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BEFORE

THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Annual Energy Efficiency Portfolio Status Report of Duke Energy Ohio, Inc.	)))	Case No.14-456-EL-EEC

ANNUAL ENERGY EFFICIENCY STATUS REPORT

OF DUKE ENERGY OHIO, INC.

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COMPLIANCE STATUS REPORT

This portfolio status report represents Duke Energy Ohio, Inc.'s fifth filing of a status report on the load impacts achieved through implementation of its energy efficiency and demand response programs pursuant to Rule 4901:1-39-05 (C), O.A.C. This report is composed of the following two sections: (1) Compliance Benchmarks which provide information on load impact achievements relative to the baseline and (2) Program Performance Assessment which summarizes program activities and evaluation, measurement, and verification information. Following this report are ten appendices that fulfill the remaining requirements set forth in the Commission's regulations. For the reasons

1. Compliance Benchmarks

4901:1-39-05 (A) and (B) Initial Benchmark Report

Pursuant to Rule 4901:1-39-05 (A), O.A.C., Duke Energy Ohio must file the following information in a benchmark report:

(1) The energy and demand baselines for kilowatt-hour sales and kilowatt demand for the reporting year; including a description of the method of calculating the baseline, with supporting data.

(2) The applicable statutory benchmarks for energy savings and electric utility peak-demand reduction.

In compliance with 4901:1-39-05(B), in preparing the baseline, Duke Energy Ohio is required to adjust the sales and/or demand baseline for normal weather as well as for changes in numbers of customers, sales, and peak demand to the extent such changes are outside its control.

This benchmark update report provides information on two areas. The first area involves the baseline for 2013, including a discussion of adjustments made to normalize for weather and to adjust for changes in numbers of customers, sales, and peak demand, where those changes are outside the control of Duke Energy Ohio. The second area involves an estimate of the statutory benchmarks for energy savings and electric utility peak-demand reduction.

In estimating the baseline for Duke Energy Ohio for the year 2013, the Company uses the three-year average of the actual level of total energy sold (sales plus losses) and peak demand, adjusted for differences from normal weather. Table 1 provides the historical level of total energy (kWh) for the years 2006 to 2012, the amount of the weather adjustment, and the weather normalized level of total energy.

Table 1 - Duke Energy Ohio Baseline and Benchmark for 2013

Year	Total Energy (MWh)	Weather Normalization Adjustment (MWh)	Weather Normal Level of Total Energy (MWh)	Baseline: Three Year Average (MWh)	Benchmark Percentage	Benchmark Requirement (MWh)
2006	22,402,660	262,896	22,665,556			
2007	23,510,777	(763,963)	22,746,814			
2008	22,321,489	(72,401)	22,249,088			
2009	20,405,122	320,494	20,725,616	22,553,819	0.3%	67,661
2010	22,545,823	(621,454)	21,924,369	21,907,173	0.5%	109,536
2011	20,238,172	(207,407)	20,030,765	21,633,024	0.7%	151,431
2012	19,919,494	(15,568)	19,903,926	20,893,583	0.8%	167,149
2013				**20,619,687**	**0.9%**	**185,577**

Year	Peak Demand (MW)	Weather Normalization Adjustment (MW)	Weather Normal Level of Peak Demand (MW)	Baseline: Three Year Average (MW)	Benchmark Percentage	Benchmark Requirement (MW)	Incremental Benchmark Percentage	Incremental Benchmark Requirement (MW)
2006	4,520	71	4,591					
2007	4,607	(279)	4,328					
2008	4,125	337	4,462					
2009	4,002	476	4,478	4,460	1.00%	44.6	1.00%	44.6
2010	4,114	330	4,444	4,423	1.75%	77.4	0.75%	33.2
2011	4,398	(28)	4,370	4,461	2.50%	111.5	0.75%	33.5
2012	4,020	281	4,301	4,431	3.25%	144.0	0.75%	33.2
2013				**4,372**	**4.00%**	**174.9**	**0.75%**	**32.8**

The Company employs the following process to normalize kWh and kW for differences in the weather: Using econometric equations for each customer class, from the load forecast process discussed in the Long-Term Forecast Report filing, the adjustment process for kWh is performed as follows:

Let: $KWH(N) = f(W(N))g(E)$

$KWH(A) = f(W(A))g(E)$

Where: $KWH(N)$ = electric sales - normalized

$W(N)$ = weather variables - normal

E = economic variables

$KWH(A)$ = electric sales - actual

$W(A)$ = weather variables – actual

Then: $KWH(N) = KWH(A) * f(W(N))g(E)/f(W(A))g(E)$

$= KWH(A) * f(W(N))/f(W(A))$

With this process, weather-normalized sales are computed by scaling actual monthly sales for each class by a factor from the econometric equation that accounts for the impact of deviations from monthly normal weather. Similarly, using an econometric equation for peak, the adjustment process for kW is performed as follows:

Let: $KW(N) = f(W(N))g(E)$

$KW(A) = f(W(A))g(E)$

Where: $KW(N)$ = electric peak demand - normalized

$W(N)$ = weather variables - normal

E = economic variable

$KW(A)$ = electric peak demand - actual

$W(A)$ = weather variables - actual

Then: $KW(N) = KW(A) * f(W(N))g(E)/f(W(A))g(E)$

$= KW(A) * f(W(N))/f(W(A))$

With this process, weather-normalized peak demand is computed by scaling actual peak demand by a factor from the econometric equation that accounts for the impact of deviations from normal weather.

Once total energy and peak demand have been adjusted for normal weather, the computation of the baseline for 2013 is simply the average of the load values for the three years 2010 to 2012. The baseline values for energy and demand are provided above in Table 1.

4901:1-39-05(C)(1)(a)-(c) Portfolio Status Report and Compliance Demonstration

In accordance with 4901:1-39-05(C)(1)(a), with the establishment of the baseline energy and peak demand, the level of the statutory benchmark is computed by applying the appropriate incremental percentage of achievement, as established in S.B. 221, to the baseline. The computation of the benchmark achievement level for 2013 is provided above on Table 1. The baseline for energy is 185,577 MWH and the baseline for peak loads is 32.8 MW.

Duke Energy Ohio respectfully submits that this information is responsive to all of the baseline and benchmark calculations as set forth in Rule 4901:1-39-05(A), O.A.C., and requests that the Commission approve these baseline and benchmark calculations as submitted.

In response to 4901:1-39-05(C)(1)(b), which requires a comparison of the applicable benchmark of actual energy savings and peak-demand reductions achieved, as a result of the Company's 2013 efforts to promote customer participation in its energy efficiency and demand response programs, the Company has achieved incremental energy and demand impacts in 2013 as summarized below in Table 2. Details of impacts for each program are provided in Appendix A.

Table 2: Incremental Energy Efficiency and Demand Response Program Impact Summary			
	Participants / Measures	MWH	MW
Demand Response Programs			
Power Manager			1.0
PowerShare			(11.2)
PowerShare Generators			(13.5)
Large Transmission Customer			46.1
Total Demand Response Programs		**0**	**22.4**
Energy Efficiency Programs			
Residential Programs	1,118,220	49,546	7.7
Non-Residential Programs	540,800	94,556	17.9
Total EE Programs	**1,659,020**	**144,102**	**25.5**
Prior Bank per SB-221		585,536	221.8
Total Load Impacts		**729,638**	**270**

Table 3 provides a comparison of the impacts relative to the benchmarks previously mentioned. This indicates that the Company has complied with the S.B. 221 statutory benchmarks for the year 2013.

Table 3: Comparison of Achieved Impacts to the 2013 Benchmark			
	2013 Benchmark	Achievement	Variance Over / (Under)
MWH	185,577	729,638	544,061
MW	32.8	270	236.9

In addition, since the Company's efforts exceeded the requirement, there is still a residual amount of load impacts that carry forward to support achievement of the benchmarks for 2014 and beyond.

In compliance with 4901:1-39-05(C)(1)(c), an affidavit indicating that the reported performance complies with the statutory benchmarks is provided in Appendix B.

4901:1-39-05(C)(2) Program Performance Assessment

As part of Duke Energy Ohio's Electric Security Plan (ESP) filing in 2008, the Company proposed a set of energy efficiency and demand response programs. These were subsequently approved on December 17, 2008 and reaffirmed (except for the Prepaid Meter Program) in the Commission's Order in Case No. 09-1999-EL-POR. Implementation of the Save-A-Watt programs began January 2009. On July 20, 2011, Duke Energy Ohio filed for a new recovery mechanism to replace Save-A-Watt due to expire on December 31, 2011. In Case No. 11-4393-EL-RDR, Duke Energy Ohio proposed a recovery mechanism as well as three new programs. The recovery mechanism and programs were approved on August 15, 2012. In compliance with the Commission's Order, after reviewing the market potential study conducted by Forefront Economics Inc, Duke Energy Ohio filed its three-year portfolio plan for 2014-2016 with the Commission on April 15, 2013. The Commission's approved the new portfolio proposed by the Company in its Opinion and Order in Case No. 13-0431-EL-POR on December 4, 2013.

