEP Retail Lighting programs discounted 231 unique products across a range of bulb types and wattages. Program staff effectively managed this large portfolio of products, as evidenced by highly accurate and consistent program sales records.

During the evaluation period, the majority of units were sold through thrift and dollar stores (67% for DEC, 68% for DEP), accounting for comparable portions of ex ante savings (68% for DEC, 66% for DEP). DIY retailers accounted for the next largest portion of program sales (29% for DEC, 23% for DEP). Table 4 summarizes sales and ex ante energy savings by retail channel for each jurisdiction.

Table 4. Retail Lighting Program Performance by Jurisdiction and Retail Channel

Jurisdiction	Retail Channel	Units	% of Sales	Ex Ante Gross Energy Savings (kWh)	% of Savings
DEC	**Discount Stores**				
	Thrift	948,332	38%	35,231,661	37%
	Dollar	720,680	29%	27,612,674	29%
	Subtotal	*1,669,012*	*67%*	*62,844,336*	*67%*
	Non-Discount Stores				
	DIY	722,128	29%	26,510,047	28%
	Big Box	132,466	5%	5,066,956	5%
	Hardware	1,367	<1%	55,626	0%
	Subtotal	*855,961*	*34%*	*31,632,629*	*33%*
	All Channels	**2,524,973**	**100%**	**94,476,965**	**100%**
DEP	**Discount Stores**				
	Thrift	739,092	41%	24,608,247	41%
	Dollar	488,552	27%	15,653,069	26%
	Subtotal	*1,227,644*	*68%*	*40,261,316*	*66%*
	Non-Discount Stores				
	DIY	417,629	23%	14,447,387	24%
	Big Box	80,206	4%	2,882,529	5%
	Hardware	79,867	4%	3,011,640	5%
	Subtotal	*577,702*	*31%*	*20,341,556*	*34%*
	All Channels	**1,805,346**	**100%**	**60,602,872**	**100%**

Reflector LEDs accounted for the most ex ante energy savings for both the DEC and DEP programs, contributing over one-third of savings. Specialty LEDs represented nearly one-fourth of savings in each jurisdiction. For the DEC program, LED fixtures accounted for another 23% of savings with standard LEDs making up the remaining 18%. For the DEP program, standard LEDs represented 25% of savings while LED fixtures made up the remaining 16%. Table 5 provides a summary of program sales and ex ante energy savings.

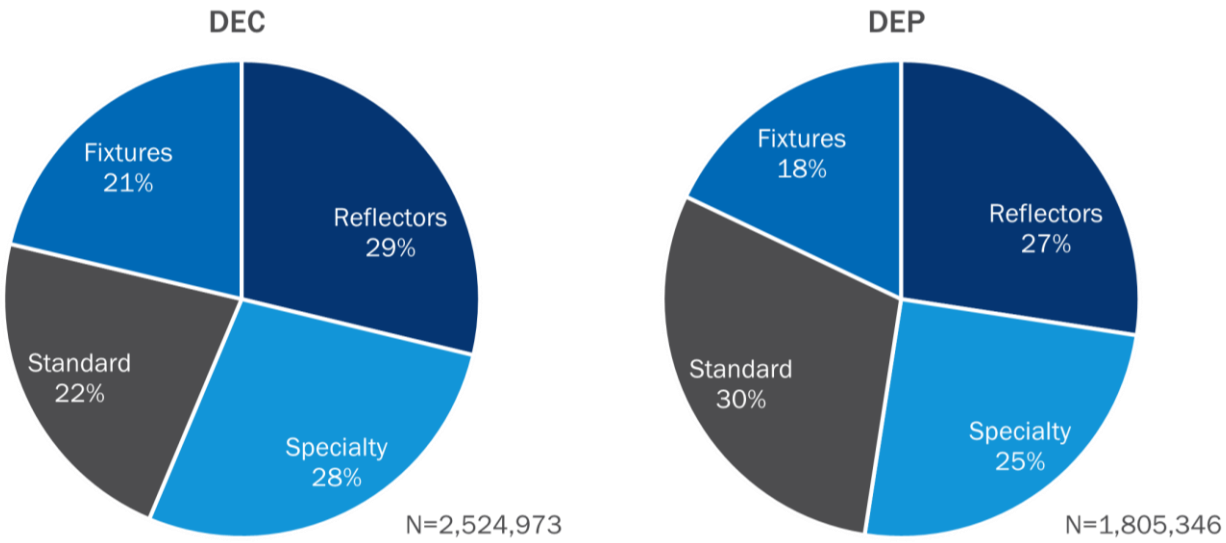
Table 5. Retail Lighting Program Performance by Jurisdiction and Product Category

Jurisdiction	Product Category	Units	% of Sales	Ex Ante Gross Energy Savings (kWh)	% of Savings
DEC	Reflector LEDs	726,421	29%	34,645,143	37%
	Specialty LEDs	696,192	28%	21,384,591	23%
	Standard LEDs	564,965	22%	16,999,797	18%
	LED Fixtures	537,395	21%	21,447,434	23%
	All Categories	**2,524,973**	**100%**	**94,476,965**	**100%**
DEP	Reflector LEDs	495,137	27%	21,421,623	35%
	Specialty LEDs	451,764	25%	14,248,159	24%
	Standard LEDs	534,719	30%	15,341,088	25%
	LED Fixtures	323,726	18%	9,592,001	16%
	All Categories	**1,805,346**	**100%**	**60,602,872**	**100%**

Note: Specialty LEDs include globe, decorative, and three-way bulbs; reflector LEDs include both indoor and outdoor bulbs; LED fixtures include both portable and direct-wire products.

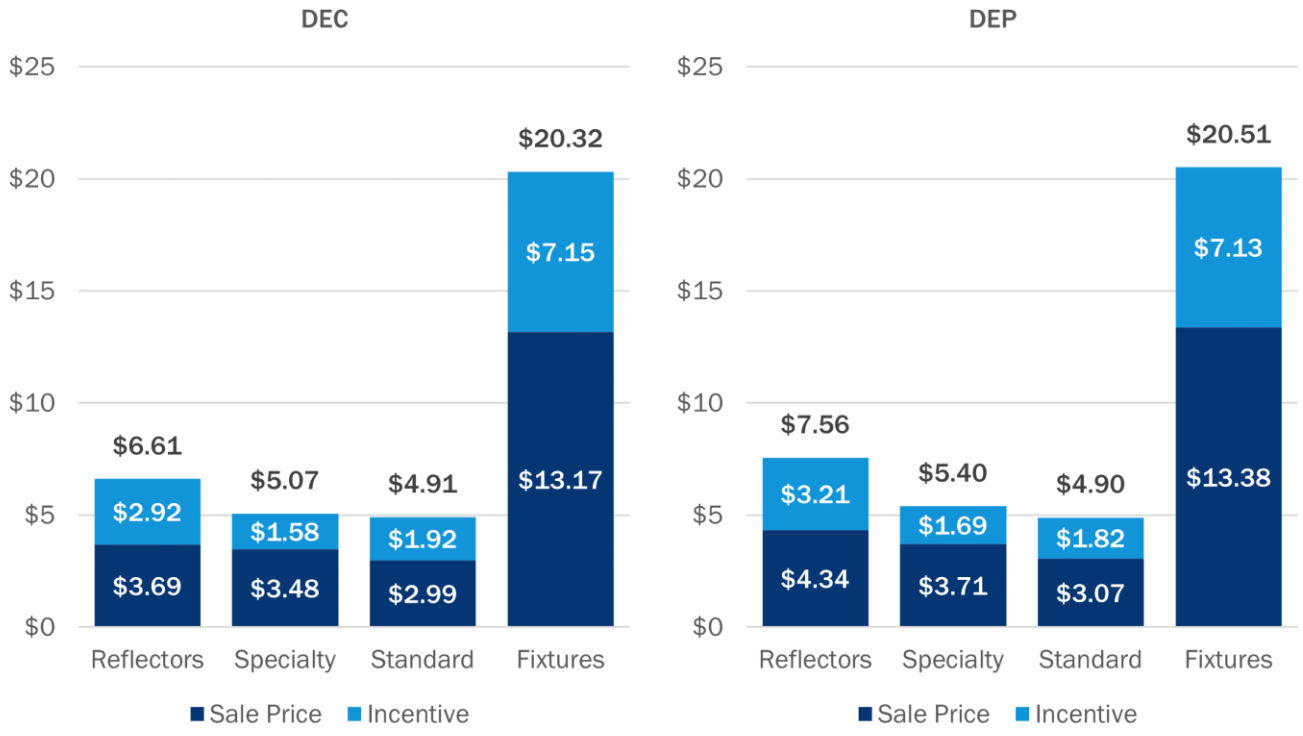
Figure 1 illustrates the relative contribution of each product category to overall program sales by jurisdiction. In each jurisdiction, reflector and specialty products made up a majority of all program sales (57% for DEC, 52% for DEP). For the DEC program, standard bulbs and LED fixtures each accounted for just over 20% of sales. For the DEP program, standard LEDs represented 30% of sales while LED fixtures made up the remaining 18%.

