APPENDIX F

EM&V Report for the Small Business Energy Saver Program

Duke Energy Ohio

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1. EVALUATION SUMMARY

1.1 Program Summary

The Small Business Energy Saver (SBES) Program is part of a portfolio of energy efficiency programs operated by Duke Energy. Duke Energy selected SmartWatt Energy to implement the SBES program in the Duke Energy Ohio (DEO) jurisdiction for this evaluation cycle. The program caters specifically to small business customers and offers a performance-based incentive up to 80 percent of the total project cost, inclusive of both materials and installation, on high-efficiency lighting and refrigeration equipment.

The SBES Program generates energy savings and peak demand reductions by offering eligible customers a streamlined service including marketing outreach, technical expertise, and performance incentives to reduce equipment and installation costs from market rates on high-efficiency lighting, refrigeration, and HVAC equipment. The SBES Program seeks to bundle all eligible measures together and offer them as a single project in order to maximize the total achievable energy and demand savings, while working with customers to advise equipment selection to meet their unique needs.

1.2 Evaluation Objectives and High Level Findings

Evaluation, Measurement, and Verification (EM&V) involves the use of a variety of analytic approaches, including on-site verification of installed measures and application of engineering models. EM&V also encompasses an evaluation of program processes and customer feedback, typically conducted through participant surveys and program staff interviews. This report details the EM&V activities that Navigant Consulting, Inc. (Navigant) performed on behalf of Duke Energy for the SBES Program.

This report covers EM&V activities performed for projects covering the period between January 1, 2015 through February 29, 2016, referenced simply as PY2015 for the remainder of this report. This evaluation period begins at program inception, although organizational activities began in late 2014 in preparation of program launch.

The primary purpose of the evaluation assessment is to estimate net annual energy and peak demand impacts associated with SBES activity. Net savings are calculated as the reported “gross” savings from Duke Energy, verified and adjusted through EM&V, and netted for free ridership (i.e., savings that would have occurred even in the absence of the program) and spillover (i.e., additional savings attributable to the program but not captured in program records).

- Navigant performed impact and process evaluations for this EM&V assessment. The impact evaluation consists of engineering analysis and on-site field verification and metering to validate energy and demand impacts of reported measure categories, as well as a participant survey to assess net impacts.
- For the process evaluation, Navigant completed surveys with 92 participants and interviews with program staff and the implementation contractor (IC) to characterize the program delivery and identify opportunities to improve the program design and processes. The evaluation team also used the participant survey data to estimate free ridership and spillover to calculate an NTG ratio.

The evaluation team verified gross energy savings at 100 percent of deemed reported energy savings, and gross summer peak demand reductions at 77 percent. A net-to-gross (NTG) ratio was estimated at

1.02, yielding total verified net energy savings of 23,065 megawatt-hours (MWh), and net summer peak demand reductions of 3.8 megawatts (MW) (Table 1-1 through Table 1-4). It is important to note that although the gross realization rate was 100 percent, there was variability in the verified savings at the individual project level. Furthermore, the evaluation team found that metered hours of use for lighting measures were often lower than reported hours of use, but these impacts were offset by the fact that Duke Energy did not incorporate HVAC interactive effects into the reported savings estimates. The NTG ratio of 1.02 indicates that the program is directly responsible for energy and demand savings, and that savings would not have occurred in the absence of the program.

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

	Claimed	Evaluated	Realization Rate
Gross Energy Impacts (MWh)	22,611	22,613	1.00

Source: Navigant analysis and Duke Energy tracking data.

Table 1-2. Program Claimed and Evaluated Gross Peak Demand Impacts

	Claimed	Evaluated	Realization Rate
Gross Summer Peak Demand Impacts (MW)	4.8	3.7	0.77
Gross Winter Peak Demand Impacts (MW)	5.3	3.2	0.59

Source: Navigant analysis and Duke Energy tracking data.

Table 1-3. Program Net Energy Impacts

	MWh
Net Energy Impacts (MWh)	23,065

Source: Navigant analysis.

Table 1-4. Program Net Peak Demand Impacts

	MW
Net Summer Peak Demand Impacts (MW)	3.8
Net Winter Peak Demand Impacts (MW)	3.2

Source: Navigant analysis.

1.3 Evaluation Parameters and Sample Period

To accomplish the evaluation objectives, Navigant performed a variety of primary and secondary research activities including:

- Engineering review of measure savings algorithms
- Field verification and metering to assess installed quantities and characteristics
- Participant surveys with customers to assess satisfaction and decision-making processes.

Table 1-5 summarizes the evaluated parameters. The targeted sampling confidence and precision was 90 percent ± 10 percent, and the achieved was 90 percent ± 2.1 percent for energy savings, 8.5 percent for summer and 4.4 percent for winter peak demand reductions.[1]

Table 1-5. Evaluated Parameters

Evaluated Parameter	Description	Details
Efficiency Characteristics	Inputs and assumptions used to estimate energy and demand savings	1. Lighting wattage 2. Operating hours 3. Coincidence factors 4. HVAC interactive effects 5. Baseline characteristics
In-Service Rates	The percentage of program measures in use as compared to reported	1. Measure quantities found onsite
Satisfaction	Customer satisfaction with various stages of their project	1. Overall satisfaction with program 2. Satisfaction with implementation and installation contractors 3. Satisfaction with program equipment
Free Ridership	Fraction of reported savings that would have occurred in the absence of the program	
Spillover	Additional, non-reported savings that occurred as a result of participation in the program	1. Inside spillover (at same facility as program measures) 2. Outside spillover (at different facility as program measures)

Source: Navigant analysis

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

Table 1-6. Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification and metering	October 24, 2016	December 9, 2016
Participant Phone Surveys	October 17, 2016	October 27, 2016

Source: Navigant analysis

[1] Navigant designed the impact sample to achieve 90/10 confidence and precision using the industry-standard coefficient of variation of 0.5, results from previous (PY2013 through PY2015) SBES program evaluations in other Duke Energy jurisdictions, and Navigant judgement. The final precision was different due to natural variation in individual site level characteristics.

1.4 Recommendations

The evaluation team recommends ten discrete actions for improving the SBES Program, based on insights gained through the evaluation effort. These recommendations, summarized in Table 1-7, provide Duke Energy with a roadmap to fine-tune the DEO SBES Program for continued success and include the following broad objectives.

Table 1-7. Summary of PY2015 SBES Recommendations

Increasing Program Participation
1. **Increase marketing and publicity for the program.** This is the most common recommendation from participants, indicating that there is significant opportunity for participation beyond those that participated in PY2015. As a new program for PY2015 it is reasonable to have a phased rollout with growing participation, however.
2. **Emphasize non-energy benefits of program participation**, especially reduced maintenance. This can also include increased lighting quality, comfort for both business employees and customers, and environmental benefits. LED lighting measures typically offers the most significant non-energy benefits, and should be featured in program marketing materials.
Increasing Customer Satisfaction
3. **Prioritize customer satisfaction through training for installation contractors and customer follow-up services.** A minority of customers reported issues with installation and lighting equipment. Additionally, some customers are not perceiving savings on their electric bill, and managing this expectation should enhance customer satisfaction.
4. **Phase out fluorescent lighting systems and CFL lamps.** Linear LED lighting offers substantial savings above high-performance/reduced wattage T8 lamps and ballasts, which are increasingly perceived as outdated. Similarly, LED lamps offer slight savings above CFL lamps, and typically result in higher customer satisfaction.
Improving Accuracy of Reported Savings
5. **Ensure that detailed customer contact information is populated in the tracking database.** The evaluation team found missing contact information for some projects, which increases the difficulty of reaching customers for EM&V activities. Accurate contact information ensures that the team is able to get in touch with the key decision maker and ensures that data collected is as accurate as possible.
6. **Track burnout lamps and fixtures during the initial audit.** While the tracking data has a field for recording burnout fixtures, this was populated with a value of zero for all measures. It is likely that some burnouts were present, and may contribute to customers not realizing expected savings on their energy bills.
7. **Track LED refrigerated case lighting measures together.** LED case lighting measures are not always a direct 1-for-1 replacement, and therefore removal of the baseline equipment and installation of the efficient equipment were separated in the tracking data. The evaluation team suggests linking these measure records in the data so that it's clear what the baseline and efficient systems are.
8. **Add connected load to occupancy sensor savings estimates.** Occupancy sensor savings were missing details on connected fixture load. This is a key input to the savings calculation and should be recorded

9.	**Apply HVAC interactive effects and coincidence factors for lighting measures.** Duke Energy should apply relevant HVAC interactive effects and coincidence factors to lighting measures as appropriate, and ensure these values are selected based on the installation location. For example, lighting measures installed in unconditioned spaces should not receive HVAC interactive effects, and exterior lighting that is not on during the day should not receive coincident demand savings. Duke Energy should also consider different deemed coincident factors for summer and winter demand savings.
10.	**Ensure that efficient lighting power ratings for high bay, exterior, and linear LED systems are accurate.** Manufacturer specifications for lighting power report different wattages that the system may draw depending on the specific configuration. As the share of savings attributed to linear LED systems grow, this should be quantified to reduce EM&V risk in future years.

Source: Navigant analysis

2. PROGRAM DESCRIPTION

The Small Business Energy Saver (SBES) Program is part of a portfolio of energy efficiency programs operated by Duke Energy. The program launched in the DEO jurisdiction in late 2014, and first claimed energy savings in January 2015. Duke Energy followed best practices from the successful SBES program operating in other Duke Energy jurisdictions since 2013.

2.1 Program Design

The SBES Program is available to qualifying commercial customers with less than 100 kilowatts (kW) demand service. After completing the program application to assess participation eligibility, customers receive a free energy assessment to identify equipment for upgrade. SmartWatt Energy reviews the energy assessment results with the customer, who then chooses which equipment upgrades to perform. Qualified contractors complete the equipment installations at the convenience of the customer.

The SBES Program recognizes that customers with lower savings potential may benefit from a streamlined, one-stop, turnkey delivery model and relatively high incentives to invest in energy efficiency. Additionally, small businesses may lack internal staffing dedicated to energy management and can benefit from energy audits and installations performed by an outside vendor.

The program offers incentives in the form of a discount for the installation of measures, including high-efficiency lighting and refrigeration equipment. These incentives increase adoption of efficient technologies beyond what would occur naturally in the market. In PY2015, the SBES Program achieved the majority of program savings from lighting measures, which tend to be the most cost-effective and easiest to market to potential participants. The SBES program also achieved program savings from refrigeration measures, namely LED case lighting and upgraded motors.

The program offers a performance-based incentive up to 80 percent of the total project cost, inclusive of both materials and installation. Multiple factors drive the total project cost, including selection of equipment and unique installation requirements.

2.2 Reported Program Participation and Savings

Duke Energy and the implementation contractor maintain a tracking database that identifies key characteristics of each project, including participant data, installed measures, and estimated energy and peak demand reductions based on assumed (“deemed”) savings values. In addition, this database contains measure level details that are useful for EM&V activities.

In addition to the aforementioned measure level tracking database, Duke Energy maintains demand savings ratios (kW/kWh) by measure that are used to calculate the final claimed summer and winter demand savings estimates. These ratios are based on the energy savings (kWh) values reported in the primary tracking database and include average adjustments for coincidence factors and other parameters affecting demand savings. For this report, Navigant based the analysis of verified demand savings on the primary tracking database despite the incomplete coincidence factor information, while calculating final demand realization rates by comparing verified demand savings to reported demand savings calculated from these ratios. This was done in an effort to both provide accurate demand realization rates and attempt to reduce sampling uncertainty.

Table 2-1 provides a summary of the gross reported energy and demand savings and participation for PY2015.

