STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

PETITION OF DUKE ENERGY INDIANA, INC. FOR APPROVAL OF (1) ITS PROPOSED DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY PROGRAMS FOR 2015, INCLUDING COST RECOVERY, LOST REVENUES AND SHAREHOLDER INCENTIVES; (2) AUTHORITY TO OFFER ADDITIONAL DEMAND SIDE MANAGEMENT PROGRAMS WITH COST RECOVERY, INCLUDING LOST MARGINS AND A SHAREHOLDER INCENTIVE; (3) AUTHORITY TO DEFER COSTS INCURRED UNTIL SUCH TIME THEY ARE REFLECTED IN RETAIL RATES; (4) RECONCILIATION OF DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY PROGRAM COST RECOVERY THROUGH DUKE ENERGY INDIANA, INC. STANDARD CONTRACT RIDER 66A; AND (5) REVISIONS TO STANDARD CONTRACT RIDER 66A	)	**CAUSE NO. 43955 DSM-2**

UPDATED ANNUAL COMPLIANCE FILING

Pursuant to the Final Order in this proceeding, dated December 30, 2014, the Commission directed Duke Energy Indiana:

> File annually by July 1 under this Cause its independent EM&V report concerning its 2015 EE programs. The EM&V report must include the completed cost/benefit analysis that identifies the total costs, total benefits, and associated benefit cost ratios for the utility cost test, total resource cost test, ratepayer impact measure test, and the participant cost test. It shall also identify the discount rate used in the cost/benefit calculations.

On June 30, 2016, Duke Energy Indiana filed its Annual Compliance filing attaching the results of the completed cost/benefit analysis, as well as the formulae for calculating total costs and total benefits for each of the tests specified, and the discount rate; along with, the current EM&V schedule for Duke Energy Indiana's energy efficiency programs. Program Evaluation Reports had not been completed at the time of this Annual Compliance filing.

Duke Energy Indiana has since received four (4) Program Evaluation Reports and attaches such reports as follows:

Attachment A:	The Cadmus Group, Inc.'s Process Evaluation of the 2013-2014 Smart $aver® Nonresidential Custom Incentive Program in Indiana dated August 12, 2016.
Attachment B:	The Cadmus Group, Inc.'s Evaluation of the Smart $aver® Nonresidential Custom Incentive Program in Indiana dated August 12, 2016.
Attachment C:	Nexant My Home Energy Report Program Evaluation dated August 12, 2016.
Attachment D:	The Cadmus Group, Inc.'s Impact and Process Evaluation of the 2015 Power Manager Program® Duke Energy Indiana dated May 17, 2016

Respectfully submitted,

DUKE ENERGY INDIANA, LLC

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Annual Compliance Filing was electronically delivered this 18th day of November, 2016, to:

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Process Evaluation of the 2013-2014 Smart $aver® Nonresidential Custom Incentive Program in Indiana

August 12, 2016

Evaluation, Measurement, & Verification for Duke Energy Indiana

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Prepared by:
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Table of Contents

Evaluation Summary

This report presents findings from the process evaluation of the Smart $aver Nonresidential Custom Incentive Program (Custom Program) from January 2013 through January 2015 and covers the Duke Energy Indiana jurisdiction. Two different evaluation teams completed the process evaluation in two phases. TecMarket Works completed the first phase of the process evaluation in 2013 and 2014. Following the transfer of evaluation work in 2015, Cadmus, along with a subcontractor, Yinsight, Inc., (the evaluation team) completed the final phase of the process evaluation.

Program Description

The Custom Program provides incentives for Duke Energy's nonresidential customers to use high-efficiency equipment. The program design is intended to complement the Smart $aver Prescriptive Program (Prescriptive Program), which offers incentives on preselected measures. Participants must calculate a measure's energy savings when filling out a Custom application, and then they receive incentives based upon these calculations and other factors. Customers who want to install measures not on the Smart $aver Prescriptive list are provided the opportunity to apply for a rebate through the Custom Program.

Evaluation Objectives

The evaluation team sought to document program operations, identify areas for improvement during future program implementation, and gauge customer and trade ally satisfaction with the program. Key research questions included the following:

- *What level of satisfaction do participants and trade allies have with the Smart $aver Custom Program?*
- *What recent challenges has the program faced, and how have they been addressed by Duke Energy program staff?*
- *Can any improvements be made to the application process?*
- *Does the program, including the various actors involved in the implementation of the program, provide adequate information to facilitate participation?*
- *What can be done to increase participation from both customers and trade allies, other than by increasing marketing?*
- *Are changes to program design or operations warranted?*

Evaluation Parameters

The evaluation team used in-depth interviews, participant surveys, and trade ally interviews to conduct this process evaluation. Table 1 lists these activities' parameters, along with estimated confidence and precision levels (confidence/precision).

Table 1. Evaluated Parameters with Value, Units, and Confidence/Precision

Program	Parameter	Value	Units	Confidence/ Precision
Smart $aver Custom	Participant survey responses	Varies by question	Varies by question	±13.9% precision at the 90% confidence interval

Table 2 lists the start and end dates for activities conducted for the process evaluation.

Table 2. Sample Period Start and End Dates

Evaluation Component	Sample Period	Dates Conducted	Total Conducted
Management Interviews	–	July 25, 2014 and May 27, 2015	2
Participant Surveys	Jan 1, 2013 – Feb 3, 2015	Phase 1: July 22, 2014 – September 12, 2014 Phase 2: Aug 10, 2015 – Aug 24, 2015	29
Trade Ally Interviews	Jan 1, 2013 – Feb 3, 2015	Phase 1: Aug 1 – Aug 8, 2014 Phase 2: Aug 26 - September 4, 2015	10

High-Level Process Findings

This section summarizes the evaluation team’s key process findings for the evaluation period.

Management Interviews

Interviews with program management and implementation staff focused on elements of the program process and delivery, touching upon upcoming changes to the program. Program operations have fundamentally remained unchanged and the program managers have a sound understanding of challenges related to the program. Duke Energy recently instituted a number of improvements to meet those challenges; among them, program managers reported that the recent addition of the energy efficiency engineers (EES) has allowed for a better distribution of resources, enabling program staff to focus on increasing customer energy savings. Other changes included the addition of online calculators to assist customers with providing the necessary savings calculations, and a flat-rate incentive that removes much of the customers’ uncertainty about the amount of the incentive they will receive. As Duke Energy recently instituted these changes, it is unlikely participant surveys captured any resulting increases in satisfaction.

Trade Ally Feedback

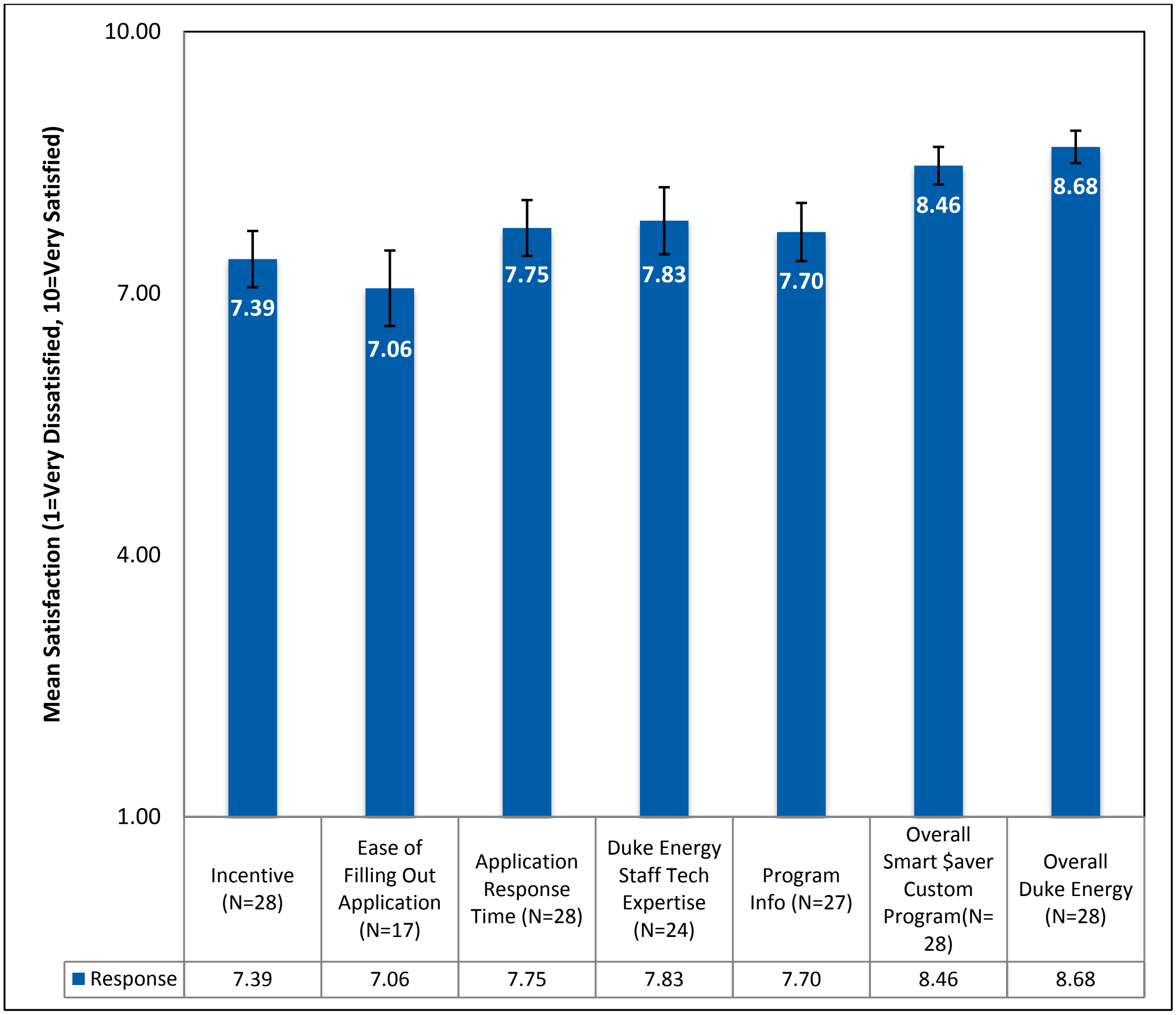
As found in past evaluations, trade allies continued to value this program as a key energy cost-reduction service to their customers as well as a way of increasing sales for their business; they see the Custom incentive as critical to move a customer project forward. Trade allies continued to praise the Duke Energy’s trade ally outreach representatives as being unfailingly helpful with a wide range of issues. However, they also reported that they had difficulty helping customers with making decisions about their energy efficiency upgrades due to the lack of transparency with the incentive process. Additionally, trade allies said that the length of the application review process was too long and the amount of paperwork involved was too much. Trade allies rated their overall satisfaction (on a scale of 1 to 10; 1= very dissatisfied and 10= very satisfied) with the Custom Program at 7.8 their overall satisfaction with Duke Energy at 8.7. Due to the small sample size, these ratings are not representative of the larger trade ally population. In this sample, the trade ally feedback only provides a glimpse into the range of issues they encountered, but does not reveal prevalence of those issues.

Participant Feedback

Participants primarily learned about the Custom Program through a trade ally or through their Duke Energy account manager. The primary driver of participation was energy cost savings; accordingly, participants' are most interested in knowing the amount of the incentive. During the application process, participants directed some program- and application-related questions to Duke Energy staff, while they directed program- and technical-related questions to the trade allies. While participants have high satisfaction with the overall Smart $aver Program, as well as with Duke Energy, they have moderate satisfaction with particular aspects of the Custom Program. While participants continued to find the application process satisfactory, they gave this program element the lowest ratings.

Figure 1 shows participant satisfaction ratings, on a scale of 1 to 10, with 1 indicating "very dissatisfied" and 10 indicating "very satisfied."

Figure 1. Participant Satisfaction with the Indiana Smart $aver Custom Program



Conclusions and Recommendations

In summary, the Smart $aver Custom Program is well-integrated into Duke Energy's offerings to its nonresidential sector, and participants have high satisfaction with the program and Duke Energy itself. Duke Energy has expanded program staffing in the past year; however, in 2015, program staff continued to try to balance resources to meet the needs of the majority of participants who had small projects (contributing a smaller portion of program savings) with the needs of the few participants who had large projects (contributing a larger portion of program savings). While some aspects of program delivery and implementation can still be improved, Duke Energy program managers have already begun to address these issues with the recent innovations to the Custom Program. Due to the recent introduction of these new program elements, the evaluation team did not include them in the scope of this study. Historically, the Custom Program in the Midwest states has achieved high realization rates year after year. Given the program's successful track record, and the fact that program staff has made recent improvements to the program, few recommendations are warranted at this time. However, the evaluation team recommends that Duke Energy conduct a process evaluation of the new components of the Custom Program sooner rather than later because some customers and trade allies have difficulty distinguishing between the Custom and Prescriptive Programs (and between Duke Energy and other program implementers); changes to the customer expectations have far-reaching consequences. In evaluation after evaluation, both trade allies and participants compare the Custom Program negatively in direct comparison to the less complex Prescriptive Program. In summary, the evaluation team's key findings include the following conclusions and recommendations:

- **Conclusion:** Program managers need to allocate resources to meet the needs of the majority of participants with smaller projects even though most program savings are achieved by a few large projects. Participants, particularly the smaller businesses, sometimes report that providing savings calculations poses a difficulty due to their lack of technical expertise.
  - **Action Taken, No Recommendation Needed:** Program managers have added online calculators that participants and trade allies can use to provide savings calculations for a wide number of applications.
- **Conclusion:** Participants and trade allies sometimes report that uncertainty about the amount of the incentive makes it difficult to decide on their project scope.
  - **Action Taken, No Recommendation Needed:** Program managers have introduced a flat rate incentive to remove uncertainty for certain Custom projects.
- **Conclusion:** Participants and trade allies would like the option of submitting an online application.
  - **Action Taken, No Recommendation Needed:** Program managers have developed an application that can be submitted via email.
- **Conclusion:** The Smart $aver Custom Program achieves high success with energy savings and is perceived by trade allies as an important influence on the energy efficiency equipment market.
  - **Recommendation:** Duke Energy should conduct a process evaluation within the first year of the Custom Program's recent innovations to ensure that customer experiences with and attitudes toward the Custom Program continue to be positive and the program continues to achieve high energy savings.

Introduction

Program Description

The Duke Energy Smart $aver Custom Program (Custom Program) provides incentives for Duke Energy's nonresidential customers to use high-efficiency equipment. This program supplements the Smart $aver Prescriptive Program (Prescriptive Program), which provides prescriptive rebates for preselected measures. Customers wishing to install eligible measures not included in the Prescriptive Program equipment list may apply for a rebate through the Custom Program. The Custom Program was originally designed to provide incentives for larger retrofit projects that could not fit within the parameters of the Prescriptive Program. Over the years, the success of the Custom Program has driven the expansion of the website, outreach materials, and the trade ally network. The program managers reported that while the number of smaller applications have grown over the past few years, the bulk of the energy savings still come from a relatively small number of large projects. Of the applications, approximately 50% are for lighting projects.

The Custom Program differs from the Prescriptive Program in a number of ways, but the two programs are closely coordinated. As measures in the Custom Program become more popular, Duke Energy must decide whether to move them to the Prescriptive Program. Moving measures from the Custom to the Prescriptive Program means that customers have easier access to the associated incentive, but it also affects the Custom Program's ability to meet its savings objectives.

From the customers' perspectives, the Custom Program allows them to receive incentives that are not available on the Prescriptive Program's list of approved measures, but they must also apply for the Custom incentive prior to purchasing or installing the measures. The Prescriptive Program allows customers to apply for an incentive after purchase and installation. Custom incentives are capped at 50% of the incremental project cost, and the project's simple payback must be greater than one year.

Approval of the Custom applications is resource intensive, requiring review by qualified engineers. The amount of work required to review an application for a small project and large project is about the same. As was noted in past evaluations, the 2015 Custom Program staff continued to seek a balance between providing low-effort support to all customers who wish to participant with smaller projects, while providing a higher level of support to the development and review of applications for larger projects.

As a way to provide more support to customers with smaller applications and customers who do not have account managers, Duke Energy has developed two vehicles for participating in the Custom Program: Custom-to-Go and Fast Track. At the time of these interviews in 2015, Custom-to-Go had just recently launched, while Fast Track was still under development; they are not included in the scope of this evaluation. However, the evaluation team anticipates that these two new vehicles will likely address some historical concerns voiced by participants about the Custom Program, such as difficulty with providing savings calculations, the length of time for application review, and the complexity of the application. In addition, the program manager reported that the Custom Program started offering customers a flat-rate incentive. Staff believes the flat-rate incentive will remove a lot of uncertainty about the incentive approval process and give customers solid financial information on which to base their decisions. Because of these recent additions to the program, many of the concerns documented in this report may no longer be a concern or a concern for future program cycles.

Program Design and Goals

The Custom Program is marketed primarily through two channels: Duke Energy's extensive network of trade allies, including vendors, distributors, and contractors, who are able to share their expertise in energy-efficient technologies and leverage the Custom incentive to increase their own businesses. Duke Energy Large Account Managers also market the program to their assigned large customers (>500 kW).

In the most recent Indiana filing for program years 2016 to 2018, the Custom Program is planned to contribute 24% of the forecasted nonresidential energy efficiency gross saving targets.[1] Duke Energy combined the contribution targets for prior program years for the Custom and Prescriptive Programs. Table 3 shows the most recent reported gross savings for the Custom Program from January 2013 through January 2015.

Table 3.Duke Energy Indiana Smart $aver Program Performance

Performance Period	January 2013 - January 2015
Number of projects completed during the performance period	160
Reported gross savings for the performance period (kWh)	64,052,604

1 Indiana Utility Regulatory Commission. *Petition of Duke Energy Indiana, Inc., Cause 43955 DSM-3*. Filed May 28, 2015.

Evaluation Methodology

Overview of the Evaluation Approach

The evaluation team collected data from in-depth telephone interviews with program managers, participant surveys that were fielded by phone and online, and trade ally phone interviews. The team analyzed the data by coding open-ended responses and conducting descriptive statistics when warranted by the number of responses. Other than filtering questions designed to assure that a person knowledgeable about the Custom project was located, there were no other mandatory questions in the surveys or interviews. This resulted in responses to some questions that may not tally with the total number of responses.

Table 4 lists the start and end dates for activities conducted for the process evaluation.

Table 4. Sample Period Start and End Dates

Evaluation Component	Sample Period	Dates Conducted	Total Conducted
Management Interviews	–	July 25, 2014 and May 27, 2015	2
Participant Surveys	Jan 1, 2013 – Feb 3, 2015	Phase 1: July 22, 2014 – September 12, 2014 Phase 2: Aug 10, 2015 – Aug 24, 2015	29
Trade Ally Interviews	Jan 1, 2013 – Feb 3, 2015	Phase 1: Aug 1 – Aug 8, 2014 Phase 2: Aug 26 - September 4, 2015	10

Management Interviews

In 2014, the evaluation team conducted a joint interview with the two Duke Energy program managers responsible for the Custom Program in the Midwest and in the Carolina System, due to the close coordination of program delivery across Duke Energy's service territory. In 2015, the evaluation team conducted a brief interview to obtain updates about program operations with the new product manager for the Custom Program in the Midwest. The team interviewed the following number of program managers as part of this evaluation:

- 2014 Program Manager Interviews (two)
- 2015 Program Manager Interviews (one)

Trade Ally Interviews

The evaluation team conducted interviews with 10 trade allies who had worked on or submitted applications for the Custom Program during the 2013 and 2014 program years.

Participant Surveys

Twenty-nine Indiana Smart $aver Custom participants agreed to answer questions about their experiences with the program. Of these respondents, 21 successfully applied for and received a Custom incentive (Closed Won from here on), while eight did not receive an incentive (Closed Lost from here on).

Study Methodology

Data Collection Methods, Sample Sizes, and Sampling Methods

Participant survey respondents were randomly selected from Duke Energy's database of Custom application records between January 2013 and January 2015. The Custom applications listed both a contact within the customer company and a contact from the trade ally that assisted the customer. Therefore, the evaluation team selected trade ally interviewees from the same sampled applications. However, due to the fact that not all participants or trade allies could be reached, or agreed to participate in the evaluation, the resulting respondents were not all from the same applications.

The evaluators administered the participant survey as a phone survey in Phase 1. In Phase 2, the evaluation team administered the survey online using the Qualtrics survey platform to increase efficiency in completing the surveys and facilitate data analysis. Qualtrics offers a straightforward programming interface for the evaluation team and a user-friendly interface for the respondents.

Since questions cannot be clarified or expanded upon in an online survey, prior to implementing the participant surveys online, the evaluation team revisited the survey instruments to clarify questions as necessary. The team moved a number of questions to allow for branching in the online survey and added prompted responses to a number of questions to facilitate data analysis. The survey used satisfaction response scales from 1 to 10, which was consistent with the response scales used in Phase 1.

The trade ally surveys were implemented as phone surveys in both Phase 1 and 2. In Phase 2, the evaluation team revisited the survey instrument to clarify questions as necessary.

Number of Completed Surveys and Sample Disposition

In Phase 1, the evaluation team attempted to contact 20 participants by telephone and e-mail and completed 11 surveys (all Closed Won). These surveys were administered by telephone.

In Phase 2, the evaluation team attempted to contact 44 participants by telephone and e-mail. The evaluation team completed 17 surveys and obtained responses to one partially completed survey. The team reached eight Closed Lost and 10 Closed Won (including the partial survey) participants and administered these surveys online.

Overall, the evaluation team surveyed 29 participants out of 64 attempted contacts.

Expected and Achieved Confidence and Precision

Twenty-nine participants completed surveys from a population of 171 organizations that applied for incentives through the Custom Program during the evaluation period. The precision based on this sample size is ±13.9% at the 90% confidence interval. Table 5 lists the confidence interval and precision value achieved for the evaluated parameters.

Table 5. Evaluated Parameters with Value, Units, and Confidence/Precision

Program	Parameter	Value	Units	Confidence/ Precision
Smart $aver Custom	Participant survey responses	Varies by question	Varies by question	±13.9% precision at the 90% confidence interval

Threats to Validity, Sources of Bias, and How Those Were Addressed

The sample sizes for the participant surveys were too small to allow responses to be considered statistically representative; as a result, the responses should be considered indicative of the program but should not be generalized to all Custom Program participants. The evaluation team's survey staff reviewed the surveys to help ensure that questions were clear and unbiased.

Because of the relatively small size of the sample, the unique characteristics of the sample may affect the evaluation team's ability to extrapolate the current findings to the larger program population. Some characteristics of the sample are described below and should be kept in mind when considering the findings.

Process Evaluation Findings

This section presents the process evaluation findings for Duke Energy's Smart $aver Nonresidential Custom Incentive Program in the state of Indiana. The findings are presented in three sections: management interviews, trade ally interviews, and participant surveys.

Management Interviews

Marketing and Outreach

The Custom Program is marketed primarily through Duke Energy's trade ally network and through Duke Energy's large account managers (LAMs). Program information and outreach to the trade allies is handled by eight Duke Energy trade ally representatives (covering all five of Duke Energy's operating territories). These trade ally (TA) representatives make presentations to trade allies at their offices at "lunch and learns," and may accompany trade allies on visits to prospective customers. The TA representatives also hold periodic webinar presentations about the Smart $aver programs, advertising these to the trade allies through e-mail. Duke Energy relies on the trade-ally network to reach the midsize and smaller customers and offers the trade allies the benefit of being able to use Smart $aver incentives to increase their own sales.

Duke Energy assigns its large customers to the Large Account Managers. The Large Account Managers (LAMs) are responsible for generating interest and for helping with the applications. The LAMs already have an ongoing relationship with their assigned accounts, one that includes regular review of the large customer's energy usage and energy efficiency needs.

Program staff coordinates marketing efforts with the Smart $aver Prescriptive Program, and trade allies are taught to "lead with Prescriptive." The two programs are so closely coordinated that customers and occasional trade allies sometimes do not make a distinction between the two.

Duke Energy also provides information about both Smart $aver programs on its website. Duke Energy's outreach to the trade allies reinforces the use of the website as the repository of the most updated program information, in particular for the Prescriptive Program, which is more frequently used and periodically revises its approved measures list. For the Custom Program, the Duke Energy website includes separate portals for customers and for trade allies. These pages offer application materials, Custom-to-Go calculators, and information on local trade allies who ask to be listed.

Application Review Process

Within 24 hours of receipt of a Custom application, Duke Energy sends out an e-mail acknowledgement that provides an estimate of the approval time and a reminder to not purchase or install any equipment prior to approval of the application. The review is conducted in stages by different teams. First, a team of subcontractors conducts the administrative review and completeness check, notifying the customer immediately if any information is missing. Next, the first team passes the application to another team that reviews the measures to make sure they do not fit the criteria for the Prescriptive Program. Finally, engineering staff perform a technical review of the application to determine, among other things, if savings can persist throughout the life of the measure and if incorrect maintenance or operation may degrade savings. Once an application is approved, an offer letter with the incentive amount is sent to the customer. After the project is completed, Duke Energy staff conducts a final technical review of the project invoices and documentation before issuing a check.

At the time of these interviews in May 2015, the program manager reported that the entire application turnaround takes approximately four to six weeks from the application to the offer letter, depending on a number of factors including whether the application is complete or not. With simpler lighting measures, the turnaround is closer to four weeks.

Process Improvements

Duke Energy is in the process of developing an integrated customer database system that contains information about each Smart $aver application along with the associated trade ally contacts. At the time of the interviews, due in part to a transition to a different vendor, Duke Energy was tracking applications across three databases. Within these databases are status flags for each Custom application to track an application as it moves from submission, to approval, to offer letter, through to project completion and payment (these are designated Closed Won). In some cases, an offer may be made but the customer does not pursue the project. Duke Energy periodically reviews these flags to see whether follow up is warranted with certain applications.

The program manager reported that Duke Energy was in progress of developing an online application and the evaluation team confirmed that Duke Energy launched email applications in 2015.

Energy Efficiency Engineers

In an effort to encourage customers to take on larger and more complex projects, Duke Energy hired a team of four energy efficiency engineers (EEEs) in the past year. These EEEs help customers, both small and large, with the front-end application process. They act as technical advisors and as subject matter experts about the Custom Program's requirements and benefits. The program manager reported that, so far, feedback on the EEEs has been good and that the EEEs have been able to help with program operations. "I see an improvement there; it gives us a wider knowledge base, and we have gotten really good feedback from the LAMs." The EEEs prioritize their assistance on projects that have two or three measures that are not lighting, and those with half a million kWh of potential savings. However, the project manager reports that the EEEs have not had to decline assistance to any customers who do not meet those characteristics.

Program Successes and Challenges

The current program manager reported high satisfaction with the flat-rate incentive, a recent program innovation that removes the customers' uncertainty about the amount of the incentive. The previous program manager reported that he was pleased with the Custom Program's high realization rates, citing the rigorous application review process as one of the main drivers.

The current program manager acknowledged that maintaining that high realization rate is a challenge for the program. He said that with the recent program additions of the EEEs and the Custom-to-Go tools, he and his staff will be able to devote more of their time and resources to encouraging customers to take on larger projects with higher energy savings.

In the state of Indiana, customers were recently given the option to opt out of programs and pay for an energy efficiency rider. The Duke Energy program manager reported that he has not seen the effect of that change on program participation, but expects that some customers may opt out of Duke Energy's energy efficiency programs. Because the majority of savings from the Custom Program comes from a relatively small number of large projects, a decrease by two or three large projects may affect Duke Energy's savings objectives for the Custom Program. The program manager said that the EEEs and Custom-to-Go tools will do much to proactively address this upcoming challenge.

Despite these challenges, at the time of these interviews, the program managers reported that they are on track to meet their program objectives in Indiana.

Trade Ally Interviews

Trade Ally Sample Characteristics

The evaluation team conducted interviews with 10 trade allies who had worked on or submitted applications for the Smart $aver Indiana Program during the evaluation period.

These trade allies were well-experienced in their field, with an average of over 20.6 years of experience. Seven of the trade allies were able to recall where they first learned of the Smart $aver Custom Program. Two learned through participating in other Duke Energy programs, two learned from a customer, and the others learned from a Duke Energy presentation to their company, the Duke Energy website, and a coworker. The trade allies included those with past experience with both the Custom and Prescriptive Programs (n=7), with the Custom Program only (n=2), and one who had past experience with the Prescriptive Program. Six of them reported they were listed as trade allies on the Duke Energy website, while three could not recall.

Custom Participation Process

The evaluation team asked respondents who had experience filling out the Custom application if they had any suggestions for streamlining the applications. There was only one suggestion: modify invoicing requirements to allow for annual invoicing so the trade allies do not have to draw up dummy invoices for the application. The evaluation team recognizes that this is likely a minority opinion and that annual invoicing interferes with the existing need for timely verification of projects.

One trade ally reported that the review process seems to include a broader spectrum of questions on equipment, specifications, and hours of usage stating, "It appears as though they are being more diligent in reviews than in the past." Three trade allies reported that their clients did have some complaints about the length of the application review time, the amount of paperwork needed, and the fact that application approval is required before starting a project. The evaluation team recognizes that these result from Duke Energy's rigorous review process.

Five trade allies were able to provide estimates of how long the application review process took; their estimates ranged from three to eight weeks. One trade ally was not able to answer saying, "We don't hear about the offer; [it] needs to go to TA as well as customer." This issue has arisen in past evaluations, and Duke Energy has changed their process to ensure that trade allies are also notified. This respondent may be reporting an old experience, but Duke Energy should continue to track trade ally notifications to see if reports of these experiences decrease in future evaluations.

Trade allies also contacted Duke Energy staff with questions. Six reported they contacted their Smart $aver trade ally outreach representative. Three reported that they contacted Smart $aver program managers. Three reported that they interacted with the third-party application processing staff, and one interacted with an EEE. In general, trade allies had questions about their applications with one reporting weekly contact with their outreach representative. When asked for suggestions to improve the quality of the interactions, respondents reported none. With regard to the outreach representatives, one respondent said, "Those guys are great to work with."

Trade Ally Outreach Feedback

Six of the trade allies reported having attended the Smart $aver outreach presentations, and all but one learned about the opportunity through a call or e-mail newsletter directly from Duke Energy. The remaining trade ally learned from a coworker. The trade allies rated the usefulness of these presentations at 9, on a scale of 0 (not useful at all) to 10 (always useful). None of the respondents had any suggestions for improving the usefulness of these presentations.

Only one trade ally reported regularly providing Smart $aver marketing materials to a customer. When asked if there were any materials that they would like to have, one trade ally suggested a trifold that listed programs for industrial accounts, and another said, "maybe something digital, I rarely use print."

Half of the respondents reported that they have directed customers to the Duke Energy website. None of the respondents had any additional suggestions for improvement, but one said, "[It} increases my credibility to be able to pull up the DE website and show them the program."

Trade Ally Perspective on Customers

The evaluation team asked respondents to estimate what percentage of their customers was already aware of the Smart $aver Custom incentive. On average, respondents (n=8) reported that 45% of customers already had some familiarity with the Custom Program. One respondent commented that more customers seem to know about Energizing Indiana, while another commented that most customers seemed to be aware that there are utility incentives, if not necessarily by program name. Eight respondents also estimated that, on average, more than 70% of their customers used the Custom incentive for early replacement of their equipment, with responses ranging from 35% to 100%. One trade ally commented that larger pieces of equipment were more likely to undergo early replacement, while smaller equipment tended to be replaced on burnout.

Importance of the Custom Incentive

All respondents brought up the availability of a Custom incentive early in their discussions with the customers. However, their reasons for doing so differed, suggesting that for some customers the incentive is less critical than others. While one trade ally said, "The custom incentive is instrumental in closing the deal", another said "[I use it] to get a sale, it's a different way to get someone to switch to a product. I used to sell based on energy efficiency alone, now the incentive is a kicker."

Only one trade ally thought the incentive was too low; six other respondents thought they were appropriate, with one saying they were "generous." These opinions are likely affected by the measure type. The trade ally who thought the incentive was low said that sales boosted when Energizing Indiana offered double rebates. Even though this was one comment, and was in reference to a prescriptive program, it suggests that there may be some minority trade ally population with distorted expectations for utility incentives due to Energizing Indiana.

Trade allies considered the Custom incentive an important driver of high-efficiency equipment use. When asked what they thought customers would do if there were no incentives, three thought customers would not pursue the project, and three thought customers would rescope the project or use cheaper equipment. One trade ally said he "heard [the] entire Custom Program was going away" and wanted Duke Energy to know that the Custom Program was "beneficial to everybody. Customers win; it helps the economy and vendors," and that he uses his trade ally status as a differentiating factor from his competitors.

Increasing Participation

To try to understand barriers to participation for the trade allies, the evaluation team asked respondents why they thought their competitors might not be participating in Smart $aver. Three responded: one thought the competitors may just be lazy, another thought that they may be new to the incentive process and be deterred by the paperwork, and a third thought they may not be doing their homework, adding, "It's a valuable tool to help people make improvements that has worked well for us." As was found in past Indiana Smart $aver Prescriptive evaluations, the trade allies perceive their expertise with the Smart $aver Program as an area of competitive advantage, and some said that they are not sure they want to diminish that advantage by having more trade allies participate in Smart $aver.

Strengths and Areas of Improvement

The evaluation team asked trade allies if they thought the Custom Program had any aspect that was working particularly well. Five trade allies thought the program was working well overall, and two others said the incentives were effective, with one responding, "people know about them and they work." When asked about areas where Smart $aver Custom needed improvement, one said the application processing time should be shortened, another said that the website could be used to track applications and that the Custom Program should provide incentives for demand reduction. The latter suggestion may have resulted from the respondent not knowing Duke Energy's method of calculating incentives. Duke Energy may want to consider adding the weight of demand savings when calculating incentives to its program materials. Three trade allies gave suggestions related to equipment: one suggested more measures be moved to the Prescriptive Program, one suggested that the Custom Program be more "proactive with LEDs," and another suggested loosening the DesignLights Consortium (DLC) requirements for lighting measures. [2]

Trade allies rated their overall satisfaction with the Smart $aver Custom Program at 7.8 and their overall satisfaction with Duke Energy at 8.7.