Figure 1. Program Sales by Jurisdiction and Product Category



Customers shopping at participating store locations were able to purchase qualifying LED products at substantially discounted price points. Average per-unit sale prices were lowest for standard bulbs ($2.99 for DEC, $3.07 for DEP) and highest for fixtures ($13.17 for DEC, $13.38 for DEP). Average per-unit incentives for products sold through the DEC program ranged from $1.58 for specialty LEDs to $7.15 for LED fixtures, and per-unit incentives for products sold through the DEP program ranged from $1.69 for specialty LEDs to $7.13 for LED fixtures. Relative to list prices, specialty LEDs received the lowest discounts (31% of list price for both DEC and DEP). Reflector LEDs received the highest discounts relative to list prices (44% of list price for DEC and 43% for DEP). Figure 2 summarizes average program discounts by product category during the evaluation period.

Figure 2. Per-Unit Pricing Summary by Jurisdiction and Product Category



3. Overview of Evaluation Activities

To address the evaluation objectives outlined in Section 1.2, Opinion Dynamics performed a range of data collection and analytic activities, including the following:

- Program staff interviews (n=1)
- Data and deemed savings review
- Leakage analysis
- Sales data modeling
- Market actor interviews (n=9)

3.1 Program Staff Interviews

The evaluation team conducted an in-depth qualitative telephone interview with Duke Energy program staff in March 2022 to (1) obtain a full understanding of the Retail Lighting Program, including implementation processes, eligibility requirements, and available program-tracked information; (2) obtain program staff's perspective on current and past program successes and challenges; and (3) identify program staff's priorities for the process evaluation, including researchable questions.

3.2 Data and Deemed Savings Review

As part of this evaluation, we reviewed program tracking data, assessed its completeness and accuracy, and sought to identify any errors or inconsistencies. We discuss our findings and their implications for program-tracked savings in Section 4.2 of this report. We also conducted a detailed review of deemed savings estimates used to track program performance, assumptions behind those values, and sources of those assumptions. We delivered a memorandum presenting the findings of this review and recommended updates to per-unit savings, which is included in Appendix B.

3.3 Leakage Analysis

Upstream lighting programs that provide POS discounts through retailers are generally unable to restrict sales to customers of the sponsoring utility. As a result, customers of neighboring utilities may purchase some of the program-discounted products. In effect, these energy savings "leak" out of the sponsoring utility's service territory. Duke Energy cannot claim savings from those products, so the savings associated with them must be excluded from the overall program impacts.

The program leakage rate reflects the percentage of program bulbs purchased by non-Duke Energy electric customers. The key factor affecting leakage for an upstream residential lighting program is the location of the participating stores in relation to DEC and DEP service territory borders. The evaluation team relied on geographic information system (GIS) analysis for leakage rate estimates.

3.4 Market Actor Interviews

Opinion Dynamics staff conducted in-depth interviews with corporate-level retailer and manufacturer contacts to inform NTG estimation. In addition, as part of the interview, we explored retailer and manufacturer perspectives on the state of the market and future trends.

The sample included a total of 11 corporate-level contacts from manufacturers and retailers producing and selling program-discounted products supplied to us by the program team.[3] We conducted interviews with nine contacts from retailers and manufacturers representing 97% of DEC and 93% of DEP program sales volume. Table 6 provides a summary of market actor interview fielding.

Table 6. Market Actor Interview Fielding Summary

Sample	Completed Interviews	Percentage of DEC Program Sales	Percentage of DEP Program Sales
11	9	97%	93%

[a] We spoke with nine contacts, eight of whom provided feedback to inform NTG estimates. The contact who declined to provide feedback informing NTG represented less than one percent of program sales.
Source: Opinion Dynamics analysis of market actor interview data.

3.5 Sales Data Modeling

The goal of the sales data modeling was to develop a net-to-gross (NTG) estimate for sales through non-discount retailers. As part of this research activity, we developed regression models of program-tracked sales data to estimate price elasticity and predict bulb sales at non-discounted prices. We calculated a NTG estimate based on the predicted sales volume in the absence of program discounts relative to the actual sales that occurred during the evaluation period. A detailed description of the sales data modeling methodology can be found in Section 5.1 of this report.

Sales data modeling uses sales data from the entire period under evaluation rather than a sample of the program sales records. In the absence of any sampling, the concept of sampling error does not apply, and there is no estimate of precision for the resulting NTG estimate.

[3] The list of contacts provided by program staff included 16 individuals representing 11 retailers and manufacturers. We attempted to interview only one contact from each organization.

4. Gross Impact Evaluation

The gross impact evaluation of the DEC and DEP Retail Lighting programs consisted of two distinct steps: (1) review of per-unit deemed savings values for incented products, and (2) application of leakage and ISR assumptions. This section describes the methodologies and results of both steps.

4.1 Gross Impact Methodology

We employed the research methods described in this section to validate program tracking data, review and update deemed savings, leakage rate, and ISR assumptions, and calculate ex post gross energy and demand savings for products sold through the program.

4.1.1 Data and Deemed Savings Review

We began by reviewing all available program tracking data, assessing it for completeness and accuracy, and identifying all available information relevant for estimation of per-unit savings. To develop ex post per-unit savings, we reviewed savings algorithms and parameters from the following sources:

- Program tracking data: We relied on program tracking data to inform product-specific parameters and measure specifications, including LED wattage and bulb shape. We utilized program tracking data as it is the most reliable and evaluation-specific source of information when available for the population.
- Technical Reference Manual (TRM) assumptions: We used algorithms and parameters from Version 10.0 of the Mid-Atlantic TRM, with the exception of lighting operation assumptions.
- Metering studies: To inform lighting operation parameters, we relied on the 2016 DEC Commercial Lighting Logger Study and 2017 DEC and DEP Residential Lighting Logger Study.

For more information on the algorithms and inputs used to develop deemed per-unit savings estimates for each product category, see Appendix B.

4.1.2 Leakage Analysis

Leakage occurs when non-Duke Energy customers purchase program-discounted products and install them in homes (or businesses) located outside of Duke Energy's service territory. The program leakage rate reflects the percentage of program bulbs purchased by non-Duke Energy electric customers. Duke Energy cannot claim savings from those products, so the savings associated with them must be excluded from the overall program impacts. The key factor affecting leakage for an upstream residential lighting program is the location of the participating stores in relation to service territory borders.

The evaluation team attempted to estimate leakage using a geographic information system (GIS) analysis for the DEC and DEP jurisdictions but found currently available data sources to have fundamental misalignments that prevented development of a defensible estimate of program leakage. Namely, US Census 2021 American Community Survey (ACS) five-year estimates[4] indicated fewer households in many block groups than 2021 Duke Energy residential customer data, resulting in anomalous (negative) leakage rates. We therefore rely on

[4] The evaluation team used Table B25003 - TENURE, which provides total occupied housing units (both owned and rented) at the block group level. US Census Bureau; American Community Survey, 2021 American Community Survey 5-Year Estimates, Table B25003; accessed via data.census.gov.

leakage results from a comparable analysis conducted as part of the most recent prior evaluation of the DEC and DEP Retail Lighting programs (Opinion Dynamics, 2018).

4.1.3 In-Service Rate

First-year ISR is estimated by technology and application. Because participants in upstream programs are generally not tracked, we leveraged secondary sources of ISRs. For bulbs in residential applications, we relied on the results from the 2021 DEC-DEP Online Store Participant Survey (Opinion Dynamics, 2021). For bulbs in commercial applications and for fixtures in both residential and commercial applications, we applied a first-year ISR of 100%, as recommended by the Mid-Atlantic TRM, Version 10.0.