Table 2-1. Reported Participation and Gross Savings Summary

Reported Metrics	PY2015
Participants	871
Measures Installed	56,942
Gross Annual Energy Savings (MWh)	22,611
Average Quantity of Measures per Project	65
Average Gross Savings Per Project (MWh)	26.0

Source: SBES Tracking Database

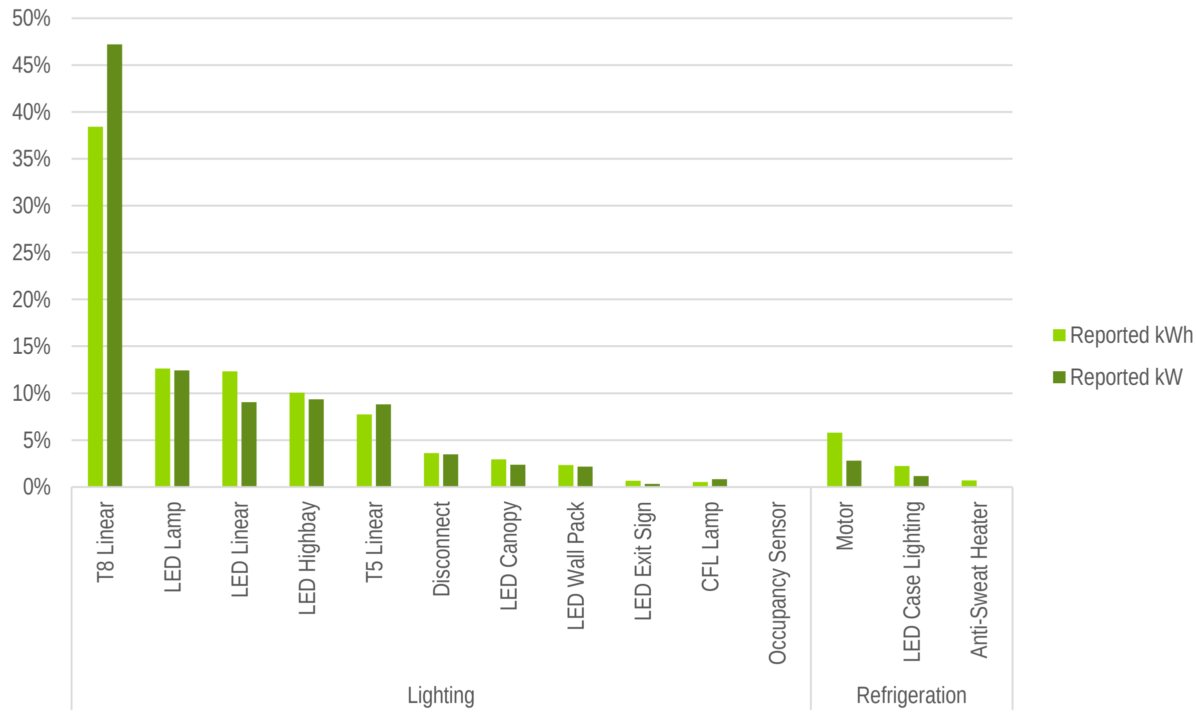
Duke Energy Ohio uses assumptions and algorithms from the Pennsylvania Technical Reference Manual[2] (PA TRM) as the basis for reported (deemed) energy and demand savings for program measures. This TRM is robust, well-established, and follows industry best practices for the measures found in the SBES program. The team used the PA TRM rather than the draft Ohio TRM because it receives annual updates that reflect current research into energy savings parameters, such as annual hours of use and appropriate baseline wattages, whereas the draft Ohio TRM has not been updated since 2010.The evaluation team believes the PA TRM is an appropriate basis for estimating savings in the DEO jurisdiction.

2.2.1 Program Summary by Measure

Efficient T8 lighting retrofits were the highest contributor to program energy and demand savings in PY2015, followed by a variety of LED lighting measures. In addition, refrigeration measures (including EC motors, LED case lighting, and anti-sweat heaters), compact fluorescent lamps (CFLs), and occupancy sensors also contributed to savings. The SBES program has adopted a variety of LED lighting products in PY2015, but linear T8 lighting makes up the majority of savings. Overall, lighting measures contribute 91 percent of reported program energy savings, while refrigeration measures contribute the remaining 9 percent. Figure 2-1 shows the reported gross savings by measure category as reported by Duke Energy.

[2] TECHNICAL REFERENCE MANUAL. State of Pennsylvania Act 129: Energy Efficiency and Conservation Program & Act 213: Alternative Energy Portfolio Standards. June 2015.

Figure 2-1. Reported Gross Energy Savings by Measure Category

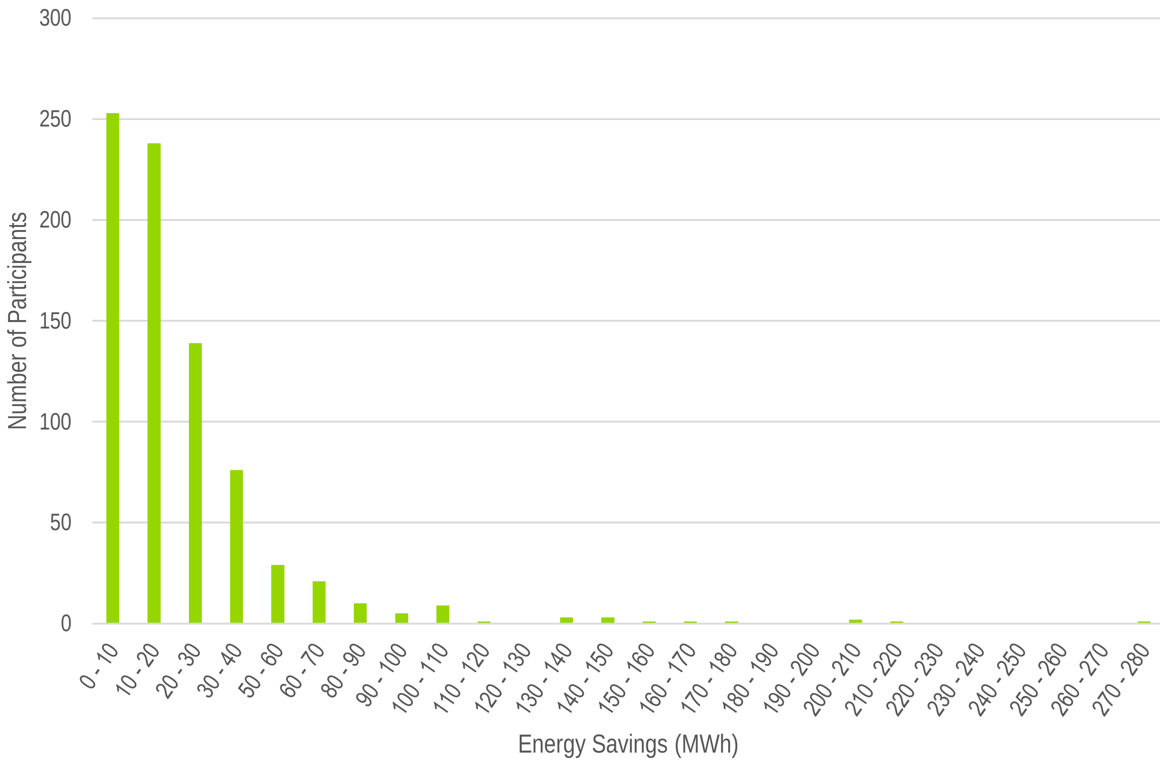


Source: SBES Tracking Database

2.2.2 Savings by Project

Because the SBES program is limited to small business customers only, the variations in project energy and peak demand savings and the quantity of measures installed exhibit a more narrow spread than typical large business program offerings. Nevertheless, there is still a mix of various project sizes, as shown in Figure 2-2, with very few project sites reporting savings over 200 MWh per year. The largest site reported savings of 273 MWh per year.

Figure 2-2. Histogram of Reported Energy Savings per Project

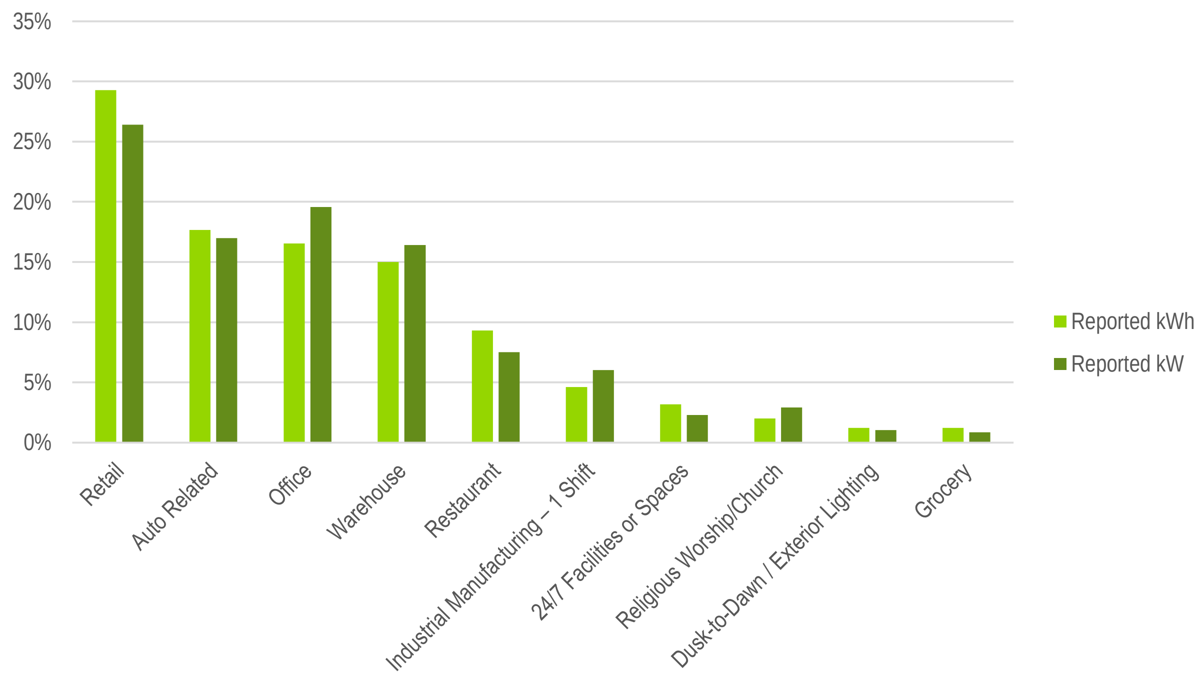


Source: SBES Tracking Database

2.2.3 Savings by Facility Type

The evaluation team reviewed the business type data in the tracking database to understand the participant demographics. The top ten facility types are shown below in Figure 2-3. The distribution of facility types is representative of a large variety of small business customers, indicating that the program is successfully recruiting participants across several sectors. The retail, auto, office and warehouse facilities represent the largest contributors or energy and demand savings.

Figure 2-3. Reported Energy Savings by Facility Type



Source: SBES Tracking Database

3. KEY RESEARCH OBJECTIVES

As outlined in the Statement of Work (SOW), the primary purpose of the EM&V activities is to estimate verified gross and net annual energy and peak demand impacts associated with program activity for PY2015. Additional research objectives include the following:

3.1 Impact Evaluation

The impact evaluation focuses on quantifying the magnitude of verified energy savings and peak demand reductions. Objectives include:

- Verify deemed savings estimates through review of measure assumptions and calculations.
- Perform on-site verification of measure installations, and collect data for use in an engineering analysis.
- Estimate the amount of observed energy and peak demand savings (both summer and winter) by measure via engineering analysis.