Participant Surveys

Participant Sample Characteristics

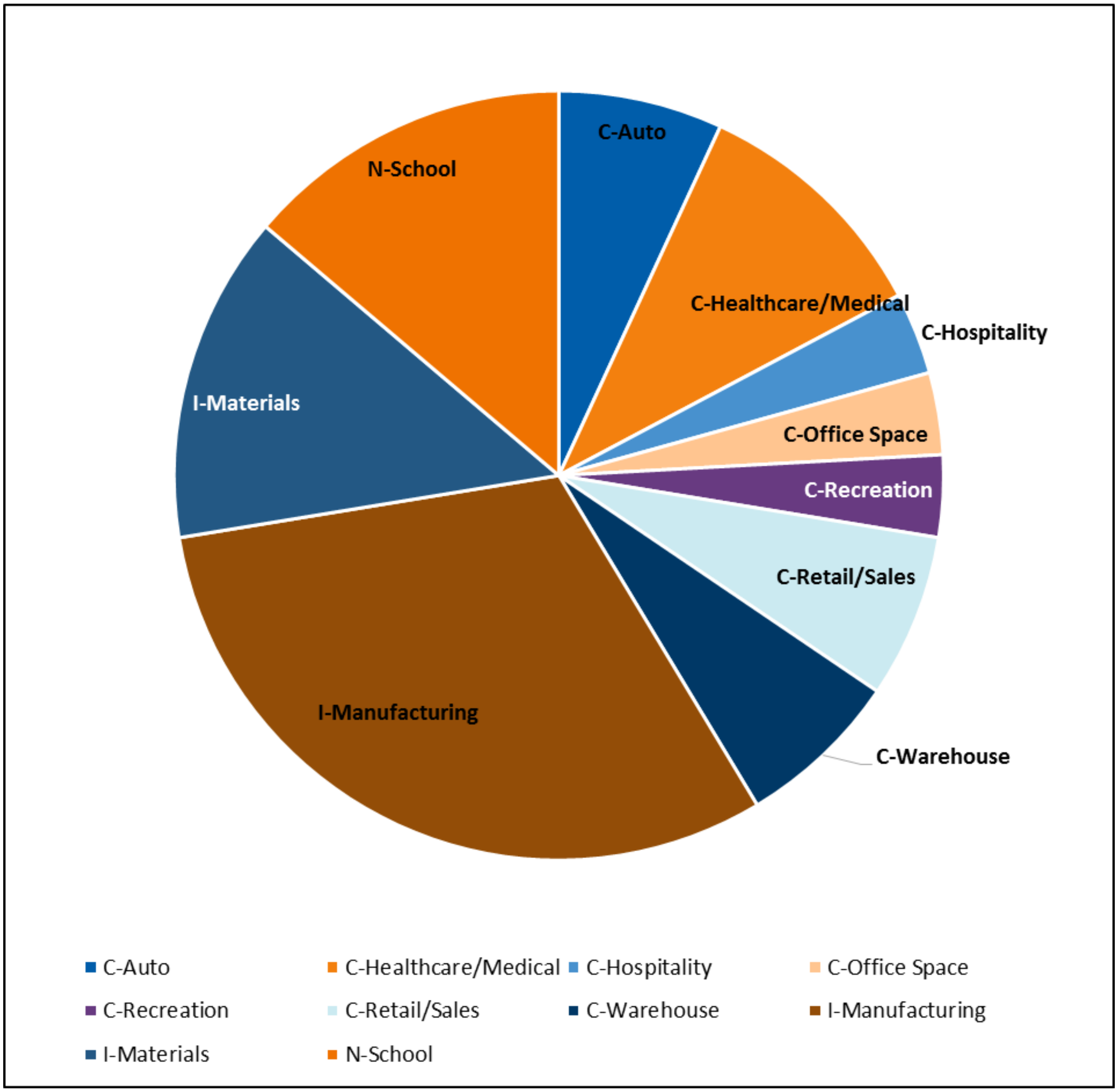
Twenty-nine Indiana Smart $aver Custom participants agreed to answer questions about their experience with the program; of those respondents, 21 successfully applied for and received a Custom incentive.

These respondents held a variety of roles within their company, with four in engineering or technical roles, 11 in facility/property manager roles, 11 in general management or company officer roles, and one who was an analyst. In general, the respondents appeared to have been in positions where they would have participated in or been aware of the rationale for the equipment decisions made for their Custom project.

Figure 2 shows the distribution of the respondents across various commercial and industrial sectors—12 were in commercial sectors, 13 were in industrial sectors, and one was a nonprofit.

[2] The DLC administers the [Qualified Products List](#) (QPL) that distinguishes quality, high-efficiency LED products for the commercial sector.

Figure 2. Indiana Smart $aver Custom Respondents' Sectors (n=29)



Twelve respondents reported their company had a Duke Energy assigned account manager, eight did not, while the remaining seven did not know whether they had an account manager.

The majority of the respondents applied for a lighting incentive (n=20); three applied for a process equipment incentive, three applied for a chiller incentive, one applied for an EMS incentive, and one applied for multiple measure incentives.

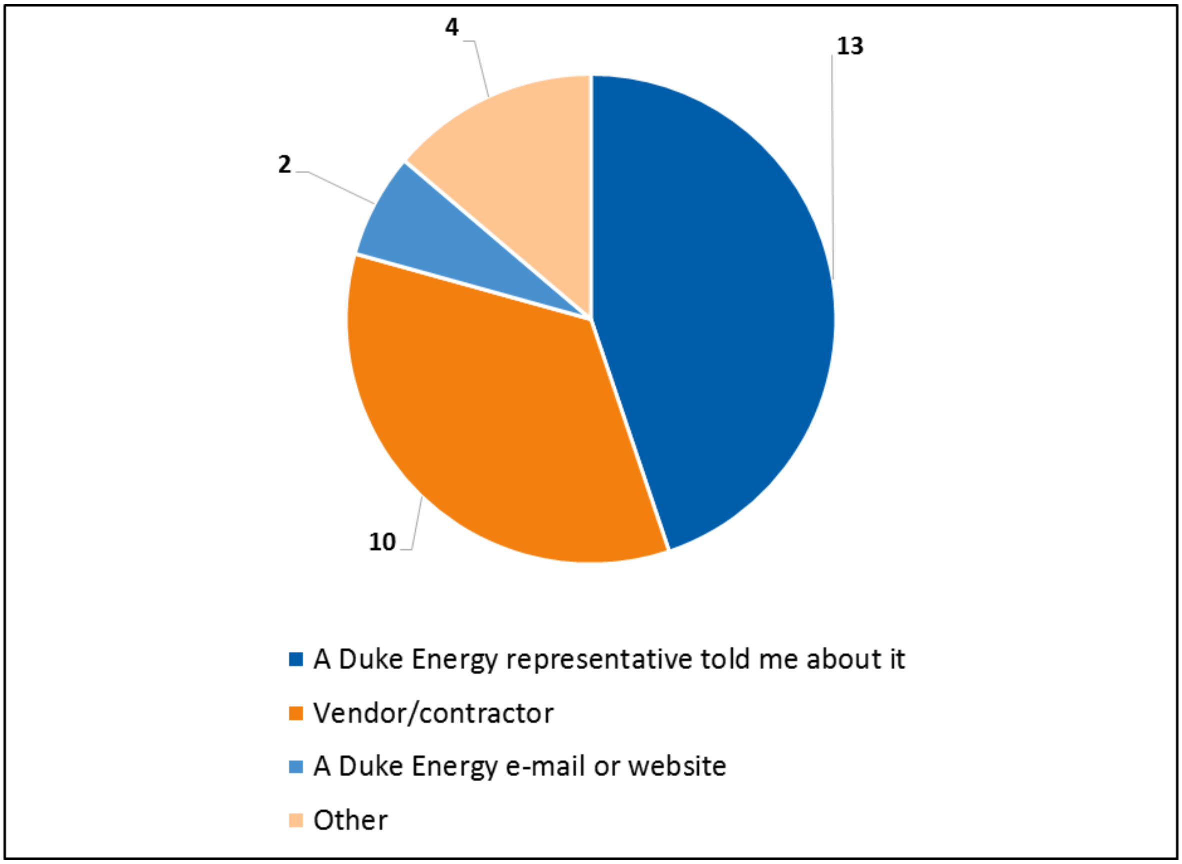
The respondents included an equal mix of participants who did and did not have previous experience with Smart $aver. Six respondents had previously submitted Custom and Prescriptive applications, while another six had previously submitted only Custom applications.

Smart $aver Custom Program Outreach

Source of Smart $aver Awareness

The participants primarily learned about the Custom Program from two sources: Duke Energy representatives and trade allies (see Figure 3). Only two learned about the Custom Program from Duke Energy's website or a Duke Energy e-mail. Of the remaining four respondents, two learned about the Custom Program through the Smart $aver Prescriptive Program, one heard about the program through their experience with another Duke Energy program (not related to Smart $aver), and one heard through word of mouth from a customer. This finding is not surprising given that Duke Energy markets the Smart $aver Custom Program primarily through its account managers and trade allies.

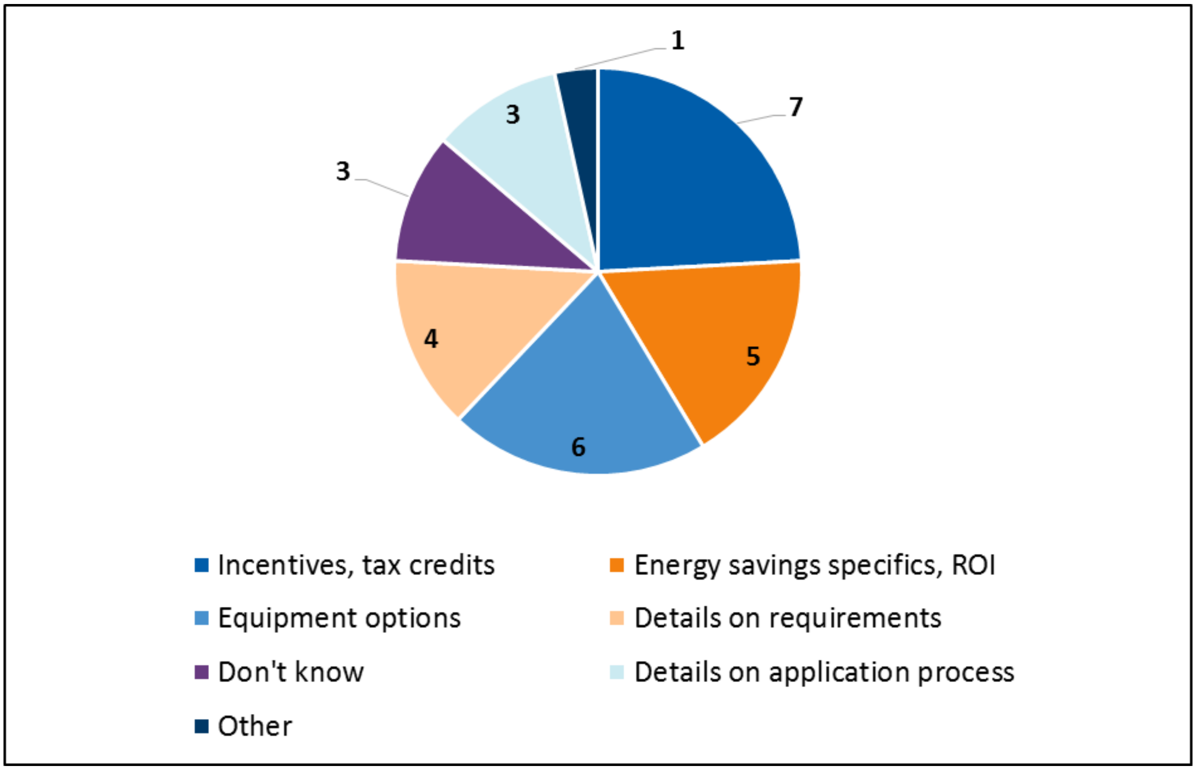
Figure 3. How Participants Heard About the Smart $aver Program (n=29)



Program Information Needed

The evaluation team investigated whether the information provided to the participants could be improved or augmented in any way. The team asked respondents if they needed to seek out any additional information when they were first learning about the Custom Program's benefits and requirements. Seventeen of the 27 who responded to this question said they did, while the remaining 10 said they did not. Of the 17 respondents who needed information, 10 were able to share details on what they needed: they listed anywhere from one to four types of information (multiple responses accepted). Figure 4 shows the types of additional information that participants sought.

Figure 4. Additional Information Needed for Participation in the Smart $aver Custom Program (n=10)



These responses could be placed into three overall categories: (1) program and application information that Duke Energy can potentially provide, and may wish to add to future outreach materials, if they are not already there, (2) information specific to the Custom project that Duke Energy may not be able to provide such as energy savings specifics and return on investment, and (3) information that may be idiosyncratic to the company's internal decision-making process. The responses showed that much of needed information seems to be project-specific, which may not be something that Duke Energy could easily provide. Over a third of the responses mentioned project-specific outcomes, including the size of the incentive (n=7) and the amount of energy that could be saved (n=5).

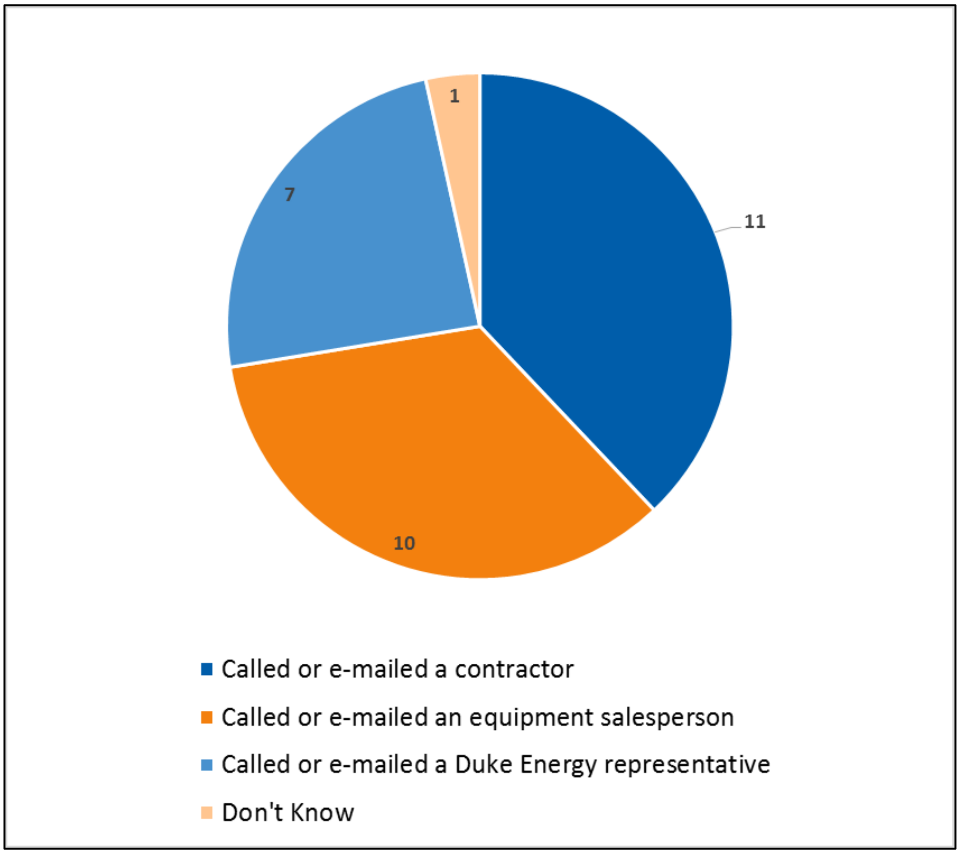
Approximately a quarter of the information needs pertained to program requirements (n=4) and the application process and time frame (n=3). Duke Energy may wish to investigate further to see whether the Custom Program can provide more details on these processes in their outreach and online materials. Given the nature of the open-ended questions, respondents only provided a high-level description of their needs. However, Duke's account managers likely have a good understanding of the types of information that prospective participants need in this area, and the evaluation team expects they are already included in reviews of outreach material.

The respondents reported they also needed to consider their equipment and installation options (n=6). Only one respondent reported needing to check with others who had previously participated in the program. These needs are likely idiosyncratic and not information that Duke Energy can provide.

Sources of Additional Information

Respondents turned mainly to trade allies to find the additional information they needed (see Figure 5); all 17 respondents reported they were able to find that information successfully. This confirms that Duke Energy's trade ally network plays an important role in implementing the Smart $aver Custom Program, and suggests that the trade allies are successful at answering both project-related questions as well as program-related questions.

Figure 5. Sources of Additional Information for Custom Program Participants (n=17)



Suggestions to increase participation

The evaluation team asked all respondents if they had suggestions to increase participation in the Custom Program "other than increasing the level of marketing." This tactic was devised to avoid the tendency of respondents only to suggest increasing the marketing. Table 6 shows that there were no dominant suggestions. Four respondents suggested simplifying the application process, three suggested that Duke Energy increase personal outreach (i.e., making calls and staying in touch), and three others suggested increasing the recruitment of trade allies.

Table 6. Suggestions for Increasing Participation (Aside from Increasing Marketing; n=17)

Suggestion	Frequency
Simplify application process	4
More personal outreach	3
Increase trade ally participation	3
Continue providing incentives/larger incentives	2
More marketing/television ads	2
Don't know	1
Share success stories	1
Remove itemization requirement for receipts	1
Use account managers	1

Assistance with Application Process

Respondents worked with trade allies and account managers during the project scoping and application phases. Of those twelve who had assigned account managers, nine reported that they did work with their account manager on their Custom application. Of the remaining respondents, two did not know and one reported not working with the assigned account manager. Table 7 shows that the account managers provided a variety of assistance to the respondents on program and application-related matters, without any area being particularly dominant.

Table 7. Account Manager Assistance to Custom Program Participants (n=9)

Type of Assistance	Frequency
Providing updates on the application status	4
Resolving problems with applications	3
Verify completeness of rebate applications/paperwork	3
Payback calculations/estimating return on investment	2
Provided general program information	2
Providing information about eligible equipment options/equipment specs	2
Budgeting/project scoping/resource planning	1
Don't know	2

Respondents tended to work more frequently with trade allies. Twenty-four of the 29 respondents reported that they worked with a trade ally during the scoping and application phases. Table 8 shows that respondents relied upon the trade allies primarily for providing equipment-related information, including help with calculating energy savings as payback and only peripherally with funding the projects.

Table 8. Trade Ally Assistance to Custom Program Participants (n=24)

Type of Assistance	Frequency
Providing information about equipment options/equipment specs	17
Acquiring and installing equipment	15
Rebate applications/paperwork	13
Payback calculations/return on investment	12
Finding and qualifying for rebates	9
Budgeting/resource planning	2
Other	2

These two tables suggest that the respondents lean heavily on the trade allies during the project scoping and application processes. Those who had account managers did turn to them for more programmatic questions. These data reflect customer practices prior to Duke Energy's addition of the EEEs, who are now available to assist customers with technical issues. These data can be used as a baseline against which to measure an increasing role of the EEEs during the project scoping and application process. Future surveys should specifically ask customers about the roles that the EEEs play and their satisfaction with the EEEs' assistance.

In addition, the participants had access to information on Duke Energy's website as well as program staff and technical experts via phone and e-mails. Thirteen respondents reported that they reached out to Duke Energy staff for help during the application process. Of these, 11 reported that their requests were handled satisfactorily. Of the remaining two respondents, one suggested that Duke Energy could improve by providing more information on how to fill out forms, while the other could not provide any suggestions for improvement. Overall, these two were in the minority and the respondents generally reported they were satisfied with their interaction with Duke Energy staff.

When asked specifically about their satisfaction with the technical expertise of Duke Energy staff, participants rated it an average of 7.83. Sixteen participants gave a satisfaction rating of 8 or higher, while the remaining eight respondents gave a satisfaction rating of 7 or lower (see Table 9). Of these 10, only two provided specifics: one suggested that Duke Energy assign a liaison that specializes in the type of equipment being installed, while the other suggested that the same engineer be used across multiple projects from the same participant.

Table 9. Participants' Satisfaction with Technical Expertise of Duke Energy Staff

The Technical Expertise of Duke Energy Staff			
Satisfaction Rating	1-3	4-7	8-10
Frequency of response	0	8	16

When asked to give their satisfaction program information from all the information sources, participants rated their satisfaction at an average of 7.70. Table 10 lists the results.

Table 10. Participants' Satisfaction with Information Provided Explaining the Program

The Information Provided Explaining the Program			
Satisfaction Rating	**1-3**	**4-7**	**8-10**
Frequency of response	1	8	18

Application Process Satisfaction

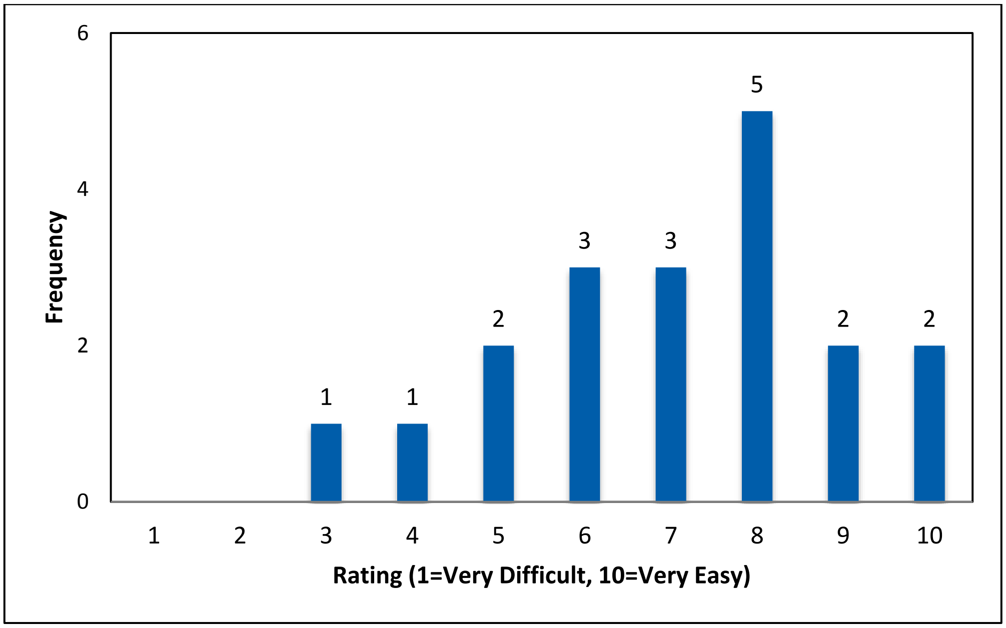
Most of the respondents completed the application themselves, occasionally with assistance from a trade ally (see Table 11).

Table 11. Participants' Responses to "Who filled out the application?" (n=28)

Response	Frequency
Self	12
Contractor	4
Self and salesperson	3
Self and contractor	3
Salesperson	3
Company	2
Self and Duke Energy representative	1

The 19 respondents who had a role in filling out the Custom application rated the application as being moderately easy to understand (a 7.05 using a scale of 1 to 10, with 1 indicating "extremely difficult" and 10 indicating "extremely easy"). Only five respondents suggested improvements. Four respondents said they did not have suggestions. Figure 6 shows the distribution of satisfaction ratings.

Figure 6. Participants' Satisfaction with the Ease of Understanding Application (n=19)



When asked for suggestions on how Duke Energy may streamline the application, only a few respondents replied. The suggestions included requests for more personalized attention, as illustrated in the following verbatim quotes:

- *Duke requires too much information beforehand. They could assign a specialist to work with on a per-project basis, rather than subjecting the customer to different levels of the Duke corporate structure throughout the application process.*
- *The Custom application could be made more customer-friendly by tailoring it for the specific type of business, school, industry, etc.*

Satisfaction with Ease of Filling out the Application

To determine whether participant concerns were about their ability to understand the forms, or their ability to provide the required information, the evaluation team asked participants to rate their satisfaction with the ease of filling out program forms.

Table 12 shows that twelve participants gave a satisfaction rating of 8 or higher, while the other fourteen respondents gave a satisfaction rating of 7 or lower. When asked how Duke Energy could improve in this area, most mentioned their desire for less paperwork. One respondent said some of the paperwork seemed to be repetitive, while another said it was confusing as to "which form to use for which program."

Table 12. Participants' Satisfaction with the Ease of Filling out the Participation and Incentive Forms

The Ease of Filling Out the Participation and Incentive Forms			
Satisfaction Rating	**1-3**	**4-7**	**8-10**
Frequency of response	3	11	12

Three respondents reported that they had experienced some problems during the application process. They were in the minority, however. Seventeen respondents reported no problems, with nine additional respondents declining to respond. These problems related to the number of iterations required for completing an application, with two respondents citing the following challenges:

- *I had to amend and resubmit the application three times. Each different level of approval at Duke required something new, and sometimes they hadn't communicated with the previous level to obtain the information I had already supplied. Eventually, everything was resolved to my satisfaction.*
- *There was too much back and forth between us and Duke regarding the application. Eventually it was approved but it took a long time and quite a bit of effort.*

The Smart $aver Custom Program managers are well aware of these issues, and, in part, the amount of information that is required in these applications stems from Duke Energy's rigorous review process.

Participation Drivers

Respondents reported that their primary motivations for undertaking their Custom projects were to reduce costs, both energy costs and repair and maintenance costs. Table 13 shows the drivers of participation from the 29 respondents. Twenty-six of the respondents (almost 90%) mentioned the need to reduce energy costs, followed by over 60% of respondents who cited a need to reduce repair and maintenance costs. Equipment reliability was the third most-frequently listed motivation (n=13). An equal number of respondents cited environmental concerns (n=9) as did those who said it was a good deal (n=9). This suggests that while environmental responsibility can play a role in motivating customer decisions, the more frequent motivator is the financial case for energy and cost savings. The two respondents who cited non-energy benefits specifically mentioned they needed brighter and better quality lighting.

Table 13. Participants' Reasons for Upgrading Equipment (multiple responses allowed; n=29)

Response	Frequency
To reduce energy costs	26
To reduce repair, maintenance, and other labor costs	18
Because old equipment was working poorly or was unreliable	13
Due to environmental concerns	9
It was a good deal	9
Needed more modern, smarter equipment (to integrate with energy manager systems or the Smart Grid)	7
Due to my contractor's recommendation	5
Purchased as part of a broader remodel	5
Wanted non-energy related product features such as appearance, brand loyalty, decreased water use, increased comfort	2
Total Number of Responses	**94**

Project Follow-up and Payback

Closed Lost

Of the eight Closed Lost respondents, six reported that they proceeded with their project even though they did not receive an incentive (five reported to have since completed their project).[3] Seven of the Closed Lost respondents were able to share an estimate of the payback period on their projects, with their responses ranging from six months to two years (mean = 14.4).

Of the five Closed Lost respondents who completed their projects, all five installed their new equipment on the original schedule. Two installed the same equipment that was listed on their Custom applications, while three did not know whether it was the same. The remaining three Closed Lost respondents reported that they delayed their projects indefinitely. One respondent starting the project within six months, another estimates two years, and the last respondent estimates starting the project as soon as the funds become available.

Closed Won

Seventeen of the 21 Closed Won respondents were able to share their payback period, and their estimates ranged from six months to eight years (with a mean of 29.11 months).

[3] Cadmus requested additional information from Duke Energy about why these respondents were not paid an incentive. The reasons for non-payment based on Duke Energy records have been provided in Appendix A. Closed Lost Applicant Status.

At the time of the interviews, 20 Closed Won respondents had completed their projects, and one reported that the project was under way (eight declined to respond). The projects took an average of 4.04 months to complete, with a minimum of two days to a maximum of 13 months.

This difference between the project outcomes of the Closed Lost and Closed Won participants seems to confirm that the Custom Program's criteria for incentive approval successfully filtered out projects that were likely to have proceeded even in the absence of an incentive and had relatively short payback periods.

Satisfaction with Incentives

Eighteen participants gave a satisfaction rating of 8 or higher, while the remaining 10 respondents gave a satisfaction rating of 7 or lower (see Table 14). When asked how Duke Energy could improve in this area, one respondent was specifically dissatisfied with the incentives on LEDs. The others expressed general dissatisfaction, suggesting that Duke Energy could hire experts to periodically review and adjust the incentives, that Duke Energy could offer 25% payback on qualifying equipment, and that the incentive amount "did not seem to correlate well with the monthly riders on the bill."

Table 14. Participants' Satisfaction with the Amount of the Incentive Provided by the Program

The Amount of the Incentives Provided by the Program			
Satisfaction Rating	**1-3**	**4-7**	**8-10**
Frequency of response	0	10	18

Satisfaction with Time to Receive Incentive

When asked about satisfaction with time to receive incentive, 18 participants gave a satisfaction rating of 8 or higher, while the remaining 10 respondents gave a satisfaction rating of 7 or lower (See Table 15). The latter suggested that Duke Energy should pay the incentive within 30 to 45 days after receiving the complete application, a second said one to two months, and a third said four weeks or less. The remaining respondents wanted a generally faster time.

Table 15. Participants' Satisfaction with Time to Receive Incentive

The Time it Took to Receive Incentive			
Satisfaction Rating	**1-3**	**4-7**	**8-10**
Frequency of response	0	10	18

Gateway Effects

The evaluation team queried the 21 Closed Won respondents on whether participation in the Custom Program led to any "gateway effects" (i.e., increased interest and participation in other energy efficiency programs and projects). Ten respondents reported that their participation in the Custom Program did lead to participation in other programs, including the Prescriptive Program (n=3), PowerShare (n=3), additional Custom applications (n=2), a residential program, and four other unspecified or non-Duke programs (such as Energizing Indiana). Very few of these respondents calculated the additional energy savings they gained from these other programs. Only two respondents estimated savings: one at $5,000 per project and another at $6,000 per year.

In addition, five of the 21 Closed Won participants reported they participated in additional Duke Energy programs, but that their participation was not motivated by their experience with Custom Program. One did not recall the additional program, but the others reported participating in the Prescriptive Program (n=1), Energizing Indiana (n=1), and PowerShare (n=2). The fact that a non-Duke program as well as non-energy efficiency programs showed up in the responses even when the question specified "Duke Energy energy efficiency programs" suggests that customers may not always make a distinction between demand-side management programs or their implementer.

Only four of the 21 Closed Won participants reported making additional energy efficiency improvements that did not qualify for any incentive. Two installed lighting (high efficiency T8, LED exit lighting, and exterior wall sconces), and one became an "Energy Champion" for their company. The remaining respondent installed equipment that was not eligible for an incentive.

Quantification of spillover effects was not an objective of this process evaluation and the sample size did not support such calculations. This qualitative assessment shows that spillover effects might be present, but the participant survey did not peer into this effect to make a clear distinction between different energy programs and to attribute spillover effects.

Strengths and Challenges

The evaluation team asked respondents if they thought any part of the Smart $aver Program deserved mention for working particularly well. Table 16 shows the response from 11 respondents. The responses do not show any clear trends due to the small sample, but it is worth noting that there are several respondents who named "ease of participation" as a program strength.

Table 16. What Participants Said Worked Well in the Smart $aver Custom Program (n=11)

Response	Frequency
That it exists	3
The incentives/savings	3
Ease of participation	3
Mentioned particular staff	1
Good overall	1

Only seven respondents mentioned areas where they thought the Custom Program could be improved (See Table 17). Again, there are no clear patterns due to the small sample size.

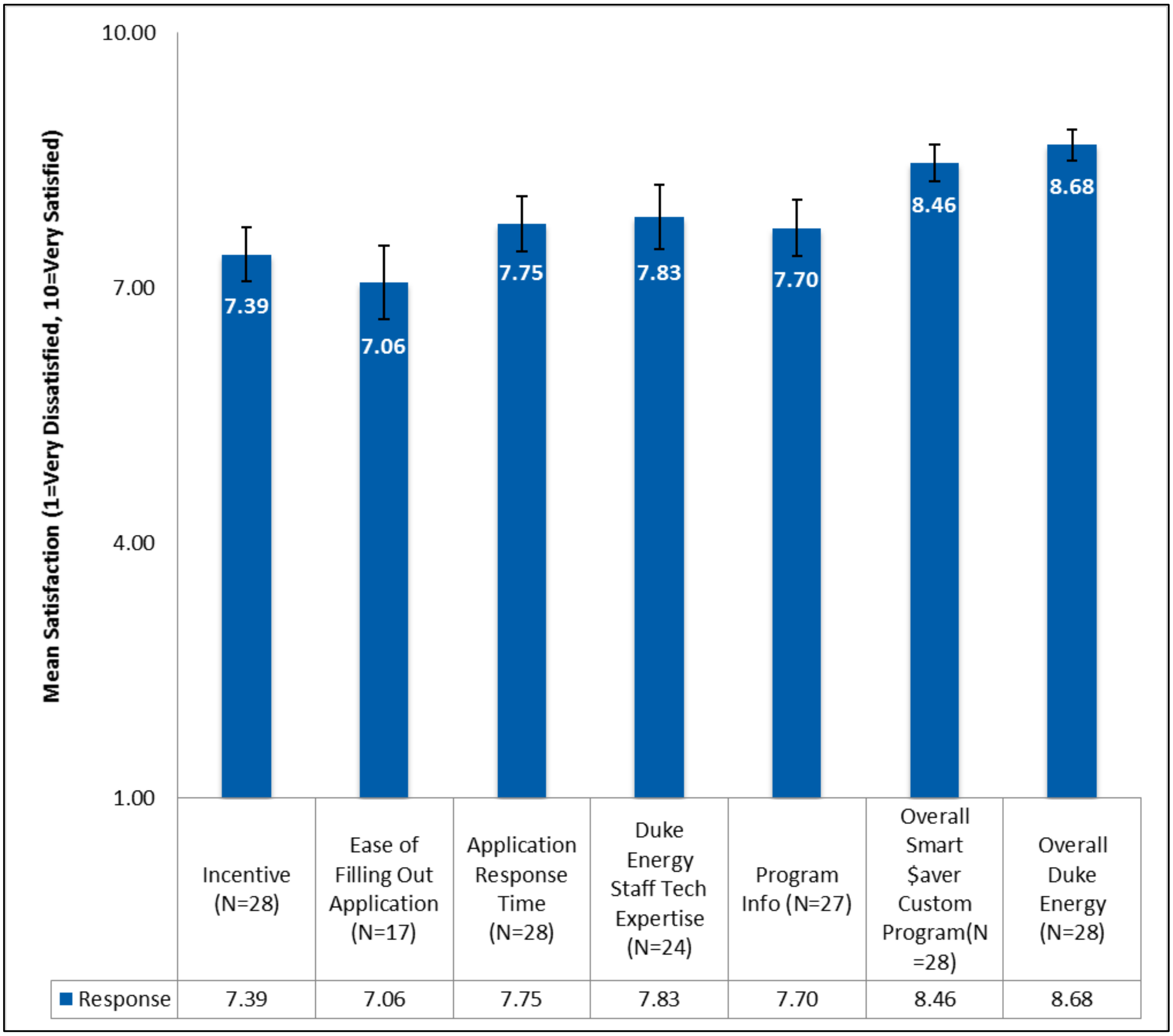
Table 17. What Participants Said Could be Improved with the Smart $aver Custom Program (n=7)

Response	Frequency
Lessen rigidity of requirements	2
Assign project liaison	2
Recruit more trade allies	1
Updates on new equipment	1
More marketing	1

In both these cases, the sample size was too small to draw conclusions and make recommendations for program changes. In future evaluations, the addition of the EEEs as a resource to customers may decrease the number of calls for project liaisons.

In summary, Figure 7 below, taken from an earlier discussion, shows the satisfaction ratings for a number of different program elements (error bars show standard error). At a glance, participants can be seen to have moderate satisfaction with the specific elements of the program, while having moderately high satisfaction with the Smart $aver Custom Program overall as well as with Duke Energy itself.

Figure 7. Participants' Satisfaction with the Indiana Smart $aver Custom Program



Appendix A. Closed Lost Applicant Status

Cadmus requested additional information from Duke Energy about why the Closed Lost businesses who responded to the participant survey were not paid an incentive. Table 18 includes the reasons for non-payment based on Duke Energy records.

Table 18. Closed Lost Non-payment Reason

State	ID	Applicant Went Ahead With Project	Reason
IN	349	Yes	Customer opted out of EE program prior to receiving incentives (2014)
IN	716	Yes	Applicant stopped responding to requests for information during technical review prior to offer
IN	913	No	Customer opted out of EE program prior to receiving incentives (2014)
IN	623	Yes	Applicant stopped responding to requests for information during technical review prior to offer
IN	925	Yes	Customer opted out of EE program prior to receiving incentives (2014)
IN	656	Yes	Customer opted out of EE program prior to receiving incentives (2014)
IN	232	No	Customer froze capital expenditures
IN	66	Yes (but not completed)	Project was committed to prior to delivery of offer letter

Appendix B. Management Interview Guide

Name: ____

Title: ____

Position description and general responsibilities:

____

____

We are conducting this interview to obtain your opinions about and experiences with the Nonresidential Smart $aver Custom Program. We'll talk about the Smart $aver Program and its objectives, your thoughts on improving the program, and the technologies the program covers. The purpose of this study is to capture the program's current operations as well as help identify areas where the program might be improved. Your responses will feed into a report that will be shared with Duke Energy and the state regulatory agency. I want to assure you that the information you share with me will be kept confidential; we will not identify you by name. However, you may provide some information or opinions that could be attributed to you by virtue of your position and role in this program. If there is sensitive information you wish to share, please warn me and we can discuss how best to include that information in the report.