Although the first-year ISR is less than 100% for bulbs in residential applications, research studies across the country have found residential customers often purchase more LED bulbs than immediately needed and continue to install these bulbs from storage in subsequent years. The two main approaches to claiming savings from these later installations are (1) staggering the savings over time and claiming some in later years, and (2) claiming the savings in the evaluation period the product was sold but discounting savings 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 provides the simplicity of claiming all costs and benefits during the evaluation period and eliminates the need to track and claim savings from future installations in future evaluations.

The evaluation team used a discounted savings approach to account for savings from future installations. To allocate installations over time, we relied on the installation trajectory recommended by the Uniform Methods Project (UMP) whereby 24% of remaining bulbs are installed in each subsequent year, for a total of five years. For example, if the Year 1 ISR is 80%, an additional 4.8% of bulbs would be installed in Year 2 ([1 − 80%] × 24%; or 20% × 24%), an additional 3.6% of bulbs would be installed in Year 3 ([1 − 80% − 4.8%] × 24%; or 15.2% × 24%), and so on.

These future installations are then discounted using Equation 1 to derive the net present value (NPV) of savings associated with future installs of LED bulbs.

Equation 1. Net Present Value Formula for Future LED Bulb Savings

$$NPV = \frac{R_t}{(1+i)^t}$$

Where:

R = Savings
i = Discount rate
t = Number of years in the future that savings take place

4.2 Gross Impact Results

This section provides gross energy and demand savings estimates for each product category offered by the DEC and DEP Retail Lighting programs and program-level savings during the evaluation period.

4.2.1 Program Tracking Data Review

Opinion Dynamics received program tracking data extracts that contained pricing, quantity, date, and retailer information along with product descriptions. As a part of the analysis, we performed the following steps:

- Checked core data fields for missing values
- Checked data for temporal gaps
- Checked key data fields for reasonableness and consistency

In reviewing the data, we found that all data fields were clean and fully populated, and program tracking data included the necessary product specifications to inform TRM-based savings calculations.

4.2.2 Per-Unit Deemed Savings

Duke Energy provided per-unit ex ante savings values separately from program tracking data in a spreadsheet containing DSMore outputs for each product category and jurisdiction. Savings values included energy, summer peak demand, and winter peak demand savings across eight LED product categories.

Ex ante savings for LED lighting products are drawn directly from the most recent prior evaluation of the DEC and DEP Retail Lighting programs (Opinion Dynamics, 2018). These values reflect average per-unit ex post savings across the mix of products included in each category during that prior evaluation period and include application of ISRs and leakage rates. For the present analysis, we backed out the ISR and leakage rate to make ex ante values more directly comparable to ex post values, which do not account for ISR or leakage.[5] Differences between ex ante and ex post per-unit savings for LED lighting are primarily attributable to shifts in the mix of specific products and LED wattages within each category. Additionally, for three-way bulbs, ex post savings reflect baseline wattage assumptions assigned based on mid-level lumen output rather than maximum lumen output.

[5] The prior DEC-DEP Retail Lighting evaluation applied cumulative ISRs of 95.9% for DEC residential bulbs, 95.8% for DEP residential bulbs, and 97.9% for all commercial bulbs, along with leakage rates of 1.3% for all DEC LED products and 8.4% for all DEP LED products to develop ex post savings. Program staff then used these as ex ante per-unit savings for the current evaluation period. We therefore recalculated average per-unit savings from the previous evaluation excluding these ISR and leakage adjustments to produce revised ex ante per-unit values shown here.

Table 7 provides ex ante and ex post per-unit savings for all product categories sold through the DEC and DEP Retail Lighting programs. Additional information about the parameters and algorithms we used to develop per-unit savings is provided in Appendix B.

Table 7. Comparison of Per-Unit Deemed Savings by Jurisdiction and Product Category (Net of ISR and Leakage)

Jurisdiction	Product Category	Energy (kWh)		Summer Demand (kW)		Winter Demand (kW)	
		Ex Ante[a]	Ex Post	Ex Ante[a]	Ex Post	Ex Ante[a]	Ex Post
DEC	Standard A-Line	31.66	49.42	0.0058	0.0080	0.0022	0.0034
	Reflector Recessed	46.26	45.32	0.0085	0.0074	0.0032	0.0032
	Reflector Outdoor	56.78	63.98	0.0105	0.0104	0.0040	0.0045
	Reflector Track Lighting	33.87	42.25	0.0062	0.0069	0.0024	0.0029
	Globe LEDs	33.01	38.44	0.0061	0.0063	0.0023	0.0027
	Decorative LEDs	24.28	33.03	0.0045	0.0054	0.0017	0.0023
	Three-Way LEDs	81.35	81.21	0.0150	0.0132	0.0057	0.0056
	LED Fixtures	40.61	44.90	0.0075	0.0073	0.0028	0.0031
DEP	Standard A-Line	32.55	46.74	0.0060	0.0076	0.0023	0.0033
	Reflector Recessed	46.14	45.63	0.0085	0.0074	0.0032	0.0032
	Reflector Outdoor	53.31	60.36	0.0098	0.0098	0.0037	0.0042
	Reflector Track Lighting	33.42	42.24	0.0062	0.0069	0.0023	0.0029
	Globe	32.73	38.30	0.0060	0.0062	0.0023	0.0027
	Decorative	26.69	33.71	0.0049	0.0055	0.0019	0.0023
	Three-Way	81.59	78.65	0.0150	0.0128	0.0057	0.0055
	Fixture	32.35	45.52	0.0060	0.0074	0.0023	0.0032

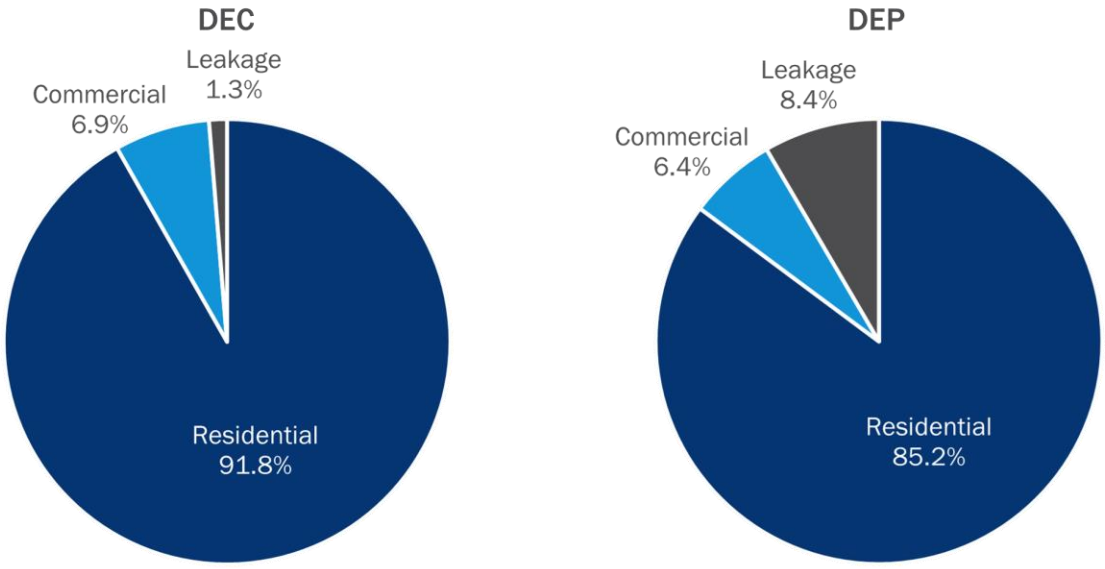
[a] For LED bulb categories, ex ante per-unit values exclude ISR and leakage to make ex ante values more directly comparable to ex post values. Ex ante values originally provided by program staff and shown elsewhere in this report include ISR and leakage.

4.2.3 Leakage Rates

To estimate leakage rates, we relied on a GIS analysis performed for the 2018 evaluation of the DEC/DEP Retail Lighting Program Evaluation (Opinion Dynamics, 2018; see also Section 4.1.2). The analysis produced a leakage rate of 1.3% for DEC and 8.4% for DEP. Based on the Mid-Atlantic TRM V10.0, we assumed 93% of sales were for residential application and 7% were for commercial application. Because program leakage represents the portion of program sales purchased by non-Duke Energy customers, it effectively detracts from the portions of sales going to Duke Energy residential or commercial customers.