3.2 Net-to-Gross Analysis

The net-to-gross analysis focuses on estimating the share of energy savings and peak demand reductions that can be directly attributed to the SBES program itself. Objectives include:

- Assess the Net-to-Gross ratio by addressing spillover and free-ridership in participant surveys.

3.3 Process Evaluation

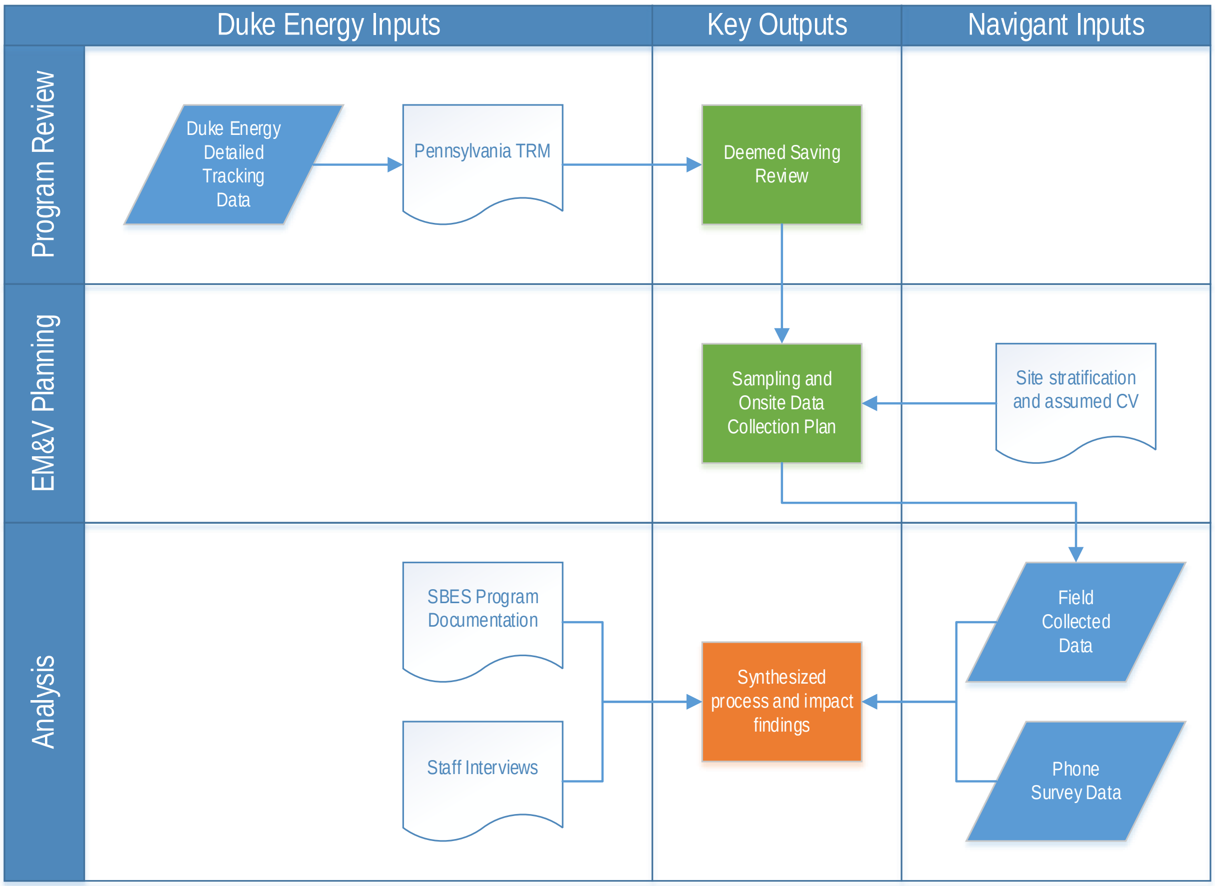
The process evaluation focuses on the program implementation and the customer experience. Objectives include:

- Perform interviews with program management and Implementation Contractor.
- Perform participant surveys with customers.
- Identify barriers to participation in the program, and how the program can address these barriers.
- Identify program strengths and the potential for introducing additional measures.

3.4 Evaluation Overview

Figure 3-1 outlines the high-level approach used for evaluating the SBES Program, which is designed to address the research objectives outlined above. The impact, net-to-gross, and process sections provide further detail for each of the individual EM&V activities.

Figure 3-1. Evaluation Process Flow Diagram



Source: Navigant analysis

4. IMPACT EVALUATION

The purpose of this impact evaluation is to quantify the verified gross and net energy and demand savings estimates for the SBES Program. Table 4-1 shows high-level program results of Navigant's impact analysis. Ultimately, Duke Energy can use these results as an input to system planning. As noted above, although the program-level gross realization rate is 100 percent, Navigant found variability in site-level results. A common finding was that metered operating hours for lighting measures were less than reported operating hours, but the effect of this was offset because Duke Energy did not incorporate HVAC interactive factors into the reported savings estimates.

Table 4-1. PY2015 SBES Summary of Program Impacts

	Energy Savings (MWh)	Summer Peak Demand Reductions (MW)	Winter Peak Demand Reductions (MW)
Reported Gross Savings	22,611	4.8	5.3
Realization Rate	1.00	0.77	0.59
Verified Gross Savings	22,613	3.7	3.2
NTGR	1.02	1.02	1.02
Verified Net Savings	23,065	3.8	3.2

Source: Navigant analysis

4.1 Impact Methodology

The methodology for assessing the gross energy savings and peak demand reductions follows IPMVP Option A (Retrofit Isolation: Key Parameter Measurement)[3]. This involves an engineering-based approach for estimating savings, supplemented by key parameter measurements. This included using time-of-use lighting loggers to directly measure operating hours and coincidence factors for program-incented lighting measures. Note that for the refrigeration measures, verification activities were performed on-site to assess installation and operation.

The evaluation team employed the following steps to conduct the impact analysis:

1. **Review Field Data and Design Sample** – First, the team analyzed the tracking data to determine the most appropriate sampling methodology. The team created four strata based on reported energy savings (small, medium, and large lighting, and refrigeration) to ensure that a variety of different businesses and measures were captured in the site visits. A subset of each strata was selected for more detailed data logger deployment (24 of 60 total sites visits were logged).
2. **Pull Sample** – Next, the team pulled a sample from the four strata and scheduled site visits, including several backup sites in the event that a visitation could not be arranged.

[3] International Performance Measurement & Verification Protocol Concepts and Options for Determining Energy and Water Savings Volume I. http://www.nrel.gov/docs/fy02osti/31505.pdf

3. **Perform Participant Site Visits** – The evaluation team used an electronic data collection system in the field to ensure consistency and decrease data processing time. For all site visits, Navigant field technicians uploaded all collected site data to the online system as soon as they were completed. Navigant performed quality control verifications for all field data collection forms and online data entry. This included a thorough inspection of each site's building characteristic inputs, operating schedules, measure-level in-service rates, and descriptions. The following steps were taken at each participant site:
   a. The team first determined the in-service rate (ISR) of the equipment for each measure found. The field technicians accomplished this by visually verifying and counting all equipment included in the project documentation.
   b. The team then calculated the difference in watts between the base-case fixtures and the energy-efficient fixtures for each fixture type installed on-site. The team verified efficient fixture wattage through visual inspection, while deriving base-case fixture wattage from customer-provided data found in the documentation review, if available, or from information found by field technicians during the site visits. There is typically little to no information about the specifications of base-case equipment that has been removed from a site. If both customer data and field data were insufficient, the team utilized the tracking data and assessed the reasonableness of their assumptions.
   c. Operating hours were determined from a detailed customer interview for each unique lighting schedule in the building, and adjusted for holiday building closures. For the subset of sites that received logging, the EM&V team left time-of-use loggers in place for roughly four weeks and then returned to retrieve the logging equipment.
   d. Coincidence factors and HVAC interactive factors were taken from the PA TRM. For logged sites, the team calculated both summer and winter coincidence factors from the logger data.
4. **Calculate Site-Level Savings** – The team calculated site-level energy and demand savings for each site in the sample based on operational characteristics found on site and engineering-based parameter estimates.
5. **Calculate Program-Level Savings** – The team calculated verification rates for all sites and applied a ratio, representing the adjustment based on the logger data, resulting in final verified savings for each sampled site. Lastly, the team calculated stratum-level realizations rates, applied those realization rates to the projects that fell into their respective strata, and arrived at final program-level realization rates. Note that for demand savings, final program-level realization rates were calculated by comparing verified demand savings to reported demand savings using the demand ratios outlined in section 2.2.

4.2 Sample Design

After reviewing the tracking data, the evaluation team opted to split up the population of projects into four strata based on the projects' estimated energy savings to ensure that the sample represented both small, medium and large customers, and that field verification assessed a large percentage of program savings. The strata were designed according to the following guidelines:

1. First, all projects with refrigeration measures were assigned to a single stratum, irrespective of project savings. Navigant classified LED case lighting as a refrigeration measure rather than a lighting measure for the purpose of sample design.
2. The remaining projects were sorted from highest claimed savings to lowest claimed savings.

3. The team then examined the reported savings and selected criteria that would result in three strata, each containing an approximately equal share of total claimed savings, and the refrigeration stratum:
    - Lighting Large – greater than 60,000 kWh reported savings;
    - Lighting Medium – between 25,000 kWh and 60,000 kWh reported savings;
    - Lighting Small – less than 25,000 kWh savings;
    - Refrigeration – all projects with refrigeration savings.

In order to achieve a 10 percent relative precision at a 90 percent confidence interval, the evaluation team targeted 60 total sites, which were spread roughly equally among the three lighting strata and the refrigeration stratum.

The evaluation team conducted on-site verification at 60 sites during the fall of 2016. While on-site, the team conducted customer interviews and visual verification to collect data on building operation, HVAC system details, and seasonal and holiday schedules. Key evaluation parameters came primarily from on-site data; however, where this data was lacking or was deemed unusable, customer application data was used in its place. As there are many parameter inputs to the savings calculation for each site, this approach ensures that the best available data are used for each site's savings estimation. Table 4-2 below details the final site visit disposition.

Table 4-2. Onsite Sample Summary

Strata	Population Size	Onsite Verification Sample Size	Onsite Metering Sample Size (Subset of Verification Sample)
Lighting Large	52	14	6
Lighting Medium	149	16	7
Lighting Small	479	15	8
Refrigeration	191	15	3
Total	871	60	24

Source: Navigant analysis

4.3 Algorithms and Parameters

Navigant used data collected from the field and the engineering review to calculate site-level energy and demand savings, using the following algorithms. Table 4-3 and Table 4-4 show the algorithms that the evaluation team used to calculate verified savings for lighting measures and refrigeration measures, respectively. The impact evaluation effort focused on verifying the inputs for these algorithms. Detailed descriptions of each parameter and any related assumption are outlined in the following section, along with relevant findings.