The interview will take about an hour to complete. Do you have any questions for me before we begin?

Program Background and Objectives (15 min)

1. Please describe your role and scope of responsibility in detail.
2. How long have you been involved with the Smart $aver Program?
3. Describe the evolution of the Smart $aver Program. Why was the program created, and has the program changed since it was it first started?
4. Have there been any recent changes been made to your duties since you started?
    a. If YES, please tell us what changes were made and why they were made. What are the results of the change?
5. In your own words, please describe the Smart $aver Program's objectives (e.g., enrollment, energy savings, non-energy benefits).
6. (PM only) Can you please walk me through the program's implementation, starting with how the program is marketed and how you target your customers, through how the customer participates and finishing with how savings are verified?

   a. Marketing/Targeting: How & Who
   b. Enrollment/Participation
   c. Application processing
   d. Technical verification: How & Who

7. Are there any challenges that would affect your program's ability to meet its objectives?
8. Which program objectives, if any, do you feel will be relatively difficult to meet, and why?
9. Are there any objectives you feel should be revised prior to the end of this program cycle? If yes, why?

Vendors (10 min)

10. (PM only) Do you use any vendors or contractors to help implement the program?
    a. What responsibilities do they have?
    b. Are there any areas in which think they can improve their services?
11. *(If not captured earlier)* Please explain how activities of the program's vendors, customers and Duke Energy are coordinated.
    a. Do you think methods for coordination should be changed in any way? If so, how and why?
12. Are there any research issues you would like to suggest for our vendor interviews?

Rebates (15 min)

13. (PM only) Please describe for me how each Custom application is processed, and reviewed.
    a. Do you use any outside vendors or experts to help with this process?
    b. What should be changed about this selection process?

Contractor Training (5 min)

14. Do you have any suggestions for improving contractor effectiveness?

Improvements (10 min)

15. Are you currently considering any changes to the program's design or implementation?
    a. What are the changes?
    b. What is the process for deciding whether or not to make these changes?
16. Do you have suggestions for improvements to the program that would increase participation rates, or is Duke Energy happy with the current level of participation?
17. Do you have suggestions for increasing energy impacts *per participant*, given the same participation rates, or is Duke Energy happy with the current per participant impact?
18. Overall, what would you say about the Smart $aver program is working really well?
    a. Is there anything in this program you could highlight as a best practice that other utilities might like to adopt?
19. What area needs the most improvement, if any?
    a. (*If not mentioned before*) What would you suggest can be done to improve this?
20. Are there any other issues or topics we haven't discussed that you feel should be included in this report?
21. Do you have any further questions for me about this study or anything else?

Thank you!

Appendix C. Duke Energy
Nonresidential Smart $aver Custom Trade Ally Survey 2015

Researchable Questions	Item
Introduction	A1-6
Participating in the program	B1-13
Program participation experience	C1-19
Market impacts and effects	D1-5
Recommended changes	E1-2
Satisfaction with program	F1-5
Satisfaction with utility	G1-2
Closing	H1

Target Quota =
[Carolinas – ten interview completes for Phases 1, 2, 3 combined]

[Ohio – ten interview completes for Phases 1 and 2]

[Indiana – ten interview completes for Phases 1 and 2]

[Kentucky – As many as possible, no minimum number of completes required in this state]

General Instructions

- Interviewer instructions are in green **[LIKE THIS]**.
- CATI programming instructions are in red [LIKE THIS].
- Items that should not be read by the interviewer are in parentheses like this ( ).

Variables to be pulled into survey from sample (return all information from sample in the final data file)

- State
  - INDIANA
  - OHIO
  - KENTUCKY
  - SOUTH CAROLINA
  - NORTH CAROLINA
- Name
- Title
- Company
- Customer Company
- Measure
- Date the customer incentive was paid

A. Introduction

A1. Hello, my name is [INTERVIEWER NAME], and I'm calling from [SURVEY FIRM] on behalf of Duke Energy. May I speak with [NAME] please?

1. (Continue) [IF PERSON TALKING, PROCEED.]
2. (No or not a convenient time) [IF PERSON IS CALLED TO THE PHONE REINTRODUCE. IF NOT FREE TO TALK, ASK WHEN WOULD BE A GOOD TIME TO CALL AND SCHEDULE THE CALL-BACK]
98. (Don't know) [ASK TO SPEAK WITH SOMEONE WHO KNOWS AND BEGIN AGAIN]
99. (Refused) [THANK AND TERMINATE]

A2. We had a call scheduled for this time to ask about your opinions about Duke Energy's Nonresidential Smart $aver Custom Incentive program. [IF NEEDED: WE'LL TALK ABOUT YOUR UNDERSTANDING OF THE SMART $AVER CUSTOM INCENTIVE PROGRAM AND ITS OBJECTIVES, YOUR THOUGHTS ON IMPROVING THE PROGRAM, AND THE TECHNOLOGIES THE PROGRAM COVERS.] The interview will take about 30 minutes to complete. May we begin?

1. (Yes)
2. (No or no understanding of the Smart $aver program)

   A2a. Is there someone else at your company who might be more appropriate for me to talk to?

   1.(Yes) [RECORD NEW CONTACT INFO FOR SCHEDULING]
   2.(No) [THANK AND TERMINATE]
   98.(Don't know) [THANK AND TERMINATE]
   99. (Refused) [THANK AND TERMINATE]

3. (No or not a good time)

   A2b. Is there a better time for us to have this call?

   4.(Yes) [RECORD NEW SCHEDULED TIME FOR CALL-BACK]
   5.(No) [THANK AND TERMINATE]
   98.(Don't know) [THANK AND TERMINATE]
   99. (Refused) [THANK AND TERMINATE]

A3. We would like to start by first asking about your company. What kind of business is it? **[DO NOT READ LIST; RECORD ONE RESPONSE]**

1. (Manufacturer)
2. (Distributor)
3. (Wholesalers)
4. (Retailer)
5. (General Contractor)
6. (Installer)
7. (Consulting/Engineering)
8. (Other) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

A4. What is your job title and what are your responsibilities at your company?
[RECORD RESPONSE]

A5. How long have you been in this profession?
[RECORD RESPONSE]

A6. Do you help customers make decisions about what type of equipment to install?

1. (Yes)
2. (No) [ASK TO SPEAK WITH A PROJECT OR SALES MANAGER INVOLVED WITH PROJECT ON CALL SHEET AND BEGIN AGAIN; THANK AND TERMINATE IF THEY CANNOT PROVIDE AN EMPLOYEE WHO HELPS CUSTOMERS WITH EQUIPMENT DECISIONS WHO KNOWS ABOUT SMART SAVER]
98. (Don't know) [ASK TO SPEAK WITH A PROJECT OR SALES MANAGER INVOLVED WITH PROJECT ON CALL SHEET AND BEGIN AGAIN; THANK AND TERMINATE IF THEY CANNOT PROVIDE AN EMPLOYEE WHO HELPS CUSTOMERS WITH EQUIPMENT DECISIONS WHO KNOWS ABOUT SMART SAVER]
99. (Refused) [ASK TO SPEAK WITH A PROJECT OR SALES MANAGER INVOLVED WITH PROJECT ON CALL SHEET AND BEGIN AGAIN; THANK AND TERMINATE IF THEY CANNOT PROVIDE AN EMPLOYEE WHO HELPS CUSTOMERS WITH EQUIPMENT DECISIONS WHO KNOWS ABOUT SMART SAVER]

B. Participating in the Program

B1. Let's move on to program participation. How did you first learn about the Smart $aver Program? [RECORD ALL THAT APPLY]

1. (Past experience with Smart $aver Custom Program)
2. (Past experience with another Duke Energy program)
3. (Duke Energy sent me a brochure or e-mail)
4. (A Duke Energy representative told me about it)
5. (Duke Energy website)
6. (Recommendation of a dealer/contractor)
7. (Recommendation of the customer)
8. (Word of mouth: colleague/friend/neighbor)
9. (Saw an advertisement in the newspaper)
10. (Saw an advertisement on television)
11. (Saw an advertisement online)
12. (Heard an advertisement on the radio)
13. (Other) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

B2. Have you participated as a trade ally in the Smart $aver Prescriptive incentive program only, Smart $aver Custom incentive program only, or both? [PROBE FOR CLARIFICATION IF NEEDED – ONE OR THE OTHER OR BOTH?] [IF NEEDED, TRADE ALLY IS AN ADVISOR, VENDOR, CONTRACTOR, DESIGNER OR ENGINEER]

1. (Prescriptive only)
2. (Custom only)
3. (Both Custom and Prescriptive)
4. (Neither program) [ASK IF THERE IS SOMEONE AT THE COMPANY WHO KNOWS MORE ABOUT SMART SAVER AND BEGIN AGAIN WITH THEM] [IF RESPONDENT INSISTS THAT THEY HAVE NOT SUBMITTED APPLICATIONS FOR EITHER PROGRAM THEN THANK AND TERMINATE]
5. (Other response) [RECORD RESPONSE]
98. (Don't know) [IF RESPONDENT SAYS THAT THEY HAVE NO KNOWLEDGE OF EITHER PROGRAM THEN THANK AND TERMINATE]
99. (Refused)

B3. How long have you been a partner in the Smart $aver Custom Program? [PROBE IF NEEDED]: When did you first submit a Smart $aver Custom application?
[RECORD RESPONSE]

B4. Typically, what is your company's role on a project?
[RECORD RESPONSE]

B5. Are you or your company signed up in the Trade Ally list on Duke Energy's website?
1. (Yes)
2. (No)
3. (Other response) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF B5=1]
B6. Have you gotten any leads from the Duke Energy website?
1. (Yes)
2. (No)
98. (Don't know)
99. (Refused)

B7. When you are talking with a prospective customer, what percentage have already heard of Duke Energy's Smart $aver Program? Would you say...? [READ LIST, CHECK ONE]
1. Almost None
2. About 25%
3. About 50%
4. About 75%
5. Almost all
98. (Don't know)
99. (Refused)

B8. When you are talking with a customer, at what point in the discussion do you usually bring up the incentive? [IF NEEDED, PROMPT: "DURING THE INTRODUCTORY MEETING, AFTER YOU'VE SCOPED THE PROJECT, ONLY IF THE CUSTOMER ASKS?"]
1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

B9. Have your customers expressed any complaints about the program to you?
1. (Yes)
    B9a. What were these complaints? [RECORD RESPONSE]

2. (No)
3. (Other response) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

B10. Please give me an estimate: What percentage of your 2014 projects include equipment that received a Smart $aver Custom incentive? [IF THEY CAN'T REMEMBER PRESCRIPTIVE SEPARATE FROM CUSTOM, HAVE THEM ESTIMATE TOGETHER AND RECORD THAT THE PERCENTAGE IS COMBINED]

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

B11. Are the incentive levels high enough to motivate customers to install high efficiency equipment?

1. (Yes)
2. (No)
3. (Other response) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF B11=2]

B12. What types of equipment should have a higher incentive, and how much higher should it be?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

B13. Why do you think some of your competitors do not participate in this program?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

C. Custom Program Participation Experience

The next few questions ask about the process for submitting application forms to the Custom Program and the incentive approval process.

C1. Do you ever submit applications to the Custom Program on behalf of your customer?

1. (Yes)
2. (No) [SKIP TO C7]
98. (Don't know) [SKIP TO C7]
99. (Refused) [SKIP TO C7]

[ASK IF 0=1]

C2. Do you think this process could be streamlined in any way?

1. Yes [RECORD RESPONSE]
2. No
98. (Don't know)
99. (Refused)

[ASK IF 0=1]

C3. How long does it typically take between the time you send in a Custom application and the time you or your customer learns whether or not the project qualifies for an incentive?

1. (Response given) [RECORD RESPONSE IN DAYS, WEEKS OR MONTHS]
98. (Don't know)
99. (Refused)

[ASK IF C3=1]

C4. On a scale of 1 to 10, with 1 indicating not satisfied at all and 10 indicating highly satisfied, how satisfied are you with the amount of time it typically takes between the time you send in the application and the time you learn whether your project qualifies for an incentive,?

1. (Rating given) [RECORD NUMBER 1-10]
98. (Don't know)
99. (Refused)

[ASK IF C4 <= 7]

C5. Why do you say that?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF C4 <= 7]

C6. How long do you think it should take between submitting an application and learning if your project qualifies for an incentive?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

C7. Have you attended any presentations made by Duke Energy's Smart $aver Program staff?

1. (Yes)
2. (No) [SKIP TO C11]
98. (Don't know) [SKIP TO C11]
99. (Refused) [SKIP TO C11]

[ASK IF C7=1]

C8. How did you hear about these presentations?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF C7=1]

C9. Can you please rate the usefulness of the presentation you most recently attended, on a scale of 0 to 10, where zero indicates "Not useful at all" and 10 indicates "always useful".

1. (Rating given) [RECORD NUMBER 0-10]
98. (Don't know)
99. (Refused)

[ASK IF C7=1]

C10. Is there any information you would like Duke to provide at these presentations, that they are not currently providing about the Custom program?

1. (Response given) [RECORD RESPONSE]
2. (No suggestions)
98. (Don't know)
99. (Refused)

C11. This next question asks about the people you interact with at Duke Energy, during the course of a custom project. Do you interact with…? **[READ LIST, CHECK ALL THAT APPLY]**

1. Large Account Managers
2. Smart $aver Outreach Representatives
3. The Smart $aver Custom program managers (SMART $AVER PROGRAM MANAGER ARE FOLKS WHO ADMINISTER THE PROGRAM)
4. Duke Energy's Energy Efficiency Engineers? (EE ENGINEERS ARE FOLKS WHO PERFORM THE TECHNICAL ANALYSIS WHEN THE APPLICATION IS TURNED IN)
5. Any other Duke Energy employees?
   C11a. Who were they? [RECORD RESPONSE]
6. (None of the above) [SKIP TO C13]
98. (Don't know) [SKIP TO C13]
99. (Refused) [SKIP TO C13]

[ASK C12 ONCE FOR EACH RESPONSE 1-5 THAT WAS CHECKED IN C11]

C12. What was the purpose of your interaction with [RESPONSE(S) 1-5 FROM C11]? [RECORD RESPONSE]

C13. On a scale of 1 to 10, with 1 indicating not satisfied at all and 10 indicating highly satisfied, please rate how satisfied you are with the communication between you and Duke Energy on Smart $aver-related issues.

1. (Rating given) [RECORD NUMBER 1-10]
98. (Don't know)
99. (Refused)

[ASK IF C13 <=7]

C14. How can Duke Energy improve the way they communicate on Smart $aver related issues? [RECORD RESPONSE]

C15. Do you use any information or technical tools from the Smart $aver website when making proposals to customers?

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

C16. Have you directed any customers to materials on Duke's website?

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

[ASK IF C15=1 OR C16=1]

C17. How would you rate the usefulness of the materials at the Duke Energy website on a scale of 0 to 10 where zero indicates "Not useful at all" and 10 indicates "always useful"?

1. (Rating given) [RECORD NUMBER 0-10]
98. (Don't know)
99. (Refused)

[ASK IF C17<= 7]

C18. How can Duke Energy improve the usefulness of these materials?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

C19. Are there any other materials you would like to have when discussing the project with customers?

1. (Yes)
   C19a. What materials? [RECORD RESPONSE]
2. (No)

98. (Don't know)
99. (Refused)

D. Market Impacts and Effects

D1. What percent of Smart $aver buyers do you think are replacing older equipment that is still functioning, but less efficient?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

D2. What percent of Smart $aver buyers do you think are replacing failed units?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

D3. If the program were not offered, do you think customers would change their project scope in any way?

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

[ASK IF D3=1]

D4. In what way would they change the scope of their projects?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF D3=1]

D5. What would they change with regards to the start date of the project?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

98.

E. Recommended Changes

E1. Is there anything about the Smart $aver Program that you would say is working exceptionally well?

1. (Yes,) [RECORD RESPONSE]
2. (No comments)
98. (Don't know)
99. (Refused)

[ASK IF E1=1]

E2. What program change or improvement should be Duke Energy's number one priority?

1. [RECORD RESPONSE]
2. (No suggestions)
98. (Don't know)
99. (Refused)

F. Satisfaction with program

[ASK IF STATE="OHIO"]

F1. I'm now going to ask you to rate your satisfaction with the program two different ways. If you were rating your overall satisfaction with the Smart $aver Custom Program, would you say you were . . . [READ LIST AND SELECT ONE RESPONSE]

1. Very Satisfied
2. Somewhat Satisfied
3. Neither Satisfied nor Dissatisfied
4. Somewhat Dissatisfied
5. Very Dissatisfied
98. (Don't know)
99. (Refused)

[ASK IF R1=1, 2, 3, 4 OR 5]

F2. Why do you give it that rating?

1. (Response given) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF STATE="OHIO"]

F3. And what numerical rating would you give for your overall satisfaction with the Smart $aver Custom Program, using a scale of 1 to 10 where 1 means "not satisfied at all" and 10 means "extremely satisfied"?

1. (Rating given) [RECORD NUMBER 1-10]
98. (Don't know)
99. (Refused)

[ASK IF STATE="NC", "SC", "IN" OR "KY"]

F4. Considering all aspects of the program, what numerical rating would you give for your overall satisfaction with the Smart $aver Custom Program, using a scale of 1 to 10 where 1 means "not satisfied at all" and 10 means "extremely satisfied"?

1. (Rating given) [RECORD NUMBER 1-10]
98. (Don't know)
99. (Refused)

[ASK IF R11 <= 7]

F5. What would you recommend to improve the program, or have we already covered it?

1. (Response given) [RECORD RESPONSE]
2. (We have already covered it / no additional comments)
98. (Don't know)
99. (Refused)

G. *Satisfaction with Utility*

G1. Using the same numerical scale, how would you rate your overall satisfaction with Duke Energy?

1. (Rating given) [RECORD NUMBER 1-10]
98. (Don't know)
99. (Refused)

[ASK IF S1 IS <= 7]

G2. What, if anything, could Duke Energy do to increase your satisfaction, or have we already covered it?

1. (Response given) [RECORD RESPONSE]
2. (We have already covered it / no additional comments)
98. (Don't know)
99. (Refused)

H. *Closing*

H1. That concludes this survey, thank you very much for taking the time to help Duke Energy improve this program. Your response is very important to us.

Appendix D. Duke Energy
Nonresidential Smart $aver Custom Participant Survey 2015

Researchable Questions	Item
Introduction / screening	A1-3
Screening questions: Closed Won and Closed Lost	B1-7, C1-8
Program awareness and information	D1-11
Decision making: Closed Won and Closed Lost	E1-17
Application process	F1-10
Spillover: Closed Won and Closed Lost	G1-14, H1-7
Program improvements	I1-6
Satisfaction with program	J1-13
Satisfaction with utility	K1-2
Closing	L
Thank and Terminate	M

Target Quota = [20 Closed Won and 20 Closed Lost in IN, NC, SC, and OH. No minimum target in KY]

General Instructions
- Interviewer instructions are in green **[LIKE THIS]** (the style is "Survey: Interviewer Instructions").
- CATI programming instructions are in red [LIKE THIS] (the style is "Survey: Programming").
- Items that should not be read by the interviewer are in parentheses like this ( ).

Variables to be pulled into survey from sample (return all information from sample in the final data file)
- State
  - INDIANA
  - OHIO
  - KENTUCKY
  - SOUTH CAROLINA
  - NORTH CAROLINA
- Measure(s)
- Year of application
- Status
  - Closed Won
  - Closed Lost
- Name
- Title
- Company
- E-mail Address
- Service City
- Service State

E-mail Invitation

To: [E-MAIL ADDRESS]
From: Rose Stoeckle (Rose.Stoeckle@duke-energy.com)
Subject: Duke Energy Smart $aver Custom Incentive Program Survey

Dear [Name]:

You recently submitted an application to participate in the Smart $aver® Custom Program. Duke Energy is actively seeking opinions about this program from customers like you through an online survey. Your participation in this short survey is important so that Duke Energy can include your perspectives in how their energy efficiency programs are offered. Duke Energy has asked The Cadmus Group to administer this survey.

Please click on the link below to begin the survey. The survey will take about 10-15 minutes to complete and will have no impact on the status of the incentive you have received or will receive. Please complete the survey by **August 19th, 2015**. The survey is designed for appearance on a computer screen rather than a mobile or tablet device.

As a token of our appreciation we would like to offer you a $10 gift card for completing the survey. Instructions for accepting the gift card or donating the funds to the United Way charity are provided at the end of the survey**. [INSERT LINK]**

If you cannot complete the survey at one time, you can go back into the survey using the link provided in the e-mail and it will resume the survey at the last question that you answered.

If you are not the best person to respond to a survey about this program, please forward this e-mail to the person who is.

If you have any technical problems, please contact David Ladd (David.Ladd@CadmusGroup.com).

If you have any questions about the program or this survey, please contact Frankie Diersing (Frankie.Diersing@duke-energy.com), or your account manager, or the Business and Industry group at Duke Energy:

Midwest Business Assistance: 800-774-1202
Duke Energy Carolinas: 800-653-5307
Duke Energy Progress: 800-636-0581

Thank you,
Rose Stoeckle
M&V Operations Manager at Duke Energy Corporation
Rose.Stoeckle@duke-energy.com

I. Introduction

Welcome! We are following up with participants of Duke Energy's Smart $aver Custom Program to help Duke Energy understand opinions that will help improve the Program. This survey will take approximately 15 minutes to complete. **Please complete the survey by August 19th, 2015.** Thank you in advance.

Please click **Next** to enter the survey.

This survey is administered by The Cadmus Group, an independent consulting firm. If you experience technical difficulties completing the survey, please e-mail The Cadmus Group at David.Ladd@CadmusGroup.com.

As a token of our appreciation we would like to offer a $10 gift card for completing the survey. Instructions for accepting the gift card or donating the funds to the United Way charity are provided at the end of the survey.

If you have any questions about the purpose of this study, or its use, please contact your account manager or the Business and Industry group at Duke Energy:

Midwest Business Assistance: 800-774-1202
Duke Energy Carolinas: 800-653-5307
Duke Energy Progress: 800-636-0581.

I1. Please describe your company - What kind of business is it?

1. (Nonprofit: church, temple, community service)
2. (Nonprofit: School district, college, university)
3. (Nonprofit: government, municipality, military)
4. (Industrial: electronics, machinery, manufacturing)
5. (Industrial: petroleum, plastic, rubber, chemicals)
6. (Industrial: mining, metals, stone, glass, concrete)
7. (Industrial: other) [RECORD RESPONSE]
8. (Commercial: warehouse, storage facility)
9. (Commercial: office space)
10. (Commercial: property management, condo association)
11. (Commercial: retailer, non-food)
12. (Commercial: grocery or convenience store)
13. (Commercial: restaurant, catering, food service)
14. (Commercial: transportation, automotive)
15. (Commercial: hospitality – hotel, resort, casino)
16. (Commercial: healthcare, hospital)
17. (Commercial: other) [RECORD RESPONSE]
98. (Don’t know)
99. (Refused)

I2. What is your role within your company?

1. (Proprietor or owner)
2. (President, CEO, COO, VP or GM)
3. (Real estate or property manager)
4. (Operations manager, operations director)
5. (Facilities manager, facilities director)
6. (Other facility management or maintenance position)
7. (Energy manager, energy coordinator)
8. (Chief financial officer)
9. (Other financial or administrative position)
10. (Other manager, director or supervisor)
11. (Engineer, architect, electrician, inspector or researcher)
12. (Government position)
13. (Other position) [RECORD RESPONSE]

I3. Do you have an assigned account manager at Duke Energy?

1. (Yes)
2. (No)
98. (Don’t know)
99. (Refused)

J. Screening Questions (Closed Won)

[ASK IF STATUS="CLOSED WON"]

J1. Our records indicate that you participated in the Smart $aver Custom Program, by installing energy-efficient technologies in a project located in [SERVICE CITY], [SERVICE STATE]. You received an incentive for your purchase of those technologies. Do you recall participating in this program?

1. (Yes)
2. (No)
98. (Don't know)
99. (Refused) **[THANK AND TERMINATE]**

[ASK IF STATUS="CLOSED WON" AND (J1=2 OR J1=98)]

J2. This program was provided through Duke Energy. In this program, your company installed **[MEASURE(S)].** In exchange for purchasing the energy efficient option, Duke Energy provided your company with an incentive. Do you remember participating in this program?

1. (Yes)
2. (No) [THANK AND TERMINATE]
98. (Don't know) [THANK AND TERMINATE]
99. (Refused) [THANK AND TERMINATE]

[ASK IF J1=1 OR J2=1]

J3. Please confirm that the following information is correct. If the information is incorrect, please edit it below. If it is correct, please hit the next button to continue:

In the year **[APPLICATION YEAR]** your company submitted an application for an incentive for installing **[MEASURE(S)].**

[ASK IF STATUS="CLOSED WON"]

J4. Is the project completed?

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

[ASK IF J4=1]

J5. How many months did it take to complete?

1. (Response given) **[RECORD RESPONSE IN MONTHS]**
98. (Don't know)
99. (Refused)

[ASK IF J4=2]

J6. What stage is the project in right now?

1. (Project has been postponed with no definite start date)
2. (Project has a scheduled start date)
3. (Project has just begun / is just beginning)
4. (Project is underway)
5. (Project is nearly complete)
6. (Other) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED WON"]

J7. What is the payback on this project (or how long will it take for this project to "pay for itself")?

1. (6 months)
2. (1 year)
3. (18 months)
4. (2 years)
5. (3 years)
6. (4 years)
7. (5 years or more)
8. (Other) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

K. Screening Questions (Closed Lost)

[ASK IF STATUS="CLOSED LOST"]

K1. Our records indicate that you submitted an application to the Smart $aver Custom Program in **[APPLICATION YEAR]** and that you either did not or were not able to participate in the program. Do you recall submitting an application for this program?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused) **[THANK AND TERMINATE]**

[ASK IF K1=2 OR K1=98]

K2. This program was provided through Duke Energy. The Smart $aver program provides a financial incentive to motivate companies to purchase qualifying equipment. Your company planned to install **[MEASURE(S)]**. Do you recall submitting an application for this program?

1. (Yes)
2. (No) **[THANK AND TERMINATE]**
98. (Don't know) **[THANK AND TERMINATE]**
99. (Refused) **[THANK AND TERMINATE]**

[ASK IF K1=1 OR K2=1]

K3. Please confirm that the following information is correct. If the information is incorrect, please edit it below. If it is correct, please hit the next button to continue:
In the year **[APPLICATION YEAR]** your company submitted an application for an incentive for installing **[MEASURE(S)].**

[ASK IF STATUS="CLOSED LOST"]

K4. Did you go ahead with the project?

1. (Yes)
2. (No)
3. (Other response) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF K4=1]

K5. Has this project been completed?

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

[ASK IF K5=1]

K6. How many months did it take to complete?

1. (Response given) **[RECORD RESPONSE IN MONTHS]**
98. (Don't know)
99. (Refused)

[ASK IF K4=1]

K7. What is the payback on this project (or how long will it take for this project to "pay for itself")?

1. (6 months)
2. (1 year)
3. (18 months)
4. (2 years)
5. (3 years)
6. (4 years)
7. (5 years or more)
8. (Other) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF K5=2]

K8. Please tell me what stage it's in right now?

1. (Project has been cancelled)
2. (Project has been postponed with no definite start date)
3. (Project has a scheduled start date)
4. (Project has just begun / is just beginning)
5. (Project is underway)
6. (Project is nearly complete)
7. (Other) [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

L. Program Awareness and Information

[ASK EVERYONE]

L1. How did you first become aware of the Smart $aver Custom Program? **[**RECORD ALL THAT APPLY**]**

1. (Past experience with Smart $aver Prescriptive Program)
2. (Past experience with another Duke Energy program)
3. (Duke Energy sent me a brochure or e-mail)
4. (A Duke Energy representative told me about it)
5. (Duke Energy website)
6. (Recommendation of dealer/contractor)
7. (Word of mouth: colleague/friend/neighbor)
8. (Saw an advertisement in the newspaper)
9. (Saw an advertisement on television)
10. (Saw an advertisement online)
11. (Heard an advertisement on the radio)
12. (Other) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

L2. At the time you were learning about the program did you need additional information about the program's requirements and benefits so that you could make a decision to participate?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

[ASK IF L2=1]

L3. What information did you look for before you could make your decision to participate in the program?

1. (Response given) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF L2=1]

L4. Where did you look for information? [RECORD ALL THAT APPLY]

1. (Went to the Duke Energy web site)
2. (Called or e-mailed assigned Account Manager or Duke Energy representative)
3. (Called or e-mailed a contractor)
4. (Called or e-mailed an equipment salesperson)
5. (Other response) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF L2=1]

L5. Were you able to get the information you needed about the program's participation requirements and benefits?

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

L6. Have you submitted other applications in the past, to either the Smart $aver Custom or Prescriptive programs?

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

[ASK IF L6=1]

L7. Which program(s) have you applied to in the past?

1. (Smart $aver Custom only)
2. (Smart $aver Prescriptive only)
3. (Both Custom and Prescriptive)
98. (Don't know)
99. (Refused)

L8. Did your company work with a trade ally, such as a contractor or engineer, during this project?

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

[ASK IF L8=1]

L9. What did the contractor, engineer or vendor assist with? **[RECORD ALL THAT APPLY]**

1. (Acquiring and installing equipment)
2. (Providing information about equipment options / equipment specs)
3. (Payback calculations / return on investment)
4. (Budgeting / resource planning)
5. (Finding and qualifying for rebates)
6. (Rebate applications / paperwork)
7. (Other) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF I3=1]

L10. Did your company work with your assigned Duke Energy account manager during this project?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

[ASK IF L10=1]

L11. What did the account manager assist with? **[RECORD ALL THAT APPLY]**

1. Provided general program information
2. (Providing information about eligible equipment options / equipment specs)
3. (Payback calculations / estimating return on investment)
4. (Budgeting / project scoping / resource planning)
5. (Verify completeness of Rebate applications / paperwork)
6. (Providing updates on the application status)
7. (Resolving problems with applications)
8. (Other assistance and/or additional details about the above) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

M. Decision Making

M1. What are the major reasons your company wanted to purchase the [MEASURE(S)]? [RECORD ALL THAT APPLY]

1. (To reduce energy costs)
2. (To reduce repair, maintenance and other labor costs)
3. Needed more modern, smarter equipment (to integrate with energy manager systems or Smart Grid).
4. Because old equipment was working poorly or was unreliable
5. (Wanted non-energy related product features such as appearance, brand loyalty. decreased water use, increased comfort)
6. It was a good deal.
7. Due to my contractor's recommendation
8. (Due to environmental concerns)
9. (Purchased as part of a broader remodel)
10. (Other [SPECIFY])
98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED LOST"]

M2. Once you learned you were not able to participate in Smart Saver, what did you decide to do? [Choose One]

1. (Installed the equipment at the same time anyway)
2. (Installed the equipment but at a later time)
3. (Delayed the installation indefinitely)
4. (Cancelled the project)
98. (Don't know)
99. (Refused)

[ASK IF M2=4]

M3. Why did you cancel the project?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF M2=2]

M4. How much later did you install the equipment?

1. (Within 3 months of originally planned installation date)
2. (3 to 6 months after originally planned installation date)
3. (6 months to 1 year after originally planned installation date)
4. (1 to 2 years after originally planned installation date)
5. (More than 2 years after originally planned installation date)
98. (Don't know)
99. (Refused)

[ASK IF M2=3]

M5. When do you realistically expect the project to start?

1. (Within 3 months of originally planned installation date)
2. (3 to 6 months after originally planned installation date)
3. (6 months to 1 year after originally planned installation date)
4. (1 to 2 years after originally planned installation date)
5. (More than 2 years after originally planned installation date)
98. (Don't know)
99. (Refused)

[ASK IF M2=3 and M5=1, 2, 3, 4 or 5]

M6. Why do you expect the project to start then, rather than sooner?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF M2=1 OR M2=2]

M7. What new equipment did you install?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF M2=1 OR M2=2]

M8. Is this the same equipment on your Smart $aver application?

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

[ASK IF M8=2]

M9. Was the upfront cost of the equipment you installed higher or lower than the equipment on your Smart $aver application?

1. (Higher)
2. (About the same)
3. (Lower)
98. (Don't know)
99. (Refused)

[ASK IF M8=2]

M10. Was the efficiency level of the equipment you installed higher or lower than the equipment on your Smart $aver application?

1. (Higher)
2. (About the same)
3. (Lower)
4. (Not applicable)
98. (Don't know)
99. (Refused)

[ASK IF M8=2]

M11. Were there other differences?

1. (Yes, response given) **[RECORD RESPONSE]**
2. (No other differences)
98. (Don't know)
99. (Refused)

[ASK IF M2=1 OR M2=2]

M12. Did you install anything else?

1. (Yes)
2. (No) **[SKIP TO N1]**
98. (Don't know) **[SKIP TO N1]**
99. (Refused) **[SKIP TO N1]**

[ASK IF M12=1]

M13. What did you have installed?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF M12=1]

M14. Is this the same equipment on your Smart $aver application?

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

[ASK IF M14=2]

M15. Was the upfront cost of the equipment you installed higher or lower than the equipment on your Smart $aver application?

1. (Higher)
2. (About the same)
3. (Lower)
98. (Don't know)
99. (Refused)

[ASK IF M14=2]

M16. Was the efficiency level of the equipment you installed higher or lower than the equipment on your Smart $aver application?

1. (Higher)
2. (About the same)
3. (Lower)
4. (Not applicable)
98. (Don't know)
99. (Refused)

[ASK IF M14=2]

M17. Where there other differences?

1. (Yes, response given) **[RECORD RESPONSE]**
2. (No other differences)
98. (Don't know)
99. (Refused)

N. Application Process

[ASK EVERYONE]

N1. Who filled out the program application forms for your company? [RECORD ALL THAT APPLY]

1. (I did)
2. (Someone from my company did)
3. (The contractor)
4. (The salesperson)
5. (Someone from Duke Energy)
6. (Other response) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF N1=1]

N2. On a scale of 1 to 10, please rate how easy it was for you to understand the application form. Please rate 1 for extremely difficult and 10 for extremely easy.

1. (Rating given) **[RECORD NUMBER 1-10]**

98. (Don't know)
99. (Refused)

[ASK IF N2 IS 7 OR LOWER]

N3. What could have been done to make this better?

1. (Response given) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED WON"]

N4. Did you have any problems with having the application approved?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

[ASK IF N4=1]

N5. What was the problem with having the application approved?

1. (Response given) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF N4=1]

N6. Was the problem with having the application approved resolved to your satisfaction?

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

O. Spillover (Closed Won)

[ASK IF STATUS="CLOSED WON"]

O1. When firms have experience with energy efficiency programs or products they may sometimes make similar decisions to continue the energy savings in other parts of their business. Would you say your experience with Smart $aver Custom has led you to participate in any other subsequent Duke Energy efficiency programs?

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

[ASK IF O1=1]

O2. Which programs have you subsequently participated in since your experience with Smart $aver Custom?

1. (Other program) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF O1=1]

O3. What did your company do, with the help of these subsequent programs?