Figure 3 illustrates the resulting distribution of program sales to residential customer homes, commercial customer facilities, and locations not serviced by Duke Energy (i.e., leakage).

Figure 3. Program Leakage and Application by Sector



4.2.4 In-Service Rates

Table 8 summarizes first-year ISRs by application and product type. For bulbs in residential applications, we relied on the results from the 2021 DEC-DEP Online Store Participant Survey. For bulbs in commercial applications and for fixtures in both residential and commercial applications, we applied a first-year ISR of 100%, as recommended by the Mid-Atlantic TRM, Version 10.0.

Table 8. First-Year ISR Summary

Application and Product Type	DEC	DEP
Residential Bulbs	61.8%	71.7%
Commercial Bulbs	100.0%	100.0%
Residential and Commercial Fixtures	100.0%	100.0%

Table 9 provides cumulative installations of residential LED bulbs by year, using the discounted approach detailed in Section 4.1.3 (i.e., incremental installations of 24% of bulbs that remain uninstalled for a total of five additional years). The values shown here are discounted to represent the NPV of installations that occur in each year. The resulting effective ISR for LED bulbs installed in residential applications is 86.6% for DEC and 89.7% for DEP.

Table 9. Residential LED Bulb Cumulative Discounted ISR

Year	DEC	DEP
2021 (Year 1)	61.8%	71.7%
2022 (Year 2)	70.5%	78.3%
2023 (Year 3)	76.6%	82.7%
2024 (Year 4)	80.8%	85.9%
2025 (Year 5)	83.9%	88.1%
2026 (Year 6)	86.1%	89.7%
Total	**86.1%**	**89.7%**

Table 10 summarizes effective ISR values by application and product type. The effective ISR for residential LED bulbs is reflective of discounted future installations, as outlined above. For fixtures and commercial installations, effective ISR is equivalent to the first-year ISR of 100% as there are no remaining units for customers to install in future years.

Table 10. Final Effective ISR Summary

Application and Product Type	DEC	DEP
Residential Bulbs	86.1%	89.7%
Commercial Bulbs	100.0%	100.0%
Residential And Commercial Fixtures	100.0%	100.0%

4.2.5 Ex Post Gross Savings Summary

Table 11, Table 12, and Table 13 present total ex ante and ex post gross energy, summer peak demand, and winter peak demand savings and realization rates, by product category.[6] The DEC program realized 104.9 GWh in ex post gross energy savings, 17.2 MW in summer peak demand savings, and 7.3 MW in winter peak demand savings during the evaluation period. In the same period, the DEP program achieved 71.2 GWh in ex post gross energy savings, 11.7 MW in summer peak demand savings, and 4.9 MW in winter peak demand savings.

Gross realization rates for the DEC program were 111% for energy savings, 111% for summer peak demand savings, and 105% for winter peak demand savings, while the DEP program gross realization rates were 117% for energy savings, 117% for summer peak demand savings and 111% for winter peak demand savings. Standard LEDs had the highest gross realization rate for the DEC program during the evaluation period, exceeding 135% for energy and demand savings. For the DEP program, LED fixtures had the highest gross realization rate, exceeding 130% for energy and demand savings. In each program, reflector LEDs were the only category that did not exceed 100% gross realization for energy and demand savings. Differences between ex ante and ex post per-unit savings are primarily attributable to shifts in the mix of specific products and LED

[6] All total ex post savings include leakage rate and ISR adjustments.

wattages within each category. Ex post savings also reflect slightly lower ISRs and a slightly higher share of units installed in residential applications, both of which slightly reduce gross realization rates.

Table 11. Detailed Energy Savings Gross Impacts Results by Jurisdiction and Product Category

Jurisdiction	Product Category	Ex Ante Savings (kWh)	Ex Post Gross Savings (kWh)			Gross Realization Rate
			Residential	Commercial	Total	
DEC	Reflector LEDs	34,645,143	27,914,337	5,095,516	33,009,853	95%
	Specialty LEDs	21,384,591	20,208,950	3,688,967	23,897,917	112%
	Standard LEDs	16,999,797	20,478,359	3,738,000	24,216,359	142%
	LED Fixtures	21,447,434	20,585,731	3,230,227	23,815,958	111%
	All Categories	**94,476,965**	**89,187,378**	**15,752,709**	**104,940,087**	**111%**
DEP	Reflector LEDs	21,421,623	18,200,239	3,187,227	21,387,466	100%
	Specialty LEDs	14,248,159	13,176,441	2,307,433	15,483,874	109%
	Standard LEDs	15,341,088	17,730,194	3,105,028	20,835,223	136%
	LED Fixtures	9,592,001	11,668,290	1,830,940	13,499,230	141%
	All Categories	**60,602,872**	**60,775,164**	**10,430,628**	**71,205,792**	**117%**

Table 12. Detailed Summer Peak Demand Savings Gross Impacts Results by Jurisdiction and Product Category

Jurisdiction	Product Category	Ex Ante Savings (kW)	Ex Post Gross Savings (kW)			Gross Realization Rate
			Residential	Commercial	Total	
DEC	Reflector LEDs	5,691	4,120	1,320	5,439	96%
	Specialty LEDs	3,524	2,982	955	3,938	112%
	Standard LEDs	2,825	3,022	968	3,990	141%
	LED Fixtures	3,547	3,038	837	3,875	109%
	All Categories	**15,586**	**13,162**	**4,080**	**17,242**	**111%**
DEP	Reflector LEDs	3,520	2,686	826	3,511	100%
	Specialty LEDs	2,361	1,945	598	2,542	108%
	Standard LEDs	2,513	2,617	804	3,421	136%
	LED Fixtures	1,586	1,722	474	2,196	138%
	All Categories	**9,981**	**8,969**	**2,702**	**11,670**	**117%**

Table 13. Detailed Winter Peak Demand Savings Gross Impacts Results by Jurisdiction and Product Category

Jurisdiction	Product Category	Ex Ante Savings (kW)	Ex Post Gross Savings (kW)			Gross Realization Rate
			Residential	Commercial	Total	
DEC	Reflector LEDs	2,542	1,998	290	2,287	90%
	Specialty LEDs	1,572	1,446	210	1,656	105%
	Standard LEDs	1,243	1,465	212	1,678	135%
	LED Fixtures	1,558	1,473	184	1,657	106%
	All Categories	**6,915**	**6,382**	**895**	**7,278**	**105%**
DEP	Reflector LEDs	1,566	1,303	181	1,484	95%
	Specialty LEDs	1,037	943	131	1,074	104%
	Standard LEDs	1,123	1,269	176	1,445	129%
	LED Fixtures	712	835	104	939	132%
	All Categories	**4,439**	**4,349**	**593**	**4,942**	**111%**

Table 14 summarizes per-unit ex post gross energy, summer peak demand, and winter peak demand savings by product category. These values are reflective of deemed per-unit savings presented in Section 4.2.2 adjusted to incorporate leakage and effective ISRs presented in Section 4.2.3.

Table 14. Per-Unit Ex Post Gross Impacts Results by Jurisdiction and Product Category

Jurisdiction	Product Category	Energy Savings (kWh)	Peak Demand Savings	
			Summer (kW)	Winter (kW)
DEC	Standard A-Line	42.86	0.0071	0.0030
	Reflector Recessed	39.30	0.0065	0.0027
	Reflector Outdoor	55.48	0.0091	0.0038
	Reflector Track Lighting	36.64	0.0060	0.0025
	Globe	33.34	0.0055	0.0023
	Decorative	28.64	0.0047	0.0020
	Three-Way	70.43	0.0116	0.0049
	Fixture	44.32	0.0072	0.0031
DEP	Standard A-Line	38.96	0.0064	0.0027
	Reflector Recessed	38.04	0.0062	0.0026
	Reflector Outdoor	50.32	0.0083	0.0035
	Reflector Track Lighting	35.21	0.0058	0.0024
	Globe	31.93	0.0052	0.0022
	Decorative	28.10	0.0046	0.0019
	Three-Way	65.57	0.0108	0.0045
	Fixture	41.70	0.0068	0.0029

4.3 References

Mid-Atlantic Technical Reference Manual, Version 10.0, May 2020.

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5. Net-to-Gross Analysis

This section describes our approach for estimating the net savings for the DEC and DEP Retail Lighting programs and presents the resulting NTGRs and net impacts.