Table 4-3. Verified Savings Algorithms for Lighting Measures

Measure	Energy Savings Algorithm	Coincident Peak Demand Savings Algorithm
Lighting Measures	kWh = Qty * HOU * Watts_Reduced * IF_Energy	kW = Qty * CF * Watts_Reduced * IF_Demand
Qty = quantity of equipment verified on-site		
HOU = annual operating hours		
Watts_Reduced = difference between efficient and baseline watts		
CF = coincidence factor		
IF_Energy = heating, ventilating, and air conditioning (HVAC) interaction factor for energy savings calculations		
IF_Demand = HVAC interaction factor for demand savings calculations		

Source: Navigant analysis and PA TRM

Table 4-4. Verified Savings Algorithms for Refrigeration Measures

Measure	Energy Savings Algorithm	Coincident Peak Demand Savings Algorithm
Refrigeration ECM Motors	kWh = kW * HOU	kW = Qty * Watts_Reduced * LF * DC * (1 / DG / COP)
Anti-Sweat Heater Controls	kWh = kW / DoorFt * 8760 * HA * (1 + Rh / COP)	kW = kW / DoorFt * HP * (1 + Rh / COP) * DF
Qty = quantity of equipment verified on-site		
Watts_Reduced = difference between efficient and baseline watts		
LF = Load factor (0.9)		
DC = Duty cycle (1.00 for coolers, 0.944 for freezers)		
DG = Degradation factor of compressor COP (0.98)		
COP = Coefficient of performance (2.5 for coolers, 1.3 for freezers)		
HOU = Hours of use (8760, or less with defined facility closures)		
HA = Percent of time case ASH with controls will be off annually (0.85 for coolers, 0.75 for freezers)		
HP = Percent of time case ASH with controls will be off during the peak period (0.2 for coolers, 0.1 for freezers)		
Rh = Residual heat fraction (0.65)		
DF = Demand diversity factor (1.0)		

Source: Navigant analysis and PA TRM

4.4 Key Impact Findings

The energy realization rates by strata are shown in Table 4-5. This shows the verification realization rate, the metering realization rate, and the final realization rate by strata. In addition, the weighted final realization rate for the program is shown.

Table 4-5. Energy Impacts by Strata

Strata	Verification Realization Rate (kWh)	Metering Realization Rate Adjustment (kWh)	Total Realization Rate (kWh)
Lighting Large	0.97	0.95	0.92
Lighting Medium	1.13	0.97	1.09
Lighting Small	1.07	0.95	1.02
Refrigeration	1.08	0.90	0.97
Total	1.03	0.95	1.00

Source: Navigant analysis

The summer and winter peak demand reductions are shown in Table 4-6 and Table 4-7. There is a reduction in the realization rates for both summer and winter demand savings due to application of coincidence factors based on both deemed values from the PA TRM and logger data. Navigant notes that these realization rates are calculated by comparing verified savings with the Duke Energy reported savings calculated from demand ratios rather than reported in the detailed measure database.

Table 4-6. Summer Peak Demand Impacts by Strata

Strata	Verification Realization Rate (Summer kW)	Metering Realization Rate Adjustment (Summer kW)	Total Realization Rate (Summer kW)
Lighting Large	0.71	1.10	0.77
Lighting Medium	0.95	1.00	0.95
Lighting Small	0.76	1.02	0.78
Refrigeration	0.70	0.82	0.57
Total	0.76	1.02	0.77

Source: Navigant analysis

Table 4-7. Winter Peak Demand Impacts by Strata

Strata	Verification Realization Rate (Winter kW)	Metering Realization Rate Adjustment (Winter kW)	Total Realization Rate (Winter kW)
Lighting Large	0.81	0.89	0.72
Lighting Medium	0.82	0.56	0.46
Lighting Small	0.83	0.86	0.72
Refrigeration	0.69	0.69	0.48
Total	0.77	0.77	0.59

Source: Navigant analysis

Overall, the realization rates are 1.00 for energy savings, and 0.77 and 0.59 for summer and winter peak demand reductions, respectively. This indicates that the program is accurately reporting energy impacts at the aggregate program level, despite varying realization rates for each individual stratum. The demand reductions reported by the program are consistently higher than those found by the evaluation team.

4.5 Detailed Impact Findings

This section examines findings from the evaluation of lighting measures in order to identify the main drivers of the verified savings values. The evaluation team uses the Field Verification Rate (FVR) to describe the overall verified savings relative to the reported savings for each measure. FVRs reflect differences between the quantity of equipment installed on-site and the quantity reported in the tracking database, as well as differences between operating characteristics verified in the field and assumed operating characteristics in the program deemed savings estimates. The team calculates the field verification rate as the verified savings divided by the reported savings by measure, which is driven by a combination of the in-service rate, the hours of use adjustment rate, the lighting power adjustment rate, the HVAC interactive effect adjustment rate, and the coincidence factor, described as follows:

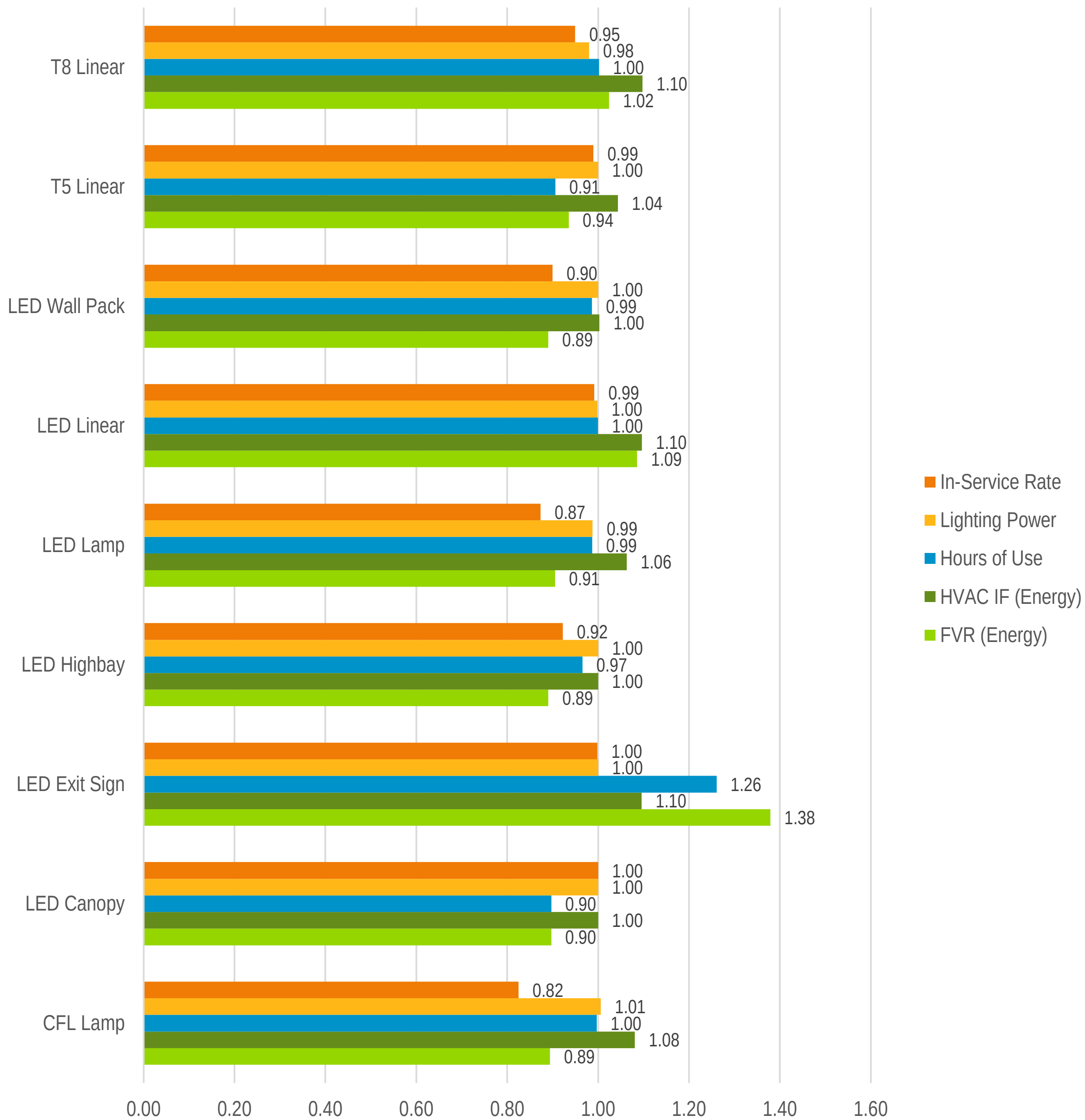
1. **In-Service Rate**[4] **(ISR)** is the ratio of the verified (i.e., installed) quantity to the reported quantity.
2. **Hours of Use (HOU) Adjustment Rate** reflects discrepancies between reported and verified operating hours.
3. **Lighting Power Adjustment Rate** is a ratio of the verified wattage difference between the efficient and baseline equipment to the reported wattage difference between the efficient and baseline equipment.
4. **HVAC Interactive Effect (IE) Adjustment Rate** is a multiplier that reflects HVAC interactive effects due to space heating and cooling loads due to a reduction in heat output from efficient lighting. Note that the IC did not deem HVAC IE for any measures so this adjustment is equal to the average HVAC IE itself. There are separate adjustments for energy savings and peak demand reduction.
5. **Coincidence Factor** represents the portion of installed lighting that is on during the peak utility hours. This affects only summer and winter peak demand reductions, not energy savings.

Figure 4-1 below shows the relative effect of each of the aforementioned adjustment rates on the measure-level FVR for energy savings, which the following subsections describe in further detail. Note that FVR cannot be used to derive program level realization rates. This is because the contributions of each parameter update are described relative to their reported value (from the detailed measure tracking dataset), while the program analysis was structured to stratify savings by participant energy savings per site rather than by individual measures.

Overall, the FVR values indicate that, across the different lighting measure types, in-service rates, lighting power, and hours of use adjustments tend to result in minor decreases to the verified energy savings, while HVAC interactive effects result in an increase in savings. These effects roughly cancel each other out.

[4] In-Service Rate is an industry-standard term that describes verified quantities of installed equipment relative to reported quantities.

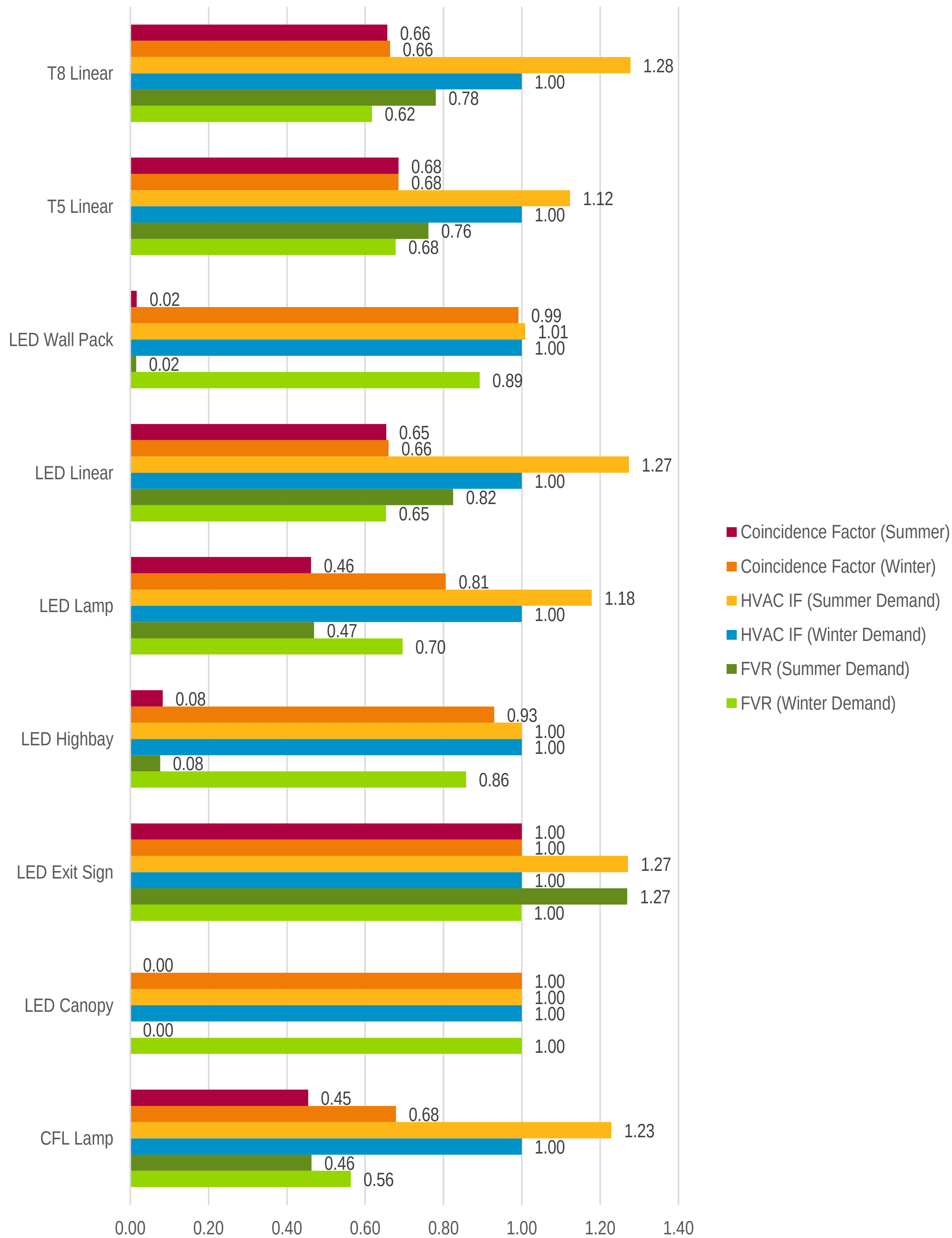
Figure 4-1. Gross Energy Savings Field Verification Rates