1. (Replaced existing equipment)
2. (Maintenance or upgrades to existing equipment)
3. (Added "smart" control technology to existing systems)
4. (Installed new equipment that did not replace existing equipment)
5. (Joined a demand response program)
6. (Other) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF 0O1=1]

O4. Has your company estimated the energy or money it saved from these subsequent projects?

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

[ASK IF O4=1]

O5. What was your estimate of how much money or energy you saved annually from those subsequent programs?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED WON"]

O6. Have you participated in any other Duke Energy energy-efficiency programs, which were NOT motivated by your participation in Smart $aver Custom?

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

[ASK IF O6=1]

O7. Which programs?

1. (Other program) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF O6=1]

O8. What did your company do, with the help of these other programs?

1. (Replaced existing equipment)
2. (Maintenance or upgrades to existing equipment)
3. (Added "smart" control technology to existing systems)
4. (Installed new equipment that did not replace existing equipment)
5. (Joined a demand response program)
6. (Other) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF O6=1]

O9. Has your company estimated the energy or money it saved from these other projects?

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

[ASK IF O9=1]

O10. What was your estimate of how much money or energy you saved annually from these other projects?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED WON"]

O11. As a result of your participation in Duke Energy's Smart $aver Custom program, have you made any other electric energy efficiency improvements that did not qualify for any kind of incentive or rebate, whether from Duke or state or federal sources?

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

[ASK IF O11=1]

O12. What did you do? [RECORD AS MUCH DETAIL AS POSSIBLE]

98. (Response given) **[RECORD RESPONSE]** (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED WON"]

O13. Have you made any other electric energy efficiency improvements that did not qualify for any kind of incentive or rebate, that were NOT motivated by your experience with Smart $aver projects?

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

[ASK IF O13=1]

O14. What did your company do? [RECORD AS MUCH DETAIL AS POSSIBLE]

1. (Other) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

P. Spillover (Closed Lost)

[ASK IF STATUS="CLOSED LOST"]

P1. Has your company taken advantage of any other Duke Energy energy efficiency programs?

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

[ASK IF P1=1]

P2. Which programs?

1. (Other program) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF P1=1]

P3. What did your company do, with the help of these other programs?

1. (Other) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF P1=1]

P4. Has your company estimated the energy or money it saved from these other projects?

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

[ASK IF P4=1]

P5. What was your estimate of how much energy or money you saved annually from these other projects?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

[ASK IF STATUS="CLOSED LOST"]

P6. Have you made any other electric energy efficiency improvements that do not qualify for any kind of incentive or rebate, whether from Duke or state or federal sources?

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

[ASK IF P6=1]

P7. What did you do?

1. (Other) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

Q. *Program Improvements*

[ASK EVERYONE]

Q1. One of the objectives that the program would like to see over the next year is increased participation of businesses like yours. Other than increasing the level of marketing, can you think of things that Duke Energy can do to increase interest in the program, from companies such as yours?

1. (Response given) **[RECORD RESPONSE]**
2. (no suggestions)
98. (Don't know)
99. (Refused)

Q2. At any time during your application process, did you need to contact Duke Energy to obtain information, ask about progress on the application, or to obtain any other help or assistance?

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

[ASK IF Q2=1]

Q3. Were your questions or needs effectively handled by the Duke Energy?

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

[ASK IF Q3 IS NO]

Q4. How might this be improved?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

Q5. Overall, is there something about the Smart $aver Program that you would say is working exceptionally well?

1. (Yes, response given) **[RECORD RESPONSE]**
2. (No comment)
98. (Don't know)
99. (Refused)

Q6. Is there something that's not working well that you would say should be prioritized for improvement?

1. (Yes, response given) **[RECORD RESPONSE]**
2. (No comment)
98. (Don't know)
99. (Refused)

R. Satisfaction with Program

[ASK IF STATE="OHIO"]

R1. If you were rating your overall satisfaction with the Custom Program, would you say you were . . . [SELECT ONE RESPONSE]

1. Very Satisfied
2. Somewhat Satisfied
3. Neither Satisfied nor Dissatisfied
4. Somewhat Dissatisfied
5. Very Dissatisfied
98. (Don't know)
99. (Refused)

[ASK IF R1=1, 2, 3, 4 OR 5]

R2. Why do you give it that rating?

1. (Response given) **[RECORD RESPONSE]**
98. (Don't know)
99. (Refused)

R3. We would like to ask you a few questions about your satisfaction with specific areas of the program. For these questions we would like you to rate your satisfaction using a 1 to 10 scale where a 1 means that you are very dissatisfied with the program and a 10 means that you are very satisfied. How would you rate your satisfaction with:

R4. The amount of the incentives provided by the program.

1. (Rating given) **[RECORD NUMBER 1-10]**
2. Not Applicable

98. (Don't know)
99. (Refused)

R5. The ease of filling out the participation and incentive forms.

1. (Rating given) **[RECORD NUMBER 1-10]**
2. Not Applicable

98. (Don't know)
99. (Refused)

R6. The time it took for you to receive your incentive.

1. (Rating given) **[RECORD NUMBER 1-10]**
2. Not Applicable
3.

98. (Don't know)
99. (Refused)

R7. The technical expertise of Duke Energy staff.

1. (Rating given) **[RECORD NUMBER 0-10]**
2. Not Applicable

98. (Don't know)
99. (Refused)

R8. The information provided explaining the program.

1. (Rating given) **[RECORD NUMBER 1-10]**
2. Not Applicable

98. (Don't know)
99. (Refused)

[ASK Once for any Rating in R4, R5, R6, R7, R8 of 7 OR LOWER]

R9. You noted your satisfaction with [R4, R5 or R6 or R7 or R8] was 7 or less. What could have been done to make this better?

1. (Response given) **[RECORD RESPONSE]**

98. (Don't know)
99. (Refused)

[ASK IF STATE="OHIO"]

R10. You were asked a similar question earlier, but please bear with us: Considering all aspects of the program, what **numerical** rating would you give your overall satisfaction with the Smart $aver Custom Program?

1. (Rating given) **[RECORD NUMBER 1-10]**
98. (Don't know)
99. (Refused)

[ASK IF STATE="NC", "SC", "IN" OR "KY"]

R11. Considering all aspects of the program, what numerical rating would you give your overall satisfaction with the Smart $aver Custom Program?

1. (Rating given) **[RECORD NUMBER 1-10]**
98. (Don't know)
99. (Refused)

[ASK IF R11 IS 7 OR LOWER]

R12. What could have been done to make this better, or have we already covered it?

1. (Response given) **[RECORD RESPONSE]**
2. (We have already covered it / no additional comments)
98. (Don't know)
99. (Refused)

S. Satisfaction with Utility

S1. Using the same numerical scale, how would you rate your overall satisfaction with Duke Energy?

1. (Rating given) **[RECORD NUMBER 1-10]**
98. (Don't know)
99. (Refused)

[ASK IF S1 IS 7 OR LOWER]

S2. What could have been done to make this better, or have we already covered it?

1. (Response given) [RECORD RESPONSE]
2. (We have already covered it / no additional comments)
98. (Don't know)
99. (Refused)

T. Closing

That concludes this survey, thank you very much for taking the time to help Duke Energy improve this program.

As a token of our appreciation we would like to offer you a $10 gift card for completing the survey.

Please provide a contact name and address to receive the gift card, or if you would like us to donate this amount to the United Way charity organization on your behalf please indicate so:

1. Send my gift card to: [RECORD RESPONSE]
2. Donate $10 to the United Way charity organization.

U. Thank and Terminate

Thank you for responding to the survey. You have indicated that you did not participate in Duke Energy's Smart $aver Custom Program.

If you have reached this page by error or if you are having technical problems with the survey, please contact David Ladd (David.Ladd@CadmusGroup.com).

If you are not the best person to respond to a survey about your company's participation in the Smart $aver Custom program, please forward the survey's e-mail invitation to another person that you believe is the best person to respond to the survey.

If you have any questions about the program or this survey, please contact Frankie Diersing (Frankie.Diersing@duke-energy.com), or your account manager, or the Business and Industry group at Duke Energy:

Midwest Business Assistance: 800-774-1202
Duke Energy Carolinas: 800-653-5307
Duke Energy Progress: 800-636-0581

Evaluation of the Smart $aver® Nonresidential Custom Incentive Program in Indiana

August 12, 2016

Duke Energy
1000 East Main Street
Plainfield, Indiana 46168

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Prepared by:

Cadmus
NORESCO
BuildingMetrics

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Executive Summary

Duke Energy Indiana (DEI) engaged Cadmus, along with NORESCO and BuildingMetrics, as subcontractors (evaluation team), to perform an impact evaluation of the Smart $aver Custom Incentive Program (Custom Program). The evaluation period included 150 program participants who submitted applications from January 2011 through March 2014 and completed their projects by June 2015.

The evaluation team performed the impact analysis using site measurement and verification (M&V) and phone verification on a sample of 50 program participants. The team calculated average electric energy and demand saving realization rates for sampled participants and applied this average realization rate to the program participant population in the evaluation period.

TecMarket Works (along with NORESCO and BuildingMetrics as subcontractors) completed site visits and prepared M&V reports for 14 program participants in the fall of 2013 and winter of 2014. In March 2015, the contract was transferred to Cadmus, with NORESCO and BuildingMetrics as subcontractors. During the winter of 2016, Cadmus conducted site visits at 12 additional participant project sites and verified lighting savings through phones surveys with another 24 program participants. This report describes the results of the evaluation based on a combination of TecMarket Works' and Cadmus' verification efforts.

Impact Evaluation Results

Table 1 shows the program's claimed, evaluated gross, and net energy savings by project type.

Table 1. Total Program Claimed, Evaluated Gross, and Net Energy Savings by Project type

Project type	Population Size	Claimed kWh Impact	Realization Rate	Gross Evaluated kWh Impact	Net-to-Gross Ratio	Net Evaluated kWh Impact
HVAC	12	8,830,728	54%	4,737,374	92%	4,350,162
Lighting	114	29,094,778	103%	29,962,109	85%	25,430,191
Process	24	31,257,816	112%	35,121,736	86%	30,035,436
Total	**150**	**69,183,321**	**101%**	**69,821,218**	**86%**	**59,815,789**

Table 2 and Table 3 show the claimed, evaluated gross, net summer coincident peak (CP- average summer peak demand reduction (July, Monday through Friday, 3:00 p.m. to 4:00 p.m.), and non-coincident peak (NCP - average annual kW reduction) demand savings for the program.

Table 2. Total Program Claimed, Evaluated Gross, and Net CP Demand Savings by Project type

Project type	Population Size	Claimed CP kW Impact	Realization Rate	Gross Evaluated CP kW Impact	Net-to-Gross Ratio	Net Evaluated CP kW Impact
HVAC	12	1,008	163%	1,640	92%	1,506
Lighting	114	4,455	109%	4,863	85%	4,127
Process	24	2,505	149%	3,716	86%	3,178
Total	**150**	**7,968**	**128%**	**10,218**	**86%**	**8,811**

Table 3. Total Program Claimed, Evaluated Gross, and Net NCP Demand Savings by Project type

Project type	Population Size	Claimed NCP kW Impact	Realization Rate	Gross Evaluated NCP kW Impact	Net-to-Gross Ratio	Net Evaluated NCP kW Impact
HVAC	12	2,153	59%	1,269	92%	1,165
Lighting	114	4,733	111%	5,243	85%	4,450
Process	24	5,595	65%	3,655	86%	3,126
Total	**150**	**12,480**	**81%**	**10,167**	**86%**	**8,741**

Table 4 shows the net energy and demand savings per unit and the total for the M&V sampled projects.

Table 4. Net Energy and Demand Savings Per Unit and Total for Sampled Projects

Project type	Number of Sampled Units	Evaluated Net Per Unit kWh	Evaluated Net Per Unit NCP kW	Evaluated Net Per unit CP kW	Evaluated Net Total kWh	Evaluated Net Total NCP kW	Evaluated Net Total CP kW
HVAC	5	248,914	53	39	1,244,571	264	197
Lighting	30	562,259	90	86	16,867,755	2,692	2,582
Process	15	1,851,794	188	200	27,776,904	2,825	3,000
Total	**50**	**2,662,966**	**331**	**325**	**45,889,230**	**5,781**	**5,778**

Evaluation Parameters

Table 5 lists the parameters reviewed in this evaluation, which consisted of gross savings realization rates for energy, CP, and NCP demand.

Table 5. Evaluated Parameters with Value, Units, and Achieved Precision and Confidence

Gross Savings Realization Rates	Value	Units	Confidence Precision
Energy (kWh)	101%	n/a	90%/±8%
CP demand (kW)	128%	n/a	90%/±8%
NCP demand (kW)	81%	n/a	90%/±8%

Table 6 lists the sample periods and dates during which the evaluation activities were conducted.

Table 6. Sample Period Start and End Dates and Dates Evaluation Activities Conducted

Component	Sample Period*	Dates Conducted	Total
Site visits (TecMarket Works)	January 2011 – March 2014	Fall 2013 & Winter 2014	14
Site visits (Cadmus)	January 2011 – March 2014	Winter 2016	12
Phone verifications (Cadmus)	January 2011 – March 2014	Winter 2016	24

*The sample period is based on the dates program staff received applications.

Impact Evaluation Findings

The evaluation team identified the following key findings and recommendations through this evaluation:

- The overall energy realization rate across all projects was 101%, indicating that the program met the expected energy savings for the evaluation period. However, energy realization rates for individual participant projects ranged from -9% to 170%, indicating large variation between evaluated savings and claimed savings.
- Industrial process (process) projects achieved the highest energy savings (realization rate of 112%) when compared to program estimates, whereas HVAC projects achieved the lowest energy savings when compared to program estimates (realization rate of 54%); lighting projects performed closest to expectations, achieving a realization rate of 103%.
- Process projects generated about half (50%) of the evaluated program savings. Some of these projects showed increased load and/or production rates based on post-retrofit monitoring data and some showed decreased load. This highlights the value of conducting pre- and post-installation measurements, since realized energy savings need to be calculated based on equivalent industrial process loads before and after the retrofit.
- Lighting projects contributed 43% to the total evaluated program savings. In general, the lighting hours of use verified through the phone verification surveys were higher than those claimed in the program application, resulting in overall increase in verified savings (realization rate of 103%).
- Program calculations for lighting projects generally excluded consideration of HVAC interactive effects. For the projects sampled in this evaluation, including the HVAC interactive effects increased energy savings by decreasing space cooling loads.
- HVAC projects contributed 7% to the total evaluated program savings. In general, control strategies that were suboptimal or not fully implemented contributed to low realization rates. Post-installation inspections or project commissioning can be effective in obtaining the full energy savings available from HVAC control measures.
- Fourteen percent of the evaluated program savings are associated with freeriders. The evaluation team did not assess spillover and assumed it to be 0%. Therefore, the program net-to-gross ratio is 86%.

Introduction and Purpose of Study

Description of Program

Customers wishing to install measures not offered through the Smart $aver Nonresidential Prescriptive Incentive Program may apply for a rebate through the DEI Custom Program. DEI received the first program application in January 2011 and paid the first incentive in June 2012.

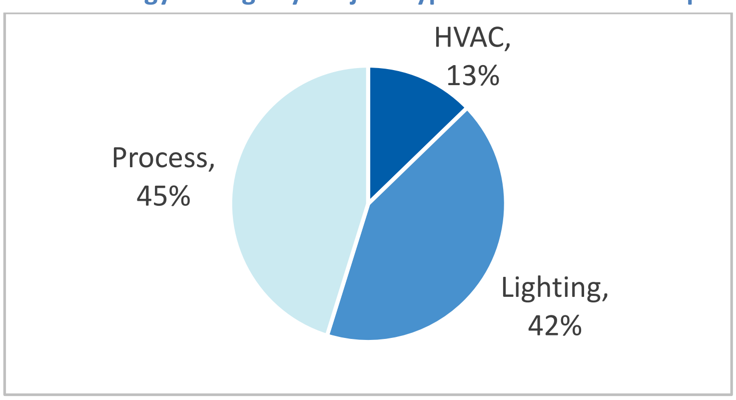
This evaluation period includes participants who submitted applications from January 2011 through March 2014, and completed their projects and received incentives by June 2015. Table 7 lists the number of participants in the evaluation period.

Table 7. DEI Custom Program Impact Evaluation Participant Count

Project Type	Number of Participants /Evaluation Period
HVAC	12
Lighting	114
Process	24
Total	**150**

Figure 1 shows the breakdown of claimed energy savings by project type in the program tracking databased for the evaluation period. As a category, process projects achieved the greatest savings, followed by lighting projects.

Figure 1. Claimed Energy Savings by Project Type for the evaluation period (n=150)



Summary of the Evaluation

The impact evaluation included a tracking system review, sample design and selection, an engineering review of DEI Custom Program applications, field M&V or phone verification of selected projects, data analysis, and reporting.

Evaluation Objectives

The goal of the impact evaluation was to verify energy savings and calculate energy and demand realization rates for a sample of participants in each project type: lighting, HVAC, and process. The evaluation team estimated program-wide savings by applying the average realization rates to the evaluation period population by project type.

Researchable Issues

The evaluation team researched the following issues to complete this study:

- Energy, NCP, and CP demand savings for each participant in the sample;
- Causes for differences between evaluated savings and claimed savings;
- Energy and demand realization rates for each participant;
- Average energy and demand realization rates for lighting, HVAC, and process participants and the confidence intervals for these estimates.

Methodology

Overview of the Evaluation Approach

Data Collection Methods, Sample Sizes, and Sampling Methodology

The evaluation team assigned participant applications to lighting, HVAC, and process categories. We then stratified lighting and process categories by size and selected participants in each stratum based on the magnitude of energy savings. We selected all projects in the large lighting and process strata to achieve targeted sample precision.

The evaluation team performed verification and metering site visits to all sampled HVAC (n=5) and process (n=15) participants and six lighting participants. We performed phone verification for the remaining 24 sampled lighting participants. In total, we included 50 of the 150 projects in the sample.

Study Methodology

The evaluation team prepared M&V plans for site visits following the options outlined by the International Performance Measurement and Verification Protocol (IPMVP). [1] We conducted site visits to verify measures, install metering equipment, and perform interviews about the pre-retrofit equipment and hours of operation with the site contacts. We used metered data or inputs collected on site to calculate evaluated energy and demand savings using engineering analysis and statistical regression modeling.

Our team also performed phone verification with the contractor, vendor, and customer contacts listed on the incentive application for 24 lighting participants.

Number of Completes and Sample Disposition for Each Data Collection Effort

The evaluation team attempted to contact 67 program participants and completed verifications with 50 participants across from the three project types.

Expected and Achieved Precision

The evaluation team designed the sample based on the claimed energy savings to achieve 90% confidence with ±10% precision for the realization rate estimates. We achieved 90% confidence with ±8 precision for energy and demand realization rate estimates.

Description of Baseline Assumptions, Methods, and Data Sources

The evaluation team used the pre-retrofit equipment as the baseline for the saving calculations. We collected data on baseline equipment from the program incentive application documents and verified the equipment through site visits or phone interviews. We conducted a site visit with one sampled participant prior to the retrofit and confirmed the baseline equipment performance through metering.

[1] International Performance Measurement and Verification Protocol. *Concepts and Options for Determining Energy and Water Savings. Volume 1. Prepared by*. January 2012. EVO 10000 – 1:2012. www.evo-world.org.

For three other participants, the team obtained pre-retrofit metered data to calculate baseline project performance.

Use of TRM Values

To calculate savings for the sampled HVAC and process participants, we used primary data collection, engineering analysis, building energy simulation modeling, and statistical regression modeling. The protocols outlined in the Indiana TRM were not applicable to these program participants.

To calculated savings for the sampled lighting participants, we used the saving algorithm outlined in the Indiana TRM for *Lighting Systems (Non-Controls) (Early Replacement, Retrofit)* and the applicable energy and demand waste heat factors specified in the TRM. We did not use the demand peak coincidence factors (CF) in the Indiana TRM to calculate peak demand reductions and instead used the hours of operation data collected on site or during phone surveys.

Sample Design

The evaluation team began the program evaluation using applications submitted to the program starting in January 2011. We assigned participants to one of three project categories: lighting, HVAC, and process. We grouped the participants into similar technology categories to minimize the variation in the realization rates across participants and provide better precision in the overall program results. We separated lighting and process participants into three size-based strata. The definitions for each of the three size-based strata are provided in Table 8.

Table 8. Stratum Definition Based on Claimed Energy Savings

Group	Stratum	kWh Savings ≥ than	kWh Savings Less than
Lighting	1	1,600,000	5,000,000
	2	500,000	1,600,000
	3	0	500,000
HVAC	1	All	All
Process	1	10,000,000	15,000,000
	2	1,000,000	10,000,000
	3	0	1,000,000

We calculated the required sample size to meet our desired precision by the following equation, which incorporates the finite population correction:

$$n = \left[Z * \frac{CV}{P}\right]^2 * \sqrt{\frac{N-n}{N-1}}$$

Where:

n = total sample size required

CV = coefficient of variation (defined as the mean divided by the standard deviation)

P = desired precision

Z = z statistic (1.645 at 90% confidence)

N = population size

We allocated samples to each stratum using Neyman's Allocation, illustrated below:

$$nk = n * \frac{Nk * CVk * KWHk}{\sum Nk * CVk * KWHk}$$

Where:

nk = total sample size required for stratum k

CVk = coefficient of Variation for stratum k

KWHk = Total expected savings for stratum k

Table 9 summarizes the total program savings by sample stratum, the expected variation in the participant realization rates, the number of participants in each stratum, and the sample size required to meet the designed relative precision at the program level. The evaluation team used CV by project type from the 2012 Ohio Custom evaluation to design the sample. [2]

Table 9. Optimum Sample Size for the DEI Custom Program

Group	Energy (kWh)	CV	Total Participants	Sample Size
HVAC	8,830,728	0.50	12	4
Lighting 1	9,110,166	0.42	3	1
Lighting 2	10,060,557	0.42	10	4
Lighting 3	9,924,055	0.42	101	32
Process 1	12,421,172	0.50	1	1
Process 2	10,412,945	0.50	4	2
Process 3	8,423,700	0.50	19	6
Total	**69,183,323**		**150**	**50**

[2] TecMarket Works. *Final Report Evaluation of the 2009 – 2011 Smart $aver Non-Residential Custom Incentive Program in Ohio*. Prepared for Duke Energy. September 2012.

Impact Evaluation Activities

Sample Status

The evaluation team completed verification activities for a total of 50 participants as originally planned. The final sample status had minor diversions from the original sample design in each stratum. Table 10 summarizes the final sample status.

Table 10. Status of Sample

Group	Stratum	Number of Participants	As Designed	As Attempted	As Completed	Notes on Sample Attempts
HVAC	1	12	4	6	5	Attempted more than designed sample due to small number of participants.
Lighting	1	3	1	3	3	Attempted more than designed sample due to small number of participants.
	2	10	4	10	5	Attempted more than designed sample due to small number of participants.
	3	101	32	31	22	Phone survey participant did not return calls made about verification survey.
Process	1	1	1	1	1	Sample completed.
	2	4	2	4	4	Attempted more than designed sample due to small number of participants.
	3	19	6	12	10	Attempted more than designed sample due to small number of participants.
Total		**150**	**50**	**67**	**50**	

The evaluation team pulled three samples in October 2013 (six participants), May 2014 (eight participants), and December 2015 (36 participants) and conducted verification in the fall of 2013, winter of 2014, and winter of 2016.

Table 11 shows the breakout of site visits and surveys for each strata.

Table 11. Sample Selected for Site and Phone Verification

Group	Stratum	Sample Size Completed	Sampled for Site Visit	Sampled for Phone Verification
HVAC	1	5	5	-
Lighting	1	3	2	1
	2	5	1	4
	3	22	3	19
Process	1	1	1	-
	2	4	4	-
	3	10	10	-
Total		**50**	**26**	**24**

Documents Review

For all sampled participants, the evaluation team performed a detailed review of program application documents, which included incentive applications, measure savings input and outputs from DSMore,[3] and supporting documentation or clarifications provided by the customer. We reviewed each application to gain an understanding of the measures included and the expected savings. We collected customer and contractor contact information and decided on an appropriate M&V approach based on this review.

The Duke Energy business relations manager associated with each sampled site contacted customers to secure participation in the evaluation. Once contact was established with the customer, we followed up with the customer via phone calls and e-mails to gain additional information about the facility, measures, and construction schedule.

M&V Plan Development

The evaluation team developed an M&V plan for all 26 program participants verified via site visits and metering. The plans and the resulting reports covered the following topic areas:

- **Introduction:** a description of the project and the measures installed including sufficient detail to understand the M&V project scope and methodology, savings by measure and a list of the M&V priorities for measures within the project, and baseline assumptions.
- **Goals and objectives:** a list of the overall goals and objectives of M&V activity.
- **Building characteristics:** an overview of the building, with a summary table of relevant building characteristics such as building size (square footage), number of stories, building envelope, lighting system, and HVAC system type.
- **Data products and project output:** specific end products such as kWh savings, coincident and noncoincident kW savings, and therm savings and a list of raw and processed data to be supplied at the conclusion of the study.
- **M&V option:** a description of the M&V Option appropriate for participant saving verification according to the IPMVP. We utilized Option A as the most appropriate M&V option for 25 participants verified on site, with the existing equipment as baseline. In one process site we could not install metering equipment due to high voltage, and relied on monthly utility data for verification.
- **Data analysis:** a list of the engineering methods and/or equations used to generate the data products identified above and a list of the data sources, either measurements or stipulated values from secondary data sources.

[3] DEI uses Demand Side Management Option Risk Evaluator (DSMore), a financial analysis tool, to estimate the costs, benefits and risks associated with the DEI Custom Program.

- **Field data points:** a list of specific field data points collected through the M&V plan. The field data included a combination of survey data, one-time measurements, and time series data collected from data loggers installed for the project or trend data collected from the site energy management system.
- **Data accuracy:** a list of meter and sensor accuracy for each field measurement point.
- **Verification and quality control:** a list of the steps taken to validate the accuracy and completeness of the raw field data.
- **Recording and data exchange format:** a list of the format of the raw and processed data files used in the analysis and supplied as data products.

Appendix G. Site M&V Reports – Full Customer Detail contains the M&V plans, along with the processed data summary and participant results.

M&V

During 2013 and 2014, TecMarket Works' subcontractors collected field data according to the M&V plan. Personnel from NORESCO trained the contractors. During winter of 2015/2016, Cadmus collected field data according to the developed M&V plans.

Metering equipment included a combination of portable data acquisition equipment capable of measuring current and motor status, cellular data loggers capable of transmitting data remotely, true electric power meters, and trend logs from facility control systems. We also obtained survey data from site personnel during meter installation. We configured the metering equipment to collect data for a period of two weeks. Where available, we collected trend logs for a month or more.

Of all 26 sites metered, the evaluation team was not able to meter three participant sites using our own metering equipment and relied on trend data or dedicated utility meters to monitor the post-retrofit equipment.

For one HVAC site, a hospital, we could not install metering equipment due to operational requirements; therefore, we collected trend data from the controls engineer. This allowed us to collect hourly trends for one year of system operation and compare winter and summer operation.

In addition to the HVAC site, we were unable to install meters at two process sites. At one process site, the voltage serving the equipment included in the application was greater than 480 V, which is the maximum voltage we can meter. However, an electric utility meter had been installed to monitor this equipment specifically, and we were able to collect monthly utility and production data for pre- and post-retrofit operation.

At another process site, safety and operational standards prevented us from installing meters, but the site had voltage, current, and energy use trends set up on all of the equipment included in the application. We were able to collect trends for one month at one-minute intervals.

This information is summarized in Table 19 in Appendix B. M&V Sampled Participant Calculation Summary.

Appendix G. Site M&V Reports – Full Customer Detail describes the specific instrumentation used at each site.

M&V Calculations

Cadmus collected post-retrofit metered and trend data for the 26 verification site visits. The evaluation team analyzed the data according to the M&V plan developed for each project except where on-site findings required changes to the original metering plan; for example, we could not install logging equipment due to high-voltage or operational limitations. To conduct data analysis, we compared the original application calculations to post-retrofit monitored data extrapolated to annual consumption and demand using simple engineering models or linear regression techniques as described in the M&V plans.

Appendix B. M&V Sampled Participant Calculation Summary provides a detailed list of all of the HVAC and process projects, along with the six lighting projects where we conducted on-site visits and metering. The appendix includes a summary of the M&V plan approach, measurements taken, duration of measurement, and the calculations and analysis techniques used to estimate final impact and demand savings results.

Appendix G. Site M&V Reports – Full Customer Detail contains detailed site M&V calculations for each project.

Phone Verification Calculations

A mentioned previously, the evaluation team following the Indiana TRM energy and demand saving algorithms to calculate savings for all 30 lighting participants. We used phone surveys to verify the inputs to this algorithm with 24 of these participants.

The Indiana TRM specifies the following algorithm for calculating lighting energy and demand savings:[4]

Energy Savings

$$\Delta kWh = ((WATTS_{BASE} - WATTS_{EE}) * HOURS * 1 + WHF_E)/1{,}000$$

Where:

$WATTS_{BASE}$ = connected wattage of the baseline fixtures

$WATTS_{EE}$ = connected wattage of high-efficiency fixtures

HOURS = annual lighting operating hours

WHF_E = lighting-HVAC interaction factor for energy representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting

Summer Peak Coincident Demand Reduction

$$\Delta kW = ((WATTS_{BASE} - WATTS_{EE}) * CF * (1 + WHF_{D}))/1{,}000$$

Where:

WHF_D = lighting-HVAC waste heat factor for demand representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting

CF = summer peak coincidence factor

WHF_E and WHF_D = specified in Appendix B – HVAC Interactive Effects Multipliers tables according to building type, location, and HVAC systems.

The evaluation team extracted the algorithm inputs from the application documentation, where available. We also developed a lighting impact verification survey to obtain verification of those inputs and information about the missing inputs. The inputs included the following:

- Incentive Building Type
- Incentive Building Location(s)
- Replaced Measures (pre-retrofit)
  - Location(s)
  - Summary Description

[4] Cadmus. *Indiana TRM 2.2*, pp. 285-286. Prepared for Indiana Demand Side Management Coordination Committee, EM&V Subcommittee. 2015.

    - Hours and schedule of operation
    - Input Wattage
    - Fixture Type
    - Fixture Count
    - Lamp Type
    - Lamp Count
    - Ballast Type (if applicable)
- Installed Measures (post-retrofit)
    - Summary Description
    - Input Wattage
    - Fixture Type
    - Fixture Count
    - Lamp Type
    - Lamp Count
    - Ballast Type (if applicable)
- Incentive Building HVAC systems

Appendix D. Phone Verification Participant Detailed Results contains the full text of the survey developed by the evaluation team and administered on the phone.

We did not use the CFs listed in the Indiana TRM to calculate peak demand reduction. Instead, the detailed information about the hours and schedule of operation allowed us to identify the demand reduction that would occur annually during the DEI peak periods, identified as July, Monday through Friday, 3:00 p.m. to 4:00 p.m.

The evaluation team conducted verification phone surveys with the contractor/vendor and/or the customer contacts who were listed on the incentive application. In most cases, we were able to obtain detailed information about the lighting measures replaced and installed from the contractor/vendor and detailed information about the building type, mechanical systems, and hours of use from the customer. In other cases, either the customer or contractor/vendor had detailed information on all inputs to the saving algorithm for us to complete the verification. Table 12 provides the detailed list of 24 sites verified on the phone.

Table 12. Lighting Phone Verification Completed Sample List

Site Number	Project Type	Completed Survey with Contractor/Installer*	Completed Survey with Customer*
27	Lighting	x	x
28	Lighting		x
29	Lighting		x
30	Lighting	x	x
31	Lighting	x	
32	Lighting	x	
33	Lighting	x	x
34	Lighting	x	x
35	Lighting	x	x
36	Lighting	x	x
37	Lighting	x	
38	Lighting	x	
39	Lighting	x	
40	Lighting	x	x
41	Lighting		x
42	Lighting		x
43	Lighting	x	x
44	Lighting		x
45	Lighting	x	x
46	Lighting		x
47	Lighting		x
48	Lighting	x	x
49	Lighting	x	x
50	Lighting	x	x
* Gray shading indicates that the evaluation team did not complete the survey with the applicable contact.			

Freeridership Calculations

[Redacted]

Table 13 shows the evaluated savings weighted results of the 150 projects with the original scoring by project type. The projects exhibited 14% freeridership overall across all project types. Spillover questions are not included in the program application. We did not calculate spillover for this program and assumed it to be 0% for the following net-to-gross calculation:

$$NTG = 100\% - Freeridership + Spillover = 100\% - \ 14\% + 0\% = 86\%$$

Table 13. DEI Custom Program Net-to-Gross Ratio

Project type	Number of Applicants With Calculated Freeridership Score	Energy Savings Weighted Freeridership Score	Net-to-Gross Ratio
HVAC	12	8%	92%
Lighting	103	15%	85%
Process	23	14%	86%
Total	**138**	**14%**	**86%**

Impact Evaluation Results

This section reports the evaluation results, which includes annual energy, CP, and NCP demand reductions as well as realization rates for each participants.

Annual Savings

Table 14 summarizes annual savings and realization rates (RR) calculated by project type for the evaluation period.

Table 14. Average Annual Gross Savings Realization Rate by Project Type

Project Type	Energy Savings (kWh)			NCP Savings (kW)			CP Savings (kW)		
	Evaluated	Expected	RR	Evaluated	Expected	RR	Evaluated	Expected	RR
HVAC	4,737,374	8,830,728	54%	1,269	2,153	59%	1,640	1,008	163%
Lighting	29,962,109	29,094,778	103%	5,243	4,733	111%	4,863	4,455	109%
Process	35,121,736	31,257,816	112%	3,655	5,595	65%	3,716	2,505	148%
Total	**69,821,218**	**69,183,321**	**101%**	**10,167**	**12,480**	**81%**	**10,218**	**7,968**	**128%**

Table 15 through Table 17 list the estimated precision for energy, NCP demand, and CP demand realization rates at 90% confidence. We achieved ±8% relative precision (the precision targeted for the study was ±10%). Some strata sampled the population census and, therefore, has relative precision of 0%, while other strata exhibited higher relative precision such as HVAC 1 and Process 3 project categories.

Table 15. KWh Realization Rate Achieved Sampling Precision at 90% Confidence

Stratum	Population Size	Sample Size	Actual Sample Error Ratio	Relative Precision
HVAC 1	12	5	0.32	±31%
Lighting 1	3	3	n/a*	0%
Lighting 2	10	5	0.07	±7%
Lighting 3	101	22	0.42	±15%
Process 1	1	1	n/a*	0%
Process 2	4	4	n/a*	0%
Process 3	19	10	0.87	±50%
Total	**150**	**50**	**0.32**	**±8%**

*Error ratio is not applicable to strata where the sample was a census of the population.

Table 16. NCP kW Realization Rate Achieved Sampling Precision at 90% Confidence

Stratum	Population Size	Sample Size	Actual Sample Error Ratio	Relative Precision
HVAC 1	12	5	0.38	37%
Lighting 1	3	3	n/a*	0%
Lighting 2	10	5	0.09	9%
Lighting 3	101	22	0.47	17%
Process 1	1	1	n/a*	0%
Process 2	4	4	n/a*	0%
Process 3	19	10	0.88	51%
Total	**150**	**50**	**0.34**	**8%**

*Error ratio is not applicable to strata where the sample was a census of the population.