2. Program Performance Assessment

Program descriptions and key activities for its current portfolio are provided below.

4901:1-39-05 (C)(2)(a)(i) Program Descriptions and Key Activities

<u>Residential Programs</u>

<u>Smart $aver® Residential Program</u>

The Smart $aver® Residential program offers a variety of programs and measures that allow customers to take action and reduce energy consumption. The program is available to residential customers served by Duke Energy Ohio.

Compact Fluorescent Lamps (CFL) Program

The CFL Program is designed to increase the energy efficiency of residential customers by offering customers CFLs to install in high-use fixtures within their homes. The CFLs are offered through an on-demand ordering platform, enabling eligible customers to request CFLs and have them shipped directly to their homes. Eligibility is based on past campaign participation (i.e. coupons, Business Reply Cards (BRCs) and other Duke Energy Ohio programs distributing CFLs). Bulbs are available in 3, 6, 8, 12 and 15 pack kits that have a mixture of 13 and 20 watt bulbs. The maximum number of bulbs available for each customer is 15, but customers may choose to order less.

Customers have the flexibility to order and track their shipment through three separate channels:

1) Telephone:

   Customers may call a toll-free number to access the Interactive Voice Response (IVR) system which provides prompts to facilitate the ordering process. Both English and Spanish-speaking customers may easily validate their account, determine their eligibility and place their CFL order over the phone.

2) Duke Energy Web Site:

   Customers can go online to complete the ordering process. Eligibility rules and frequently asked questions are also available.

3) Online Services (OLS):

   Customers who participate in the Online Services program are encouraged to order their CFLs through the Duke Energy Ohio web site if they are eligible.

The benefits of providing these three distinct channels include:

- Improved customer experience
- Advanced inventory management
- Simplified program coordination
- Enhanced reporting
- Increased program participation
- Reduced program costs

Customers continue to utilize the simple ordering process and the convenience of bulbs being shipped directly to their home. Over 57,378 orders were placed in 2013; resulting in over 777,000 bulbs distributed. Over 24 percent of the orders were placed by calling the toll free phone number, 24 percent of the orders were placed on the Duke Energy Ohio web site and 51 percent on the OLS platform.

The overall strategy of the program is to reach residential customers who have not adopted CFL bulbs. Duke Energy Ohio will continue to educate customers on the benefits of CFLs while addressing barriers for consumers who have not participated in the program. Additionally, the ease of program participation will also be highlighted to encourage use of the on-demand ordering platform.

OLS has generated a significant percentage of orders in Ohio due to login and intercept options to bring awareness of the program to eligible customers. Additionally, direct mail campaigns target Prizm segments of Ohio customers with a high propensity to participate in the program. Marketing pieces and personalized letters include the customer account number for easy ordering through the IVR or Web platform.

Duke Energy Ohio will continue to market the CFL program through various channels including Email, Bill Messages, Bill Envelopes, Social Media, Direct Mail, Printed Collateral, Earned Media[1], and other Duke Energy Program collaboration efforts. Response of each channel is tracked and monitored.

CFL Program Potential Changes

Innovative marketing campaigns and tactics will be utilized to improve awareness for hard to reach and late adopter[2] customers. Cross-promotion with the new online Savings Store will help offer lighting for specialty applications and promote LED technology to customers who are eligible for both lighting programs.

<u>Online Savings Store</u>

Duke Energy Ohio expanded its lighting offer to include specialty bulbs such as recessed lights, candelabras, globe, three-way bulbs, capsules and dimmable bulbs. Purchase limits vary by category but customers may purchase additional bulbs without incentives if they choose. The web based ecommerce store launched on April 26th, 2013 and provides discounted specialty lights and ships directly to the home.

Utilizing the existing on-demand CFL platform, customers may participate in the online Saving Store via:

1) Duke Energy Web Site

   Customers may go the Savings Store landing page to learn more about the program, review frequently asked questions and CFL recycling information. A savings calculator is available to estimate how much money customers can save and how sustainable they can be by purchasing discounted energy bulbs from the Duke Energy Savings Store.

[1] Earned media refers to favorable publicity gained through promotional efforts other than advertising.
[2] Customers who are slow to start using or buying a new product, technology, or idea.

2) Online Services (OLS)

Customers who participate in the Online Services program are encouraged to visit the Savings Store to order discounted CFL and LED bulbs through the Duke Energy Ohio web site if they are eligible.

Customers who choose to shop at the Savings Store will see a wide variety of discounted CFL and LED bulbs for different fixtures around their home. Bulbs are available in single and multi-pack sizes and various wattages. A shopping assistant is available to help customers select the right bulb types for various applications, as well as resources to understand the difference between lumens versus watts and how to compare them. The savings calculator can show how much customers may save by switching to energy efficient lighting.

The Savings Store is managed by Energy Federations Incorporated (EFI). Customers can view special promotions and feature products as well as track order history. EFI, handles inquiries regarding products, payments, shipping and warranties.

Over 3,450 orders were placed in 2013; resulting in over 50,000 bulbs purchased. Over 35 percent of orders were placed through OLS and 65 percent of orders were placed through the Duke Energy Ohio web site. The top five categories purchased on the Savings Store include; CFL reflectors, globes, candelabra, A-line capsule and three way bulbs.

Duke Energy Ohio will market the online Savings Store program through various channels including Email, Bill Messages, Bill Envelopes, Social Media, Direct Mail, Printed Collateral, Earned Media, and other Duke Energy Program collaboration efforts. Response of each channel is tracked and monitored.

Savings Store Program Potential Changes

Potential changes to encourage participation include; ability to allow Duke Energy Ohio customers to order discounted lighting via a mail-in order form and/or by phone.

Savings Store enhancements considered for 2014 include; additional shipping and discount options, product comparison, dynamic savings information, support for additional payment methods and improved customer experience and communication.

Property Manager Program

The Property Manager Program is an extension of the CFL program and allows Duke Energy Ohio to target multi-family apartment complexes. Eligible units are those Duke Energy Ohio served apartments on a residential rate. Honeywell manages the program and partners with Ohio property managers to enroll multi-family properties.

The program helps property managers upgrade lighting with energy efficiency 13 watt CFLs, reducing maintenance costs while improving tenant satisfaction by lowering energy bills. Each apartment may qualify for up to 12 bulbs per unit depending on the size.

Once enrolled, the property manager identifies the number of permanent lighting fixtures available. Duke Energy Ohio provides the CFLs but the property manager pays for all shipping costs.

The CFLs are installed in permanent fixtures during routine maintenance visits. The property manager provides tracking for the number of bulbs installed. Honeywell validates this information and provides a report for each individual unit on the property.

A Property Manager CFL promotional and landing page was developed for managers to self-serve and learn more about the program. A contract, installation worksheet and CFL frequently asked question sheets are available for download. Marketing material including information on CFL savings and safety sheets are available in English and Spanish to further support the program.

Honeywell markets the program to Ohio Property Managers through various channels including tradeshows, email, and Apartment Association events. Duke Energy Ohio will continue to support the Property Manager program by updating and maintaining program information on the Web site.

Property Manager Program Potential Changes

Beginning in March 2014, the Property Manager program will include energy efficient lighting and water saving measures including; kitchen and bath aerators, low flow shower heads and pipe wrap for electric water heated units. The final steps of the RFP process are being finalized and the vendor will offer direct install and "do it yourself" options for qualified properties.

Residential HVAC Program

Duke Energy Ohio served homeowners currently residing in or building a single family residence, condominium, duplex or mobile home are eligible for this program. Installation of a high efficiency heat pump or air conditioner will result in a $300 incentive. GoodCents administers the program and establishes relationships with home builders and HVAC contractors who interface directly with residential customers. These trade allies adhere to program requirements and submit the incentive application. Once the application is processed, GoodCents disburses the incentive funds. For replacement of an existing system, a Duke Energy Ohio customer receives $200 and the HVAC contractor receives the remaining $100. For new home construction, the home builder receives the full $300 incentive but has the option to pass the incentive on to the customer. For the additional complimentary measures offered through the HVAC program, eligible customers will receive a $50 incentive for tuning up a heat pump or air conditioning, installation of attic insulation and completion of air sealing will result in a $250 incentive, installation of duct insulation will result in a $75 incentive, and completion of duct sealing will result in a $100 incentive. All incentives are paid directly to customers upon approval of a completed application. GoodCents disburses the incentive funds to the appropriate party upon application approval. GoodCents also handles calls from trade allies and customers about the program.