Source: Navigant analysis

Figure 4-2 below shows the relative effect of each of the aforementioned adjustment rates on the measure-level FVR for summer peak demand reductions, which the following subsections describe in further detail. Overall, application of the coincidence factor minimize peak demand reductions, while HVAC interactive effects maximize summer peak demand reductions.

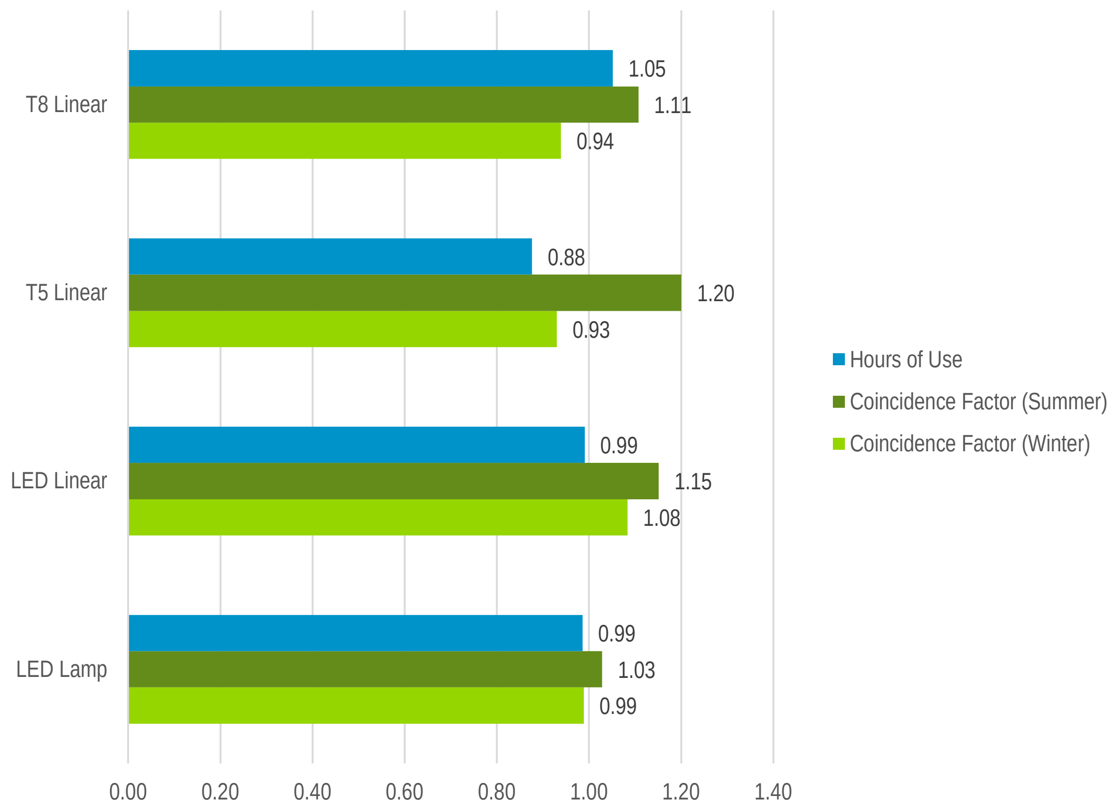
Figure 4-2. Gross Peak Demand Reductions Field Verification Rates



Source: Navigant analysis

The final adjustment to develop site-specific verified gross savings is the ratio of metered HOU and coincidence factors compared to estimated (or deemed) HOU and CF used for verification. The results of these adjustments, analogous to FVR, are shown in Figure 4-3 below. The metered data results in a downward adjustment for both HOU and winter coincidence factor, and an upward adjustment for summer coincidence factor. Note that these adjustments are relative to the evaluation team's verified energy and demand savings estimates rather than the tracking data.

Figure 4-3. HOU and CF Adjustments from Metered Data



Source: Navigant analysis

The remainder of this section discusses in more detail the parameters that are part of the energy and peak demand savings algorithms: ISR, HOU, lighting power, HVAC interactive effects and coincidence factors.

4.5.1 In-Service Rates

The Navigant evaluation team visually counted fixtures on-site to quantify the quantity and type of lighting equipment installed. The team calculated the ISR as the ratio between the findings from the on-site verification compared to the quantity reported in the program-tracking databases. On-site verifications determined the total number of installed equipment.

As shown in Figure 4-1 above, the ISR for each measure varies from 0.82 for CFL screw-in lamps and 1.00 for LED exit signs and LED canopy lights. Overall the ISR values are relatively high, but there is room for improvement to ensure that the quantities installed match the reported quantities.

4.5.2 Hours-of-Use Adjustments

Measure-level annual operating hours were determined from an interview with the SBES participant, similar to the approach taken by the IC. Hours used per day or week were rolled up to annual hours of use and corrected for holidays, seasonal variations in use, and any other change in operating characteristics. For logged sites, the team extrapolated the time of use logger data to develop annual hours of operation.

During the on-site participant interviews, the team found that the hours of use that site technicians reported was close to the HOU reported in the tracking database, with adjustment values ranging from 0.92 for T5 fixtures and 1.26 for LED exit signs. Additional adjustments based on logger data range from 0.88 for T5 retrofits and 1.05 for T8 retrofits, as shown in Figure 4-3. The team notes that overall the IC is reasonably characterizing hours of use based on both customer interviews and logger data. Additional care should be used to ensure that lights that are on 24/7, such as LED exit signs, are credited with the correct HOU.

4.5.3 Lighting Power

The evaluation team based the lighting power parameter on the best estimates available for actual power draw of the baseline and efficient equipment. The baseline equipment is assumed to be as-found lighting installed and in use at the time of the audit; however, because the baseline equipment was no longer present at the participant sites, the team could not verify the baseline power draw and defaulted to the values provided by the IC.

The evaluation team verified the efficient equipment wattage from manufacturer specification sheets to provide a more accurate lighting power figure than the deemed values that the IC used. Overall lighting power level differences were minor across the measure categories, between 0.98 for T8 retrofits and 1.01 for CFL lamps.

The evaluation team would like to note that it was often difficult or impossible to record efficient wattages due to the prevalence of exterior, canopy, and high bay LED fixtures installed in PY2015. In addition, the newer linear LED systems can be configured in a variety of ways, including with or without an electronic ballast. The manufacturer specifications for these systems typically do not account for every installation scenario with different ballast brands, models, and configurations possible. The team did not perform power measurements as part of this evaluation, but encourages the IC team to ensure that the power consumption of these systems is accurately characterized as their contribution to total program savings grows.

4.5.4 HVAC Interactive Effects

The evaluation team applied HVAC interactive effects for both energy, summer and winter peak demand. The deemed values are based on the facility heating and cooling system types as verified in the field for the sample sites. However, the IC did not apply HVAC interactive effects for any of the lighting measures claimed in PY2015. This adjustment is between 1.00 and 1.50 for energy and 1.00 and 1.50 for summer peak demand. Deemed values are described in Section 9 for energy and summer peak demand, and are based on the PA TRM; winter peak demand interactive effects were assumed to be 1.0 for all measures.

4.5.5 Coincidence Factors

Similar to the HVAC interactive effects, the team applied coincidence factors based on the deemed values found in the PA TRM. This factor takes into account that not all lights are on for the duration of the peak demand period. Coincidence factors range from 0 and 1.0, based on building type, and are detailed in Section 9. The IC applied a coincidence factor of 1.0 for all lighting measures, and did not separately report winter demand savings. The metered data further validates the deemed coincidence factors, but a sufficient sample size was not developed to determine new deemed coincidence factors at this time. Note that although the detailed IC database does not include a coincidence factor, the demand ratios implicitly include these assumptions.

LED exit signs that are on all day receive a CF on 1.0, while exterior lights receive a CF of 0 (summer) and 1.0 (winter). For logged sites, the team extrapolated the time of use logger data to develop coincidence factors. As shown in Figure 4-3, the CF adjustments based on metered data range from 1.03 to 1.20 for summer, and 0.93 to 1.08 for winter. The overall effect on demand savings from metering was an increase in summer savings and a decrease in winter savings compared to the coincidence factors applied in the verification phase based on the PA TRM. The overall effect of applying coincidence factors is a decrease from reported savings, and is the primary driver of the demand realization rates.

4.5.6 Refrigeration Measure Parameters

For refrigeration measures, the engineering analysis follows a deemed savings methodology based on the PA TRM. The assumptions and parameters used to estimate reported energy savings and peak demand reductions were deemed appropriate by the evaluation team. The team verified that the measures were installed and operational during on-site visits to projects that installed efficient refrigeration equipment.

The evaluation team focused their deemed savings review on LED case lighting, EC motor upgrades, and anti-sweat heater controls. Onsite, the team verified LED case lighting and EC motor upgrades, but no anti-sweat heater controls because they did not fall into the onsite sample. For LED case lighting, the team applied HVAC interactive effects and coincidence factors from the PA TRM, which differ from the general lighting parameters. The values used are summarized below in Table 4-8, and result in an increase in LED case lighting savings.

Table 4-8. LED Case Lighting Savings Parameters

LED Case Lighting Parameter	Value
HVAC Interactive Effects (Both Energy and Summer/Winter)	1.41 (Cooler) / 1.52 (Freezer)
Coincidence Factor	0.92

Source: PA TRM

5. NET-TO-GROSS ANALYSIS

The impact analysis described in the preceding sections addresses *gross program savings*, based on program records, modified by an engineering review, field verification, and metering of measure installations. *Net savings* incorporate the influence of free ridership (savings that would have occurred even in the absence of the program) and spillover (additional savings influenced by the program but not captured in program records) and are commonly expressed as a NTG ratio applied to the verified gross savings values.

Table 5-1 shows the results of Navigant's NTG analysis. Navigant anticipated low free ridership and spillover based on previous findings from evaluations of SBES in other Duke Energy territories.

Table 5-1. PY2015 Net-to-Gross Results

	Lighting	Refrigeration	Lighting & Refrigeration
Estimated Free Ridership	0.08	0.10	0.09
Estimated Spillover	0.12	0.10	0.11
Estimated NTG	1.04	0.98	1.02

Source: Navigant analysis, totals subject to rounding.