Table 17. CP kW Realization Rate Achieved Sampling Precision at 90% Confidence

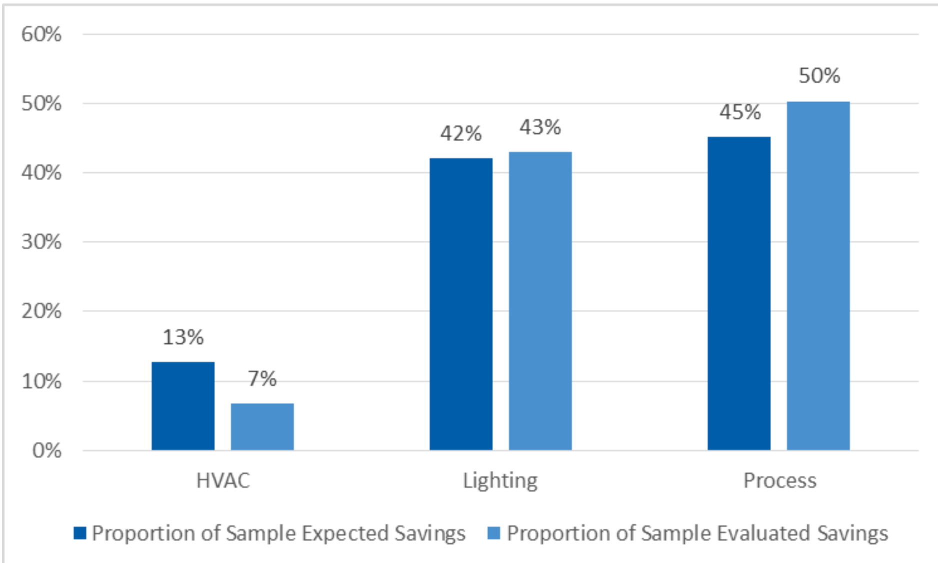
Stratum	Population Size	Sample Size	Actual Sample Error Ratio	Relative Precision
HVAC 1	12	5	0.38	36%
Lighting 1	3	3	n/a*	0%
Lighting 2	10	5	0.09	9%
Lighting 3	101	22	0.29	11%
Process 1	1	1	n/a*	0%
Process 2	4	4	n/a*	0%
Process 3	19	10	1.04	60%
Total	**150**	**50**	**0.33**	**8%**

*Error ratio is not applicable to strata where the sample was a census of the population.

Findings

Figure 2 shows the breakdown of verified energy savings by project type compared to claimed energy savings. Process projects contributed the most to the verified total program savings, followed closely by lighting projects with 50% and 43%, respectively.

Figure 2. Verified Energy Savings by Project Type for the Evaluation Period (n=150)



The evaluation team's summary of findings are provided here and described in detail in Table 21 in Appendix C. M&V Sampled Participant Detailed Results and Table 23 in Appendix D. Phone Verification Participant Detailed Results. Although overall energy realization rate across all projects was 101%, the evaluation team found large variations between evaluated savings and claimed savings in process and HVAC projects. Specific examples are provided below for these strata.

Process

Of the 15 process projects, the evaluation team found increased production load and/or operating hours compared to the program estimates in three projects, based on the post-retrofit monitoring data. To compare the installed case to an appropriate baseline, the evaluation team adjusted the baseline production load and/or operating hours to be equal to the post-retrofit productions load.

For two other process projects, the load or equipment operating hours were less than what was predicted in the DEI program estimates. The site contact at one of these sites explained that the sales for his product have been down ~20% over the past two years, which had a significant impact on the energy savings. At another site, post-retrofit metered data showed minimal equipment operation, where the baseline expected 8,760 annual hours of operation.

These differences reinforce the value of conducting pre-retrofit and post-retrofit measurements, collecting coincident production data, and establishing baseline project performance assumptions from metered data, where possible.

Lighting

In general, the lighting hours of use verified through the phone verification surveys were very close to those claimed in the program application and varied by only 4% on average. Most of the increase in evaluated savings was associated with the fact that claimed saving calculations did not account for HVAC interactive effects There are building types and HVAC systems (not included in this study) where the HVAC interactive effects can reduce the savings associated with a lighting retrofit.

HVAC

In the two HVAC hospital projects, low realization rates were generally caused by control strategies that were suboptimal or not fully implemented. Post-installation inspections or project commissioning can be effective in obtaining the full energy savings available from HVAC control measures.

One of the sampled HVAC applications claimed energy and demand savings for downsizing pumps and fans as a result of replacing steam boilers with condensing boilers. DEI does not incentivize fuel switching projects in the Custom Program. As such DEI had removed the electric demand penalty resulting from the inadvertent switch of the process heating system from steam to electric. However, Cadmus noted that the electric demand associated with running the fans and pumps for the process heating system was not removed from the baseline case in the program application calculations. Including this adjustment, the project achieved a 171% realization rate for the fan and pump claimed energy savings.

Conclusions and Recommendations

The evaluation team offers the following conclusions and recommendations resulting from the DEI Custom Program evaluation.

- **Conclusion:** DEI can improve the accuracy of its claimed saving calculations for process projects by ensuring that pre-retrofit energy use assumptions are based on metered data and tied to the industrial production load/operating hours.
  - **Recommendation:** Where feasible, consider pre- and post-retrofit measurements and collecting coincident production data to arrive at accurate realized savings, specifically in process projects.
- **Conclusion:** DEI can improve the accuracy of its claimed saving calculations by incorporating HVAC interactive effects in lighting projects.
  - **Recommendation:** Include HVAC interactive effects in lighting project saving calculations.
- **Conclusion:** DEI does not incentivize fuel switching projects under the Custom Program. The program saving calculations do not account for increased or decreased load associated with end-uses that are served by a different fuel source as a result of the project.
  - **Recommendation:** For projects that involve fuel switching, any load associated with fuel switching should be removed from both the baseline and installed case load calculations.
- **Conclusion:** Low realization rates caused by sub-optimal or incomplete control strategies indicate that post-retrofit inspection or project commissioning may be effective strategies for realizing the full energy savings available from HVAC control measures.
  - **Recommendation:** Where possible, require post-retrofit commissioning for HVAC projects to realize the full potential of retrofit savings.

Smart $aver Nonresidential Custom Incentive Program

Duke Energy Indiana
Completed EMV Fact Sheet
2016 Evaluation – Cadmus

Program Description

The Duke Energy Smart $aver Nonresidential Custom Incentive Program supplements the Smart $aver Nonresidential Prescriptive Incentive Program, which provides prescriptive rebates for preselected measures. Customers wishing to install measures not included in the Smart $aver Nonresidential Prescriptive Incentive Program list may apply for a rebate through the Custom Program. Participation requires a pre-approval from the program before measure installation.

Date	March 15, 2016
Region(s)	IN
Evaluation Period	Applications Received from January 2011 through March 2014
Gross Energy Savings (kWh)	69,821,218
Net Coincident kW Impact (Summer)	8,811
Measure life	Various
Net Energy Savings (kWh)	59,815,789
Process Evaluation	Yes, reported separately.
Previous Evaluation(s)	Yes

Evaluation Methodology

The evaluation team conducted the impact evaluation based on measurement and verification of a sample of 26 participants (HVAC, lighting and process projects) and phone verification on a sample of 24 participants (all lighting projects) in Indiana. The evaluation team estimated a savings realization rate for each project category (lighting, HVAC, and process) that was projected onto the full program participant population.

Impact Evaluation Details

- The program achieved an overall kWh RR across all projects of 101%. The majority of projects had a realization rate between -9% and 170%.
- Industrial process (process) projects achieved the highest energy savings (realization rate of 112%) when compared to program estimates, whereas HVAC projects achieved the lowest energy savings when compared to program estimates (realization rate of 54%); lighting projects performed closest to expectations, achieving a realization rate of 103%.
- Fourteen percent (14%) of the evaluated program savings are associated with freeriders. The program net to gross ratio is 86%.
- Process participants produced 50% of total program evaluated savings and lighting participants produced 43% of the total program evaluated savings.

Appendix A. Required Savings Tables

The DEI required summary parameters resulting from this evaluation are provided in Table 18.

Table 18. DEI Required Program Evaluation Summary Table

Measure Name	Gross kWh RR	NCP kW RR	CP kW RR	EUL	Net-to-Gross Ratio
Custom	101%	81%	128%	Custom	86%

Appendix B. M&V Sampled Participant Calculation Summary

Table 19 includes a summary of the M&V approach, measurements taken, and the calculations performed for each M&V participant sampled for this evaluation.

Table 19. M&V and Impact Calculation Approach Summary

Site ID	Project Type	M&V Plan Summary	Measurements Taken	Monitoring Duration	Calculations
1	Process	Post-installation true electric power logging of VFD air compressor and air dryers	VFD air compressor kW, air dryer kW, system flow and pressure	Two Weeks	Engineering equations with parameters from post-installation metered demand data
2	Process	Post-installation true electric power logging of blow molding machine	Blow molding machine kW	Two Weeks	Engineering equations with parameters from post-installation metered demand data
3	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data
4	Process	Post-installation trending of compressed air system kW, cfm, and pressure	Compressed air cfm, compressor kW, system pressure	Three Weeks	Engineering equations with parameters from metered data
5	HVAC	Post-installation current logging of a sample of heat pumps plus cooling tower	Heat pump and cooling tower current, outdoor temperature, and humidity	Three Weeks	Regression analysis of monitored kW data and outdoor temperature
6	Process	Post-installation true power logging of a sample of aeration blowers and grit pumps and current logging of WAS pump and TWAS pump	Aeration blower kW, grit pump kW, WAS pump current and status, TWAS pump current and status	Two Weeks	Engineering equations with parameters from post-installation metered demand, current, and motor status data

Table 19. M&V and Impact Calculation Approach Summary

Site ID	Project Type	M&V Plan Summary	Measurements Taken	Monitoring Duration	Calculations
7	HVAC	Post-installation trend logging of chillers, pumps, cooling towers and air- handling units	Chiller kW; cooling tower fan kW and speed; primary and secondary CHW pump kW, speed and flow rate; CW pump kW, speed and flow rate; CHW supply and return temperature; CW supply and return temperature; outdoor temperature and humidity	Three Weeks	Regression analysis of monitored kW data and outdoor temperature
8	Process	Post-installation true electric power logging of two air dryers and associated air compressor and current logging of third air dryer	Air compressor kW, air dryer kW, air dryer current	Two Weeks	Engineering equations with parameters from post-installation metered demand data
9	HVAC	Post-installation true electric power logging of a sample of condensing boiler pumps and fans and Lubrite heaters	Boiler pump kW, boiler pump status, boiler fan kW, Lubrite heater current, Lubrite electric boiler current	Two Weeks	Engineering equations with parameters from post-installation metered demand and current data
10	Process	Post-installation trend logging of chillers, pumps, cooling towers, and process loads	Cooling tower fan kW and speed; chiller kW, tower pump kW and speed	Four Weeks - Winter	Regression analysis of monitored kW data and outdoor temperature
			CHW pump kW and speed, CW supply and return temperature, process and CW flowrate; outdoor temperature and humidity	Four Weeks - Summer	

Table 19. M&V and Impact Calculation Approach Summary

Site ID	Project Type	M&V Plan Summary	Measurements Taken	Monitoring Duration	Calculations
11	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data
12	Process	Post-installation true electric power logging of three air compressors	Air compressor kW, system pressure	Two Weeks	Engineering equations with parameters from post-installation metered demand data
13	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data
14	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data
15	Process	Post-installation true electric power logging of an induction heating system and hammer forge	Induction heater kW (could not meter hammer forge)	Two Weeks	Engineering equations with parameters from post-installation metered demand data (induction heater only)
16	Process	Post-installation true electric power logging of air compressor and air dryer	Air compressor kW, air dryer kW, air compressor current	Two Weeks	Engineering equations with parameters from post-installation metered demand and current data
17	Process	Post-installation true electric power logging of a sample of battery chargers	True electric power of battery chargers	Three Weeks	Time series kW plots used to estimate kWh per-charge cycle.
18	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data

Table 19. M&V and Impact Calculation Approach Summary

Site ID	Project Type	M&V Plan Summary	Measurements Taken	Monitoring Duration	Calculations
19	Process	Post-installation true electric power logging of melting furnaces	Could not meter due to high voltage, collected electric utility data for furnaces and yearly production data	n/a	Linear regression analysis on pre- and post-installation electric utility data and production data
20	Process	Post-installation true electric power logging of VFD-controlled pumps	True electric power of VFDs	Three Weeks	Average load shape by day type from monitored data; pre kW estimated from full load kW
21	HVAC	Post-installation trend logging of chillers, pumps, and cooling tower fans	Chiller kW, cooling tower fan kW, primary and secondary CHW pump kW, condenser water pump kW, CHW supply and return temperature, CHW flow rate, CHW plant load	12 Months	Engineering equations with parameters from post-installation trend data
22	Process	Post-installation true electric power logging of furnace, galvanizing line, and cleaning line main feeds	Furnace line input kW, galvanizing line input kW, cleaning line input kW	Two Weeks	Engineering equations with parameters from post-installation metered demand data
23	Process	Post-installation trend logging of supply and exhaust fan amps, volts, and kWh	Supply and exhaust fan motor voltage, current per phase, kWh	One Month	Engineering equations with parameters from post-installation trend data
24	Process	Pre- and post-trend logging of fan kW	Fan kW	Three Weeks pre- and three weeks post-installation	Pre- and post-time series data comparison

Table 19. M&V and Impact Calculation Approach Summary

Site ID	Project Type	M&V Plan Summary	Measurements Taken	Monitoring Duration	Calculations
25	Lighting	Post-installation current logging of a sample of lighting circuits	Spot true electric power and time series lighting circuit current measurements	Three Weeks	Engineering equations with parameters from metered data
26	HVAC	Post-installation logging of temperatures and true electric power at AHUs and exhaust fans	AHU supply air, mixed air and return air temperature, supply fan power, return fan current, exhaust fan current, outdoor air temperature and humidity	Three Weeks	Load shapes derived from monitored data, engineering equations

Appendix C. M&V Sampled Participant Detailed Results

Table 20 lists the average annual realization rates by project type for the M&V sampled participants. Table 21 lists a summary of the specific findings from each participant in the M&V sample.

Table 20. Gross Savings and Realization Rate Results by M&V Sampled Participant

Site	Project Type	kWh Savings			NCP kW Savings			CP kW Savings		
		Expected	Evaluated	RR	Expected	Evaluated	RR	Expected	Evaluated	RR
1	Process	812,037	303,096	37%	93	35	37%	93	35	37%
2	Process	1,886,056	1,524,031	81%	215	408	189%	215	407	189%
3	Lighting	3,058,934	2,013,012	66%	349	291	83%	349	283	81%
4	Process	2,530,204	3,358,085	133%	289	383	133%	289	383	133%
5	HVAC	20,499	34,197	167%	8	5	67%	4	5	109%
6	Process	727,563	1,100,555	151%	83	259	312%	83	233	281%
7	HVAC	1,097,419	341,305	31%	262	88	34%	64	21	33%
8	Process	504,850	297,651	59%	52	41	79%	32	19	60%
9	HVAC	45,485	77,970	171%	7	13	183%	7	-	0%
10	Process	12,421,172	12,026,752	97%	3,191	654	20%	713	1,012	142%
11	Lighting	1,735,368	1,743,929	100%	542	355	66%	418	320	77%
12	Process	853,227	495,816	58%	97	57	58%	97	57	58%
13	Lighting	217,623	174,055	80%	6	51	825%	2	2	101%
14	Lighting	1,264,175	1,122,052	89%	144	130	90%	144	130	90%
15	Process	748,995	2,103,576	281%	148	414	280%	58	325	556%
16	Process	117,391	117,391	100%	13	13	100%	13	13	100%
17	Process	80,450	12,853	16%	9	2	19%	9	2	24%
18	Lighting	14,148	13,856	98%	2	3	119%	2	2	102%
19	Process	523,797	383,299	73%	90	44	48%	87	44	51%
20	Process	970,745	3,314,013	341%	111	152	137%	8	162	2002%
21	HVAC	942,414	664,929	71%	139	76	55%	70	141	201%

Table 20. Gross Savings and Realization Rate Results by M&V Sampled Participant

Site	Project Type	kWh Savings			NCP kW Savings			CP kW Savings		
		Expected	Evaluated	RR	Expected	Evaluated	RR	Expected	Evaluated	RR
22	Process	4,554,813	5,698,384	125%	520	651	125%	518	648	125%
23	Process	1,441,871	1,832,176	127%	238	209	88%	-	184	n/a
24	Process	1,002,044	(86,942)	-9%	148	(17)	-12%	141	(17)	-12%
25	Lighting	62,736	92,927	148%	13	18	135%	13	18	135%
26	HVAC	420,634	236,951	56%	72	106	146%	(13)	48	-363%

Table 21. Findings Summary by M&V Sampled Participant

Site Number	Project Type	kWh RR	CP RR	Findings summary
1	Process	37%	37%	Evaluation metered demand for installed 300 hp VFD compressor was higher than what was assumed in the program calculations.
2	Process	81%	189%	Evaluation showed 36% higher compressed air usage than expected and machine production is currently limited by ancillary equipment but will increase in future.
3	Lighting	66%	81%	Evaluation showed lower operating hours but higher fixture installed watt savings. HVAC interactions not included in program savings estimates.
4	Process	133%	133%	Monitoring showed air compressor power affected by control upgrades higher than program calculation assumptions.
5	HVAC	167%	109%	Savings based on monitored data in the post-period, with weather adjustments for equipment capacity, efficiency and water loop temperature.
6	Process	151%	281%	Evaluated pump and blower demand and operating hours were less than predicted in program savings estimates.
7	HVAC	31%	33%	Evaluation showed chiller plant control sequence and incented chiller part load operation not as expected.
8	Process	59%	60%	Evaluation found the CAGI ratings of non-cycling dryers to be 2/3 of the rating assumed in the original study. This reduced energy savings and demand reduction for ECM-1.
9	HVAC	171%	0%	Evaluation metered demand data for installed boiler pumps and fans was lower than originally expected resulting in higher savings. Program application savings and evaluation calculations do not include the additional electric demand associated with switching the Lubrite process heating system from gas to electric. Since DEI does not penalize or incentivize fuel switching impacts, Cadmus removed the heating load for the Lubrite process system from both the baseline and installed cases in the evaluation calculations.
10	Process	97%	142%	KWh savings were very close to program savings estimates. Low realization rate on demand savings attributed to higher cooling tower kW than assumed in project calculations.
11	Lighting	100%	77%	Evaluation showed lower average operating hours, HVAC interactions not included in program savings estimates.
12	Process	58%	58%	Evaluation installed case metered demand was much higher than was expected in the original application.
13	Lighting	80%	101%	Evaluation showed lower average operating hours. Program estimates of NCP kW savings were incorrectly calculated.

Table 21. Findings Summary by M&V Sampled Participant

Site Number	Project Type	kWh RR	CP RR	Findings summary
14	Lighting	89%	90%	Evaluation showed lower average operating hours. Fixture watts assumptions were revised.
15	Process	281%	556%	Evaluation found the installed hydraulic hammer forge does not use compressed air, as assumed in the program estimates.
16	Process	100%	100%	Site survey and metered data supported original program calculations.
17	Process	16%	24%	Evaluation showed battery chargers were used much less than the once per day assumption in the program calculations.
18	Lighting	98%	102%	The evaluation showed the annual operating hours are about 10 percent less than weighted hours from the application, while the watts saved per fixture were about 20% greater overall. HVAC interactions not included in program savings estimates.
19	Process	73%	51%	Site production has decreased by ~20% since the study was performed. Savings are highly dependent on pounds of metal produced by the furnaces.
20	Process	341%	2002%	Evaluation showed more VFD speed turndown than assumed in application. Evaluation showed more demand savings due to updated equipment staging assumptions.
21	HVAC	71%	201%	Evaluation showed lower free-cooling HX operating hours than predicted, savings are sensitive to pre-retrofit chiller staging assumptions.
22	Process	125%	125%	Evaluation power metering showed lower installed motor demand and higher operating hours than expected.
23	Process	127%	N/A	Average exhaust fan drive speeds were higher than originally predicted, but annual operating hours are 21% higher than expected and supply fan speeds were lower than expected.
24	Process	-9%	-12%	Pre/post monitoring of VFDs showed some fans with increased consumption and demand in the post period.
25	Lighting	148%	135%	Evaluation showed more operating hours and watt savings than assumed in the program estimates. HVAC interactions not included in program savings estimates.
26	HVAC	56%	-363%	The low amount of energy savings is the result of scheduling controls not yet being fully implemented. Evaluation predicted positive NCP kW savings, while the program calculations produced negative savings.

Appendix D. Phone Verification Participant Detailed Results

Table 22 lists the realization rates for each participant sampled for phone verification. Table 23 lists a summary of the specific findings from each participant in the phone verification sample.

Table 22. Gross Savings and Realization Rate Results by Phone Verification Sampled Participant

Site	Project Type	kWh Savings			NCP kW Savings			CP kW Savings		
		Expected	Evaluated	RR	Expected	Evaluated	RR	Expected	Evaluated	RR
27	Lighting	210,306	180,266	86%	24	24	100%	24	24	100%
28	Lighting	1,312,793	1,440,664	110%	252	303	120%	252	303	120%
29	Lighting	135,374	148,560	110%	26	31	120%	26	31	120%
30	Lighting	4,315,865	4,730,282	110%	492	591	120%	493	591	120%
31	Lighting	339,171	379,281	112%	44	53	120%	44	53	120%
32	Lighting	1,559,776	1,709,548	110%	178	214	120%	178	214	120%
33	Lighting	279,758	474,405	170%	46	82	179%	46	82	179%
34	Lighting	402,433	369,415	92%	80	80	100%	80	80	100%
35	Lighting	279,315	333,357	119%	61	74	120%	61	74	120%
36	Lighting	150,858	145,711	97%	35	32	93%	35	32	93%
37	Lighting	232,185	368,642	159%	65	77	120%	65	77	120%
38	Lighting	312,442	347,718	111%	36	43	120%	36	43	120%
39	Lighting	157,868	157,763	100%	10	36	367%	-	-	N/A
40	Lighting	150,207	230,949	154%	32	43	135%	32	43	135%
41	Lighting	146,108	126,047	86%	27	31	113%	27	31	113%
42	Lighting	203,285	172,806	85%	38	42	111%	38	42	111%
43	Lighting	163,290	169,317	104%	44	48	110%	44	48	110%
44	Lighting	1,016,692	1,054,832	104%	116	142	122%	116	142	122%
45	Lighting	338,749	268,547	79%	81	89	109%	81	89	109%
46	Lighting	134,447	106,095	79%	22	26	119%	22	26	120%
47	Lighting	172,464	209,960	122%	20	24	122%	20	24	122%
48	Lighting	127,923	131,711	103%	17	17	100%	17	17	100%

Table 22. Gross Savings and Realization Rate Results by Phone Verification Sampled Participant

Site	Project Type	kWh Savings			NCP kW Savings			CP kW Savings		
		Expected	Evaluated	RR	Expected	Evaluated	RR	Expected	Evaluated	RR
49	Lighting	1,066,171	1,208,404	113%	176	176	100%	176	176	100%
50	Lighting	184,643	249,650	135%	34	46	133%	34	46	133%

Table 23. Findings Summary By Phone Verification Sampled Participant

Site Number	Project Type	kWh RR	CP RR	Findings summary
27	Lighting	86%	100%	Claimed operating hours equal to 8760, phone survey operating hours equal to 7508. Fixture quantity/wattage match claimed. Process heating only, therefore claimed and evaluated saving calculations do not include interactive effects.
28	Lighting	110%	120%	Phone survey confirmed store hours, not operating hours. Claimed operating hours equal to 5200, IN TRM operating hours for spacetype: 'Retail' equal to 4984. Fixture quantity/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
29	Lighting	110%	120%	Phone survey confirmed store hours, not operating hours. Claimed operating hours equal to 5200; IN TRM operating hours for spacetype: 'Retail' equal to 4984. Fixture quantity/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
30	Lighting	110%	120%	Phone survey confirmed operating hours, fixture quantity/wattage. HVAC interactive effects not included in claimed savings calculations.
31	Lighting	112%	120%	Claimed operating hours equal to 7560, phone survey operating hours equal to 7665. Fixture quantities/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
32	Lighting	110%	120%	Phone survey confirmed operating hours, fixture quantity/wattage. HVAC interactive effects not included in claimed savings calculations.
33	Lighting	170%	179%	Claimed operating hours equal to 6240, phone survey operating hours equal to 6257. Fixture quantities/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
34	Lighting	92%	100%	Phone survey confirmed operating hours. Installed fixture wattage is more than claimed. HVAC interactive effects not included in claimed savings calculations.
35	Lighting	119%	120%	Claimed operating hours equal to 4368, phone survey operating hours equal to 4745. Fixture quantity/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
36	Lighting	97%	93%	Claimed operating hours equal to 4550, phone survey operating hours equal to 4745. Fixture quantity less than claimed. HVAC interactive effects not included in claimed savings calculations.

Table 23. Findings Summary By Phone Verification Sampled Participant

Site Number	Project Type	kWh RR	CP RR	Findings summary
37	Lighting	159%	120%	Phone survey confirmed store hours, not operating hours. Claimed operating hours IN TRM for spacetype: 'Retail' equal to 4984. Fixture quantity/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.
38	Lighting	111%	120%	Phone survey operating hours are equal to 8760 for all spaces; claimed operating hours equal to 7488. Fixture quantity/wattage match claimed. Claimed savings did not include HVAC interactive effects.
39	Lighting	100%	N/A	Phone survey confirmed operating hours, fixture quantity/wattage. Lighting serves exterior parking lot and does not achieve coincident kW savings. Evaluated savings do not include HVAC interactive effects similar to claimed savings.
40	Lighting	154%	135%	Claimed operating hours equal to 4745, phone survey operating hours equal to 5657. Installed wattage less than claimed. Claimed savings did not include HVAC interactive effects.
41	Lighting	86%	113%	Phone survey operating hours are equal to 4432; claimed equal to 5408. Claimed fixture quantity/wattage match phone survey results. Claimed savings did not include HVAC interactive effects.
42	Lighting	85%	111%	Phone survey operating hours are equal to 4432; claimed equal to 5408. Fixture quantity/wattage match claimed. Claimed savings did not include HVAC interactive effects.
43	Lighting	104%	110%	Phone survey confirmed delamping component not included in claimed saving calculations. Operating hours, and other claimed fixture details match phone survey results.
44	Lighting	104%	122%	Phone survey confirmed operating hours, fixture quantity/wattage. HVAC interactive effects not included in claimed savings calculations.
45	Lighting	79%	109%	Claimed operating hours equal to 4264, phone survey operating hours equal to 4171. Phone survey confirmed fixture quantity installed less than claimed. HVAC interactive effects not included in claimed savings calculations.
46	Lighting	79%	120%	Customer phone surveyed operating hours are equal to 4308; claimed equal to 6300. Fixture quantity/wattage match claimed. Claimed savings did not include HVAC interactive effects.
47	Lighting	122%	122%	Phone survey confirmed operating hours, fixture wattage. Confirmed quantities are more than claimed values at two locations.
48	Lighting	103%	100%	Phone survey confirmed operating hours, fixture quantity/wattage. The retrofit involved exterior lighting, therefore claimed and evaluated saving calculations do not include interactive effects.

Table 23. Findings Summary By Phone Verification Sampled Participant

Site Number	Project Type	kWh RR	CP RR	Findings summary
49	Lighting	113%	100%	Claimed operating hours equal to 6240, phone survey operating hours equal to 6882. Fixture quantity/wattage match claimed. HVAC interactive effects not included in claimed or evaluated saving calculations as this site is not conditioned.
50	Lighting	135%	133%	Claimed operating hours equal to 5408, phone survey operating hours equal to 5892. Fixture quantities/wattage match claimed. HVAC interactive effects not included in claimed savings calculations.

Appendix E. Freeridership Survey

[Redacted]

Appendix F. Lighting Impact Phone Verification Survey Instrument

Researchable Questions	Item
Introduction	0 - A7A4
Verify records	0 - B5B5
Lighting controls and hours of use	0 - C15
Heating and cooling	D1 - D9
Closing	E1

Target Quota = [38]

General Instructions

- Interviewer instructions are in green [LIKE THIS] (the style is “Survey: Interviewer Instructions”).
- CATI programming instructions are in red [LIKE THIS] (the style is “Survey: Programming”).
- Items that should not be read by the interviewer are in parentheses like this ( ).

Data to copy from sample application files:

- Application Name
- Application ID
- Total kWh expected (annual kWh gross w/o losses)
- Total non-coincident kW (annual non-coincident kW w/o losses)
- Total coincident kW (Saved Summer coincident kW w/o losses)
- Installer/Contractor Name
- Installer/Contractor’s Business Name
- Installer/Contractor Title
- Installer/Contractor Phone
- Installer/Contractor email
- Customer Name
- Customer’s Business Name
- Customer Phone
- Customer email
- Building Type
- Incentive Building Location(s)
- Invoice Date/Payment Date/Payment Request Date Month and Year (whichever is available)
- Replaced Measures (Pre-retrofit)
  - Location(s)
  - Summary Description
  - Hours
  - Input Wattage
  - Fixture Type
  - Fixture Count
  - Lamp Type
  - Lamp Count
  - Ballast Type
- Installed Measure (Post-retrofit)

- Summary Description
- Input Wattage
- Fixture Type
- Fixture Count
- Lamp Type
- Lamp Count
- Ballast Type

A. Introduction (2 min)

[Ask IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

A1. **Hello, my name is _____, and I'm calling on behalf of Duke Energy to verify information on the lighting equipment that was** installed in/purchased for [CUSTOMER'S BUSINESS NAME] through the Smart $aver Custom program. Are you the best person to speak with?

[IF NEEDED] The lighting equipment that I'm verifying was invoiced/paid/submitted for payment on [INVOICE DATE/PAYMENT DATE/PAYMENT REQUEST DATE MONTH AND YEAR].
[IF NEEDED] We need to verify that the savings are reported correctly.
[IF NEEDED] The information you provide will be kept confidential and will have no impact on the incentive that you or the customer received.

1. (Yes) – [PROCEED]
2. (No) - [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
3. (Not right now) – [SCHEDULE A TIME TO CALL BACK] If possible, please ensure detailed information about the project is available for you to review during our call.
98. (Don't know) [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
99. (Refused) [THANK & TERMINATE]

[Ask IF INTERVIEWEE IS A DUKE ENERGY CUSTOMER]

A2. Hello, my name is _____, **and I'm calling on behalf of Duke Energy to verify information on the lighting equipment that was installed in/**purchased for your company through the Smart $aver Custom program. Are you the best person to speak with?

[IF NEEDED] The lighting equipment that I'm verifying was invoiced/paid/submitted for payment on [INVOICE DATE/PAYMENT DATE/PAYMENT REQUEST DATE MONTH AND YEAR].
[IF NEEDED] We need to verify that the savings are reported correctly.
[IF NEEDED] The information you provide will be kept confidential and will have no impact on the incentive that you or the customer received.

1. (Yes) – [PROCEED]
2. (No) - [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
3. (Not right now) – [SCHEDULE A TIME TO CALL BACK] If possible, please ensure detailed information about the project is available for you to review during our call.
98. (Don't know) [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
99. (Refused) [THANK & TERMINATE]

A3. Do you have detailed information about this project handy right now?
1. (Yes) – [PROCEED]
2. (Not right now) – [SCHEDULE A TIME TO CALL BACK] If possible, please ensure detailed information about the project is available for you to review during our call.
98. (Don't know) [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
99. (Refused) [THANK & TERMINATE]

[ASK IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

A4. **Our records show that your organization installed/purchased lighting equipment for** [CUSTOMER'S BUSINESS NAME]. [CUSTOMER'S BUSINESS NAME] **received a Smart $aver Custom rebate for the installation of** [INSTALLED MEASURE SUMMARY DESCRIPTION(S)] **at a location in** [INCENTIVE BUILDING LOCATION CITY]**. Is that correct?**
1. (Yes) – [PROCEED]
2. (No) - [THANK & TERMINATE]
98. (Don't know)[ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
99. (Refused) [THANK & TERMINATE]

[ASK IF INTERVIEWEE IS A DUKE ENERGY CUSTOMER]

A5. **Our records show that your organization received a Smart $aver Custom rebate for the installation of** [INSTALLED MEASURE SUMMARY DESCRIPTION(S)] **at a location in** [INCENTIVE BUILDING LOCATION CITY]**. Is that correct?**
1. (Yes) – [PROCEED]
2. (No) - [THANK & TERMINATE]
98. (Don't know) - [ASK TO SPEAK TO SOMEONE WHO KNOWS ABOUT THE PROJECT]
99. (Refused) – [THANK & TERMINATE]

A6. What is your job title?
[RECORD RESPONSE]

A7. What was your role on the lighting project?
[RECORD RESPONSE]

B. Verify Records (5 min)

B1. Next, I would like to confirm our records about the equipment that was replaced, as well as the equipment you installed.
[IF MULTIPLE MEASURES INSTALLED, DESCRIBE THEIR ORDER IN THE SURVEY. FOR EXAMPLE, "LET'S REVIEW [installed measure summary description 1] FIRST AND THEN [installed measure summary description 2]."].

[REPEAT QUESTIONS B2 THROUGH C15 FOR EACH INSTALLED MEASURE]

B2. Please confirm the location, types, and counts of fixtures, lamps, and ballasts that were <u>replaced</u>. *FOR EXAMPLE: "DID YOU REPLACE 425 T-12 4 LAMP MAGNETIC BALLAST FIXTURES IN THE BASEMENT? WHAT WAS THE INPUT WATT OF THE FIXTURE?""*

Summary Description	
Location	
Fixture Type	
Fixture Count	
Lamp Type	
Lamp Count	
Ballast Type	
Input Wattage	

[ask if replaced fixture/lamp/ballast information is not in file]

B3. Do you have any additional information about the <u>replaced</u> fixtures? This would include details from plans, specifications, cut sheets on file, spare parts still in inventory, or similar old fixtures still in operation not part of the rebated project.

1. (Yes) - [RECORD DETAILS]
2. (No)

98. (Don't know)
99. (Refused)

B4. Next, please confirm the types and counts of fixtures, lamps, and ballasts that were <u>installed</u>. *FOR EXAMPLE: "DID YOU INSTALL 408 T-8 28W 4 LAMP ELECTRONIC BALLAST FIXTURES? WHAT WAS THE INPUT WATT OF THE FIXTURE?"*

Summary Description	
Fixture Type	
Fixture Count	
Lamp Type	
Lamp Count	
Ballast Type	
Input Wattage	

[ask if installed fixture/lamp/ballast information is not in file]

B5. Do you have any additional information about the installed fixtures? This would include plans, specifications, cut sheets on file, spare parts still in inventory.

1. (Yes) - [RECORD DETAILS]
2. (No)
98. (Don't know)
99. (Refused)

C. *Lighting Controls and Hours of Use (5 minutes)*

Now, I would like to ask a few questions about the lighting controls and the hours of use.

C1. Was there an automatic timeclock or were there photocells on the replaced lighting prior to the retrofit?

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

[Ask IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

C2. Do you have any information about the lighting hours of use prior to the retrofit?

1. (Yes) – [PROCEED]
2. (No) - [SKIP TO C6]

[ASK IF 0=1]

C3. What was the regular (i.e. not holiday or weekend) automatic switching schedule for the replaced lighting prior to the retrofit? [RECORD RESPONSE]

Business Days:	Monday	Tuesday	Wednesday	Thursday	Friday
Lighting Hours of Operation:					

[ASK IF 0=2]

C4. What was the regular (i.e. not holiday or weekend) manual switching schedule for the replaced lighting prior to the retrofit? [RECORD RESPONSE]

Business Days:	Monday	Tuesday	Wednesday	Thursday	Friday
Lighting Hours of Operation:					

C5. How was the replaced lighting controlled during holidays/weekends/unoccupied periods prior to the retrofit? [RECORD RESPONSE]

Non-business Days:	Saturday	Sunday	Holidays	Unoccupied Periods
Lighting Hours of Operation:				

C6. Is there an automatic timeclock or are there photocells on the installed lighting after the retrofit?