Duke Energy Ohio has formed strong relationships with trade allies and continues to develop relationships with trades serving the new measures. These partnerships help application fulfillment and prompt payment of incentives as well as maintain top-of-mind awareness of the program and its benefits. The buy-in and participation of the trade ally network is vital to the success of the HVAC segment of the Program. Duke Energy Ohio continues to inform the trade ally network of the new measures; however, the program shifted market practices away from traditional practices which rely heavily on decentralized training and varying knowledge levels, as well as imprecise and manual field calculations, toward industry trained and certified trade allies using higher quality instruments and processes which have proven challenging and has slowed the recruitment process. While some trade allies have registered and are capable of offering the new measures, Duke Energy Ohio expects to enroll more trade allies and customers in 2014.

Residential HVAC Program Potential Changes

GoodCents is responsible for promotion of the Program directly to potential trade allies including HVAC, home performance contractors and new home builders. Program information and trade ally enrollment forms are now available on the website to encourage participation. By increasing the participation of trade allies, it ensures more customers are aware of the Program at the time of purchase.

Duke Energy will partner with select participating trade allies during the coming year to offer additional discounts on products and services to eligible customers. This will be offered during the products true seasonality which will make trade ally buy-in and customer response positive.

Smart $aver® Residential Program changes

In 2014, the following approved measures will be available to customers as stated in Case No. 13-0431-EL-POR:

- Single Family and Multifamily faucet aerators for bath and kitchen
- Single Family and Multifamily low flow shower heads
- Single Family and Multifamily pipe wrap
- Heat pump water heaters
- Pool pumps

Residential Energy Assessments Program

The Residential Energy Assessments program includes Home Energy House Call (HEHC).

HEHC targets residential customers that own a single family home with at least four months of billing history. HEHC is a free in-home assessment designed to help customers reduce energy usage and save money. An energy specialist completes a 60 to 90 minute walk through assessment of the home and analyzes energy usage to identify energy saving opportunities. The Building Performance Institute (BPI) certified energy specialist discusses behavioral and equipment modifications that can save energy and money with the customer. A customized report is provided to the customer that identifies actions the customer can take to increase their home efficiency. Example recommendations might include the following:

- Turning off vampire load equipment when not in use
- Turning off lights when not in the room
- Using CFLs in light fixtures
- Using a programmable thermostat to better manage heating and cooling usage
- Replacing older equipment
- Adding insulation and sealing the home

Customers receive an Energy Efficiency Starter Kit with a variety of measures that can be directly installed by the energy specialist. The kit includes measures like CFLs, low flow shower head, low flow faucet aerators, outlet/switch gaskets, weather stripping and energy saving tips booklet.

Duke Energy Ohio partners with several key vendors in support of the HEHC program: WECC, ProtoType, CustomerLink and AM Conservation. WECC administers the assessment component of the program. Additional key vendors include ProtoType for mailing services, CustomerLink for customer care support and scheduling (call center and back office), and AM Conservation for fulfillment of the Energy Efficiency Starter Kits.

HEHC Program Potential Changes:

Some program enhancements to increase program impacts, raise participation satisfaction levels, and establish Duke Energy as a preferred energy provider being considered include:

- Evaluating including specialty CFL bulbs and other measures for the Energy Efficiency Start Kit.
- Revamping marketing collateral, direct mail and website landing page to expand new campaign and drive brand consistency
- Considering using HEHC as a platform to analyze customer data and market other energy saving programs based on specific customer usage and feedback.

Energy Efficiency Education Program for Schools

The Energy Efficiency Education Program for Schools Program is an energy conservation program available in Ohio. The Energy Efficiency Education Program is available to K-12 students enrolled in public and private schools and who reside in households served by Duke Energy Ohio.

The Program provides principals and teachers with an innovative curriculum that educates students about energy, electricity, ways energy is wasted and how to use our resources wisely. The centerpiece of the curriculum is a live interactive theatrical production delivered by two professional actors to students in kindergarten through eighth grade. Performances differ for elementary and middle school students. Teachers also received educational materials focused on concepts such as energy, renewable fuels, and energy efficiency for classroom and student take home assignments. All workbooks, assignments and activities meet state curriculum requirements.

School principals are the main point of contact and will schedule the performance at their convenience for the entire school. Once the principal has confirmed the performance date and time, two weeks prior to the performance, all materials are delivered to the principal's attention for distribution. Materials include school posters, teacher guides, classroom and family activity books.

Students are encouraged to complete a home energy survey with their family (found in their activity book), so they can receive an Energy Efficiency Starter Kit. The kit contains specific energy efficiency measures to reduce home energy consumption. It is available at no cost to all student households at participating schools, including customers and non-customers.

Since 2011, The National Theatre for Children has partnered with Duke Energy Ohio to engage students in the Ohio service territory on energy and energy efficiency through live theatrical performances. For the 2013-2014 school year, two new productions were launched. The 25-minute program, *Showdown at Resource Ranch* was introduced to elementary students and teaches them how to use resources wisely through a set of funny, yet knowledgeable cast of characters right out of the old West. *The Resource Force* is a 40-minute program introduced to Middle School students which combines sketch comedy with improvisation and audience participation to teach students about natural resources and compliment student studies in science and energy.

Additionally, Duke Energy has enhanced the program by

- Launching a new webpage at duke-energy.com to showcase the program
- Partnering with Duke Energy Account and District Managers to leverage existing relationships in the community and develop positive PR
- Offering school and family contests for kit sign ups to stir additional excitement in the schools/classrooms
- Enhancing all data processing methods

As the program evolves in 2014, there will be additional enhancements to improve the customer's experience when participating in the Energy Efficiency Education Program.

Low Income Services Program

The Low Income Services Program provides assistance to low income customers through several measures. The upfront costs of high efficiency equipment are an especially difficult barrier for low income customers to overcome. The Weatherization and Refrigerator Replacement program is available to any low income customer up to 200% of the federal poverty level who have not participated in this program within the past 10 years.

The Electric Maintenance Service program is available for low-income elderly and disabled customers up to 175% of poverty level. This program offers low-cost solutions for energy efficiency. Customers may receive energy efficiency products and services such as compact fluorescent bulbs, low flow showerheads and aerators, water heater wraps, HVAC cleaning, HVAC filters, and energy efficiency education.

The Habitat Lighting program is offered to new home builders, participating in Habitat for Humanity and that reside within Duke Energy's service territory. Participants enrolled in Habitat for Humanity's building program, receive installed energy efficient lighting fixtures throughout the home. Fixtures are installed at the time of the home's construction and are part of the home's overall energy efficient structure.

These programs are promoted through, but not limited to, Community Action Agencies, Non-Governmental Organizations (NGO's), and direct mail to customers.

Low Income Services Program Potential Changes:

Duke Energy Ohio has partnered with Ohio Partners for Affordable Energy (OPAE) to provide refrigerator replacement services within Duke Energy Ohio service territory. OPAE will contract with local agencies within the Duke Energy service territory to perform the work. The Program will offer low income customers refrigerator testing and/or replacement depending on the amount of energy used to operate their unit(s). The program will launch first quarter, 2014.

Duke Energy Ohio has also partnered with People Working Cooperatively (PWC) for the electric pilot program. The program targets low income customers and focuses on energy efficiency. Customers receive whole-house weatherization services which include installation of energy efficiency measures and education. Duke Energy Ohio will purchase and recognize the energy and demand savings achieved through the whole-home weatherization in the Duke Energy Ohio service territory that are currently funded by leveraged funds. The pilot is intended to allow the Company to recognize efficiency impacts that were previously unrecognized, achieve these impacts in a cost-effective manner, and create a new funding stream for additional whole-home weatherization to be performed in the Duke Energy Ohio Service Territory.

My Home Energy Report (formerly called Home Energy Comparison Report)

My Home Energy Report (MyHER or the Program) is a periodic comparative usage report that compares a customer's energy use to similar residences in the same geographical area based upon the age, size and heating source of the home. Specific energy saving recommendations are included in the report to encourage energy saving behavior.

The reports are distributed up to 12 times per year (delivery may be interrupted during the off-peak energy usage months in the fall and spring). The report delivers energy savings by encouraging customers to alter their energy use. The monthly and annual energy usage of each home is compared to the average home (top 50%) in their area as well as the efficient home (top 25%). Suggested energy efficiency improvements given the usage profile for that home are also provided. In addition, measure-specific offers, rebates or audit follow-ups from other Company offered programs are offered to customers, based on the customer's energy profile.