This report provides definitions, methods, and further detail on the analysis and findings of the net savings assessment. The discussion is divided into the following three sections:

- Defining free ridership, spillover, and net-to-gross (NTG) ratio
- Methods for estimating free ridership and spillover
- Results for free ridership, spillover, and NTG ratio

5.1 Defining Free Ridership, Spillover, and Net-to-Gross 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 even in the absence of the program (i.e., actions that the program did not induce). This is meant to account for naturally occurring adoption of energy efficient technology. The SBES Program covers a range of energy efficient lighting and refrigeration measures and is designed to move the overall market for energy efficiency forward. However, it is likely that some participants would have wanted to install, for various reasons, some high efficiency equipment (possibly a subset of those installed under the SBES Program), even if they had not participated in the program or been influenced by the program in any way.

Spillover captures program savings that go beyond the measures installed through the program. 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.

Total spillover is a combination of non-reported actions to be taken at the project site itself (*within-facility spillover*) and at other sites (*outside-facility spillover*). Each type of spillover is meant to capture a different aspect of the energy savings caused by the program, but not included in program records.

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 basic equation is shown in Equation 1.

Equation 1. Net-to-Gross Ratio

$$NTG = 1 - Free\ Ridership + Spillover$$

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

5.2 Methods for Estimating Free Ridership and Spillover

5.2.1 Estimating Free Ridership

Data to assess free ridership were gathered through the self-report method—a series of survey questions asked of SBES participants. Free ridership was asked in both direct questions, which aimed at obtaining respondent estimates of the appropriate free ridership rate that should be applied to them, and in supporting or influencing questions, which could be used to verify whether the direct responses are consistent with participants' views of the program's influence.

Respondents were asked three categories of program-influence questions:

- **Likelihood:** to estimate the likelihood that they would have incorporated lighting measures "of the same high level of efficiency," if not for the assistance of the SBES 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 same level of energy-efficient lighting prior to participating in the program. The general approach holds that if customers were not definitively planning to install all of the efficiency lighting prior to participation, then the program can reasonably be credited with at least a portion of the energy savings resulting from the high-efficiency lighting. Strong free ridership is reflected by those participants who indicated they had already allocated funds for the purchase and selected the lighting and an installer.
- **Program importance:** to clarify the role that program components (e.g., information, incentives) played in decision-making, and to provide supporting information on free ridership. Responses to

these questions were analyzed for each respondent, not just in aggregate, and were used to identify whether the direct responses on free ridership were consistent with how each respondent rated the “influence” of the program.

Free-ridership scores were calculated for each of these categories[5] and then averaged and divided by 100 to convert the scores into a free-ridership percentage. Next, a timing multiplier was applied to the average of the three scores to reflect the fact that respondents indicating that their energy efficiency actions would not have occurred until far into the future may be overestimating their level of free ridership. Participants were asked, without the program, when they would have installed the equipment. Respondents who indicated that they would not have installed the lighting for at least two years were not considered free riders and had a timing multiplier of 0. If they would have installed at the same time as they did, they had a timing multiplier of 1; within one year, 0.67; and between one and two years, 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 had a free ridership ratio of 1.

5.2.2 Estimating Spillover

The basic method for assessing participant spillover (both within-facility and outside-facility) was an approach that asked a set of questions to determine the following:

- **Whether spillover exists at all.** These were yes/no questions that asked, for example, whether the respondent incorporated energy efficiency measures or designs that were not recorded in program records. Questions related to extra measures installed at the project site (within-facility spillover) and to measures installed in non-program projects (outside-facility spillover) within the service territory.
- **The share of those savings that could be attributed to the influence of the program.** Participants were asked if they could estimate the energy savings from these additional extra measures to be less than, similar to, or more than the energy savings from the SBES program equipment.
- **Program importance.** 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.

[5] 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).

If respondents said no, they did not install additional measures, they received a zero score for spillover. If they said yes, then the individual's spillover was estimated as the self-reported savings as a share of project savings, multiplied by the program-influence score. Then, a 50 percent discount was applied to reflect uncertainty in the self-reported savings and divided by 10 to convert the score to a spillover percentage.

5.2.3 Combining Results across Respondents

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

- Individual respondents, by evaluating the responses to the relevant questions and applying the rules-based approach discussed above
- Measure categories:
  - For free ridership: by taking the average of each respondent's score within each category, weighted by the respondent's share of savings within the measure category
  - For spillover: by taking the sum of the individual spillover results (in kWh) for each measure category and dividing by the category's total program savings in the sample
- The program as a whole, by combining measure-level results:
  - For free ridership: measure category results were subsequently weighted by each category's share of total program savings
  - For spillover: similarly, measure category results were subsequently weighted by each category's share of total program savings

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

This section presents the results of the attribution analysis for the SBES Program. Specifically, results are presented for free ridership and spillover (within-facility and outside-facility), which are used collectively to calculate an NTG ratio.

5.3.1 Review of Data Collection Efforts for Attribution Analysis

The EM&V team conducted 92 surveys with SBES participants to estimate free ridership, spillover, and NTG ratios. Table 5-2 shows the number of completions, by measure group.

Table 5-2. Attribution Survey Completes by Project Type

Measure Category	Surveys
Lighting	81
Refrigeration	11
Total	92

Source: Navigant analysis

5.3.2 Free-Ridership Results

The evaluation team asked participants a series of questions regarding the likelihood, scope, and timing of the investments in energy-efficient lighting if the respondent had not participated in the program. The purpose of the surveys was to elicit explicit estimates of free ridership and perspectives on the influence of the program. The evaluation team estimates free-ridership for the SBES Program at 9 percent of program-reported savings.

5.3.3 Spillover Results

The SBES Program influenced approximately 9 percent of participants to install additional energy efficiency measures on-site and influenced 9 percent of participants to install additional measures at other locations. Based on the survey findings, the evaluation team estimates the overall program spillover to be 11 percent of program-reported savings. Participants reported a variety of spillover measures installed, including lighting (most common), air conditioners, and coolers.

5.3.4 Net-to-Gross Ratio

As stated above, the NTG ratio is defined as follows in Equation 2 below.

Equation 2. Net-to-Gross Ratio

$$NTG = 1 - \text{free ridership} + \text{spillover}$$

Using the overall free ridership value of 9 percent and the overall spillover value of 11 percent, the NTG ratio is 1 – 0.09 + 0.11 = 1.02. The estimated NTG ratio of 1.02 implies that for every 100 megawatt-hours (MWh) of realized savings recorded in SBES records, 102 MWh is attributable to the program.

Table 5-3. SBES Free Ridership, Spillover, and NTG Ratio

	Free Ridership	Spillover	NTG Ratio
SBES Program Total	0.09	0.11	1.02

Source: Navigant analysis

6. PROCESS EVALUATION

The purpose of the process evaluation is to understand, document and provide feedback on the program implementation components and customer experience for the Small Business Energy Saver (SBES) Program in the DEO jurisdiction.

6.1 Process Methodology

The evaluation team conducted in-depth interviews with SBES Program staff and IC staff and customer participant surveys, as noted previously. The process findings summarized in this document are based on the results of:

- Participant surveys with 92 program participants;
- Interviews with the Duke Energy Program Manager and the Implementation Contractor (IC) staff; and
- A review of the program documentation.

6.2 Sampling Plan and Achievements

The participant survey targeted a random sample of all PY2015 program participants broken out by measure family. The two measure families are lighting and refrigeration. Navigant weighed customer responses by their stratum savings for net-to-gross findings as described in the preceding section. The process evaluation findings presented in this section are not weighted.

The survey effort successfully completed surveys with 92 customers, of which 81 were participants that only installed lighting measures and 11 were participants that installed some refrigeration measures. The survey targets were loosely designed to achieve 90/10 confidence and precision, with significant oversampling due to the relatively inexpensive per-survey cost.

6.3 Program Review

The evaluation team designed the program review task to understand changes and updates to the program design, implementation and energy and demand savings assumptions. The key program characteristics include the following:

- **Program Design** – The SBES program is designed to offer high incentives (up to 80 percent of the total cost of the project) on efficient equipment to reduce energy use and peak demand. It specifically targets small business customers that are typically difficult for utilities to reach and often do not pursue energy efficiency on their own. The SBES program formally launched in DEO in 2014 (although savings were all claimed starting in 2015), and Duke Energy utilized expertise gained from managing similar programs in other jurisdictions.
- **Program Implementation** – A third-party contractor administers the SBES program on Duke Energy's behalf. The Implementation Contractor, (IC) handles all aspects of the program, including customer recruitment, facility assessments, equipment installation (through independent installers contracted by the IC), and payment and incentive processing. The IC reports energy and peak demand reduction estimates to Duke Energy. The program had a successful launch in DEO and was able to exceed their energy savings goal while scoring high on customer

satisfaction. Several quality control checks were carried over from similar programs in other jurisdictions.

- **Incentive Model** – The IC offers potential participants a recommended package of energy efficiency measures along with equipment pricing and installation costs. The incentive is proportional to estimated energy savings and can be as high as 80 percent of the total cost of the project.
- **Savings Estimates** – Energy and peak demand savings are estimated on a per-fixture basis, taking into account existing equipment, proposed equipment, and operational characteristics unique to each customer. The savings estimates are derived from assumptions in the PA TRM.

6.4 Key Process Findings

The following sections detail the process findings from all relevant sources of program information, including interviews with Duke Energy and IC staff and the results of the customer surveys, organized by topic. This discussion addresses 1) overall customer experience; 2) implementation contractor; 3) installation contractor; 4) program benefits; 6) upgraded equipment; and 7) participant suggested improvements.

The feedback received indicates that the SBES Program has a successful launch in DEO in PY2015 and represents an important component of Duke Energy's portfolio of business energy efficiency programs. The Duke Energy program management team and the IC staff and management have leveraged in-house expertise around quality control, especially concerning installation contractor training and automated checks in the tablet-based auditing tool. Key findings are as follows:

- Participants listed energy savings, reduced energy bills, better quality equipment, and reduced operations and maintenance as the primary reasons for participating in the SBES Program.
- A majority of SBES 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":
    - 89 percent of participants indicated 8-10 for satisfaction with overall program experience.
    - 86 percent of participants indicated 8-10 for satisfaction with the contractor's quality of work.
    - 90 percent of participants indicated 8-10 for satisfaction with their new equipment.
- Eighty-three percent of participants stated that equipment offered through the program allowed them to upgrade all of the equipment they wanted at the time.
- Sixty-six percent of participants said they plan to participate in other Duke Energy programs in the future.
- Several customers reported issues specifically related to measure installation, and others thought that the equipment recommended and installed through the program was somewhat dated (e.g., T8 fixtures and CFL lamps).

The following sections detail the process findings and addresses the following topics:

1. Overall customer experience;
2. Implementation contractor;
3. Installation contractor;

4. Program benefits;
5. Upgraded equipment; and
6. Suggested improvements.

6.4.1 Customer Experience

Customers reported very high satisfaction with their overall program experience. No customers rated their overall satisfaction as less than 5, and 89% rated their satisfaction as an 8, 9, or 10.