1. (Yes)
2. (No)

98. (Don’t know)
99. (Refused)

[ASK IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

C7. DO YOU HAVE ANY INFORMATION ABOUT THE LIGHTING HOURS OF USE AFTER THE RETROFIT?

1. (YES) – [PROCEED]
2. (NO) - [SKIP TO C14]

[ASK IF C6=1]

C8. What is the new regular (i.e. not holiday or weekend) automatic switching schedule for the installed lighting after the retrofit? [RECORD RESPONSE]

Business Days:	Monday	Tuesday	Wednesday	Thursday	Friday
Lighting Hours of Operation:					

[ASK IF C6C5=2]

C9. What is the new regular (i.e. not holiday or weekend) manual switching schedule or the installed lighting after the retrofit? [RECORD RESPONSE]

Business Days:	Monday	Tuesday	Wednesday	Thursday	Friday
Lighting Hours of Operation:					

C10. How are the installed lights controlled on holidays/weekends/unoccupied periods after the retrofit? [RECORD RESPONSE]

Non-business Days:	Saturday	Sunday	Holidays	Unoccupied Periods
Lighting Hours of Operation:				

C11. Is the operating schedule discussed above same during summer and winter?

1. (Yes)
2. (No)
3. (Don't know)

[ASK IF C11=2]

C12. How is the lighting operating schedule different between the two seasons?
[RECORD RESPONSE]

C13. Which holidays are observed during the year?
[RECORD RESPONSE]

C14. Are there occupancy-based or daylighting controls now?
1. (Yes)
2. (No)
98. (Don't know)
99. (Refused)

C15. Were there occupancy-based or daylighting controls prior to the retrofit?
1. (Yes)
2. (No)
98. (Don't know)
99. (Refused)

[REPEAT QUESTIONS B2 THROUGH C15 FOR THE NEXT INSTALLED MEASURE]

D. *Heating and Cooling (3 minutes)*

Finally, I have just a few more questions about the building type and the heating and cooling system in the location where the lighting was installed.

[REPEAT QUESTIONS D1 THROUGH D9 FOR EACH INSTALLED MEASURE LOCATION]

D1. PLEASE CONFIRM THAT THE BUILDING WHERE THE [INSTALLED MEASURE SUMMARY DESCRIPTION] IS INSTALLED IS A [BUILDING TYPE]:
1. (Yes)
2. (No)
    D1a. What is the correct building type? [RECORD RESPONSE]
3. (Don't know)
99. (Refused)

D2. Is the space where the fixtures are located heated?
1. (Yes)
2. (No)
98. (Don't know)
99. (Refused)

[ASK IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

D3. Do you have any information about the heating system in the location where the lighting is installed?

1. (Yes)
2. (No) [SKIP TO D6]

[ASK IF D2=1]

D4. What kind of heating system is used?

1. Heat Pump
2. Central or local boiler
3. Electric Heat
4. Local furnace
5. Rooftop Unit gas packs
6. Other system, specify: [RECORD RESPONSE]

98. (Don't know)
99. (Refused)

[ASK IF **D4** =1, 2, 3, 4, 5, 6]

D5. What is the nominal efficiency of the heating system?
[RECORD RESPONSE]

D6. Is the space where the fixtures are located <u>cooled</u>?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

[ASK IF INTERVIEWEE IS A CONTRACTOR/INSTALLER]

D7. Do you have any information about the cooling system in the location where the lighting was installed?

1. (Yes)
2. (No) [SKIP BACK TO D1 FOR THE NEXT INSTALLED MEASURE LOCATION OR TO E1 IF NO OTHER INSTALLED MEASURE LOCATION]

[ASK IF D6=1]

D8. What kind of cooling system is used?

1. Direct Expansion
2. Heat pump
3. Central chiller
4. Other system, specify: [RECORD RESPONSE]
98. (Don't know)
99. (Refused)

[ASK IF D6=1]

D9. Are there air side economizers?

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

[REPEAT QUESTIONS D1 THROUGH D9 FOR THE NEXT INSTALLED MEASURE LOCATION]

E. Closing

E1. That concludes my questions, thank you very much for your time!

Appendix G. Site M&V Reports – Full Customer Detail

Site ID 1

Compressed Air (13-1497255): M&V Report

March 15, 2016

Duke Energy Indiana
139 East Fourth Street
Cincinnati, OH 45201

Prepared by:
Dave Korn
Christie Amero
Ari Jackson

Cadmus

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Introduction

This report addresses M&V activities for one retrofit ECM as part of the [redacted] Smart $aver custom incentive program application; specifically for the replacement of two 300 hp load/unload air compressors with one 300 hp VFD air compressor. Energy savings are expected to result from (a) increased capacity of the new compressor, which eliminates the need for second compressor, and (b) VFD control, which reduces power demand during part load conditions.

The following facility and measure description are based on the original project documentation.

ECM-1—Replace Load/Unload Air Compressors with VFD Air Compressor

Pre-Retrofit: The pre-retrofit equipment consisted of two single-stage Ingersoll Rand XFE300 300 hp, 1,500 CFM load/unload air compressors. One of the compressors operated as the trim compressor.

The compressors operated 24/7, year-round. Based on a compressed air study performed by Ingersoll Rand, the facility's average compressed air flow demand was 814 CFM and average discharge air pressure was 94 psig.

Installed: The installed case is one two-stage Ingersoll Rand R225NE-100W 300 hp, 1,625 CFM VFD air compressor, as well as one new Ingersoll Rand NVC1600, 460V water-cooled refrigerated air dryer for the VFD compressor.

The existing load/unload compressors were left on the site as back-ups.

The majority of the energy savings will come from right-sizing the compressed air system to the facility's average demand.

Goals and Objectives

Table 1 shows projected savings goals identified in the project application.

Table 1. Project Goals

Applicant		Duke Energy			
Annual kWh Savings	Avg. Demand Reduction, kW	Projected Annual kWh Savings*	Claimed Annual kWh Savings	Claimed Coincident Peak kW Reduction	Claimed Non-CP kW Reduction
812,052	N/A	812,052	812,037	92.7	92.7

*Source: DSMore Input spreadsheet.

The M&V project sought to verify actual numbers for the following:

- Facility peak demand (kW) reduction
- Summer utility coincident peak demand (kW) reduction

- Annual energy (kWh) savings
- Annual realization ratios (kW and kWh)

Project Contacts

The Duke Energy contact listed in Table 2 below granted approval to plan and schedule the site visit for this M&V effort.

Table 2. Project Contacts

Organization	Contact	Contact Information
Duke Energy	Frankie Diersing	p: 513-287-4096 frankie.diersing@duke-energy.com
Cadmus	Christie Amero	p: 303-389-2509 christie.amero@cadmusgroup.com
Customer	[redacted]	[redacted]

Site Location/ECM Location

Address	ECM
[redacted]	1

M&V Option

IPMVP Option A.

Implementation

Cadmus reached out to the site contact provided by Duke Energy to discuss the M&V plan and schedule the site visit.

The site visit was performed on January 27, 2016. Christie Amero and Tom Davis of Cadmus attended the metering site visit.

Field Notes

While on site, Cadmus verified the facility's operating hours and shut down periods, recorded operating pressure, collected nameplate information, and installed power meters on the installed VFD air compressor and the associated two dryers.

The site contact explained that that the site has increased operating hours to two shifts, or 24/7, due to product orders. The site installed two Ingersoll Rand air compressors as part of this retrofit project, but the second compressor acts as a backup only.

The system maintains a discharge air pressure of 95 psi. The air compressor minimum VFD speed is 40%.

Two air dryers serve the compressed air system and operate simultaneously.

Field Data

Figure 1 shows the Ingersoll Rand 300 hp VFD air compressor and Figure 2 shows the compressor's control panel with real-time discharge air pressure and percent capacity. Figure 3 shows the nameplate for the installed 300 hp VFD air compressor.

Figure 1. 300 hp VFD Air Compressor

Figure 2. Air Compressor Control Panel – Discharge Pressure and % Capacity

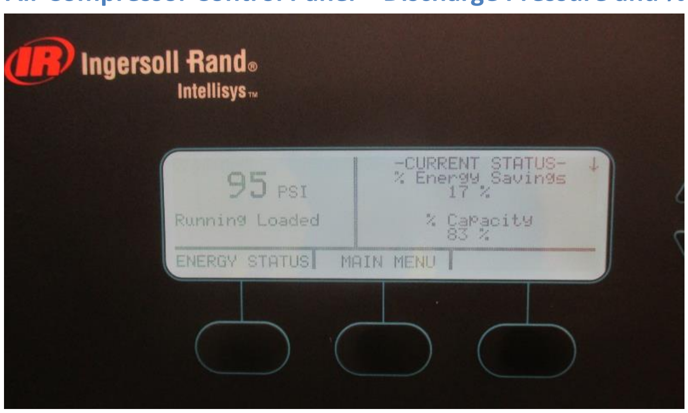


Figure 3. 300 hp VFD Air Compressor Nameplate

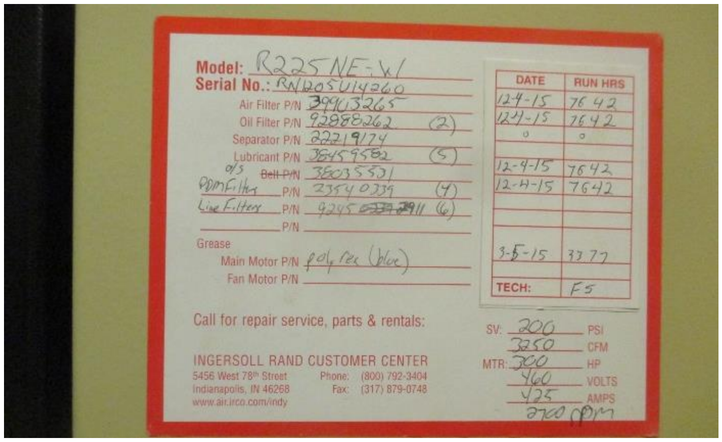


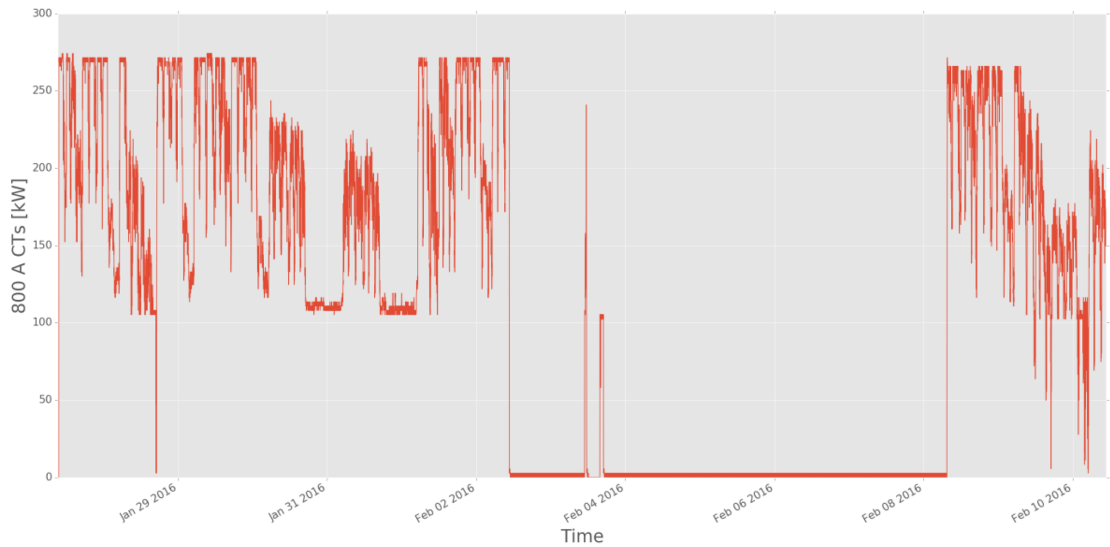
Table 3 summarizes the installed metering equipment and Figure shows the power meter installation for the 300 hp air compressor. Figure 5 shows a plot of the air compressor's demand and operating hours during the metering period.

Table 3. Summary of Installed Metering Equipment

Equipment ID	RX3000	WattNode 3D-480	Current Transducers (Qty/Size)
Comp-1	1	1	3 / 400 A
Dryer-1	1	1	3 / 100 A
Dryer-2		1	3 / 100 A

Figure 4. 300 hp Air Compressor Meter Installation

Figure 5. Air Compressor Power Consumption



Data Accuracy

Table 4. Metering Equipment Accuracy

Measurement	Sensor	Accuracy	Notes
Current	Magnelab CT	±1%	Recorded load must be < 130% and > 10% of CT rating
kW	Wattnode Power Meter	±1%	

Data Analysis

Cadmus used the post-installation metered demand data for the air compressor and dryers to verify the power demand and operating hours.

The post-installation power demand calculated in the initial analysis assumed the airflow of 814 CFM used in the baseline calculation would not change. Then, using CAGI data, a total power was calculated by weighting the rated demand of 134.9 kW at 854.6 CFM for a demand of 129.5 kW. This value is 64.5 kW lower than what the metered data collected by Cadmus showed, which was an average 193 kW during periods when the compressor was operational. This discrepancy indicated the compressor was not operating as initially assumed, and as a result the post-installation power consumption used in the savings calculations is 193 kW.

The baseline demand comes from the one week of metering Ingersoll Rand preformed prior to the installation of replacement air compressor. During that metering period, the average power draw was 227.6 kW and the average capacity was 814 CFM; the compressor operation was continuous and showed low variability. To bolster the 270.4 kW baseline used in the original analysis, the average airflow can be combine with the manufacturer's specifications to calculate what could also serve as the pre-installation demand. Taking rated total power and capacity from CAGI and looking up the percent power usage based on a load/unload, 1 gal/CFM compressor operating at 60% load (814 CFM/ 1,395 CFM), the power demand is 229.8 kW, which is within 1% of measured baseline.

Conclusion

The post-installation data collected by Cadmus showed that the 300-hp VFD air compressor had a higher demand on average then was assumed in the original study. The annual energy savings realization rate compared to Duke Energy claimed was 37% and the demand reduction realization rate was 37%.

Table 5 compares the applicant, Duke Energy claimed, and evaluation energy savings and demand reduction.

Table 5. Comparison of Applicant, Duke Energy claimed, and Evaluated Savings

Applicant		Duke Energy Claimed			Evaluation		Realization Rates	
Annual kWh Savings	Avg. kW Reduction	Annual kWh Savings	CP kW Reduction	Non-CP kW Reduction	kWh Savings	kW Reduction	kWh Savings, %	kW Reduction, %
812,052	N/A	812,037	92.7	92.7	303,096	34.6	37%	37%

Site ID 2 Process (14-1652252): M&V Report

March 15, 2016

Duke Energy Indiana
139 East Fourth Street
Cincinnati, OH 45201

Prepared by:
Dave Korn
Christie Amero
Ari Jackson

Cadmus

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Introduction

This report addresses the installation of a new, high-efficiency, blow molding machine for the bottle production line as part of [redacted] Smart $aver custom incentive program application. The machine is expected to produce ~36,000 energy drink bottles per hour. Anticipated energy savings derived from reduced compressed air demand from an efficient blow molder and reduced electric demand from the machine's internal heating elements.

The following facility and equipment descriptions are based on the original project documentation.

The high-pressure, compressed air system consists of four centrifugal compressors and six reciprocating compressors, and the low-pressure system consists of six centrifugal compressors and two scroll compressors.

ECM-1—High-Efficiency Blow Molding Machine

Pre-Retrofit: The pre-retrofit molding machine was a Sidel SBO-24/26 HR, operating ~5,000 hours per year at a rate of 1,050 bottles per minute. According to the original energy study, the machine had electric demand of 238 kW and consumed nominal 600 psi high-pressure compressed air (actually set to 480 psi at the machine) and ~125 psi low-pressure compressed air.

Installed: The installed molding machine—a Sidel SBO-20/22HR Matrix L—includes the following energy-reducing options:

- Heat recovery unit for precise oven temperature control
- Two-stage air recovery system (AirEco2) to reduce high-pressure air consumption
- High-pressure air internal air recovery (does not require a separate low-pressure air input)
- High-performance air blower

Based on the equipment invoice and discussions with the plant manager, Cadmus verified that the machine includes an AirEco2 package. Manufacturer's specifications for the 40,000 bottles/hour machine with an AirEco2 package are 1,370 Nm^3/hour[1] of high-pressure compressed air (according to a brochure in the file materials). The plant manager's materials from the maker show projected use of 1,404 NM3/hour—similar to but 2% higher than the file materials.

Table 1 (from the project's files) compares the pre-retrofit and installed machines' operating parameters to meet the same total yearly production. Items highlighted in yellow changed after metering and verification.

[1] An Nm3/hour is a normal cubic meter per hour and is a standard European measurement used by the French maker of the blow molding machine. It equals roughly 0.59 CFM, the standard U.S. unit of measurement.

Table 1. Comparison of Pre-Retrofit and Installed Operating Parameters

Machine Parameters	Unit	Pre-Retrofit SBO-24/26HR	Installed SBO-20/22HR	Difference
Speed	bpm	720	600	-53
Speed	bph	43,200	36,000	-7,200
Number of Molds on SBO	N	24	20	-4
Bottle Weight	Gr	36	32	-4
Bottle Capacity	Oz	20	20	0
Working Time / Year	Hrs	5,167	6,200	1,033
Bottles per Year	bpy	223,214,400	223,214,400	0
Machine Electrical Requirements*	kW	238	184*	-54*
Machine hp Air Consumption*	Nm3/h	3,000	1,323*	-1,677*
Machine LP Air Consumption	Nm3/h	247	0	-247

*Parameters changed after metering and verification.

According to the original energy study, the installed machine has an electric demand of 140 kW, consumes 966 Nm^3/hour of high-pressure compressed air, and does not require additional low-pressure compressed air.

Projected Savings

Table 2 presents projected savings goals, identified in the project application.

Table 2. Project Goals

Applicant		Duke Energy			
Annual kWh Savings	Avg. Demand Reduction, kW	Projected Annual kWh Savings*	Claimed Annual kWh Savings	Claimed Coincident Peak kW Reduction	Claimed Non-CP kW Reduction
3,420,000	N/A	1,888,092	1,886,056	215.3	215.2

*Source: DSMore Input spreadsheet.

The M&V project objectives included verifying actual numbers for the following:

- Facility peak demand (kW) reduction
- Summer utility coincident peak demand (kW) reduction
- Annual energy (kWh) savings
- Annual realization ratios (kWh and kW)

Project Contacts

The Duke Energy contact listed in Table 3 granted approval to plan and schedule the site visit for this M&V effort.

Table 3. Project Contacts

Organization	Contact	Contact Information
Duke Energy	Frankie Diersing	p: 513-287-4096 frankie.diersing@duke-energy.com
Cadmus	Christie Amero	p: 303-389-2509 christie.amero@cadmusgroup.com
Customer	[redacted]	[redacted]

M&V Option

IPMVP Option A.

Implementation

Cadmus reached out to the site contact (provided by Duke Energy) to review the M&V plan and to schedule the site visit. The metering site visit was performed on January 29, 2016. Dave Korn of Cadmus attended the site visit.

Field Notes

David Korn of Cadmus discussed several items with the plant manager after the site visit, including:

- The unexpectedly high compressed air consumption (2,200 vs 1,370 Nm^3/hour); and
- The operation of the machine during the metering period.

The plant manager agreed that the 2,200 Nm^3 value was curiously high and expressed some uncertainly over the installed sensors' accuracy. He checked the Sidel machine's reading and found a constant reading of 1,810 Nm^3/hour and a value of 15 Nm^3/hour, recycled to the plant's system for a net value of 1,795 Nm^3/hour. He also noted that the machine may have a "stoker" that positions the bottles and consumes compressed air. Because the plant manager started after installation of the new machine, it was not possible to determine whether the older machine had a similar add-on.

The plant manager indicated that the plant tested some prototype bottles during the metering period, a likely reason for the periodic reduction of power usage (down to 20 kW). These periods were removed from the analysis to not artificially reduce the post-installation consumption values.

The site manager also provided a list of the air compressors and dryers used to serve the high and low pressure air systems (Tables 4, 5, and 6). The compressors are not tied to the process machines but rather serve a header as a group.

Table 4. List of High Pressure Compressors

Equipment #	Manufacturer	Type	Model	HP	KW	PSI	CFM	RPM	Year
Centac 1	Ingersoll Rand	Centrifugal	IACV18M2	450	336	125	1752	3575	1994
Centac 2	Ingersoll Rand	Centrifugal	IACV18M2	450	336	125	1752	3575	1994
Centac 3	Ingersoll Rand	Centrifugal	IACV18M2	450	336	125	1752	3575	1994
Centac 4	Ingersoll Rand	Centrifugal	IACV18M2	450	336	125	1507	3574	1992
Centac 5	Ingersoll Rand	Centrifugal	2CII45M3	1500	1119	180	6500	3575	1984
Centac 6	Ingersoll Rand	Centrifugal	2CV35M3	800	597	150	3174	3575	2004
Sierra	Sierra	Scroll	HH250W	250	187	150	837		2000
Kobelco	Kobelco	Scroll	KNW2-DH or X	400	299	150	1480		2008

Table 5. List of Low Pressure Compressors

Equipment #	Manufacturer	Type	Model	HP	KW	PSI	CFM	RPM	Year
Centac 7	Ingersoll Rand	Centrifugal	L/C75021M4HPEXT	1000	850	610	2050	3575	2005
Centac 8	Ingersoll Rand	Centrifugal	L/C75021M4HPEXT	1000	850	610	2050	3575	2005
Centac 9	Ingersoll Rand	Centrifugal	L/C75021M4HPEXT	1000	850	584	2050	3575	2006
Centac 10	Ingersoll Rand	Centrifugal	LC105038M4	1500	1150	580	3791	3575	2006
PHE 1	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	350	261	650	1350	325	1994
PHE 2	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	350	261	650	1350	325	1994
PHE 3	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	350	261	650	1350	325	1995
PHE 4	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	350	261	650	1350	325	1992
PHE 5	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	400	298	600	2300	506	2002
PHE 6	Ingersoll Rand	RECIPROCAL	9 & 6 X 9 PHE-NL	400	298	600	2300	506	2002

Table 6. List of Air Dryers

Equipment #	Manufacturer	COMPRESSOR	Model	AMPS	KW	PSI	CFM	REFRIG
DRYER 1	Ingersoll Rand		TZB5600EMS	182	151	N/A	5600	N/A
DRYER 2	Ingersoll Rand		TZB5600EMS	182	151	N/A	5600	N/A
DRYER 3	Ingersoll Rand		TZB5600EMS	182	151	N/A	5600	N/A
DRYER 4	Ingersoll Rand		TZB5600EMS	182	151	N/A	5600	N/A
DRYER 5	Ingersoll Rand	Centac 5	TZB3700-3V	113		N/A	N/A	N/A
DRYER 6	Ingersoll Rand		TZB2700-EMS	77		N/A	N/A	N/A
DRYER 7	Ingersoll Rand		HC-21-650			N/A	N/A	N/A
DRYER 8	Ingersoll Rand		HC-21-650			N/A	N/A	N/A
DRYER 9	Ingersoll Rand	Centac 9	HPS2000W			700	2000	404A
DRYER 10	Ingersoll Rand	Centac 10	PET4000-W4-CC	40		610	4000	404A

Field Data

Cadmus recorded machine energy use at one-minute intervals for two weeks, yielding both kWh and kW values. Table 7 summarizes the logging equipment installed during the site visit.

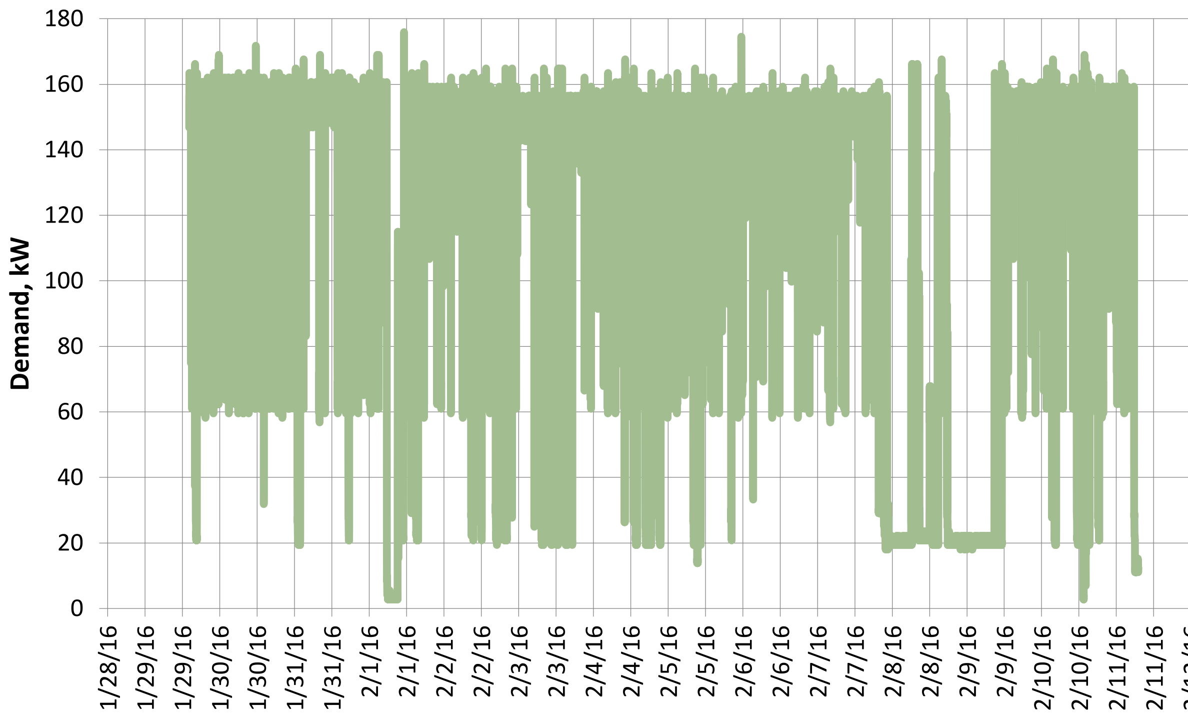
Table 7. Summary of Installed Metering Equipment

Equipment ID	RX3000	WattNode 3D-480	Current Transducers (Qty/Size)
Blow Molding Press	1	1	3 / 200A

During the metering period, the machine operated at an average of 142 kW, with peak readings at roughly 160 kW, and lower cycled values of about 60 kW, with some lower readings (that were removed).

The SCADA systems showed compressed air consumption of 2,200 Nm^3/hour during an observed period of about 10 minutes. The site did not currently have trends set up for the data requested. The compressed air pressure was 490 psi upstream of the filters. Figure 1 summarizes the power metering data for the blow molding machine.

Figure 1. Power Metering of Sidel Machine, Starting January 29



Data Accuracy

Table 8. Metering Equipment Accuracy

Measurement	Sensor	Accuracy	Notes
Current	Magnelab CT	±1%	Recorded load must be < 130% and > 10% of CT rating
Power	Watt Node	±1%	

Data Analysis

Cadmus used the power metered data to verify the power demand and operating hours of the installed injection molding machine. There are three components that contribute to energy savings, described in the sections below.

Machine Electric Demand

Based on the metered average electric power demand of 142 kW for the installed machine and a reported pre-retrofit electric power demand of 238 kW, the average power reduction was 96 kW:

Demand Savings (kW) = (kW_{pre}) – (kW_{post})

Demand Savings (kW) = (238kW) – (142kW) = 96 kW

Annual energy savings were calculated as follows:

Energy Consumption Savings (kWh) = (kW_{pre} * Annual EFLH $_{pre}$) – (kW_{post} * Annual EFLH $_{post}$)

Energy Consumption Savings (kWh) = (238 kW * 5,167) – (142 kW * 6,200) = 349,346

Where:

kW_{pre} = From application

$EFLH_{pre}$ = Equivalent full-load operating hours based on annual production and base hourly production

kW_{post} = Determined by metering 1/29 – 2/15

$EFLH_{post}$ = Equivalent full-load operating hours based on discussion with H. Patel on 2/25/16

Low-Pressure Compressed Air

The second component of energy savings came from reduction in the use of compressed air. Based on eliminating a flow of 247 Nm^3/hour through compressed air recovery and a compressor performance of 0.20 kW/CFM, the demand reduction is 29 kW and the annual energy savings are ~149,000 kWh.

High-Pressure Compressed Air

Based on eliminating a flow of 1,205 Nm^3/hour through compressed air recovery and a compressor performance of 0.40 kW/CFM for high compression (allowing for some energy use in the dryer, losses, and part load operation), the demand reduction and energy savings are 283 kW and 1,024,946 kWh, respectively.

Energy Savings Summary

The total evaluated demand reduction and energy savings for this measure are 408 kW and 1,524,031 kWh, respectively, as shown in Table 9. Total savings are combined savings from the installed machine's more efficient electrical power consumption, elimination of low-pressure compressed air usage, and reduction of high-pressure compressed air usage.

Table 9. Evaluated Savings Calculations Based on Observed and Metered Values

Parameter	Pre	Post	Difference	Notes
Speed, bhp	43,200	36,000		Speed limited by other machines will rise to 40,000, increasing savings.
Operating Hours / Year	5,167	6,200	(1,033)	Derived based on the same production.
Bottles / Year	223,214,400	223,214,400	-	Application.
Machine Electrical Demand, kW	238	142	96	Pre is application, post is metering.
Machine hp Air Consump., Nm3/h	3,000	1,795	1,205	Pre is application, post is SCADA.
Machine LP Air Consump., Nm3/h	247	-	247	Application and site visit.
Machine Energy Use, kWh	1,229,746	880,457	349,289	Calculated.
High-Press. Air Demand, kW	703	421	283	Calculated from compressed air.
High-Press. Air Energy Use, kWh	3,634,562	2,609,616	1,024,946	Calculated.
Low-Press. Air Demand, kW	29.0	-	29	Calculated from compressed air.
Low-Press. Air Energy Use, kWh	149,795	-	149,795	Calculated.
Total Installed Demand, kW			**408**	Calculated.
Total Installed Energy Use, kWh			**1,524,031**	Calculated.

Conclusion

Overall, demand reduction was higher than anticipated, but energy savings were 80% of projected savings. Several factors resulted in the lower energy savings:

- The high-pressure compressed air usage was indicated at 1,323 Nm^3/hour to 1,404 Nm^3/hour in the Sidel literature, but the observed consumption from the machines SCADA was 1,795 Nm^3/hour, about 36% higher than the value in the application and a reduction of about 75% of planned values. Evaluated savings were slightly higher than this percentage because Cadmus used a slightly higher kW/CFM factor, based on CAGI data, and because savings from the Sidel machine were higher, based upon metering. If the value of 1,795 Nm^3/hour is inserted into the application calculations, annual energy savings identical to the evaluated energy savings are produced.
- The machine purchased is capable of 40,000 bottles per hour but is limited by ancillary equipment to 36,000 bottes/hour at present. [redacted] indicates that it plans to increase future production to 40,000 bottles/hour. This increase may possibly provide additional energy savings but only if the increase in production is greater than increased energy use.

Table 10 provides a comparison of the energy savings and demand reduction submitted in the original application, Duke Energy's claimed, and the evaluated savings. Table 11 provides a summary of the evaluated realization rates compared to Duke Energy's claimed savings.

Table 10. Summary of Application, Duke Energy Claimed, and Evaluated Savings

Applicant	Duke Energy Claimed			Evaluation		
Annual kWh Savings	Annual kWh Savings	CP kW Reduction	Non-CP kW Reduction	Annual kWh Savings	CP kW Reduction	Non-CP kW Reduction
3,420,000	1,886,056	215.3	215.2	1,524,031	407.5	407.5

Table 11. Evaluated Realization Rates Compared to Duke Energy Claimed

Annual kWh Savings, %	CP kW Reduction, %	Non-CP kW Reduction, %
80.8%	189.3%	189.4%

Site ID 3 (13-1306646)
Lighting Replacement
M&V Report

Prepared for
Duke Energy Indiana

April 2014 V2.0
Revised February 2016 V2.1

This project has been randomly selected from the list of applications for which incentive agreements have been authorized under Duke Energy's Smart $aver® Custom Incentive Program.

The M&V activities described here are undertaken by an independent third-party evaluator of the Smart $aver® Custom Incentive Program.

Findings and conclusions of these activities shall have absolutely no impact on the agreed upon incentive between Duke Energy and the program participant.

Submitted by:

Doug Dougherty
Architectural Energy Corporation

Stuart Waterbury
Architectural Energy Corporation

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Boulder CO
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ARCHITECTURAL ENERGY CORPORATION

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On February 9, 2016 Cadmus reviewed this M&V report in preparation for final draft EM&V program evaluation report. Cadmus revised the Duke Energy projected savings under Goals and Objectives, and in Table 3 to reflect the correct projected savings found in Duke Energy's program tracking database. Cadmus revised the realization rates in Table 3 accordingly.

[redacted] (13-1306646)	**Erroneous Duke Energy Projected Savings (in April 2014 v2.0 draft)**	**Corrected Duke Projected Savings (in current February 2016 v2.1 draft)**
Energy (kWh)	1,974,642	3,058,934
Demand (kW)	225	349.0
Coincident Peak Demand (kW)	225	349.2

Introduction

This document addresses M&V activities and results for the new lighting fixtures at [redacted].

The measures include:

- ECM-1: Retrofit (1445) 400 W MH fixtures with 6L T8 fixtures.

Goals and Objectives

The projected savings goals identified in the application and by Duke Energy are:

Application Proposed Annual Energy Savings (kWh)	Application Proposed Peak Demand Savings (kW)	Duke Projected Energy Savings (kWh)	Duke Projected Peak Demand Savings (kW)
2,151,849	246	3,058,934	349

The objectives of this M&V project were to:

- Verify installed fixture information and operating hours
- Obtain baseline (replaced) fixture information and operating hours
- Obtain information about the building HVAC system
- Verify annual gross energy (kWh) savings
- Verify summer peak demand (kW) savings
- Determine kWh & kW Realization Rates.

Project Contacts

Duke Energy M&V Coordinator	Frankie Diersing	513-287-4096	
Customer Contact	[redacted]		
AEC Contact	Doug Dougherty	303-459-7416	ddougherty@archenergy.com

Site Locations/ECM's

Address

[redacted]

Data Products and Project Output

- Post retrofit survey of lighting fixtures.
- Average post-retrofit lighting fixture load shapes.
- Equivalent Full Load Hours (HOURS) by day type (weekday/weekend).
- Summer peak demand savings.
- Summer utility coincident peak demand savings.
- Annual Energy Savings.

M&V Option

IPMVP Option A

M&V Implementation Schedule

- Post-retrofit data was collected.
- Survey data was collected during normal operating hours (including holidays).

Field Data Points

Post – installation

Contacted Customer via Phone

- Indicated to the customer that there are three parts to the M&V process (details below):
    - Customer Interview
    - Field Lighting Survey
    - Logger Deployment
- Customer Interview was conducted on-site.
- Agreed on a time to perform the work. Logger deployment was scheduled during a time when the facility was expected to operate under normal conditions.

Customer Interview

- What types of fixtures, lamps, and ballasts were replaced?
  ___________400-Watt metal halide fixtures____
  ____
  ____

- Do you have any information about the replaced fixtures (plans, specifications, cut sheets on file, spare parts still in inventory)? Are there any similar fixtures still in operation not part of the rebated project?