5.1 NTG 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 gross savings that are attributable to the program. The NTGR generally consists of free ridership (FR) and spillover (SO) and is calculated as *(1 – FR + SO)*. FR is the proportion of the verified gross savings that would have been realized absent the program. SO reflects additional energy-saving actions that were influenced by program interventions but did not receive program support. However, the standard NTGR methodologies used for upstream lighting programs (i.e., market actor interviews and sales data modeling) only produce estimates of FR. As such, the estimates of NTGR presented in this report only include FR and are estimated as *(1 – FR)*.

The assessment of NTG for upstream residential lighting programs is especially challenging for the following reasons:

- Since customers purchase discounted bulbs in a retail setting where they do not need to provide contact information, there is not a list of participants with whom we can conduct a follow-up self-report NTG survey (i.e., customers who purchased discounted bulbs through the program). Additionally, most customers do not put extensive thought into or have reliable recall of their purchase decision because light bulbs are a low-cost commodity product. Customers may not even be aware they purchased discounted bulbs. Therefore, we cannot conduct a participant nor a general population survey in which we ask customers about their past light bulb purchases and the influence of program discounts on those purchases.
- Although we have detailed data regarding sales for the bulbs associated with the program, we lack any information about sales of other bulbs sold at the same retailers (including less efficient and non-discounted products). Thus, while we can attempt to model the relationship between bulb price and sales for the products associated with the program, we cannot account for how other factors (e.g., discounts of non-program bulbs) may have affected our results. In addition, modeling the relationship between bulb pricing and sales volumes requires substantial variation in product pricing.
- Program interventions (i.e., discounts on select products, marketing materials, field representative engagement) may affect manufacturer supply chains and retailer stocking practices, resulting in shelf space changes. Those changes are not visible to participants and therefore call for research with a range of market actors and, ultimately, triangulation of NTG estimates from multiple sources.

To understand counterfactual customer behaviors and to develop the most accurate possible estimates of program NTGRs, Opinion Dynamics relied on two distinct methods:

- Market actor interviews
- Sales data modeling

Below we discuss the methodology associated with each approach.

5.1.1 Market Actor Interviews

Opinion Dynamics staff conducted in-depth interviews with corporate-level retailer and manufacturer contacts to inform estimation of NTG. In addition, as part of the interview, we explored retailer and manufacturer perspectives on the state of the market and future trends.

The sample included a total of 11 corporate-level contacts from manufacturers and retailers producing and selling program-discounted products supplied to us by the program team. Opinion Dynamics staff conducted nine in-depth interviews with corporate-level retailer and manufacturer contacts. Of those interviews, eight informed NTGR estimates for the Retail Lighting Program, and one provided only process feedback because the interviewee declined to give quantitative estimates relating to NTG. The eight retailers and manufacturers who provided NTG feedback account for 97% of total program sales for DEC and 93% for DEP.

We asked each interviewee to estimate the percentage by which the sales of efficient bulbs would be different in the absence of the program for each bulb category. Respondents who said that sales of energy-efficient products would have decreased received a follow-up question asking to estimate the percent that would have shifted to other energy-efficient products. The percentage of energy-efficient bulb sales expected to move to non-energy-efficient products in the program's absence represents the NTGR for the respondent. As part of the interview guide, we embedded a range of validation questions to check responses for consistency and asked respondents to provide their rationale for the reported percent change in sales in the absence of the program.

We estimated a NTGR for each retail channel associated with each respondent, which we then aggregated, weighting by program sales, to produce two separate NTGRs for each jurisdiction: one for discount retailers and one for all other retail channels. As part of the analysis and aggregation process, a single manufacturer could contribute to the NTGRs across several retail channels, as long as that manufacturer was supplying its product to those retail channels.

5.1.2 Sales Data Modeling

The sales data modeling approach to estimating NTGRs is based on the simple economic principle that a change in price causes a change in product sales. This assumption is the foundation of upstream program theory, so measuring the effect of program discounts on bulb sales serves as a good indicator of a program's net impact. The sales data modeling method models this relationship between product price and sales volume using the program-tracked sales data. The model produces price elasticity curves, allowing for predictions of sales at various prices, namely, program-discounted and non-discounted price levels.

For the modeling effort to succeed, there must be sufficient price variation for identical products during the evaluation period. As the first step in our analysis, we reviewed the data and confirmed that there was sufficient price variation to support data modeling.

The program tracking data for both programs contained transaction-level sales summaries. Depending on the retailer and manufacturer, most transaction periods ranged from one week to one month. To ensure time series consistency and to maximize the potential for capturing the effect of in-store events on bulb sales, we normalized transaction periods to a monthly level.

To reach our final price elasticity estimates, we fit a series of theoretically driven models predicting sales volume from product price. We tested a range of models including varying product specifications, retailer information, and transaction periods. For each model, we examined several diagnostics to assess the model's

performance in terms of efficiency, omitted variables, and heteroscedasticity of residuals.[7] We also considered model fit indices, favoring models with larger R-squared values[8] and lower Akaike's Information Criterion (AIC) values[9] relative to other models based on comparable bulb quantities or sales transactions.

A model using unique product identifiers and unique store location identifiers (inherently representative of bulb characteristics and store traffic patterns, respectively), emerged as the best performing for both DEC and DEP. Although the methodology and model design were the same for both programs, we present separate results for each.

Equation 2 contains the final sales data model specification. As is common in this type of analysis, we used the log of both price and sales quantity, which greatly improves the distributions of those variables, and allows for the interpretation of the price coefficient as the percent increase in sales given a one percent decrease in price, simplifying the process of analyzing price elasticity and NTGR.

Equation 2. Final Sales Data Model Specification

$$ln(Q_{ms}) = \alpha + \beta_x ln(P_{ms}) + \sum_{\mu}(\beta_\mu model_m) + \sum_{\gamma}(\beta_\gamma store_s)$$

Where:

ln = natural log

Q = quantity of bulbs sold

P = price per bulb[10]

m = model

s = store location

model = a vector of dummy variables equaling 1 for each unique model number, and 0 for all others

store = a vector of dummy variables equaling 1 for each unique store location, and 0 for all others

β_x = coefficient representing average price elasticity

β_μ = a vector of coefficients representing each unique model number (*m*)

β_γ = a vector of coefficients representing each unique store location (s)

α = constant

[7] Heteroscedasticity is a statistical term that describes errors in prediction that vary in size across different values of a predictor. One of the assumptions of the Ordinary Least Squares (OLS) regression is that the errors are homoscedastic (that the variance around the regression line is the same for all values of a predictor variable), so when they are heteroscedastic, an assumption of the method is violated.

[8] R-squared value is a summary statistic for many regression techniques. It shows the proportion of the total variance in the outcome variable that is correctly predicted by the model's predictor variables.

[9] AIC is a summary statistic that is based on how well the outcome variable is predicted given the number of predictor variables in the regression model. The AIC value has no inherent meaning except in comparison to the values on the same statistic produced by alternative models under consideration. Modelers seek to minimize the AIC value, along with other ways of judging the models.

[10] We received two discounted prices in the data set, one that reflects program discounts and one that reflects other retailer or manufacturer discounts. We included the other retailer or manufacturer discounts in both discounted and non-discounted pricing.

Using the modeled results, the evaluation team estimated sales at non-discounted prices using Equation 3. We used MSRP data supplied as part of the program sales data extract for estimates of non-discounted prices.

Equation 3. Estimating Sales at Non-Discounted Prices

$$\widehat{Sales}_{wo} = Sales_w * \left(\frac{Price_{wo}}{Price_w}\right)^{PC}$$

Where:

$\widehat{Sales}_{wo}$ = Estimated sales without discount (MSRP)

$Sales_w$ = Sales with discount (actual sales)

$Price_{wo}$ = Price without discount (MSRP)

$Price_w$ = Price with discount (actual price)

PC = Price coefficient

We excluded bulbs sold at thrift and dollar stores from the sales data modeling due to lack of price variation, observed in sales data during the evaluation period. We developed NTGRs by comparing the predicted sales at non-discounted prices to the actual sales at program-discounted prices using Equation 4 below.