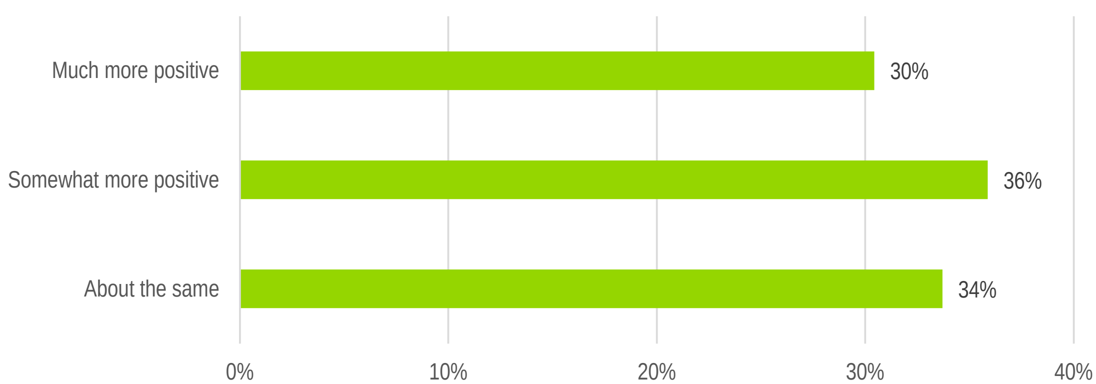
Navigant identified some correlations with overall program satisfaction that provide insight into drivers of high satisfaction:

- Highly satisfied customers were more likely to report that SmartWatt Energy had helped them with their choice of energy-efficient measures (80% of highly satisfied customers vs. 30% of less satisfied customers).
- Customers with overall high program satisfaction were more satisfied on average with every program element, but the difference was particularly noticeable on two program elements:
    - **The proposal provided by SmartWatt Energy**: highly satisfied customers gave an average rating of 9.2 vs. 6.8 among less satisfied customers.
    - **The energy efficiency assessment**: highly satisfied customers gave an average rating of 8.9 vs. 6.5 among less satisfied customers.

Four out of five customers (80%) said they were very likely to participate in this program or a similar program in the future, rating their likelihood as an 8, 9, or 10 on a 10 point scale. Customers who said they were unlikely to participate again explained that they didn't see the need because they had no other facilities or equipment to upgrade. Similarly, 66% of customers said they *plan* to participate in other Duke Energy programs in the future. These findings indicate both high program satisfaction and an opportunity to continue to market energy efficiency programs to previous participants to achieve deeper savings.

Participation in the SBES program generally served to improve customers' satisfaction with Duke Energy overall (Figure 4). In no cases did SBES participation lead to a more negative attitude toward Duke Energy.

Figure 4. Impact of SBES Participation on Attitude Toward Duke Energy

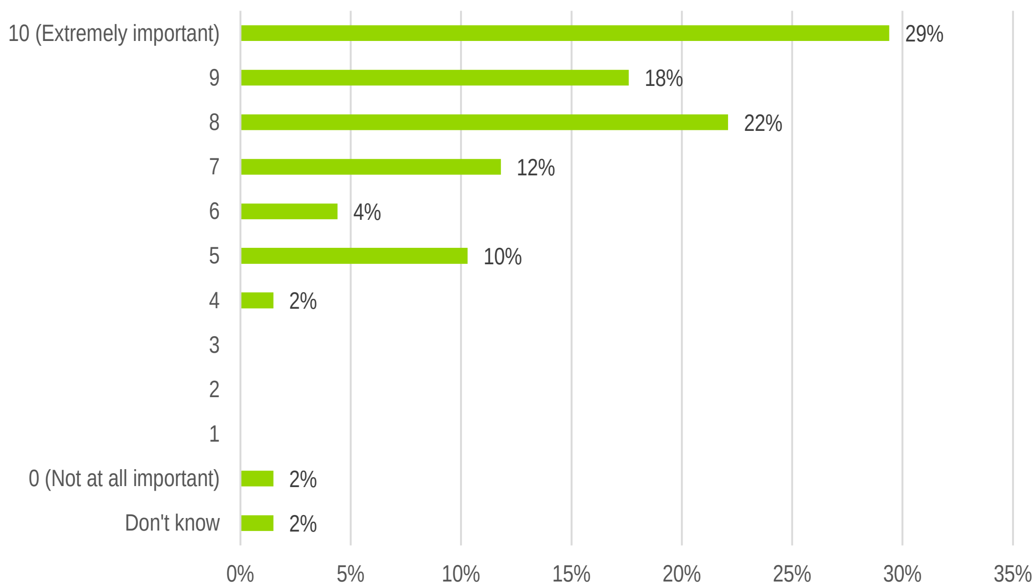


Source: Navigant analysis

6.4.2 Implementation Contractor

As mentioned in the previous section, customers are highly satisfied with the services provided by the implementation contractor, SmartWatt Energy and that high satisfaction translates to high overall program satisfaction. Overall, 74% of customers said that SmartWatt Energy helped them with their choice of energy-efficient measures. Of those customers, 69% said that the SmartWatt Energy's recommendation was very important in their decision to install energy-efficient equipment (8, 9, or 10), as shown in Figure 5.

Figure 5. Importance of SmartWatt Energy Recommendation (n=68)



Source: Navigant analysis

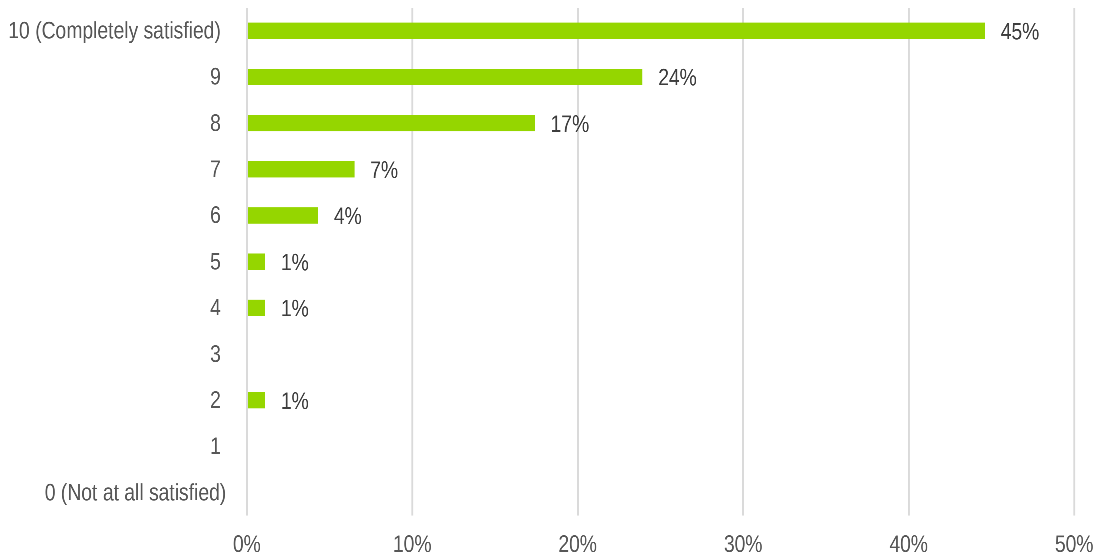
Similarly, customers are highly satisified with the proposal prepared for them by SmartWatt Energy, with 87% rating their satisfaction with the proposal as an 8 or higher. Nearly all (98%) said that the proposal was clear about the scope of work to be performed, and 95% said that the proposal was clear about their share of project costs.

Half of customers received a post-installation inspection performed by SmartWatt Energy. Of those customers, 87% rate their satisfaction with the inspection as an 8 or higher, and none rate their satisfaction lower than a 5.

6.4.3 Installation Contractors

Customer satisfaction with contractor quality of work is high. Figure 6 shows that 86 percent of survey respondents ranked their satisfaction with contractor work as an 8, 9, or 10.

Figure 6: Customer Satisfaction with Contractor Quality of Work (n=92)



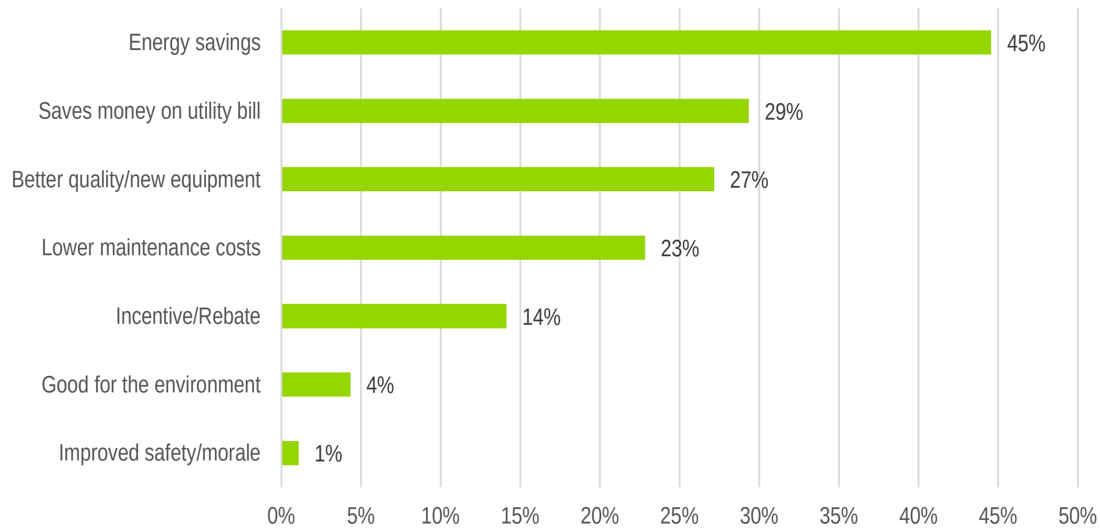
Source: Navigant analysis

Very few customers (8%) indicated that they experienced installation issues that required follow-up visits. Other participants were impressed by the installation contractors' efficiency or tidiness. This indicates that the customer experience varies between installation contractors, but overwhelmingly participants are satisfied with this portion of the program.

6.4.4 Program Benefits

Customers identified the energy savings and associated utility bill savings as the top benefits of participating in the SBES program (Figure 7). Better quality/newer equipment and lower maintenance costs were also significant benefits to many customers.

Figure 7. Top Benefits of Participation in SBES Program



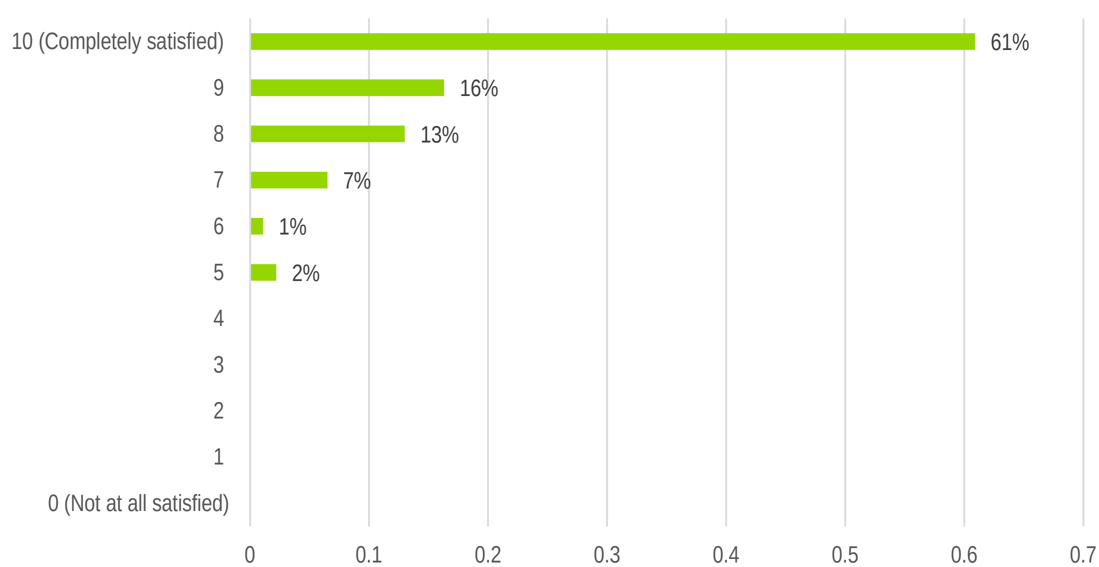
Source: Navigant analysis

Another important survey finding was that 83 percent of customers stated that equipment offered through the program allowed them to upgrade all of the equipment they wanted at the time of the project, rather than piecing together the upgrades in multiple phases.