___________Not available____
____
____

- How are the lights controlled on Holidays? Which holidays are observed during the year?

___________ Manually turned off ____
___________ Assumed eight holidays ____
____

- What was the switching schedule prior to the retrofit and what is the new switching schedule?
    - Is (was) there an automatic timeclock? (YES / NO)
        - If yes what are (were) the on/off time settings?
          ___________No____
          ____
        - If no, when are (were) the lights switched on and off?
          ___________N/A____
          ____
- Are there occupancy sensors now? (YES / NO) NO
- Were there occupancy sensors before? (YES / NO) NO
- Is the space where the fixtures are located heated and/or cooled?
    - Heated (YES / NO) YES
    - Cooled (YES / NO) YES

  If the space is cooled, what kind of cooling system is used?
    - Economizer (Y/N)
    - DX
    - Heat Pump
    - Central chiller YES
- What is the heating system fuel?
    - Gas / Oil GAS
    - Electricity

Field Lighting Survey

- Verified that all pre (existing) fixtures were removed
- Confirmed the new fixtures were installed. (A complete count was not performed.)
- Confirmed that the new fixtures, lamps and ballasts correspond to the application.

Logger Deployment

Hobo current loggers were used.

Selected Sample

- Randomly selected three lighting circuits representing control zones serving the new lighting. A control zone is any group of fixtures that is switched in unison with a manual switch or automatically switched via a device, relay, contactor, breaker, or occupancy sensor. Control zones may also be groups of switched zones which are controlled simultaneously.

Data Accuracy

Measurement	Sensor	Accuracy
Current	CTV-A 20A	±4.5%

Field Data Logging

The following table summarizes all the logging equipment needed to accurately measure the above noted ECM's:

ECM	**Hobo (U12)**	**CTV-A 20A**
1	1	3

<u>Hobo current loggers</u>

- Installed one CT on each of the randomly selected circuits.
- Spot measured the lighting load connected to the circuit by measuring the kW load and current draw of the circuit during the post-retrofit survey. Each lighting load circuit had only one fixture type on the circuit. Recorded the logger current readings in addition to the measurements from the portable power meter to ensure an accurate scale factor.
- Set up loggers for 5 minute instantaneous readings and allowed loggers to operate for a minimum period of three weeks.
- Record the logger installation information in an Excel spreadsheet.
- Determined how lighting is controlled.

Data Analysis

- Used the standard calculation template for estimating pre and post demand and energy consumption that incorporates the methodology described below.
- From survey data, calculated the actual pre and post fixture kW.

- Weighted the time-series data according to connected load per control point. Methodology included in analysis worksheet.
- From time-series data, determined the actual schedule of post operation.

$$LF(t) = \frac{\sum_{i=1}^{N_{Logged}} \left(Current_{ControlPoint_i} * ScaleFactor_i\right)}{\sum_{i=1}^{N_{Logged}} kWControlPoint_i}$$

$$kW_{Lighting}(t) = LF(t) * \sum_{i=1}^{N_{ControlPoints}} kWControlPoint_i$$

Where

LF(t) = Lighting Load factor at time = t
$kWControlPoint_i$ = connected load of control point i
$CurrentControlPoint_i$ = logged current at control point i from time series data
$ScaleFactor_i$ = Convert logged current to kW
NLogged = population of logged control points
NControlPoints = population of all control points

- Created separate schedules for weekdays and weekends using LF(t).
- Tabulated average operating hours by day-type (e.g. weekday and weekend).
- Tabulated average equivalent full load operating hours by day-type (e.g. weekday and weekend)
- Equivalent full load operating hours for each day type were calculated from the time-series LF by averaging the daily average load factor for each day type (0 to 100 percent), and then converting that to an equivalent number of daily operating hours (0-24 hours).
- Extrapolated annual operating hours from the recorded hours of use by day-type.
- Generated the post-retrofit load shape by plotting surveyed fixture kW against the actual schedule of post-retrofit operation for each day-type.
- Calculated pre-retrofit annual operating hours using the adjusted schedules by day-type and extrapolating to the full year.
- Calculated energy savings and compared to project application:

$$kWh_{savings} = (N_{Fixtures} * kW_{Fixture} * HOURS)_{PRE} - (N_{Fixtures} * kW_{Fixture} * HOURS)_{Post}$$

$$NCP\ kW_{savings} = (N_{Fixtures} * kW_{Fixture})_{PRE} - (N_{Fixtures} * kW_{Fixture})_{Post}$$

$$CP\ kW_{savings} = NCP\ kW_{savings}\ x\ CF$$

- Waste heat factors were taken from the Indiana Technical Reference Manual[1], which provided waste heat factors by commercial building type, HVAC system and climate. The average value between Indianapolis and Ft Wayne for the lighting industrial building type with HVAC system type = "AC with gas heat" was used. The Savings with HVAC interactions are calculated from:

$$kWh_{savings\ with\ HVAC} = kWh_{savings}\ x\ (1 + WHFe)$$
$$kW_{savings\ with\ HVAC} = kW_{savings}\ x\ (1 + WHFd)$$

Verification and Quality Control

1. Visually inspected time series data for gaps
2. Compared readings to expected values; identified out of range data
3. Looked for physically impossible combinations.

Recording and Data Exchange Format

1. Hobo logger binary files
2. Excel spreadsheets

Results Summary

This project involved replacing (1445) 400-Watt metal halide lighting fixtures with the same quantity of 6-lamp T8 fluorescent fixtures. The new lighting fixtures draw 290 W of power, a savings of 168 W per fixture.

Several lighting circuits were monitored for a period of almost three weeks in order to determine the operating schedule. The application states that the lights are on 24/7. However, facility personnel stated that weekend lighting shutdowns were being tried since July 2013 to reduce operating costs. The monitored data clearly shows that the lights are indeed off for parts of the weekends. In addition, the lighting is also off for the Thanksgiving holiday (including the Friday after Thanksgiving).

[1] Indiana Technical Reference Manual Ver 1.0, Appendix B HVAC Interactive Effects Multipliers, Prepared by TecMarketWorks, January 10, 2013.

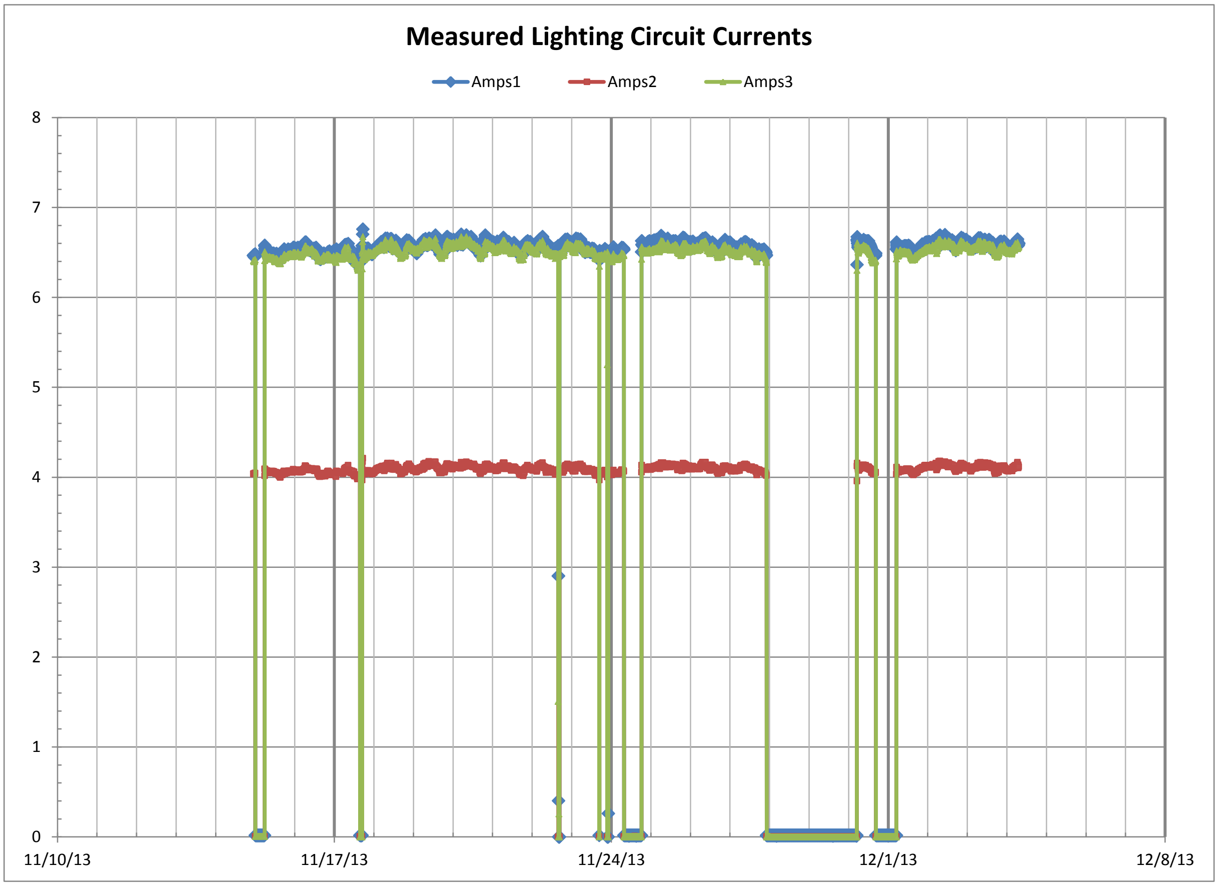

Figure 1: [redacted] Monitored Lighting Data

The following chart shows the average daily load shape that results from the above data for the circuits logged. (A holiday load shape is not shown, but it is all off.)

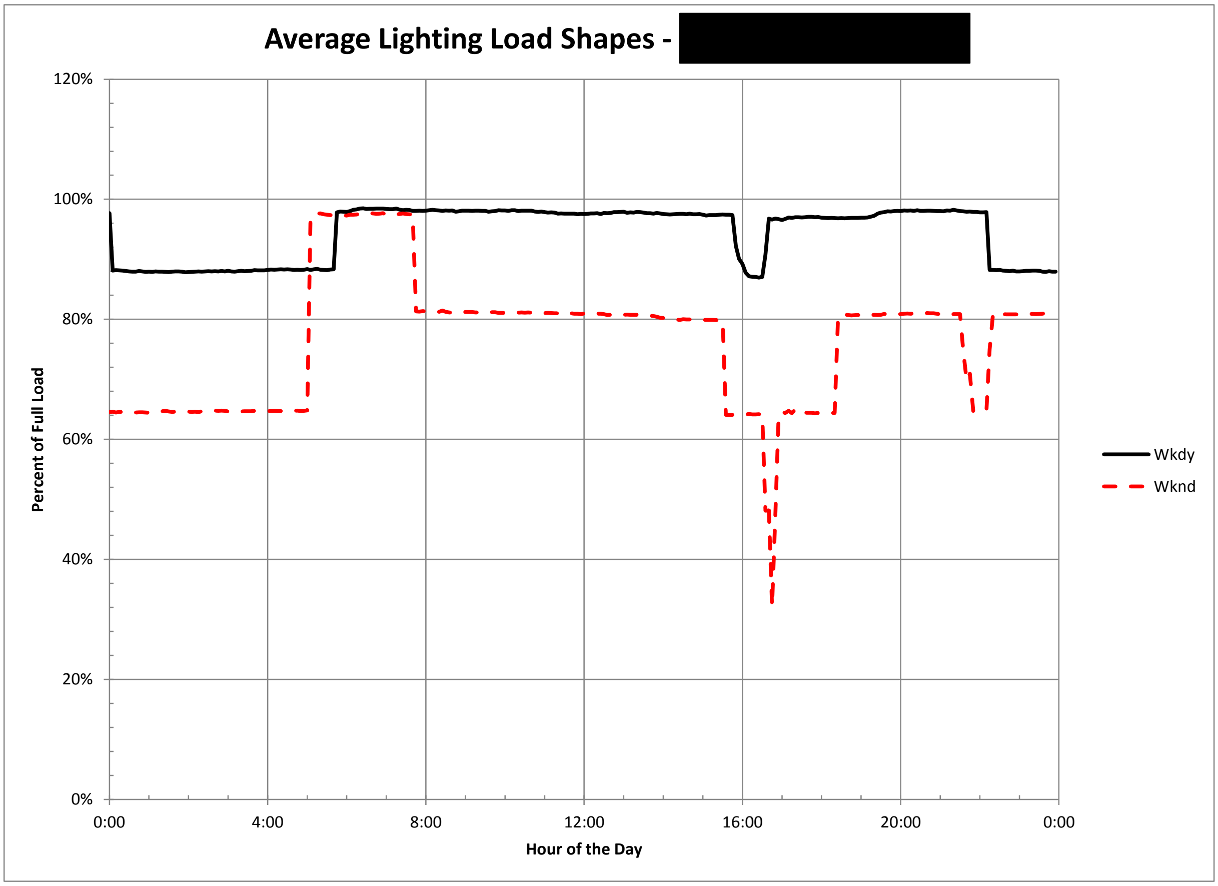

Figure 2: Average Daily Lighting Load Shapes

Applying the above load shapes to an annual load calculation gives the energy and demand savings shown below for the lighting retrofit at [redacted]. Since the plant is also cooled with a central chiller and air handling units, reducing the lighting load also saves some cooling energy and demand. An estimate of the cooling savings is included in the total savings.

Table 1: Projected Energy Savings

	Lighting	HVAC	Total
Pre-Retrofit Energy Usage (kWh/yr)	5,057,930		
Post-Retrofit Energy Usage (kWh/yr)	3,202,619		
Annual Energy Savings (kWh/yr)	1,855,311	157,701	**2,013,012**

Table 2: Projected Demand Savings

	Lighting	HVAC	Total
Pre-Retrofit Lighting Power (kW)	661.8		
Post-Retrofit Lighting Power (kW)	419.1		
Demand Savings (kW)	242.8	48.6	**291.3**
Coincident Peak Demand Savings (kW)	235.5	47.1	**282.6**

The energy and demand realization rates are presented in the following table. Although the lighting schedule has been reduced from round-the-clock operation, the energy savings are within 6% of the Duke projection. Coincident peak demand savings are 8% higher than expected. For Indiana in 2013, the coincident peak demand is the maximum demand that occurs in the 3-4 PM hour on weekdays (the lighting operation is not weather dependent).

Table 3: Savings Summary and Realization Rates

	Duke Projected Savings	Realized Savings		Realization Rates	
		Lighting Only	Lighting and HVAC	Lighting Only	Lighting and HVAC
Energy (kWh)	3,058,934	1,855,311	2,013,012	61%	66%
Demand (kW)	349.0	242.8	291.3	70%	83%
Coincident Peak Demand (kW)	349.2	235.5	282.6	67%	81%

The individual fixture watts assumptions and savings calculations are summarized in the following tables:

Table 4: Fixture Wattage Assumptions

ECM	EE Technology					Base Technology				
	Quantity	**EE Fixture Type**	**W/Fixture**	**Source**	**Connected kW**	Quantity	**Base Fixture Type**	**W/Fixture**	**Source**	**Connected kW**
1	1445	6L T8	290	Cut sheet	419.050	1445	400 W Metal Halide	458	IN TRM	661.810
Total					419.050					661.800

Notes:
IN TRM – Commercial lighting table from the Indiana Technical Resource Manual, Ver 1.0 12/5/12.

Table 5: Calculation Summary

				Lighting Only			With HVAC interactions WHFe= 0.085 WHFd= 0.2		
Base kW	EE kW	HOURS	CF	kWh savings	NCP kW	CP kW	kWh savings	NCP kW	CP kW
661.810	419.050	7642.6	0.97	1,855,311	242.8	235.5	2,013,012	291.3	282.6

Site ID 4 (12-167)
Air Compressor Controls Upgrade
M&V Report

Prepared for
Duke Energy Indiana

December 2014 v2.1

Note: This project has been randomly selected from the list of applications for which incentive agreements have been authorized under Duke Energy's Smart $aver® Custom Incentive Program.

The M&V activities described here are undertaken by an independent third-party evaluator of the Smart $aver® Custom Incentive Program.

Findings and conclusions of these activities shall have absolutely no impact on the agreed upon incentive between Duke Energy and [redacted].

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Introduction

This report addresses M&V activities for the [redacted] Compressor custom program application. The application covers an air compressor controls upgrade in [redacted]. From the application documentation, the measure includes the following:

ECM-1: Air Compressor Controls Upgrade on 5 Existing Compressors

- Pressure reduction
- Leak loss reduction
- Networked capacity control
- Centrifugal blow-off reduction
- Water valve savings

Goals and Objectives

The projected savings goals identified in the application are:

Duke Projected Annual Savings (kWh)	Duke Projected Non-Coincident Peak Savings (kW)	Duke Projected Coincident Peak Savings (kW)
2,530,204	288.7	288.8

The objective of this M&V project will be to verify the actual:

- Annual gross kWh savings
- Summer peak kW savings
- Summer Utility coincident peak demand savings
- kWh & kW Realization Rates

Project Contacts

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Customer Contact	[redacted]	[redacted]	[redacted]
Duke Energy M&V Coordinator	Frankie Diersing	Frankie.Diersing@duke-energy.com	o: 513-287-4096 c: 513-673-0573

Site Locations/ECM's

Address
[redacted]

Data Products and Project Output

- Average pre-replacement and post- replacement load shapes by day-type for controlled equipment
- Peak demand savings
- Coincident peak demand savings
- Annual energy savings

M&V Option

IPMVP Option A

M&V Implementation Schedule

- Surveyed site personnel to obtain information on pre-retrofit system operations.
  - Obtained the pre-retrofit sequence of operations and or operating schedule for the compressed air system.
  - Obtained the pre-retrofit operating pressure.
- Surveyed site personnel to obtain information on post-retrofit system operations.
  - Obtained and verified the post-retrofit sequence of operations and or operating schedule for the new compressed air system.
  - Noted any differences between pre- and post-retrofit operations resulting from changes in production or operating schedules.
  - Obtained the post-retrofit operating pressure.
  - Noted any difference between the pre- and post-retrofit operating pressure.
  - Obtained the facility’s holiday schedule.
  - Determined whether the facility has periodic or annual shut-downs for maintenance or other reasons.
- Collected data from the new Baywatch system on the new compressor. This data was used to determine post-retrofit load shapes and energy consumption.
  - Collected data during normal operating hours.
- Evaluated the energy savings of the new compressor operating system.

Field Data Points

Post – installation

Survey data (for all compressors)

- Compressor make/model/serial number

- Spot watt data could not be obtained because the compressors are all high voltage (4,160V and above).

Field Data Logging

Post – installation

All compressors are high voltage (4160 or greater). Because of this, monitoring equipment could not be installed. The new Baywatch system was used to trend the following points.

ECM-1

- Recorded compressed air delivered flow (CFM) and pressure.
- Recorded kW for each compressor
- Trends were collected at 15 second intervals for a total of 3 weeks.

Data Analysis

The overall savings for this set of measures can be expressed in the following set of equations.

$$kW_{pre} = \frac{kW_{post(measured)}}{\left(1 - \frac{PSI_{\%reduction}}{2}\right)\left(1 - F_{LLR}\right)\left(1 - F_{NCC}\right)}$$

Where: F_{LLR} (Leak Loss Reduction Factor) = 15% * $PSI_{\%\ reduction}$

F_{NCC} (Newtorked Capacity Control Factor) = 10%

The savings for the individual measures were estimated by the vendor using the following "chained" analysis, where the "baseline" is incremented for each measure, i.e., the savings for each measure uses the reduced electrical demand from the previous measure. The above equation was used to estimate the pre-retrofit demand, based on the measured post-retrofit demand and savings factors for each of the measures. The following equations and assumptions have been reviewed. No issues were identified, and the assumptions were considered reasonable.

- **Annual Precise Pressure Reduction (PPR):**

  The controller will maintain plant air pressure within a pressure window of ± 2 PSIG. The pressure window commonly permits a significant air pressure set-point reduction. At [redacted], the Normal Production shift's current nominal air pressure set-point is 106 PSIG. Existing controls are set artificially high to ensure that the pressure does not fall below 97 PSIG. The addition of the new controller on all operating compressors allows the pressure set-point to be 99-100 PSIG. Post retrofit data confirmed that the new system pressure is 100 PSIG, reducing the system pressure by 6 PSIG.

  - $PSI_{reduction} = PSI_{pre(application)} - PSI_{post(measured)}$

- $PSI_{\%reduction} = \frac{PSI_{reduction}}{PSI_{pre(application)}}$

- Adjust the post-retrofit demand and value for the change in system pressure by using the following equation:

$$\%kW_{(PPR)} = 0.01*\left(\frac{P_O - P_f}{2}\right) = 0.01*\left(\frac{106-100.78}{2}\right) = 2.61\%$$

Where: P_o = Initial System Pressure

P_f = Final System Pressure

Note: The Compressed air handbook from the National Resource Canada states: 1% change in kW per 2 psi change in system pressure.

$$\Delta kW_{(PRR)} = \%kW_{(PPR)} * kW_{(\mathrm{Pr}\,e)}$$
$$\Delta kWh_{(PRR)} = HOURS * \Delta kW_{(PRR)}$$

Where: $\Delta kW_{(PRR)}$ = demand savings using Precise Pressure Reduction control

$\Delta kWh_{(PRR)}$ = energy savings using Precise Pressure Reduction control

HOURS = annual operating hours

- **Annual Leak Loss Reduction (LRR):**

The plant air system unregulated leak flow rate was estimated by the vendor at 15% of highest CFM at the respective pressure. The amount of air flow that leaks from the plant air system is greatly influenced by pressure. Lowering the pressure set-point consequently lowers the leak rate. This would save energy due to lower CFM demand. During the M&V onsite survey, it was not possible to confirm the actual compressed air leakage rate, although the 15% estimate of leakage flow is a conservative estimate of leakage rates. Note that savings come only from pressure reduction. No actual leaks were sealed.

- $kW_{PPR} = kW_{pre} - kW_{savings(pressure-reduction)}$
- $\%Savings_{LLR} = PSI_{\%reduction} \times \%Leaks_{estimated}$
- $kW_{(LLR)} = (1 - \%Savings_{LLR}) \times kW_{PPR}$
- $\Delta kW_{LLR} = kW_{PPR} * \%Savings_{LLR}$

- $\Delta kWh_{(LLR)} = \Delta kW_{(LLR)} \times HOURS$

Where:

kW$_{PPR}$ = updated "baseline" demand after PPR measure

ΔkW$_{(LLR)}$ = demand savings after Leak Loss Reduction

ΔkWh$_{(LLR)}$ = energy savings after Leak Loss Reduction

HOURS = annual operating hours

- **Annual Networked Capacity Control (NCC):**

Prior to implementing the Networked Capacity Control, each compressor in the plant operated independently, frequently at reduced capacities. Whenever a compressor is running partially loaded there is a potential waste of energy. With a coordinated compressor control system, the waste associated with independent compressor control can be minimized.

Per Bay Controls, the system vendor, 10% energy reduction can be attributed to the use of NCC based on their experiences of system networking and the current conditions of the plant. By adding a system pressure manifold, all of the units will control to one central pressure reading location in the header.

- $kW_{NCC} = kW_{LLR} * (1 - \%_{energy-reduction(estimated)})$
- $\Delta kW_{(NCC)} = kW_{LLR} \times \%_{energy-reduction(estimated)}$
- $\Delta kWh_{(NCC)} = \Delta kW_{(NCC)} \times Hours_{operating}$

Where:

kW$_{LLR}$ = updated "baseline" demand after LLR measure

ΔkW$_{(NCC)}$ = demand savings with networked capacity control

ΔkW$_{(LLR)}$ = energy savings with networked capacity control

HOURS = annual operating hours

- **Annual Centrifugal Blow-off Reduction (CBR):**

In order to avoid surge, centrifugal compressors often blow off large quantities of air. The air blown off is a direct waste of energy. Energy is used to compress air which is never used by the plant. By operating the compressors in a coordinated fashion, the amount of blow-off can be eliminated.

Prior to the installation of these measures, a centrifugal blow-off time of 30% of the annual run hours was witnessed by the Bay engineer in the field at [redacted], as was the 600 HP @ 90% blow-off output.

- $Hours_{(CBR)} = \%_{Blow-Off-Time(CBR)} \times Hours_{operating}$
- $\Delta kW_{(CBR)} = hp_{(CBR)} \times \%_{blow-off-output} \times .746 \frac{kW}{hp}$
- $\Delta kWh_{(CBR)} = \Delta kW_{(CBR)} \times Hours_{(CBR)}$

Where: $\Delta kW_{(CBR)}$ = demand savings with centrifugal blow-off reduction

$\Delta kW_{(CBR)}$ = energy savings with centrifugal blow-off reduction

HOURS = annual operating hours

$HOURS_{(CBR)}$ = Hours of blow-off

- Compared calculated energy and coincident demand savings to Duke-projected savings and calculated the realization rates.

Verification and Quality Control

1. Visually inspected trend data for consistent operation. Looked for data out of range and data combinations that were physically impossible.
2. Verified pre-retrofit and post retrofit equipment specifications and quantities were consistent with the application.

Recording and Data Exchange Format

1. Baywatch system binary files
2. Excel spreadsheets

Results

Table 1. [redacted] Results

[redacted] Results			
	kWh	Non-coincident Peak (kW)	Coincident Peak (kW)
Pressure Reduction	568,402.8	64.9	64.9
Leak Loss Reduction	156,667.0	17.9	17.9
Networked Capacity Control	2,103,683.1	240.1	240.1
Centrifugal Blow-off Reduction	529,331.8	60.4	60.4
Realized Savings	3,358,084.7	383.3	383.3
Duke Estimated Savings	2,530,204.0	288.80	288.70
Realization Rate	132.72%	132.78%	132.7%

Table 2. Calculation Variables

[redacted] Variables		Source
NCC Improvement	10%	Assumed from application
Blow-off Reduction Improvement	50%	Assumed from application
Plant Leakage	15%	Assumed from application
Pre-retrofit Pressure	106	Assumed from application
Post-retrofit Pressure	100.78	M&V observation
Pressure Reduction	4.93%	M&V observation
Pressure kW Reduction	2.61%	M&V observation
Total kW in use	2,484.2	M&V observation
Operating Hours	8760	M&V observation

Table 1 shows the final analysis results as determined through the analysis described in the previous section broken out by savings type. Table 2 shows the variables that were used in the calculations. As mentioned in the previous section, some of the variables were derived from the application. These are identified in the table.The minimum pressure, pressure reduction, pressure kW reduction and total kW in use were all determined from the time series data. The system pressure was reduced 5.22 psi vs. the estimated 7 psi noted in the application. This in turn, reduced the pressure reduction percentage and pressure kW reduction. Because of the nature of the Network Capacity Control (NCC) measure, it is not possible to verify the manufacturer's savings estimate of 10%, without pre-retrofit data.

The total kW in use was found to be higher than estimated 2200 HP (1641 kW) noted in the application.

Figure 1 shows the total savings broken out per savings type. The majority of the savings are due to the Networked Capacity Control.

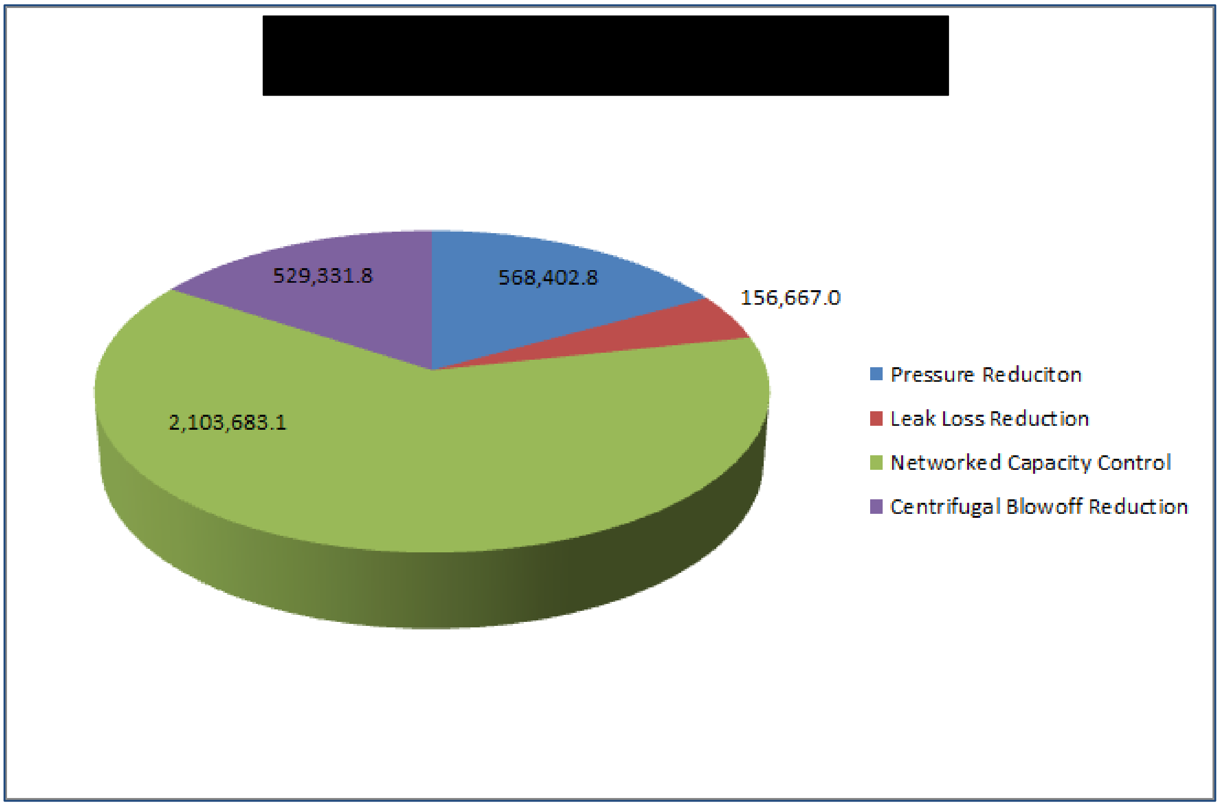

Figure 1. Total Savings Broken Out per Savings Type

The compressor power data collected with the Baywatch system is shown in Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6 below. 15-second data was collected and rolled up to hourly data to create the following figures. Data was collected for one month. The new control method is performing well, allowing the system pressure to be reduced from 106 psi to about 100 psi. During the logging period, it was noted that compressors 5, 6, & 7 ran the majority of the time while compressors 2 & 3 were used to trim the load.

The compressor power is a function of product throughput and not outside air temperature.

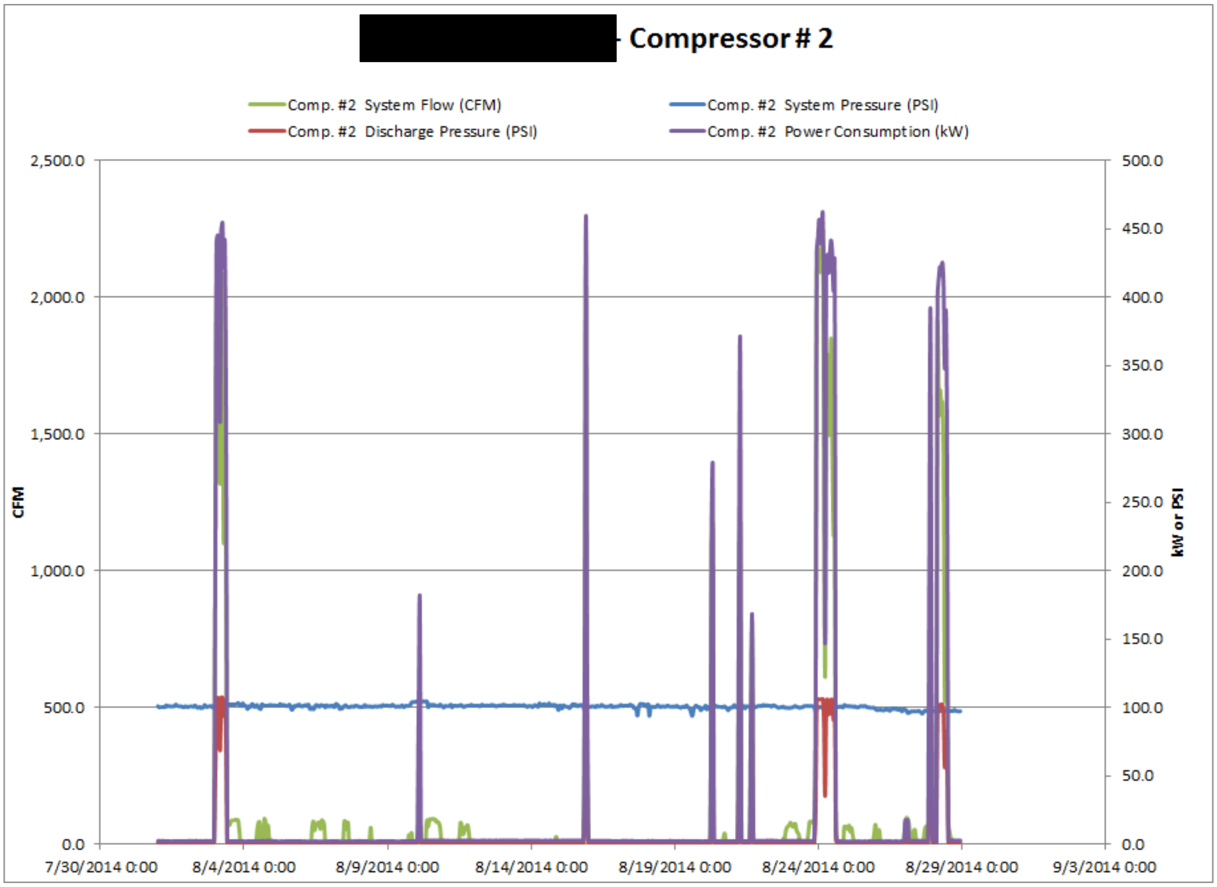

Figure 2. Compressor #2 Power Data

Evidence of the networked capacity control can be seen in Figure 2 and Figure 3. Compressor 2 appears to be used to trim the system pressure while compressor 3 appeared to run idle for the entire logging period.