Equation 4. Sales Data Modeling NTGR Estimation Formula

$$NTGR = \frac{\widehat{Sales}_{wo} - Sales_w}{Sales_w} = \frac{NetSales}{DiscountedSales}$$

Where:

$NTGR$ = NTGR (excluding any SO)

$\widehat{Sales}_{wo}$= Estimated sales without discount (MSRP)

$Sales_w$= Sales with discount

5.2 NTG Results

5.2.1 Market Actor Interviews

Retailer and manufacturer contacts representing sales through non-discount retailers provided widely varying estimates of the portion of ENERGY STAR LED sales that would not occur in the program's absence, ranging from 10% to 90%. However, they consistently suggested that the majority of customers who would move away from ENERGY STAR LEDs would look instead to cheaper non-ENERGY STAR LEDs, which despite being lower quality are still far more efficient than halogen or incandescent alternatives. The provided estimates result in savings-weighted NTGRs at non-discount retailers of 0.137 for DEC and 0.215 for DEP. Because we attempted a census of available retailer and manufacturer contacts, the concept of sampling error does not apply, so there is no estimate of precision for resulting NTGR estimates.

Higher NTGRs for the discount retail channel (0.845 for DEC, 0.852 for DEP) reflect feedback from interviewees that availability of energy-efficient lighting products at many of these stores is largely dependent on the Retail Lighting Program, with the exception of one contact who reported their company would still sell

a small portion of their LEDs through the discount retail channel even in the absence of the program. Customers who shop at these stores, in turn, are likely to be price-sensitive and, in the absence of the energy-efficient products offered through the program, are assumed to purchase the lowest-cost alternative on the market (i.e., an incandescent or halogen product).[11]

Table 15 summarizes the savings-weighted NTGRs based on feedback from retailer and manufacturer contacts.

Table 15. Retailer and Manufacturer Interview NTGR Results

Retail Channel	DEC	DEP
Discount	0.845	0.852
Non-Discount	0.137	0.215

5.2.2 Sales Data Modeling

Using the results from the sales data model, Opinion Dynamics estimated total sales at program-discounted and non-discounted prices separately for each LED product category included in the model (specialty LEDs and reflector LEDs). To arrive at the program-wide NTGR, we weighted the bulb category-specific NTGR estimates by program sales. Because sales records across the entire evaluation period were used and there was no sampling needed, the concept of sampling error does not apply, so there is no estimate of precision for resulting NTGR estimates.

According to the results of the sales data modeling, customers would have purchased fewer LEDs in the absence of program discounts. We found that 86.6% of DEC program sales and 87.0% of DEP program sales would have occurred regardless of the program discounts (i.e., a NTGR of 0.134 for DEC and 0.130 for DEP). It should be noted that this analysis excluded discount store sales.

Table 16 summarizes NTGR results from sales data modeling.

Table 16. Sales Data Modeling NTGR Results

Jurisdiction	NTGR
DEC	0.134
DEP	0.130

Source: Opinion Dynamics sales data modeling analysis.

[11] https://consumerfed.org/wp-content/uploads/2017/11/led-light-bulb-survey-report.pdf

5.2.3 NTG Triangulation and Program-Level NTGR

Based on market actor interview feedback, we estimated a NTGR for sales through discount retailers of 0.845 for DEC and 0.852 for DEP (i.e., we rely on results from the market actor interviews without any additional triangulation). For non-discount retail channels, we developed a final NTGR by averaging the NTGRs derived through market actor interviews (0.137 for DEC; 0.215 for DEP) and sales data modeling (0.134 for DEC; 0.130 for DEP). The resulting NTGR for non-discount sales is 0.135 for DEC and 0.172 for DEP. To arrive at the program-level NTGR, we weighted the NTGRs for the discount and non-discount channels using respective shares of program sales. The resulting program-level NTGR is 0.604 for DEC and 0.635 for DEP, as shown in Table 17.

Table 17. Final Program-Wide NTG Triangulation

Jurisdiction	Retail Channel	Market Actor Interview NTG	Sales Data Modeling NTG	Percentage of Program Sales	Final NTG
DEC	Discount	0.845	N/A	66.1%	0.845
	Non-Discount	0.137	0.134	33.9%	0.135
	Total	**N/A**	**N/A**	**100.0%**	**0.604**
DEP	Discount	0.852	N/A	68.0%	0.852
	Non-Discount	0.215	0.130	32.0%	0.172
	Total	**N/A**	**N/A**	**100.0%**	**0.635**

5.3 Net Impact Results

The evaluation team applied the program-level NTGR to ex post gross energy and peak demand savings to arrive at ex post net savings, as shown in Table 18. The DEC program realized 63.4 GWh in net energy savings, 10.4 MW in net summer peak demand savings, and 4.4 MW in net winter peak demand during the evaluation period. In the same period, the DEP program achieved 45.2 GWh in net energy savings, 7.4 MW in net summer peak demand savings, and 3.1 MW in net winter peak demand.

Table 18. Ex Post Net Savings Summary by Jurisdiction

Jurisdiction	Metric	Ex Post Gross	NTGR	Ex Post Net
DEC	Energy Savings (kWh)	104,940,062	0.604	63,383,847
	Summer Peak Demand Savings (kW)	17,241		10,414
	Winter Peak Demand Savings (kW)	7,278		4,395
DEP	Energy Savings (kWh)	71,205,797	0.635	45,215,699
	Summer Peak Demand Savings (kW)	11,670		7,410
	Winter Peak Demand Savings (kW)	4,942		3,138

6. Process Evaluation

This section details research questions, evaluation activities, and key findings from the process evaluation of the DEC and DEP Retail Lighting programs.

6.1 Research Questions

The evaluation team developed the following process-oriented research questions with input from Retail Lighting Program staff.

- How effective are program implementation, marketing, and data tracking practices?
- Which types of products, retail channels, or store locations can the program target to maximize its influence and minimize free ridership?
- What are the program's strengths or key successes and in what areas are there potential opportunities for improvement?
- What are the current and anticipated future trends in the lighting market?

6.2 Methodology

The process evaluation relied on the following data collection and analytic activities:

- Market actor interviews (n=9)
- Analysis of program tracking data

6.3 Key Findings

The following sections present key findings regarding the evaluation's process-oriented research questions.

6.3.1 Program Implementation and Data Tracking

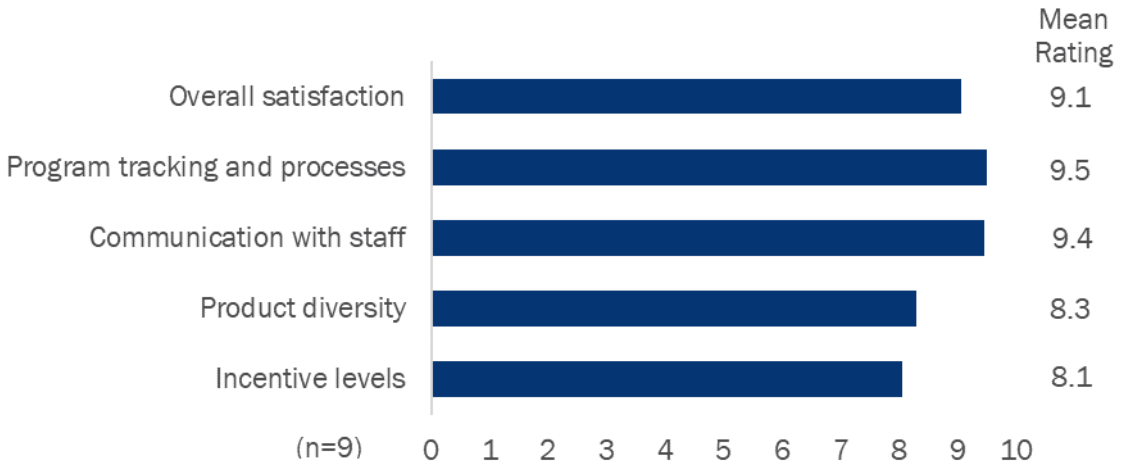
Duke Energy and CLEAResult staff continued to operate the DEC and DEP Retail Lighting programs effectively and without interruption over the course of the evaluation period, adapting on an ongoing basis to target product categories and retail channels where program incentives are most impactful. Program staff maintain clean and comprehensive program tracking data, and the evaluation team found that all data fields were fully populated, including dates, retailer information, product descriptions, pricing, quantities, and specifications. Values appeared both reasonable and internally consistent and included all necessary information to support core evaluation activities.