Target customers reside in individually-metered, single-family residences with active account and 12 months of usage history. Analyzing only single-family residences eliminates the possibility of erroneous data caused by thermal transfer between adjacent units in multi-family structures.

In July 2013, the format of the report was modified. The modified report shows the comparison of customer usage in kWh instead of dollars. This modification was implemented to minimize the possibility of confusion associated with dollars showing on the report and the customer's bill. The new report format enables The Company to now offer the report to customers on budget billing plans.

MyHER Program Potential Changes:

Work is underway to implement an online and mobile experience incorporating the report and other behavior modification advice and tools as well as email communication.

Analysis is underway to assess the benefits of offering this program to Budget Bill customers.

Power Manager® Program

The Power Manager Program provides incentives to residential consumers who allow the company to cycle their air conditioner's outdoor compressor and fan during peak energy periods between May and September. Participating customers of the Company who have a functioning outdoor A/C unit are eligible for the program.

Participants in the Power Manager program allow Duke Energy Ohio to control their air conditioners during peak summer demand periods. Customers receive a one-time enrollment incentive of $25 or $35 depending on the Power Manager option they choose. In addition, they receive credits for each Power Manager event. Following the end of the event season, which runs from May through September, if warranted, customers receive a credit that ensures their total credit for the season is a minimum of $5 or $8 depending on the option in which they enrolled.

Due to a cool start to the summer of 2013, the first Power Manager event occurred in mid-July. Over the course of the following two months, Power Manager was activated a total of seven times in Ohio. During these events, Duke Energy cycled customers' air conditioning units off and on, helping shift demand and lower the afternoon peak. In three of these seven events, Power Manager reduced load to meet commitments made to the regional transmission organization PJM.

Using lessons learned from the telemarketing begun in 2012, Power Manager was successfully promoted throughout 2013 using outbound calling. Additional marketing channels include: zip code specific direct mail, targeted email offers and the company website. Over 3,900 additional Power Manager devices were installed in 2013. A third party installs the device on customers' A/C units.

Power Manager Program Potential Changes:

There are no plans to change the operation of the Power Manager program in 2014. Duke Energy will continue to enhance the Power Manager value proposition by cycling events held in conjunction with PJM.

Non-Residential Programs

Smart $aver® Non-Residential Prescriptive Program

The Smart $aver® Non-residential Prescriptive Incentive Program provides incentives to commercial and industrial consumers for installation of energy efficient equipment in applications involving new construction, retrofit, and replacement of failed equipment. The program also uses incentives to encourage maintenance of existing equipment in order to reduce energy usage. Incentives are provided based on Duke Energy Ohio's cost effectiveness modeling to assure cost effectiveness over the life of the measure.

Commercial and industrial consumers can have significant energy consumption, but may lack knowledge and understanding of the benefits of high efficiency alternatives. Duke Energy Ohio's program provides financial incentives to customers to reduce the cost of high efficiency equipment. This allows customers to realize a quicker return on investment. The savings on utility bills, allows customers to reinvest in their business. The Smart $aver® program also increases market demand for high efficiency equipment. Because of the increased demand, dealers and distributors will stock and provide high efficient alternatives as they see increased demand for the products. Higher demand can result in lower prices.

The program promotes prescriptive incentives for the following technologies – lighting, HVAC, pumps, variable frequency drives, food services, process equipment, and information technology equipment. Equipment and incentives are predefined based on current market assumptions and Duke Energy's engineering analysis. The eligible measures, incentives and requirements for both equipment and customer eligibility are listed in the applications posted on Duke Energy's Business and Large Business websites for each technology type.

Effective January 1, 2013, Duke Energy Ohio contracted with Ecova to handle both the fulfillment responsibilities and call center services for the Smart $aver® program. Effective September 16, 2013, call center services are being handled by Duke Energy Ohio.

All non-residential customers served by Duke Energy in Ohio are eligible for the Smart $aver® program. Although customers may choose to opt-out of the Duke Energy program and energy efficiency rider, all customers are opted in at this time.

Getting the Trade Allies (TA) to support the program has proven to be the most effective way to promote the program to our business customers. The Smart $aver outreach team builds and maintains relationships with trade allies associated with the technologies in and around Duke Energy Ohio's service territory. Trade ally company names and contact information appear on the TA search tool located on the Smart $aver® website. This tool was designed to help customers who do not already work with a TA, to find someone in their location who can serve their needs.

Duke Energy Ohio continues to look for ways to engage the trade allies in promotion of the program, including the utilization of focus groups. Duke Energy Ohio developed a collateral tool kit to allow tto use the Smart $aver® logo along with white papers, case studies, and other types of collateral developed by Duke Energy Ohio. Originally, a tool kit was available for Variable Frequency Drives. Toolkits are now available for Lighting and HVAC. In 2013, Duke Energy Ohio offered co-funding to trade allies for approved marketing supplies and activities for promoting the Smart $aver program. Funds were available on a first come first serve basis. Duke Energy Ohio plans to continue co-funding in 2014.

In 2014, Duke Energy Ohio plans to partner with trade allies to offer incentives at the point of sale. Product distributors will reduce the purchase price by the incentive amount to eligible Duke Energy Ohio customers during the purchase. Distributors will provide Duke Energy Ohio with the customer participation information at which time Duke Energy Ohio will reimburse the distributor for the amount of the incentive.

Duke Energy Ohio has also added an outreach team member to focus on the unassigned small and medium business customers. This team member splits time between Ohio, Kentucky, and Indiana and will focus on marketing and program support.

In 2013, Duke Energy Ohio also launched the Duke Energy Ohio Online Savings Store. The store allows Duke Energy Ohio commercial and industrial customers to purchase products eligible for Smart $aver incentives. The purchase price of the products is reduced by the amount of the incentive at the time of purchase. Products available on the store include: CFLs, LEDs, occupancy sensors, and programmable thermostats. The marketing channel resulted in 29 orders and incentives paid in the amount of $2,300. Duke Energy Ohio promoted the store and product offerings via e-newsletters, emails, and through the Duke Energy Ohio website.

Duke Energy Ohio's website is a great source of program information. Customers and trade allies can visit the website and learn about the program, program benefits, search for participating vendors, ask questions on-line, and complete application forms. The website includes a video for programmable thermostats. An HVAC calculator is available in addition to the lighting and VFD calculators.

Duke continues to develop case studies and testimonials from customers who have participated in the program to be used to help promote the program – showing actual savings and benefits for each technology type.

In accordance with new federal standards, Duke Energy Ohio has phased out the incentives for T5 fixtures replacing T12s and for standard 4 foot T8s replacing T12s. Duke Energy Ohio continues to offer incentives for reduced wattage (RW) and high performance (HP) T8 lamps.

Recently, Duke Energy Ohio added additional incentives to the Prescriptive Incentive program. Incentives are now offered for faucet aerators, showerheads, energy star vending machines, dishwashers, automatic closers for walk-in freezer and coolers, many IT measures, ductless mini-split air conditioners and heat pumps, chilled water reset, cool roofs, demand controlled ventilation, water heater pipe insulation, and additional interior and exterior lighting and controls.

Smart $aver® Non-Residential Prescriptive Program Potential Changes:

Standards continue to change and new, more efficient technologies continue to emerge in the market. The Company expects to continue to add new measures to provide incentives for customers to take advantage of a broader suite of products. The Company undertakes an annual review of technologies and efficiency levels through internal sources and with the assistance of outside technical experts. The review includes the existing technology categories as well as other emerging areas for energy efficiency.

Smart $aver® Custom Rebate Program

Duke Energy Ohio's Smart $aver® Nonresidential Custom Incentive Program offers financial assistance to qualifying commercial, industrial and institutional customers (that have not opted out) to enhance their ability to adopt and install cost-effective electrical energy efficiency projects.

The Smart $aver® Custom Incentive program is designed to meet the needs of Duke Energy Ohio customers with electrical energy saving projects involving more complicated or alternative technologies, or those measures not covered by standard Prescriptive Smart $aver® Incentives.

The Custom Incentive application is for projects that are not listed on the applications for Smart $aver® Prescriptive Incentives. Unlike the Prescriptive Incentives, Custom Incentives require approval prior to the customer's decision to implement the project. Proposed energy efficiency measures may be eligible for Custom Incentives if they clearly reduce electrical consumption and/or demand.

Currently there are the following application forms that are located on the Duke Energy Ohio website under the Smart $aver® Incentives (Business and Large Business tabs).