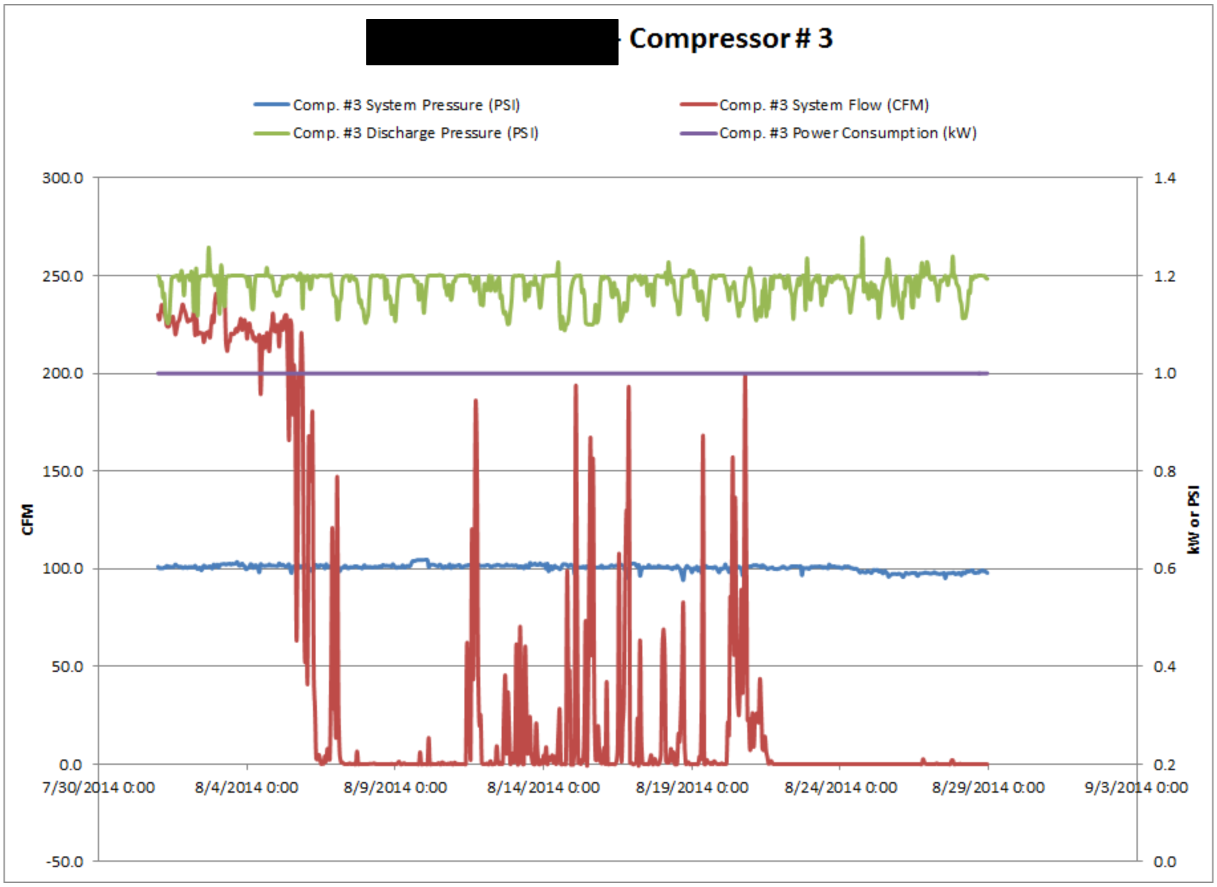

Figure 3. Compressor #3 Power Data

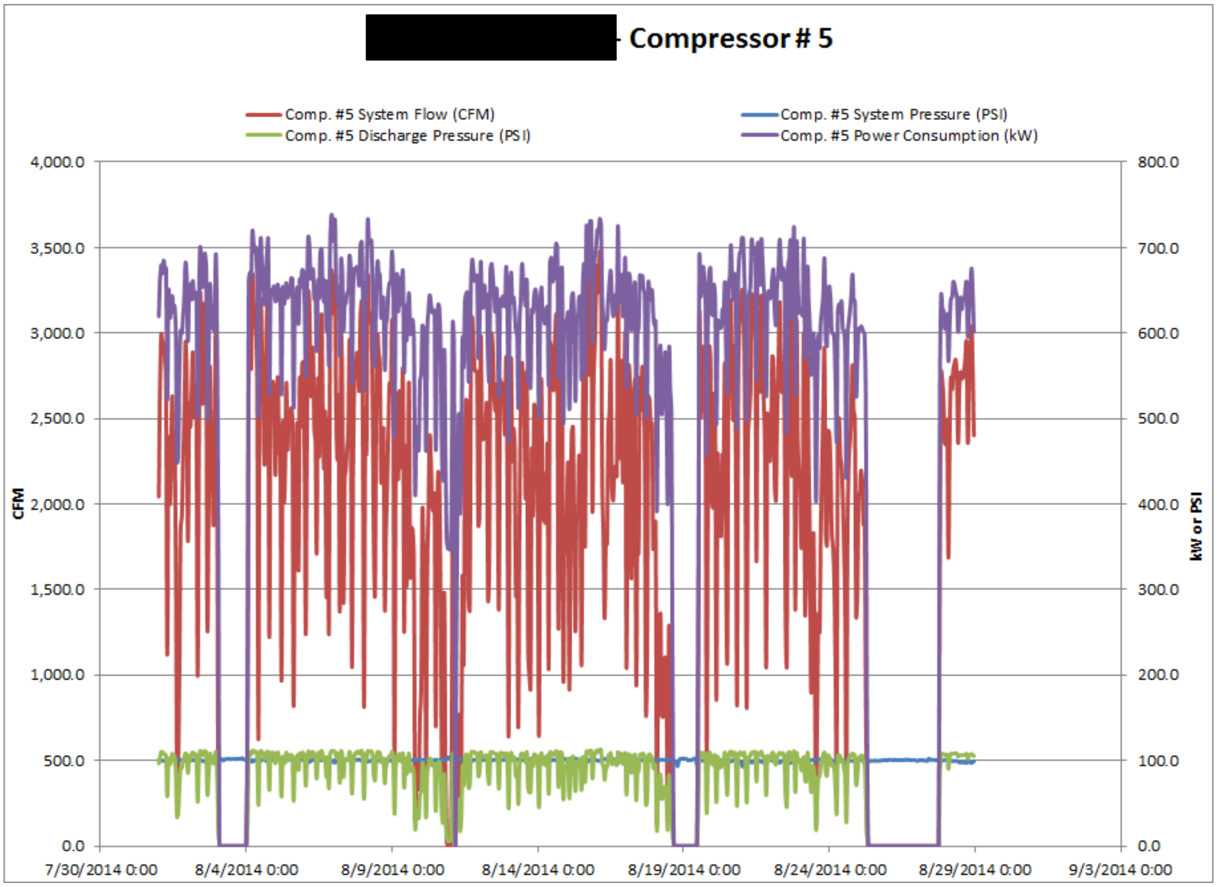

Figure 4. Compressor #5 Power Data

Compressor # 5 was cycling quite a bit during the logging period as can be seen in Figure 4.

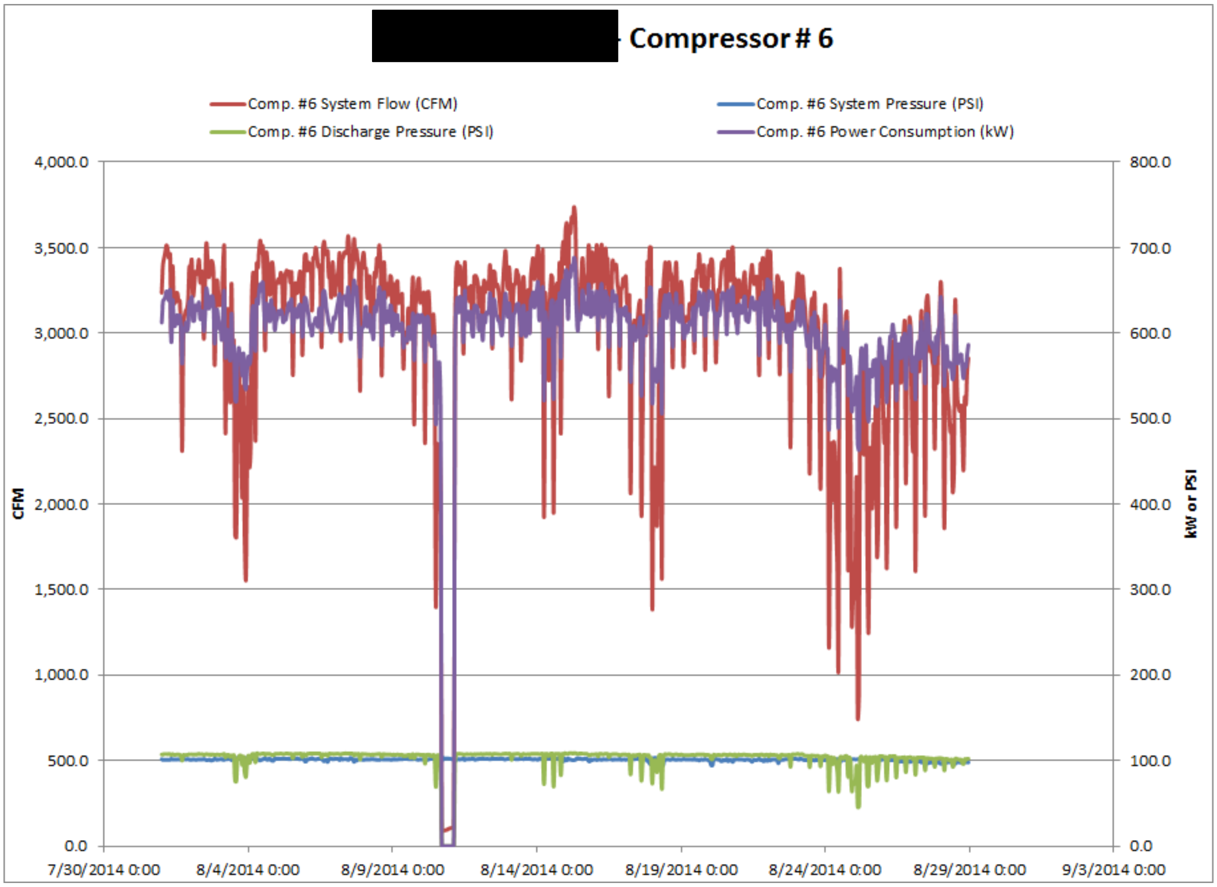

Figure 5. Compressor #6 Power Data

Compressors 6 & 7 appear to be running properly as can be seen in Figure 5 and Figure 6. CFM tracks compressor power and discharge pressure as it should for both compressors.

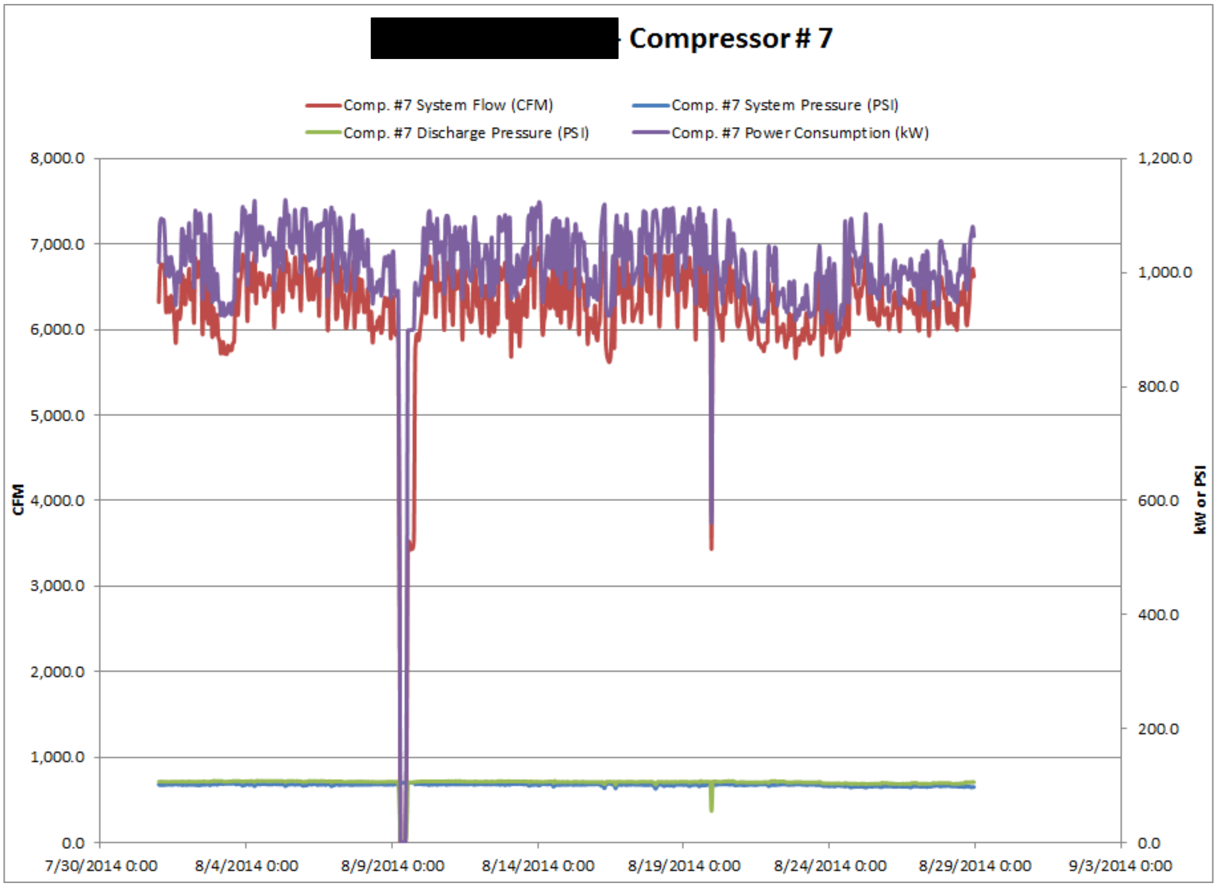

Figure 6. Compressor #7 Power Data

Site ID 5 (12-619)
Heat Pump Retrofits
M&V Report

Prepared for
Duke Energy Indiana

February 2015, v3

Note: This project has been randomly selected from the list of applications for which incentive agreements have been authorized under Duke Energy's Smart $aver® Custom Incentive Program.

The M&V activities described here are undertaken by an independent third-party evaluator of the Smart $aver® Custom Incentive Program.

Findings and conclusions of these activities shall have absolutely no impact on the agreed upon incentive between Duke Energy and [redacted].

Submitted by:

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Introduction

This report addresses M&V activities for the [redacted] custom program application.

The measure included:

ECM-1

- **Heat Pump Retrofits.** Existing McQuay water source heat pumps were replaced with new, more efficient Trane units. Existing units were installed in approximately 1994. This project upgraded 28 of the 73 existing units. Actual performance of the old units is likely to be compromised both due to the age of the units and because of the heat pump efficiency improvements of the last 20 years.

Note: ECMs were already implemented as of December 2012. Only post measurements were taken for this M&V project.

Goals and Objectives

The projected savings goals identified in the application were:

ECMs	Application Proposed Annual savings (kWh)	Application Proposed Peak Savings (kW)	Duke Projected savings (kWh)	Duke Projected Demand Savings (kW)	
1	9,120	5	20,499	7.7 (NCP)	4.1 (CP)

The objective of this M&V project was to verify the actual:

- Annual gross kWh savings
- Summer peak kW savings
- Utility Coincident peak demand savings
- kWh & kW Realization Rates

Project Contacts

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Customer Contact	[redacted}	[redacted}	[redacted]

Site Locations/ECMs

Address
[redacted]

Data Products and Project Output

- Average pre/post load shapes by day type for controlled equipment
- Model predicting pre/post kWh as a function of outdoor temperature
- Summer peak demand savings
- Coincident peak demand savings
- Annual Energy Savings

M&V Option

IPMVP Option A

Field Data Points

Building Operation

- Monitored heat pumps (listed in **BOLD)** included:

Table 1. Sampled equipment by capacity.

¾-Ton	1-Ton	1.5-Ton	2-Ton	2.5-Ton	3-Ton	3.5-Ton	4-Ton
02.14	01.02	02.0B	**02.15**	02.1C	01.03	**02.01**	**02.1D**
	02.0C	**02.0E**		**02.02**	01.08		**02.11**
	02.0D	02.04		02.07	02.0A		
	02.1A	02.06			**02.0F**		
	02.1B	02.08			**02.03**		
	02.12	**02.09**			02.13		
		02.10			02.19		

- The [redacted] building's normal occupancy schedule was found to be 7am to 5:30pm on weekdays, 5:30am to 2:30pm on Saturdays and closed on Sundays.

Survey data (for all equipment logged)

- The make/model/serial number/capacity was recorded for all new heat pumps.

One-time measurements for all equipment logged (to check and validate Elite Pro data)

- Eleven sampled heat pumps (indicated in **bold** in Table 1 above): volts, amps, kW and power factor
- OA Temperature and RH
- Condenser water supply and return temperature

Data Accuracy

Measurement	Sensor	Accuracy	Notes
Temperature	Hobo thermistor	±0.5%	
Current	CTV Current Transducer	±4.5%	> 10% of rating

Field Data Logging

ECM-1

- **Sampled** heat pumps: whole unit current (on one leg if 3-phase)
- Cooling tower fans: current (on one leg if 3-phase)

- **Outdoor Air**

1. A weather logging station was installed to record outside air temperature and relative humidity in 5 minute intervals. This data was logged for 3 weeks post-measure installation.

Data Analysis

1. Time series data on logged equipment (heat pumps and cooling tower fans) was converted into post average load shapes by building operation (open/closed).
2. A post-retrofit regression model was created to predict hourly kWh as a function of average outdoor drybulb and wetbulb temperature, as well as building open/closed status. TMY3 data for Indianapolis was used to determine weather conditions for the typical year.
3. Hourly kWh predictions were then scaled according to the tonnage of sampled heat pumps versus total installed tonnage.
4. A pre-retrofit model was generated from performance data obtained from the California Energy Commission's Data for Energy Efficient Resources (DEER) database and post retrofit consumption from field data.
5. Peak demand savings was estimated by subtracting pre/post time series data during time of peak heat pump and cooling tower use. Coincident peak savings was calculated by subtracting pre/post peak kW values at the utility coincident peak hour (July 16th at 3pm).

Verification and Quality Control

1. Visually inspected time series data for gaps
2. Compared readings to nameplate and spot-watt values; identified out of range data

Recording and Data Exchange Format

1. Elite Pro logger and weather station binary files
2. Excel spreadsheets

Results Summary

According to the [redacted] building's occupancy schedule and TMY3 data for Indianapolis, the outdoor air temperatures during occupied and unoccupied hours correspond to Figure 1.

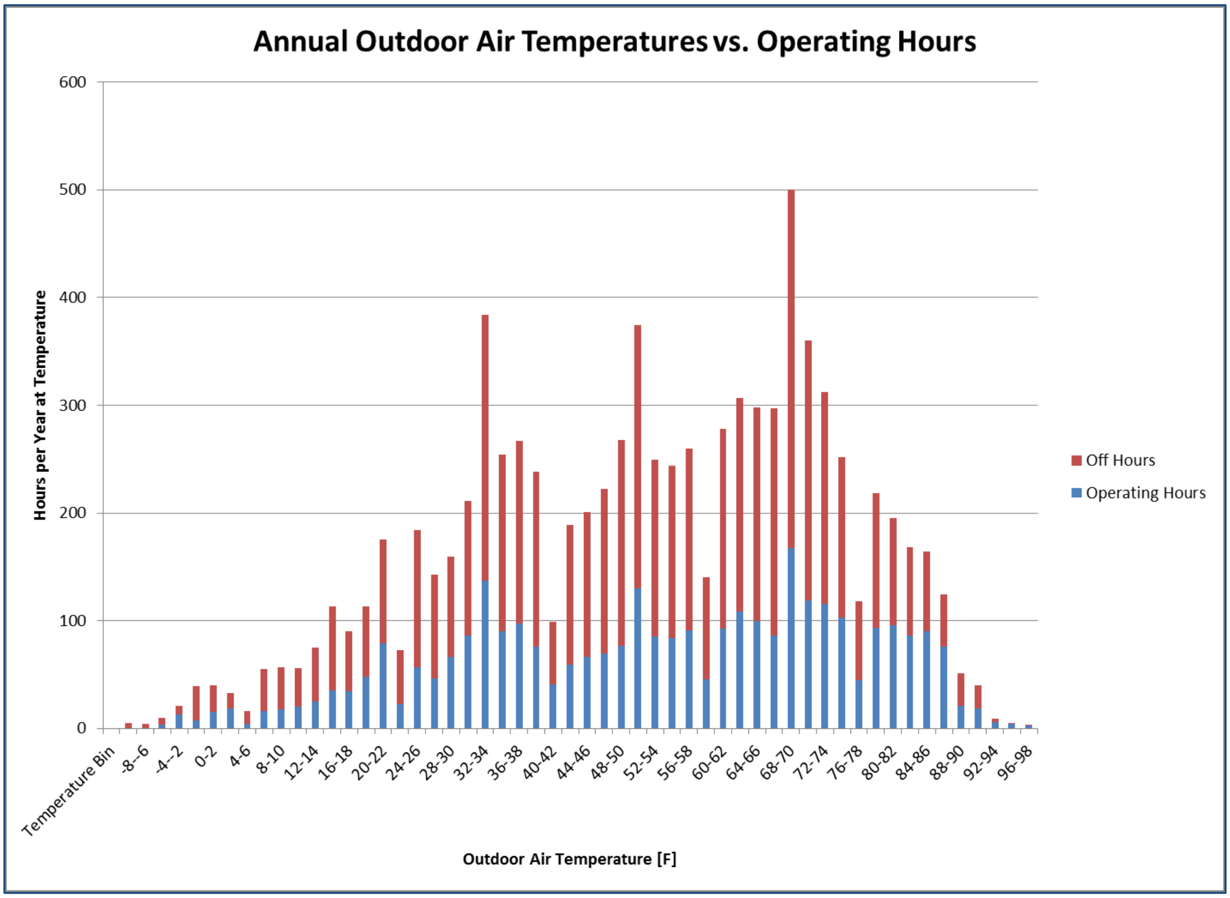

Figure 1. Outdoor Air Temperatures vs. Operating Hours

Sampled heat pump wattage was seen to behave differently during operating and non-operating hours, as would be expected. There was also an observed heating/cooling changeover at approximately 45-47F. Based on three weeks of trend data, Figure 2 shows sampled heat pump wattage versus outdoor air temperature.

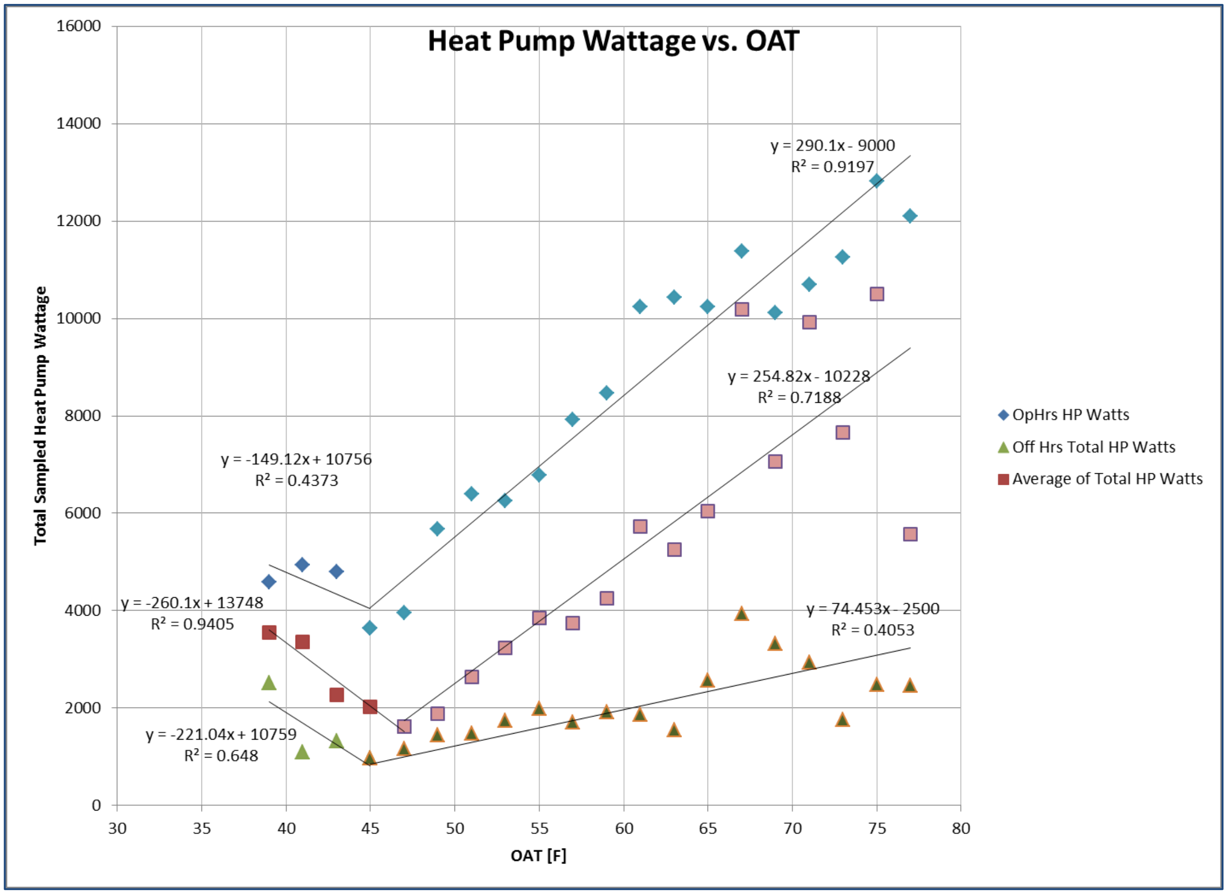

Figure 2. Heat Pump Power vs. OAT for Operating and Non-Operating Hours

The cooling tower fans were also regressed versus outdoor air temperature, as seen in Figure 3.

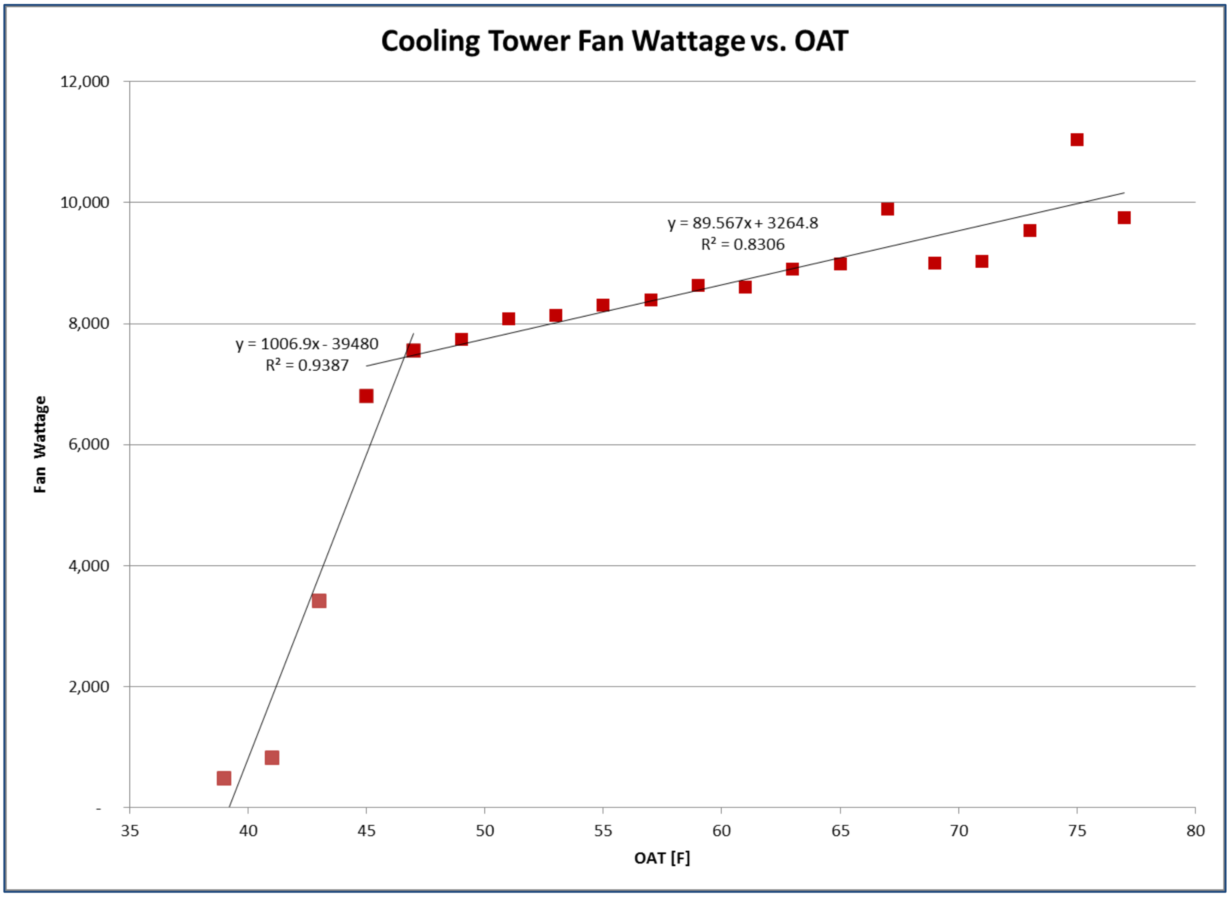

Figure 3. Cooling Tower Fan Power vs. OAT

For the purposes of this analysis, the fan was considered to be OFF below 45F, as no heat rejection was expected at these temperatures.

Cooling tower loop temperatures were also measured and the temperature differential calculated. In order to determine the reduction in cooling tower fan energy as a result of the heat pump retrofit, a 28% reduction (equivalent to the estimated combined heating/cooling efficiency differential between old and new heat pumps) in loop temperature differential was assumed, and fan energy was recalculated with the new assumed temperature differentials, as seen in Figure 4.

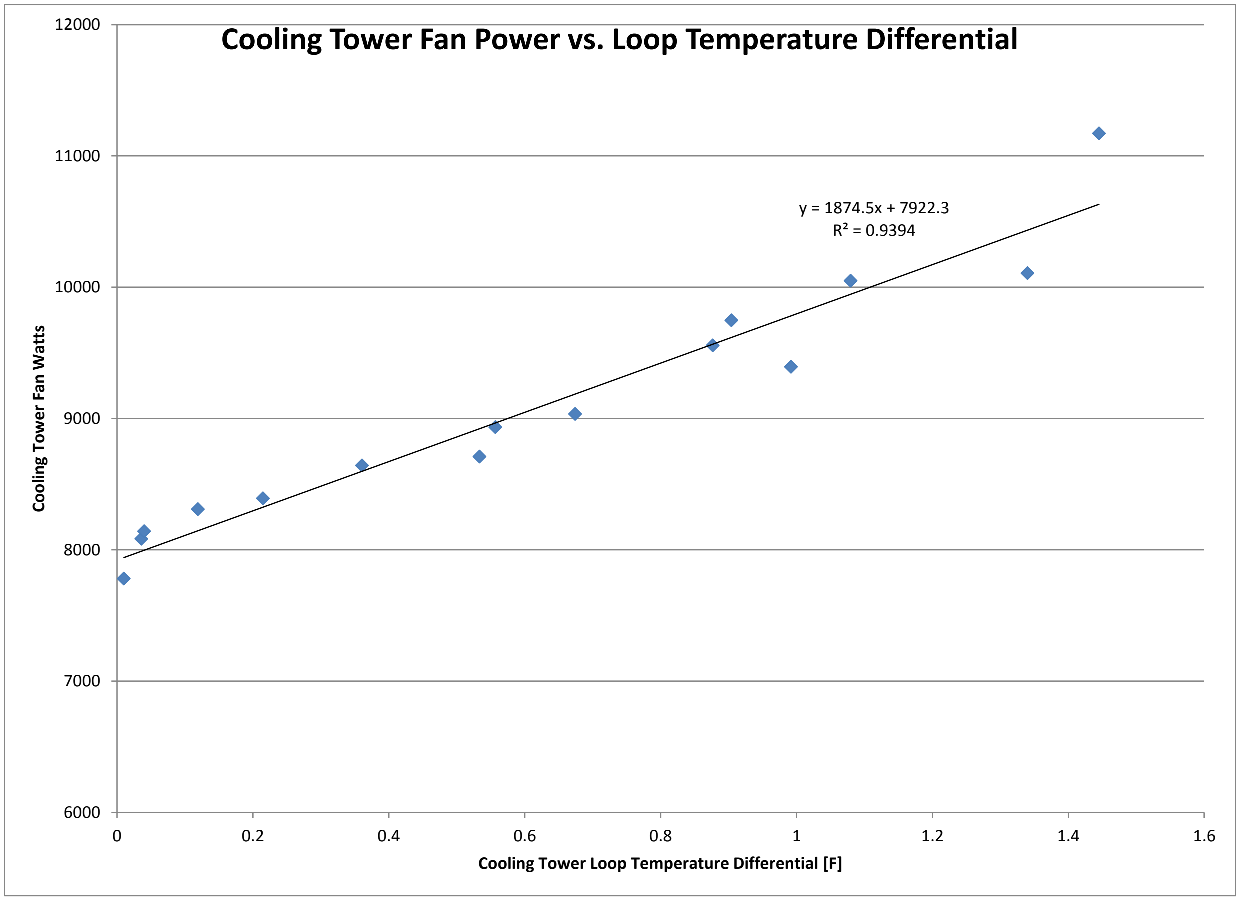

Figure 4. Cooling tower fan Power vs. loop temperature differential

Annual energy consumption based on the new equipment was calculated by combining the annual typical temperature data with the heat pump and fan power regressions for both operating and non-operating hours. Pre-retrofit data was calculated by comparing the efficiencies of the new and old equipment.

The weighted average heating EER and cooling COP for the new and old equipment is summarized in Table 2. New values are weighted by equipment tonnage, while old values were obtained from the DEER database, and based on equipment vintage (1994) and capacity.

Table 2. Old and new equipment efficiencies.

New weighted EER	Old Estimated EER	New weighted COP	Old Estimated COP
13.9	10.5	4.7	3.8

Table 3 summarizes the energy and demand savings for the project.

Table 3. Energy Savings and Realization Rates

	Duke Savings	Verified Savings	Realization Rates
Energy (kWh)	20,499	34,197	167%
Peak Demand (kW)	7.7	5.1	67%
CP Demand (kW)	4.1	4.5	109%

Site ID 6
Process (13-1380086): M&V Report

March 15, 2016

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Cadmus

Table of Contents

Introduction

This report addresses M&V activities for four waste water plant retrofit energy conservation measures (ECMs) as part of the [redacted] Smart $aver custom incentive program application; specifically:

- ECM-1: New feed pumps with VFD control for a waste activated sludge (WAS) system.
- ECM-2: New pump with a high-efficiency motor for a thickened waste activated sludge (TWAS) system.
- ECM-3: High-efficiency grit removal system to reduce pump operating hours.
- ECM-4: New aeration blowers with VFD control for aeration tanks.

These ECMs also were enabled by the installation of a new SCADA system for improved plant operations monitoring. Cadmus bases the following facility and measure descriptions on original project documentation.

ECM-1—New Feed Pumps with VFD Control for WAS System

Pre-Retrofit: The pre-retrofit system consisted of two 15-hp sludge thickening feed pumps, conveying WAS from the return-activated sludge pump station. The estimated full-load motor efficiency was 84%, with a motor load factor of 91%.

One of the two pumps ran at a time, with an assumption that they rotated throughout the year with equal operating hours.

Installed: The installed system used a new rotary drum thickener, which allowed downsizing the pumps to two 10-hp pumps. Both pumps were installed with VFDs, but they pumped at a constant rate. It was assumed operating hours and rotation of the installed pumps equaled the pre-retrofit case.

The energy savings calculations for this measure did not account for the cube law relationship between drive speed and brake horsepower, and may underestimate the measure's savings.

ECM-2—New Pump with High-Efficiency Motor for TWAS System

Pre-Retrofit: One 5-hp pump served the pre-retrofit TWAS system; this conveyed thickened sludge from the thickened sludge wet well to the anaerobic digestion process. The full-load motor efficiency of the existing pump motor was estimated at 84%. The pump operated 24/7, year-round.

Installed: The installed system replaced the existing TWAS pump with a new, 5-hp pump with a 91% full-load motor efficiency. With the installation of ECM-1 (the new rotary drum thickener), the amount of TWAS was expected to decrease by ~50%. The operating hours of the new pump were also expected to decrease by 50%.

ECM-3—High-Efficiency Grit Removal System

Pre-Retrofit: Two 15-hp pumps served the pre-retrofit grit removal system that operated 24/7, year round.