As part of market actor interviews, we asked contacts at participating retailers and manufacturers to rate their satisfaction and provide feedback on key program elements. Interviewees expressed high satisfaction with all elements of the DEC and DEP Retail Lighting programs, particularly with program processes and program staff engagement. We heard the following comments from interviewees discussing their satisfaction with the Program:

- "We have great communication with the [program] team and CLEAResult, and the in-store execution of their field team is really good."
- "The program is really mature and they've managed it well in the past, so we're in a very good spot where the communication we get is exactly what we need."
- "The Duke program is really well designed, and well implemented by CLEAResult. So our satisfaction is a 10 and I very rarely give that, but like I mentioned before, the Duke program is probably the best-designed program in the country."
- "The communication has been remarkable…many, many utilities don't communicate as well, and it causes issues. We work with CLEAResult staff to identify trouble points in advance, and they discuss with Duke staff and make sure we're all on the same page."

Figure 4 provides average ratings of satisfaction with key program elements from participating retailer and manufacturer staff.

Figure 4. Retailer and Manufacturer Partner Program Satisfaction



The only suggested changes came from those who would like to see a broader mix of bulb types offered at each store. Three of the nine contacts we spoke with expressed an interest in restoring discounts on standard LEDs, with one interviewee commenting, "they don't include some of the higher volume movers. The 60-watt A-line is probably our number one seller and I don't think that's being offered by the program anymore." One interviewee also suggested smart bulbs should be included.

6.3.2 Participating Retailer Coverage

Program staff have made efforts in recent years to prioritize thrift and dollar stores, targeting 65% of program sales through these retailers for the 2021 calendar year. The DEC program came within 1% this target (64%), and the DEP program slightly exceeded it (67%). In the first three months of 2022, 73% of DEC program sales and 75% of DEP program sales occurred at thrift and dollar stores, an increase which reflects the program team's ongoing efforts to reach low-income customer segments less likely to adopt LED products in the absence of program incentives.

Table 19 provides a breakdown of participating store locations and program sales across retail channels. During the evaluation period, discount stores accounted for two-thirds of sales (DEC: 66%, DEP: 68%) in both jurisdictions. DIY stores were another major retail channel for program sales, accounting for 29% of DEC sales and 23% of DEP sales.

Table 19. Program Sales by Jurisdiction, Retail Channel, and Year

Jurisdiction	Retail Channel	2021 Sales		2022 Sales		Total Sales	
		Units	%	Units	%	Units	%
DEC	**Discount Stores**						
	Thrift	759,746	37%	188,586	40%	948,332	38%
	Dollar	561,806	27%	158,874	34%	720,680	29%
	Subtotal	*1,321,552*	*64%*	*347,460*	*74%*	*1,669,012*	*67%*
	Non-Discount Stores						
	DIY	617,807	30%	104,321	22%	722,128	29%
	Big Box	110,048	5%	22,418	5%	132,466	5%
	Hardware	1,367	<1%	0	0%	1,367	<1%
	Subtotal	*729,222*	*35%*	*126,739*	*27%*	*855,961*	*34%*
	All Channels	**2,050,774**	**100%**	**474,199**	**100%**	**2,524,973**	**100%**
DEP	**Discount Stores**						
	Thrift	639,908	42%	99,184	37%	739,092	41%
	Dollar	384,977	25%	103,575	38%	488,552	27%
	Subtotal	*1,024,885*	*67%*	*202,759*	*75%*	*1,227,644*	*68%*
	Non-Discount Stores						
	DIY	365,664	24%	51,965	19%	417,629	23%
	Big Box	66,357	4%	13,849	5%	80,206	4%
	Hardware	77,242	5%	2,625	1%	79,867	4%
	Subtotal	*509,263*	*33%*	*68,439*	*25%*	*577,702*	*31%*
	All Channels	**1,534,148**	**100%**	**271,198**	**100%**	**1,805,346**	**100%**

Source: Opinion Dynamics analysis of program tracking data.

6.3.3 Non-Participating Discount Retailers

Two of the manufacturer representatives we spoke with as part of the market actor interviews work with both participating retailers and several other discount retailers not currently engaged with the program. These retailers do not fall into traditional thrift or dollar store categories, including stores like Ollie's Bargain Outlet, Maxway, Super 10, and Bargain Town. When speaking with these manufacturing contacts, we explored the potential for future sales of program-discounted LEDs at these retailers. Both interviewees confirmed these retailers would be interested in selling program-discounted bulbs and that they currently do not stock lighting products or predominantly stock halogens and incandescents. The two contacts also indicated that these retailers cater to disadvantaged customers and that the majority of their market is low-income, indicating they are strong candidates for future targeting by the Retail Lighting Program.

6.3.4 Program Marketing and Outreach

In spite of the COVID-19 pandemic, program staff continued to implement a wide range of promotions, marketing, and outreach while abiding by applicable and evolving health and safety standards throughout 2021 and Q1 2022. Program marketing focused on promoting program discounts and educating customers about the benefits of energy-efficient LED lighting. Over the course of the evaluation period, the DEC and DEP Retail Lighting programs relied on a range of marketing and outreach tactics, including direct mail and email campaigns and store visits to ensure proper placement of POP marketing:

- Store visits and POP marketing material placement. Over the course of the evaluation period, field staff completed a total of 3,172 store visits in DEC territory and 2,390 in DEP territory. During these visits, field staff checked for the presence and proper placement of program POP materials, updated materials as necessary, and checked for sufficient levels of inventory of program-discounted lighting products. The frequency of store visits varied by retailer based on sales volume. This enabled team members to concentrate their visits on stores that had higher sales volumes and tended to discount more products.
- Direct mail, mass media, and other marketing. Other sources of program marketing included targeted direct mail, email blasts, and web banners.

6.3.5 Lighting Market Dynamics

Industry professionals acknowledged an ongoing shift in market trends and customer preferences towards LED products. LED manufacturing costs continued to drop in recent years, and sale prices are further reduced by utility program discounts, allowing rapid market growth over the past decade. Many manufacturers have now halted production of CFLs; in fact, just one of the nine contacts we spoke with reported their company still manufactures CFLs. Many are producing both ENERGY STAR and non-ENERGY STAR LEDs, which often have shorter lifespans and lower light quality. Among the manufacturer contacts we interviewed, non-ENERGY STAR LEDs made up as much as 40% of shipments. Two interviewees acknowledged that utility incentives play a role in their company's decisions regarding how many products are designed to meet ENERGY STAR qualifications. The general consensus among industry experts we spoke with was that although most customers recognize the ENERGY STAR label, it does not play as big of a role in their decision-making as other considerations such as cost, brand, or utility endorsements.

Industry professionals also acknowledged impacts of the COVID-19 pandemic, which caused supply chain slowdowns that continued into 2021 and early 2022. Of the six contacts who reported supply chain challenges, five indicated that while some issues persisted, they had established stocking practices by the start of 2022 that effectively counteract any unanticipated shipping delays. Two interviewees also

acknowledged that while store traffic was lower during the pandemic, lighting sales were actually higher with customers spending more time at home and perhaps utilizing certain parts of the home more regularly than they did previously. Both of these contacts acknowledged that these patterns had started to subside in late 2021 and early 2022.

6.3.6 Lighting Market Outlook

Among the three manufacturers we spoke with that still produce incandescent or halogen bulbs in 2022, all expect to cease production and shipment of those less efficient products before the end of the year to comply with new federal efficiency standards announced in April 2022. Both contacts familiar with stocking practices at participating retailers commented that their stores will continue selling incandescent and halogen bulbs in the first half of 2023 but will plan to sell through that stock in Q1 or Q2. While this feedback reflects a small sample of retailers and manufacturers, it signals industry leaders are likely to conform to new federal standards on the proposed timeline to avoid incurring financial penalties. As such, LEDs are likely to be the only products available on most store shelves by July 2023 at the latest. In light of these developments, Duke Energy staff plan to end POS lighting discounts by July 2023, and also anticipate introducing POS discounts for non-lighting energy-efficient consumer electronics at many of the same retailers currently selling program-discounted lighting.

7. Conclusions and Recommendations

7.1 Conclusions

From January 1, 2021, through March 31, 2022, the Duke Energy Retail Lighting Program sold over 2.5 million discounted energy-efficient bulbs and fixtures in the DEC jurisdiction and 1.8 million in the DEP jurisdiction. The DEC program achieved ex ante gross energy savings of 94.5 GWh, and the DEP program achieved 60.6 GWh of gross savings. Sales and ex ante gross savings by jurisdiction and product category are reported in Table 20.