- Application Part 1 – Administrative Information
- Applications Part 2 Worksheets – Energy Savings Calculations & Basis
    - Variable Frequency Drives
    - Energy Management Systems
    - Compressed Air
    - Lighting

- General

The program is promoted through but not limited to the following;

- Trade ally outreach
- Duke Energy Ohio Business Relations Managers
- Duke Energy Ohio segment specific workshops
- Company website

Smart $aver® Custom Rebate Program Potential Changes:

In 2013, Duke Energy Ohio added engineers to its staff to provide application technical support and consulting to customers considering highly complex projects. Additionally, the Custom program has successfully implemented calculation assistance on behalf of customers who lack resources to complete the engineering calculations required by the Custom program. Program management continues to look for additional improvements that will enhance participation and program efficiency.

Mercantile Self-Direct Rebates Program

The Duke Energy Ohio Mercantile Self-Direct program was enacted in accordance with Public Utilities Commission of Ohio (Commission) Rule 4901:1-39-05(G).A.C., and the Commission's Opinion and Order in Case No. 10-834-EL-POR. Customers who use 700,000 kWh or greater annually and national accounts are eligible for the program.

These customers may elect to commit energy savings or demand reductions from projects completed in the prior three calendar years that did not receive Smart $aver® incentives to Duke Energy Ohio's benchmark achievements. In return, Duke Energy Ohio will assist the customer in filing an application with PUCO for approval of a portion of the incentive the customer would have received had they participated in Duke Energy Ohio's standard Smart $aver® Non-Residential programs.

Any customers that paid a reduced rider amount as the result of a negotiated settlement and wish to receive a Self-Direct rebate will be invoiced for the differential from the date of project completion until the last effective date of the negotiated settlement.

The marketing channels for Mercantile Self-Direct project applications closely resemble those of the Smart $aver® Prescriptive and Smart $aver® Custom programs, based on applicability, as described in previous sections of this filing.

Rebates for Self-Direct projects eligible for a cash rebate reasonable arrangement will be a maximum of 50% of the dollar amount that would apply to the same project if evaluated in the Smart $aver® Prescriptive & Custom programs.

Self Direct Prescriptive Program - The Self-Direct Prescriptive program provides rebates for mercantile customers who implement energy efficiency and/or demand reductions projects to install higher efficiency equipment. Major categories include lighting, motors, pumps, VFD's, food service, information technology, HVAC and process equipment. Eligible measures are reflective of the Smart $aver® Prescriptive Incentive portfolio. While many of the measures recorded under the Smart $aver® Prescriptive program will remain Prescriptive in nature under the Self-Direct program, in accordance with Commission rules and orders on the mercantile program, certain measures may be evaluated under the Self-Direct Custom program to enable the use of as-found baseline.

Self Direct Custom Program - The Self-Direct Custom program offers rebates for completed mercantile projects involving more complicated scopes, or unique technologies that resulted in improvements upon facility electrical energy efficiency. A proposed energy efficiency measure may be eligible for a Self-Direct Custom rebate if it clearly reduces electrical consumption and/or demand. Unlike the Smart $aver® Custom program, measurable and verifiable behavioral and operational measures are eligible in the Mercantile Self Direct program.

Non-Residential Energy Assessments Program

The purpose of the Non-Residential Energy Assessment Program is to assist non-residential customers in assessing their energy usage and providing recommendations for more efficient use of energy. The program will also help identify those customers who could benefit from other Duke Energy Ohio Energy Efficiency non-residential programs.

Duke Energy Ohio offers two types of assessments to help customers identify energy efficiency opportunities. First, an Online Assessment tool is available for all non-residential customers through the Duke Energy Ohio website. This tool is available free of charge. Second, Duke Energy Ohio offers various types of On-Site Assessments wherein an assessor will spend one or more days at a customer's site identifying opportunities for increased energy efficiency. The various types of assessments include those defined by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (Level II and Level III) as well as assessments focused on specific market segments or systems (i.e. commercial real estate, data centers, hospitals, compressed air systems, and chilled water systems). After the audit is completed, the customer receives a written report of the audit findings as well as assistance applying for Smart $aver Incentives if desired. The cost of the On-Site Assessment varies depending on the complexity, size of the facility, and length of time required. Customers determined eligible may receive financial assistance with a subsidy of up to 50% of the total assessments cost.

Impacts captured as a result of Energy Assessment recommendations are recorded in Duke Energy Ohio's non-residential incentive programs. As a result, they are not presented for this section.

Non-Residential Energy Assessment Program Potential Changes:

Duke Energy Ohio is continuously evaluating assessments and determining if other types may be offered in order to assist customers in saving energy.

<u>PowerShare® Program</u>

The PowerShare® program is Duke Energy Ohio's demand side management (or demand response) program geared toward Commercial and Industrial customers. The primary offering under PowerShare® is named CallOption and it provides customers a variety of offers that are based on their willingness to shed load during times of peak system usage. These credits are received regardless of whether an event is called or not. Energy credits are also available for participation (shedding load) during curtailment events. The notice to curtail under these offers is between 6 hrs (emergency) and day-ahead (economic) and there are penalties for non-compliance during an event.

- The program is promoted through but not limited to the following;
    - Duke Energy Ohio Business Relations Managers
    - Email to customers
    - Duke Energy Ohio website

Customer targets in 2013 continued to be large manufacturers, water/wastewater facilities and school systems. The market is very competitive with other Curtailment Service Providers acquiring customers during 2013 that had previously been PowerShare® participants.

PowerShare® Program Potential Changes:

The largest change in 2014 is to move the contracts to "Summer Only" status for Emergency/Economic PowerShare CallOption events (June 1 to September 30). This is to match the "Limited Demand Response" timeframe from PJM. Duke Energy Ohio will use PowerShare QuoteOption to provide voluntary curtailment events for customers in the non-summer months.

Appliance Recycling Program

The Duke Energy Ohio Appliance Recycling Program (ARP) launched on October 4, 2012 in cooperation with the selected program vendor, JACO Environmental, Inc. ARP encourages customers to responsibly dispose of functional refrigerators and freezers. Customers enroll in the program receive free in home appliance pick up and receive a $30 incentive for participating in the program. Up to 95% of the appliance materials will be recycled in an environmentally responsible manner and the remaining materials are disposed of at landfills. Program marketing utilized a variety of methods to engage customers including the following:

- Direct mail
- Bill inserts & messages
- Digital and broadcast media
- Social media
- Community presentations
- Special events and promotions
- Newsletters

The advertising strategy was diverse and effective as reflected in the "How Heard" response from our customers provided in the table below. Some channels were clearly more memorable for customers, but there were often multiple outreach efforts taking place at the same time which could mean that multiple outreach methods could have influenced customer behavior. The oldest Fridge in Ohio was particularly engaging and unique while providing valuable program lift.

Customer "How Heard" about the program table:

Marketing Channel	%
Appliance retailer	4.4%
Electric utility office	1.0%
Friend/neighbor	11.4%
Magnet mailer	0.5%
Newspaper advertising	10.7%
Repeat customer	0.7%
Television advertising/news	13.9%
Truck sign	0.3%
Utility bill insert	43.8%
Utility company web site	6.1%
Utility newsletter	1.7%
Web advertisement/search	5.4%
Total	100%

The Duke Energy Ohio Appliance Recycle Program recycled 3,614 (2,757 refrigerator and 857 freezers) appliances in 2013 and ended the year at 83% of annual participation goal.

Appliance Recycling Program Potential Changes

Program results fell short of expectations even though considerable time an effort was expended in marketing campaigns. Based on results from a pricing test ($30, $40 and $50) conducted in North Carolina, Duke Energy Ohio requests an increase of the customer incentive from the current $30 incentive to $50 per qualified appliance. The pricing test justified the increased incentive through additional enrollments. The increased participation resulted in lower fixed costs per participant and those savings were more than the increase in the per participant incentive, thus the program remained cost effective.

Low Income Neighborhood Program

The Low Income Neighborhood Program ("Program") assists low-income customers in reducing energy costs through energy education and by installing energy efficient measures into customer's homes. The primary goal of the Residential Neighborhood Program is to empower low income customers to better manage their energy usage.

Duke Energy Ohio has partnered with GoodCents to administer the program. The Program will target neighborhoods with a significant low income customer base using a grassroots marketing approach to interact on an individual customer basis and gain trust. Participation is driven through a neighborhood kick-off event that includes trusted community leaders supporting the benefits of the Program. The purpose of the kick-off event is to rally the neighborhood around energy efficiency and to educate customers on methods to lower their energy bills. Customers will have the option to sign-up for an energy assessment at the time of the event.

In addition to the kick-off event, GoodCents will use the following channels to inform potential customers about the Program:

- Direct mail
- Door hangers
- Press releases
- Community presentations and partnerships
- Inclusion in community publications such as newsletters, etc.