6.4.5 Upgraded Equipment

Customers are extremely satisfied with their new energy efficiency measures. Nearly two-thirds (61%) rated their satisfaction as a 10 out of 10 (see Figure 8), and the average rating was 9.2.

Figure 8: Participant Satisfaction with New Equipment (n=92)

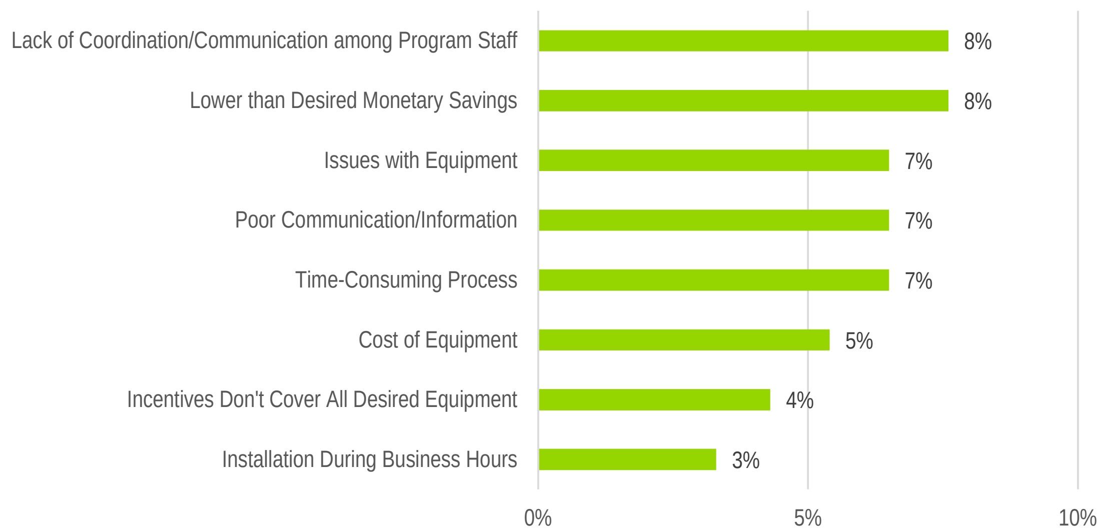


Source: Navigant analysis

6.4.6 Suggested Improvements

Overall program satisfaction is very high, but a few customers had minor complaints or identified drawbacks of the program. The most common challenges (all mentioned by 8% of customers or less) are identified in Figure 9. Some customers expected higher monetary savings or had issues with the customers; others felt that the program staff lacked coordination/communication.

Figure 9. Program Challenges or Drawbacks



Source: Navigant analysis

When asked how to improve the program, most customers (84 percent) did not have any suggestions. Several of the suggested improvements reflected the high program satisfaction, as they suggest expanding the existing program to benefit more customers. Suggestions (with the number of mentions noted in parentheses) included:

- Increase publicity for the program (4 mentions)
- Incent more equipment (2)
- Improve program information/communication (2)
- Offer program to residential customers (1)
- Increase incentives (1)
- Increase funds for the program (1)
- Make participation less time-consuming (1)

7. SUMMARY FORM

Program Name

Completed EMV Fact Sheet

Description of program

Duke Energy's Small Business Energy Saver Program provides energy efficient equipment to eligible small business customer at up to an 80 percent discount. The program is delivered through an implementation contractor that coordinates all aspects of the program, from the initial audit, ordering equipment, coordinating installation, and invoicing.

The program consists of lighting and refrigeration measures.

- **Lighting measures:** LED lamps and fixtures, T8 fluorescent fixtures, occupancy sensors.
- **Refrigeration measures:** LED case lighting, EC motor upgrades, anti-sweat heater controls.

Date	April 7, 2017
Region(s)	Duke Energy Ohio
Evaluation Period	1/1/15 – 2/29/16
Annual MWh Savings	22,613 MWh
Per Participant MWh Savings	26.0 MWh (across 871 total participants)
Coincident MW Impact	3.7 MW
Net-to-Gross Ratio	1.02
Process Evaluation	Annual
Previous Evaluation(s)	None

Evaluation Methodology

The evaluation team used engineering analysis, onsite field inspections, and time-of-use metering as the primary basis for estimating program impacts. Additionally, telephone surveys were conducted with participants to assess customer satisfaction and determine a net-to-gross ratio. Interviews were conducted with program and implementation team staff to understand program operational changes and enhancements.

Impact Evaluation Details

- **Onsite visits were conducted at 60 participant sites, while 24 of those sites were logged.** The evaluation team inspected program equipment to assess measure quantities and characteristics to compare with the program tracking database, and installed lighting loggers to verify hours of use and coincidence factors.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 0.82 for CFL screw-in lamps to 1.00.
- **Participants achieved an average of 26.0 MWh of energy savings per year.** The program is accurately characterizing energy and demand impacts.

8. CONCLUSIONS AND RECOMMENDATIONS

The evaluation team performed extensive on-site work, telephone surveys, and analysis to determine gross and net verified savings. Overall conclusions and recommendations appear in the following sections.

8.1 Conclusions

Overall, the SBES Program performed very well for a newly launched program in the DEO jurisdiction. The key to continued success is maintaining the strong foundation that the SBES program has built and continuing to monitor and improve customer issues as they arise.

- **Duke Energy has successfully launched the SBES into the DEO jurisdiction** in PY2015. The program was able to hit the ground running following best practices and lessons learned from the SBES program in other Duke Energy jurisdictions.
- **Participants are overwhelmingly satisfied with the SBES Program, the implementation contractor, and Duke Energy.** A majority of customers plan to participate in Duke Energy programs in the future, and all participants surveyed reported a more positive or similar attitude towards Duke Energy. Customers are largely happy with all aspects of the SBES program, including the customer experience, the audit and installation process, and the upgraded equipment.
- The **energy savings realization rate is 1.00,** and is driven by several EM&V adjustments that roughly balanced out. The key adjustments the EM&V team made were the in-service rates and HVAC interactive effects. The **peak demand realization rate is lower at 0.77 (summer) and 0.59 (winter)** and is driven by HVAC interactive effects and coincidence factors.
- The evaluation effort estimated **free ridership for the SBES Program at 9 percent and spillover at 11 percent**, which drives an **NTG ratio of 1.02**. This indicates that the SBES Program is successfully reaching customers that would have not completed energy efficiency upgrades in the absence of the program. Spillover indicates that the program is showcasing the benefits of energy efficiency and driving customers to perform additional energy savings activities.

8.2 Recommendations

The evaluation team recommends a number of actions for improving the SBES Program, based on insights gained through the comprehensive evaluation effort for PY2015. These recommendations provide Duke Energy with a roadmap to fine-tune the SBES Program for continued success and include the following broad objectives:

Increasing Program Participation

1. **Increase marketing and publicity for the program.** This is the most common recommendation from participants, indicating that there is significant opportunity for participation beyond those that participated in PY2015. As a new program for PY2015 it is reasonable to have a phased rollout with growing participation, however.
2. **Emphasize non-energy benefits of program participation**, especially reduced maintenance. This can also include increased lighting quality, comfort for both business employees and

customers, and environmental benefits. LED lighting measures typically offers the most significant non-energy benefits, and should be featured in program marketing materials.

Increasing Customer Satisfaction

3. **Prioritize customer satisfaction training for installation contractors and customer follow-up services.** A minority of customers reported issues with installation and lighting equipment. Additionally, some customers are not perceiving savings on their electric bill, and managing this expectation should enhance customer satisfaction.
4. **Phase out fluorescent lighting systems and CFL lamps.** Linear LED lighting offers substantial savings above high-performance/reduced wattage T8 lamps and ballasts, which are increasingly perceived as outdated. Similarly, LED lamps offer slight savings above CFL lamps, and typically result in higher customer satisfaction.

Improving Tracking Data and Reported Savings

5. **Ensure that detailed customer contact information is populated in the program tracking database.** The evaluation team found missing contact information for some projects, which increases the difficulty of reaching customers for EM&V activities. Accurate contact information ensures that the team is able to get in touch with the key decision maker and ensures that data collected is as accurate as possible.
6. **Track burnout lamps and fixtures during the initial audit.** While the tracking data has a field for recording burnout fixtures, this was populated with a value of zero for all measures. It is likely that some burnouts were present, and may contribute to customer not realizing expected savings on their energy bills.
7. **Track LED refrigerated case lighting measures together.** LED case lighting measures are not always a direct 1-for-1 replacement, and therefore removal of the baseline equipment and installation of the efficient equipment were separated in the tracking data. The evaluation team suggests linking these measure records in the data so that it's clear what the baseline and efficient systems are.
8. **Add connected load to occupancy sensor savings estimates.** Occupancy sensor savings were missing details on connected fixture load. This is a key input to the savings calculation, and should be recorded
9. **Apply HVAC interactive effects and coincidence factors for lighting measures.** Duke Energy should apply relevant HVAC interactive effects and coincidence factors to lighting measures as appropriate, and ensure these values are selected based on the installation location. For example, lighting measures installed in unconditioned spaces should not receive HVAC interactive effects, and exterior lighting that is not on during the day should not receive coincident demand savings. Duke Energy should also consider different deemed coincident factors for summer and winter demand savings
10. **Ensure that efficient lighting power ratings for high bay, exterior, and linear LED systems are accurate.** Manufacturer specifications for lighting power report different wattages that the system may draw depending on the specific configuration. As the share of savings attributed to linear LED systems grow, this should be quantified to reduce EM&V risk in future years.

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.

Table 9-1. HVAC Interactive Effects[6]

Space Type	Energy HVAC Interactive Effect	Demand HVAC Interactive Effect
Air Conditioned/Cooled space	1.12	1.34
Freezer space	1.5	1.5
Medium-temperature refrigerated space	1.29	1.29
High-temperature refrigerated space	1.18	1.18
Uncooled space	1	1

Table 9-2. Coincidence Factors[7]

Facility Type	Annual Hours of Use	Summer Coincidence Factor
Auto Related	4,056	0.62
Daycare	2,590	0.62
Dusk-to-Dawn / Exterior Lighting	3,833	0
Education – School	1,632	0.31
Education – College/University	2,348	0.76
Grocery	4,660	0.87
Health/Medical – Clinic	3,213	0.73
Hospitals	5,182	0.8
Industrial Manufacturing – 1 Shift	2,857	0.57
Industrial Manufacturing – 2 Shift	4,730	0.57
Industrial Manufacturing – 3 Shift	6,631	0.57
Libraries	2,566	0.62
Lodging – Guest Rooms	914	0.09
Lodging – Common Spaces	7,884	0.9

[6] Pennsylvania Technical Reference Manual (TRM), 2015

[7] Pennsylvania Technical Reference Manual (TRM), 2015

Multi-Family (Common Areas) - High-rise & Low-rise	5,950	0.62
Nursing Home	4,160	0.62
Office	2,567	0.61
Parking Garages	6,552	0.62
Public Order and Safety	5,366	0.62
Public Assembly (one shift)	2,610	0.62
Public Services (nonfood)	3,425	0.62
Restaurant	3,613	0.65
Retail	2,829	0.73
Religious Worship/Church	1,810	0.62
Storage Conditioned/Unconditioned	3,420	0.62
Warehouse	2,316	0.54
24/7 Facilities or Spaces	8,760	1