Table 20. DEC & DEP Retail Lighting Program Performance

Jurisdiction	Product Category	Units	% of Sales	Ex Ante Gross Savings (kWh)	% of Savings
DEC	Reflector LEDs	726,421	29%	34,645,143	37%
	Specialty LEDs	696,192	28%	21,384,591	23%
	Standard LEDs	564,965	22%	16,999,797	18%
	LED Fixtures	537,395	21%	21,447,434	23%
	All Categories	**2,524,973**	**100%**	**94,476,965**	**100%**
DEP	Reflector LEDs	495,137	27%	21,421,623	35%
	Specialty LEDs	451,764	25%	14,248,159	24%
	Standard LEDs	534,719	30%	15,341,088	25%
	LED Fixtures	323,726	18%	9,592,001	16%
	All Categories	**1,805,346**	**100%**	**60,602,872**	**100%**

The DEC program realized 104.9 GWh in ex post gross energy savings, 17.2 MW in summer peak demand savings, and 7.3 MW in winter peak demand savings during the evaluation period. In the same period, the DEP program realized 71.2 GWh in ex post gross energy savings, 11.7 MW in summer peak demand savings, and 4.9 MW in winter peak demand savings.

Gross realization rates for the DEC program were 111% for energy savings, 111% for summer peak demand savings, and 105% for winter peak demand savings. The DEP program gross realization rates were 117% for energy savings, 117% for summer peak demand savings, and 111% for winter peak demand savings.

After applying NTGRs established by the current evaluation, the DEC program achieved 63.3 GWh in ex post net energy savings, 10.4 MW in summer peak demand savings, and 4.4 MW in winter peak demand ex post net savings. The DEP program achieved 45.2 GWh in ex post net energy savings, 7.4 MW in summer peak demand savings, and 3.1 MW in winter peak demand ex post net savings.

Table 21 summarizes total ex ante, ex post gross, and ex post net savings.

Table 21. Program Impact Evaluation Results

Jurisdiction	Metric	Ex Ante	Gross RR	Ex Post Gross	Effective NTGR	Ex Post Net
DEC	Energy Savings (kWh)	94,476,965	111%	104,940,087	0.604	63,383,847
	Summer Peak Demand Savings (kW)	15,586	111%	17,241		10,414
	Winter Peak Demand Savings (kW)	6,915	105%	7,278		4,395
DEP	Energy Savings (kWh)	60,602,872	117%	71,205,792	0.635	45,215,699
	Summer Peak Demand Savings (kW)	9,981	117%	11,670		7,410
	Winter Peak Demand Savings (kW)	4,439	111%	4,942		3,138

The evaluation team identified the following high-level process findings based on research conducted as part of the current evaluation:

- Participating manufacturer and retailer contacts express high satisfaction with key program elements and the program overall.
- Program tracking data is clean and comprehensive, contained fully populated and internally consistent data fields, and included all necessary information to support core evaluation activities.
- The program team's ongoing efforts to prioritize dollar and thrift stores and reach low-income customer segments has been a success with these retail channels accounting for 64% of all DEC sales and 67% of DEP sales during the evaluation period.
- Several discount retailers that do not fall into traditional thrift or dollar store categories, such as Ollie's Bargain Outlet and Maxway, share key characteristics (i.e., stocking practices and customer demographics) and are therefore strong candidates for future program engagement.
- LED market share continues to increase aided by ongoing decreases in manufacturing costs and by the availability of utility program discounts. Non-ENERGY STAR LEDs, which are energy-efficient but often have shorter lifespans and lower light quality, are emerging as a more prevalent lower-cost alternative to ENERGY STAR LEDs.
- The COVID-19 pandemic affected the residential lighting supply chain, store traffic, and customer demand, but these patterns started to subside in late 2021 and early 2022.
- Participating retailer and manufacturer staff expect to halt production of halogen and incandescent products by the end of 2022 and sell through any existing inventory of those products by the end of Q2 2023 to comply with new federal lighting efficiency standards announced in April 2022.
- In light of anticipated market developments, Duke Energy staff plan to end POS lighting discounts by July 2023 and will begin offering POS discounts for non-lighting energy-efficient consumer electronics.

7.2 Recommendations

Based on the findings of this evaluation, the evaluation team identified the following opportunities for program improvement:

- Continue to prioritize retailers that disproportionally serve low-income customers, such as thrift, dollar, and other discount stores, given this customer segment is less likely to purchase energy-efficient lighting in the absence of incentives (i.e., exhibit lower free ridership).
- Continue to provide discounts on LED bulbs and fixtures through the end of 2022, and potentially the first half of 2023 at retailers that continue to stock incandescent or halogen lighting products. Anticipate that LED products will be the only lighting available on most store shelves by July 2023 at the latest.
- Given the new federal lighting efficiency standards and associated market changes, we support Duke Energy's plans to end POS lighting discounts by July 2023 and diversify upstream program offerings to include non-lighting energy-efficient products.

8. Summary Form

DUKE ENERGY CAROLINAS & DUKE ENERGY PROGRESS RETAIL LIGHTING PROGRAM

COMPLETED EM&V FACT SHEET

PROGRAM DESCRIPTION

The Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) Retail Lighting program provides incentives to provide price markdowns on efficient LED lighting products. The program, launched in DEP in January 2010 and expanded to DEC in early 2016, promotes customer awareness and adoption of program-discounted products through a range of marketing and outreach strategies. Product mix includes a wide range of ENERGY STAR® LED bulbs and fixtures. Participating stores represent a variety of retail channels with an emphasis on thrift and dollar stores.

Date:	December 5, 2022
Region(s):	Duke Energy Carolinas (DEC) Duke Energy Progress (DEP)
Evaluation Period:	January 1, 2021– March 31, 2022
Annual MWh Savings: **(Ex Post Net)**	DEC: 63,384 MWh DEP: 45,216 MWh
Coincident MW Impact: **(Ex Post Net)**	DEC: 10.4 MW (Summer), 4.4 MW (Winter) DEP: 7.4 MW (Summer), 3.1 MW (Winter)
Measure Life:	Not Evaluated
Net-to-Gross Ratio:	DEC: 0.604 DEP: 0.635
Process Evaluation:	Yes
Previous Evaluation(s):	DEP-DEC Energy Efficient Lighting & Retail LED Programs Evaluation. April 6, 2018.

EVALUATION METHODOLOGY

The evaluation team reviewed program tracking data and ex ante deemed savings assumptions. We then developed updated per-unit deemed savings based on review of secondary sources including Technical Reference Manuals and prior evaluations. We conducted an engineering impacts analysis, applying leakage and in-service rate assumptions from secondary sources to ex post per-unit savings to calculate ex post gross energy and demand savings estimates.

The evaluation team interviewed participating retailer and manufacturer contacts and used their feedback along with results of sales data modeling to develop channel and jurisdiction-specific net-to-gross ratios. We applied these net-to-gross ratios to ex post gross savings to determine net program impacts.

We also completed a process analysis based on interviews with retailer and manufacturer contacts, conversations with program staff, and review of program sales data extracts, marketing materials, and field reports.

9. DSMore Table

The Excel spreadsheet containing measure-level inputs for Duke Energy Analytics is provided below. Per-measure savings values in the spreadsheet are based on the gross and net impact analyses reported above. The evaluation scope did not include updates to measure life assumptions.

[DSMore Table provided as a separate file]

Appendix A. Detailed Impacts Dataset

The Excel spreadsheet provided in this appendix contains detailed analysis of program gross and net impacts. The data in the file are provided by jurisdiction, state, and unique product. The file contains ex ante, ex post gross, and net savings, and all parameters and assumptions used to calculate ex post gross and net savings.

[Detailed Impacts Dataset provided as a separate file]

Appendix B. Deemed Savings Review

This appendix contains the deemed savings review memorandum developed as part of this evaluation, which provides a detailed summary of gross impacts assumptions, their sources, and resulting per-unit savings.

[Deemed Savings Review Memorandum provided as a separate file]

Appendix C. Market Actor Interview Guide

This appendix contains the data collection instrument used for the market actor interviews conducted in support of this evaluation.

[Market Actor Interview Guide provided as a separate file]

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