Customers participating in the Program will receive an energy assessment to identify energy efficiency opportunities in the customer's home and one-on-one education on energy efficiency technique. Additionally, the customer receives a comprehensive package of energy efficient measures. Each measure listed is installed or provided to the extent the measure is identified as an energy efficiency opportunity based on the results of the energy assessment. For customers receiving furnace filters as part of their comprehensive kit, will be provided a year's supply after the initial has been installed.

The Program is available only to individually-metered residential customers in neighborhoods selected by Duke Energy Ohio, at its sole discretion, which are considered low-income based on third party data, that includes income level and household size. Areas targeted for participation in this Program will approximately have 50% of the households with an income equal to or less than 200% of the federal poverty level as established by the U. S. Government.

The program launched second quarter, 2013.

Low Income Neighborhood Program Potential Changes

Since the Program's launch, we have seen a slow increase in participation. Multiple factors have contributed to the slow increase. To combat the issue, we have added additional direct mailings and neighborhood canvassing. When necessary, we will set-up informational booths at multiple locations prior to the start of the neighborhood event. This will allow flexibility for customers unable to attend kickoff events, but wanting one-on-one information about the program. We will be adding outbound calls as a way to further employ customers to attend kickoff events and participate in the program. Additionally, we are reviewing other incentives to offer customers as part of the program.

<u>Home Energy Solutions (formerly called Home Energy Management) Program</u>

Home Energy Solutions is an approach to delivering energy efficiency solutions to customers in a way that combines a number of energy efficient measures into more valuable solutions. Home Energy Solutions will combine energy usage information and recommendations with the ability to leverage potential pricing options and energy management offerings into convenient in-home solutions. At launch, Home Energy Solutions will center around a professionally installed Wi-Fi thermostat offering to customers.

Upon notification of portfolio approval in August 2012, Duke Energy Ohio immediately launched an RFP process to select a vendor. In anticipation of receiving approval, the RFP was designed in advance to ensure getting it into the market quickly. Given the fact that this is for a commercialized program, the RFP was very comprehensive and required substantial detail on the part of participating vendors. This included live access to their current product for Duke Energy Ohio evaluation/testing. The objective through the entire process was to ensure that the solution is tested, scalable, and will deliver the intended features/value for Ohio customers and Duke Energy Ohio. The RFP went out to 11 vendors, all of whom agreed to participate.

Over the last few months, each vendor has been through extensive reviews and testing. This includes lab and employee home testing of their solutions, interviews with each vendor's current customers (utilities), financial risk assessments, etc. A final vendor was selected and contract signed November of 2013, and implementation work officially commenced at that time.

Duke Energy Ohio has established the development/launch timeline with the requirements for this program as well other internal IT work we must align with (such as Ohio meter interval data feed integration work). Given these factors, we are targeting an official program launch early in the second half of 2014.

4901:1-39-05(C)(2)(a)(i) Cont'd... Number and Type of Participants and Comparison of Forecasted Savings to Achieved Savings

The number of participants or measures installed by customer type is summarized above in Table 2. Details on participation by measure are provided in Appendix A.

The Company's programs are approved for implementation through December 31, 2013. A new portfolio filing seeking program approval for January 1, 2014 – December 31, 2016 was filed on April 15, 2013[3] and approved on December 4, 2013. Table 4 provides a comparison of achieved impacts for 2013 as well as the forecasted impacts for 2014.

[3] Case No. 13-0431-EL-POR

Table 4: Comparison of Achievement to Forecasted Impacts and Trend Projection Through 2014								
	Achieved Load Impacts		Forecasted Load Impacts					
	MWH 2013	MW 2013	MWH 2013	MWH 2014	MWH Total	MW 2013	MW 2014	MW Total
Other Programs								
Powershare Generators	0.0	(13.5)	0	0	0	0	0	0
Low Income Weatherization	716.6	0.2	0	0	0	0	0	0
Large Transmission Customer	0.0	46.1	0	0	0	0	0	0
Residential Programs								
Appliance Recycling Program	5,970.4	1.6	7,296	8,136	15,432	2	2	4
Home Energy Solutions	0.0	0.0	0	1,010	1,010	0	1	1
Home Energy Solutions - DR	0.0	0.0	0	0	0	0	2	2
Low Income Neighborhood Program	255.4	0.1	1,377	1,262	2,638	0	0	1
Energy Efficiency Education Program for Schools	1,112.8	0.1	875	2,026	2,901	0	0	0
Home Energy Comparison Report	410.0	0.1	(806)	458	(348)	(0)	0	(0)
Low Income Services	0.0	0.0	108	108	216	0	0	0
Power Manager	0.0	1.0	0	0	0	3	4	7
Residential Energy Assessments	3,661.0	0.5	7,388	2,332	9,720	1	0	1
Smart $aver Residential	37,419.9	5.1	15,157	15,413	30,570	4	3	7
Weatherization Pilot	0.0	0.0	0	51	51	0	0	0
Non Residential Programs								
Smart $aver Non Residential Custom	18,416.2	2.2	27,784	28,027	55,811	3	3	6
Smart $aver Non Residential Prescriptive	58,020.6	11.6	55,938	55,056	110,994	12	11	22
Non Residential Energy Management Information System	0.0	0.0	0	1,974	1,974	0	0	
PowerShare*	0.0	(11.2)	0	0	0	(3)	(0)	(3)
Mercantile Self-Direct	18,118.9	4.1	0	0	0	0	0	0
Total for All Programs	**144,102**	**48**	**115,118**	**115,851**	**230,969**	**22**	**27**	**49**

1. Low Income Weatherization reflects 2013 incremental impacts.
2. 2013 forecasted impacts from the previous extension filing.
3. 2014 forecasted impacts have been updated with more recent estimates to align with updated projection filing.
4. HECR and DR are shown as incremental to be consistent with achievements.

This table indicates that the achieved MWH and MW impacts through 2013 are above the 2013 forecasted load impacts.

4901:1-39-05(C)(2)(a)(ii) Energy Savings Counted Toward Benchmark as a Result of Mercantile Customers

The energy savings counted towards the benchmark for 2013 as a result of energy efficiency improvements and implemented by mercantile customers and committed to the Company are 18,119 MWH.

4901:1-39-05(C)(2)(a)(iii) Peak Demand Reduction Counted Toward Benchmark as a Result of Mercantile Customers

The peak-demand reductions counted towards the benchmark for 2013 as a result of energy efficiency improvements and implemented by mercantile customers and committed to the Company are 4 MW.

4901:1-39-05(C)(2)(a)(iv) Peak-Demand Reductions Claimed Due to Transmission and Distribution Infrastructure Improvements

The Company is not claiming any impacts from transmission and distribution infrastructure improvements at this time.

4901:1-39-05(C)(2)(b) Evaluation, Measurement, and Verification (EM&V)

In its Order in Case Number 09-512-GE-UNC, July 31 2013, the Commission stated an intention to treat the 2010 Draft TRM and those comments agreed to by VEIC as a "safe harbor" rather than a mandate. As a result of this Commission direction Duke Energy Ohio has directed third-party evaluators to consider guidelines presented by the TRM in evaluations going forward into the 2014 program evaluation year. For the current compliance filing the independent EM&V was generally conducted consistent with the most current draft of the TRM. It should be noted however, that the TRM provides no specific methodologies for behavior programs or direct load control.

Energy savings and peak-demand reduction values are documented in the individual program EM&V studies in the appendices. The following studies have been completed:

Power Manager Impact Evaluation (June 17, 2013)	Appendix D
PowerShare Impact Evaluation (June 18, 2013)	Appendix E
Smart Saver®Non-Residential Prescriptive Impact Evaluation (November 21, 2013)	Appendix F
My Home Energy Report (MyHER) Process and Impact Evaluation (November 22, 2013)	Appendix G

Appendix C provides an up-to-date summary EM&V methodologies and protocols.

The cost effectiveness of the current programs is provided below in Table 5.

Table 5: Cost Effectiveness Test Results of Current Programs

	Utility Test	TRC Test	RIM Test	Participant Test
RESIDENTIAL CUSTOMER PROGRAMS				
Appliance Recycling	3.59	4.25	1.99	NA
Energy Efficiency Education Program for Schools	2.35	3.64	1.52	NA
Home Energy Comparison Report	2.48	2.48	1.53	NA
Home Energy Solutions	1.59	2.35	1.44	4.29
Low Income Neighborhood Program	1.33	2.31	1.02	NA
Low Income Services	1.26	4.69	0.92	NA
PowerManager	3.98	4.75	3.98	NA
Residential Energy Assessments	2.83	3.04	1.68	NA
Residential Smart $aver® Products and Services	3.00	2.61	1.82	3.88
NON-RESIDENTIAL CUSTOMER PROGRAMS				
Smart $aver® Prescriptive	5.80	2.59	3.41	2.68
Smart Saver® Custom	4.90	1.23	2.81	1.45
Power Share®	4.05	7.83	4.05	NA

1. Home Energy Comparison Report is now the My Home Energy Report

4901:1-39-05(C)(2)(c) Continuation of Programs

Based on the success experienced and feedback from customers and trade allies, Duke Energy Ohio proposes continuing with the existing suite of offers, as well as, including additional measures and programs upon approval of Case No. 13-0431-EL-POR into the current portfolio. The portfolio is subject to annual adjustments for changes in efficiency levels or market conditions.

With respect to future program expansion or modification, the Company did not offer any piloted programs in calendar year 2013. However, the following program was submitted for inclusion and approved for 2014 in Case No. 13-0431-EL-POR.

Energy Management and Information Services (EMIS)

Duke Energy Ohio's proposed Energy Management and Information Services program is a systematic approach to reducing energy usage at qualified commercial or institutional customer facilities and persistently maintaining those savings over time. In order to achieve these goals, the program will deploy an energy management and information system and perform a remote or light onsite energy assessment. The EMIS will be software-as-a-service (SaaS) hosted by a third party vendor. The EMIS SaaS will use next day interval meter data from the customer's meter. The customer commits to implementing a bundle of energy-saving low cost operational based measures that meet certain financial investment criteria. Both the customer and Duke Energy Ohio also commit to periodic energy monitoring, analysis and reporting.

This program has the potential to encourage customers to be more proactive in their management of energy. Their interaction with the software and with the energy analysts will likely evolve the customers' views of energy as a manageable expense. Duke Energy Ohio needs to test this program offer with customers in order to prove that it is cost-effective. Several other U. S. utilities are rolling out programs and measures with similar components and are seeing cost-effective results, but Duke Energy Ohio needs to test it with our customers and the EMIS vendors that we have prequalified.

Duke Energy Ohio is currently considering three potential additions to the non-residential portfolio due to success in other jurisdictions in 2014. The Company is continually researching other energy efficiency opportunities for both the residential and non-residential customer classes.

4901:1-39-05(D) Independent Program Evaluator Report

Appendix C, provides an up-to-date summary EM&V methodologies and protocols. Individual reports have been provided as appendices D through G.

4901:1-39-05 (E)(1) and (2)(a-b) Peak Demand Reductions

Duke Energy Ohio has satisfied its peak-demand reduction benchmarks through energy efficiency and peak-demand response programs implemented by the Company and programs implemented on mercantile customer sites where the mercantile program is committed to the electric utility.

4901:1-39-05(F) and (G)(1-5) Mercantile Customers

Duke Energy Ohio's Mercantile Self Direct program is the avenue through which mercantile customers commit energy and demand impacts from their energy efficiency projects to Duke Energy Ohio in exchange for cash rebates or commitment payments. The program uses the constructs for calculating and deeming energy and demand savings that are present in the Custom Incentive and Prescriptive Incentive programs, respectively.

Upon approval of the customer's application, Duke Energy Ohio tenders an offer letter agreement to the customer which outlines the cash rebate or commitment payment offered. After the customer signs the offer letter agreement, Duke Energy Ohio submits a mercantile application to the Commission on behalf of the customer. Upon Commission approval of the application or the passing of 60 days, Duke Energy Ohio remits payment to the customer for the agreed dollar amount.

The offer letter provided to applicants pursuant to each project submitted to Duke Energy Ohio requires the customer to affirm its intention to commit and integrate the energy efficiency projects listed in the offer into Duke Energy Ohio's peak demand reduction, demand response and/or energy efficiency programs. The offer letter agreement also requires the customer to agree to serve as joint applicant in any future filings necessary to secure approval of this arrangement as required by the Commission and to comply with any information and reporting requirements imposed by rule or as part of that approval. Noncompliance by the customer with the terms of the commitment is not applicable at this time.

The attached offer letter agreement template (Appendix H), used for each mercantile application (examples in Appendix I and Appendix J), provides for formal declaration. Additionally, the attached example application documents request that the applicant allow Duke Energy Ohio to share information only with vendors associated with program administration. The release is limited to use of the information contained within the application and other relevant data solely for the purposes of reviewing the application, providing a rebate offer, submitting documentation to the Commission for approval and payment of the rebate. All program administration vendor contracts strictly prohibit the sharing of customer information for other purposes.

Upon customer request, Duke Energy Ohio will agree, as it is able to do so, to provide information to the Commission in the proper format such that confidential customer information is redacted from the public record.

With regard to the customers in Duke Energy's Ohio territory who have undertaken self-directed energy efficiency projects, these initiatives will not be evaluated by the Company's independent evaluation contactor (TecMarket Works). These efforts have been implemented in the past and were self-directed by our mercantile customers without involvement in Duke Energy Ohio's energy efficiency or demand reduction programs under Duke Energy Ohio's Shared Savings Cost Recovery mechanism. As a result they will not be included in the evaluations of Duke Energy Ohio programs.

As of December 31, 2013, only one customer requested rider exemption in exchange for commitment of energy and demand savings to Duke Energy Ohio however the application was dismissed by the Commission in January 2014.

4901:1-39-05(H) Prohibition Against Counting Measures Required by Law Toward Meeting the Statutory Benchmark

Duke Energy Ohio did not count, in meeting its statutory benchmark, the adoption of measures that were required to comply with energy performance standards set by law or regulation, including but not limited to, those embodied in the Energy Independence and Security Act of 2007, or an applicable building code.

4901:1-39-05 (I) and (J) Benchmarks Not Reasonably Achievable

The above referenced sections do not apply to Duke Energy Ohio as it has met and exceeded the statutory benchmarks for the 2013 calendar year.

III. Conclusion

With this status report, Duke Energy Ohio has demonstrated that it is in compliance with the statutory load impact requirements as measured and reported in its Benchmark Report.

Duke Energy Ohio respectfully requests that the Commission find that the Company has met its compliance requirements for the 2013 compliance year.

Respectfully submitted,

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4901:1-39-05(C)(1)(b) - SB 221 Appendix A

2013 Total Reported Achievement

Program	Customer	Product Code	Measure	Annual KW Gross FR, @ Plant Total	Annual KWH Gross FR, @ Plant Total	Participants
Grand Total				47,891	144,101,736	1,659,020

Other EE Programs

Program	Customer	Product Code	Measure	Annual KW Gross FR, @ Plant Total	Annual KWH Gross FR, @ Plant Total	Participants
PowerShare Generators	NonRes		PowerShare Generators	(13,504)		
Large Transmission Customer	NonRes		Large Transmission Customer	46,075		
Low Income Weatherization	Res		Low Income Weatherization	193	716,562	726
Grand Total				**32,764**	**716,562**	**726**

Shared Savings and Mercantile Portfolios

Program	Customer	Product Code	Measure	Annual KW Gross FR, @ Plant Total	Annual KWH Gross FR, @ Plant Total	Participants
Home Energy Comparison Report	Res	HECR	Home Energy Comparison Report	-	-	-
Home Energy Comparison Report	Res	HECR	Home Energy Comparison Report - Commercialized	125	410,024	252,105
Home Energy Comparison Report	**Res**	**HECR Total**		**125**	**410,024**	**252,105**
Home Energy Comparison Report Total				**125**	**410,024**	**252,105**
Power Manager	Res	PWRMGR	PowerManager -Midwest	963		
Power Manager	**Res**	**PWRMGR Total**		**963**		
Power Manager Total				**963**		
PowerShare®	Non-Res	PWRSHR	PS CallOption 0_5	(10,892)		
PowerShare®	Non-Res	PWRSHR	PS CallOption 10_5	-		
PowerShare®	Non-Res	PWRSHR	PS CallOption 15_5	-		
PowerShare®	*Non-Res*	*PWRSHR*	*PS CallOption 5_5*	(269)		
PowerShare®	**Non-Res**	**PWRSHR Total**		**(11,161)**		
PowerShare® Total				**(11,161)**		
Mercantile Self-Direct	Non-Res	NRCSSD	Custom -	866	8,301,164	1,924
Mercantile Self-Direct	**Non-Res**	**NRCSSD Total**		**866**	**8,301,164**	**1,924**
Mercantile Self-Direct	Non-Res	NRPRSD	SD AC < 65,000 3 Ph per ton	0	865	19
Mercantile Self-Direct	Non-Res	NRPRSD	SD AC 135,000 - 240,000 per ton	2	4,215	38
Mercantile Self-Direct	Non-Res	NRPRSD	SD AC 65,000 - 135,000 per ton	1	3,567	57
Mercantile Self-Direct	Non-Res	NRPRSD	SD Air Cooled Chiller Tune Up per ton	56	156,417	1,220
Mercantile Self-Direct	Non-Res	NRPRSD	SD ECM Case Motors	6	34,993	92
Mercantile Self-Direct	Non-Res	NRPRSD	SD ENERGY STAR Commercial Glass Door Freezers 30 to 50ft3 - var	1	12,369	3
Mercantile Self-Direct	Non-Res	NRPRSD	SD ENERGY STAR Commercial Glass Door Refrigerators 15 to 30 ft3 - var	0	712	1
Mercantile Self-Direct	Non-Res	NRPRSD	SD ENERGY STAR Commercial Glass Door Refrigerators more than 50ft3 - var	0	957	1
Mercantile Self-Direct	Non-Res	NRPRSD	SD Exterior HID replacement above 250W to 400W HID retrofit		6,050	8
Mercantile Self-Direct	Non-Res	NRPRSD	SD High Bay T8 4ft Fluorescent 6 Lamp (F32 Watt T8)	61	326,665	319
Mercantile Self-Direct	Non-Res	NRPRSD	SD Occupancy Sensors under 500 Watts	7	35,514	68
Mercantile Self-Direct	Non-Res	NRPRSD	SD T-8 2ft 2 lamp	0	697	6
Mercantile Self-Direct	Non-Res	NRPRSD	SD T-8 4ft 2 lamp	3	15,328	245
Mercantile Self-Direct	Non-Res	NRPRSD	SD T-8 4ft 4 lamp	10	49,283	319
Mercantile Self-Direct	Non-Res	NRPRSD	SD VFD HVAC Fan	60	358,503	270
Mercantile Self-Direct	Non-Res	NRPRSD	SD VFD HVAC Pump	153	907,848	240
Mercantile Self-Direct	*Non-Res*	*NRPRSD*	*SD VFD Process Pump 1-50 HP*	17	81,531	80
Mercantile Self-Direct	Non-Res	NRPRSD	SD Water Cooled Chiller Tune Up per ton	2,613	7,241,772	112,967
Mercantile Self-Direct	Non-Res	NRPRSD	SD Water-Cooled cent Chiller > 300 ton 0.58 kW_ton w/ 0.35 kW_tonIPLVperton	101	280,791	1,500
Mercantile Self-Direct	Non-Res	NRPRSD	SD Water-Cooled cent Chiller > 300 ton 0.58 kW_ton w/ 0.41 kW_tonIPLVperton	108	299,661	2,250
Mercantile Self-Direct	**Non-Res**	**NRPRSD Total**		**3,202**	**9,817,737**	**119,703**
Mercantile Self-Direct Total				**4,068**	**18,118,901**	**121,627**
Appliance Recycling Program	Res	FRCYCL	Freezer Recycle	301	1,118,907	857
Appliance Recycling Program	**Res**	**FRCYCL Total**		**301**	**1,118,907**	**857**
Appliance Recycling Program	Res	RRCYCL	Fridge Recycle	1,305	4,851,459	2,757

Appliance Recycling Program	**Res**	**RRCYCL Total**		**1,305**	**4,851,459**	**2,757**
Appliance Recycling Program Total				**1,606**	**5,970,366**	**3,614**
Energy Efficiency Education Program for Schools	Res	K12CFL	K-12 Education Program- Curriculum (Jan-Mar)	20	228,786	1,895
Energy Efficiency Education Program for Schools	Res	K12CFL	K-12 Education Program- Curriculum (Apr-Dec)	100	883,975	3,491
Energy Efficiency Education Program for Schools	**Res**	**K12CFL Total**		**120**	**1,112,762**	**5,386**
Energy Efficiency Education Program for Schools Total				**120**	**1,112,762**	**5,386**
Low Income Neighborhood Program	Res	HWLI	Low Income Neighborhood	69	255,376	271
Low Income Neighborhood Program	**Res**	**HWLI Total**		**69**	**255,376**	**271**
Low Income Services	Res	REFRPL	Low Income Weatherization- Refrigerator Replacement	-	-	-
Low Income Services	**Res**	**REFRPL Total**		-	-	-
Low Income Services Total				**69**	**255,376**	**271**
Residential Energy Assessments	Res	HEHC	Home Energy House Call - Energy Efficiency Starter KIT (Jan-Apr)	369	2,616,530	1,219
Residential Energy Assessments	Res	HEHC	Home Energy House Call - Energy Efficiency Starter KIT (May-Dec)	114	1,044,517	1,542
Residential Energy Assessments	**Res**	**HEHC Total**		**483**	**3,661,047**	**2,761**
Residential Energy Assessments Total				**483**	**3,661,047**	**2,761**
Smart $aver Non Residential Custom	Non-Res	NRPRSC	Custom -	2,236	18,416,161	3,653
Smart $aver Non Residential Custom	**Non-Res**	**NRPRSC Total**		**2,236**	**18,416,161**	**3,653**
Smart $aver Non Residential Custom Total				**2,236**	**18,416,161**	**3,653**
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Anti-sweat Heater Controls	1	400,625	224
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ECM Case Motors	21	244,570	643
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ECM Cooler and Freezer Motors - ECM replacing PSC	8	93,861	50
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Glass Door Freezers 15 to 30 ft3 - var	0	2,140	1
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Glass Door Refrigerators 30 to 50ft3 - var	0	1,555	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Glass Door Refrigerators more than 50ft3 - var	0	1,918	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Solid Door Freezers < 15ft3 - var	0	1,271	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Solid Door Freezers 15 to 30 ft3 - var	0	1,856	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Solid Door Freezers 30 to 50ft3 - var	0	3,690	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Solid Door Refrigerators < 15ft3 - var	0	577	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	ENERGY STAR Commercial Solid Door Refrigerators 15 to 30 ft3 - var	0	502	1
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Holding Cabinet Half Size Insulated	1	3,836	2
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Icemaker (> 1000 lbs_day)	1	10,981	8
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Night covers for displays	-	2,608	32
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Snack Machine Controller	0	2,981	10
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Steamer_6 pan	3	16,207	1
Smart $aver Non Residential Prescriptive	Non-Res	NRFS	Vending Equipment Controller	7	36,970	43
Smart $aver Non Residential Prescriptive	**Non-Res**	**NRFS Total**		**43**	**826,146**	**1,027**
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC < 65,000 1 Ph per ton	1	1,094	18
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC < 65,000 3 Ph per ton	1	410	9
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC > 760,000 per ton	25	19,541	350
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC 135,000 - 240,000 per ton	37	29,624	414
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC 240,000 - 760,000 per ton	8	6,572	90
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	AC 65,000 - 135,000 per ton	21	16,628	284
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Air Cooled Chiller Tune Up per ton	124	262,431	3,275
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Air-Cooled Screw Chiller COP = 2.86, IPLV = 3.97 per ton	38	80,164	352
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Air-Cooled Screw Chiller COP = 2.86, IPLV = 4.33 per ton	105	221,041	536
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Energy Star Room AC under 14,000 Btu hr	0	138	1
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Guest Room Energy Management, Electric Heating	191	1,112,848	1,595
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Packaged Terminal AC	0	41	1
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Setback Programmable Thermostat	(0)	211,668	171
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Thermal Storage	310		2
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Water Cooled Chiller Tune Up per ton	1,152	2,436,510	57,012
Smart $aver Non Residential Prescriptive	Non-Res	NRHVAC	Window Film	214	492,733	112,692
Smart $aver Non Residential Prescriptive	**Non-Res**	**NRHVAC Total**		**2,227**	**4,891,442**	**176,802**
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	2 High Bay 6L T-5 High Output replacing 1000W HID	6	30,561	18
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS 2 High Bay 6L T-5 High Output replacing 1000W HID	78	382,015	225
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay 2L T-5 High Output	6	33,730	81
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay 4L T-5 High Output	137	739,721	775
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay 6L T-5 High Output	162	876,782	2,179
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay 8L T-5 High Output	151	818,067	289
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay Fluorescent 3 Lamp (F32 Watt T8)	1	6,368	16
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay Fluorescent 4 Lamp (F32 Watt T8)	175	947,423	1,426

Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,549	8,377,090	8,065
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Bay Fluorescent 8 Lamp (F32 Watt T8)	11	56,848	81
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance Low Watt T8 4ft 1 lamp, replacing standard T8 (Jan-Nov)	3	17,182	506
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance Low Watt T8 4ft 2 lamp, replacing standard T8 (Jan-Nov)	246	1,209,980	24,943
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance Low Watt T8 4ft 3 lamp, replacing standard T8 (Jan-Nov)	31	150,089	1,820
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance Low Watt T8 4ft 4 lamp, replacing standard T8 (Jan-Nov)	50	246,760	2,826
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 1 lamp, replacing T12-HPT8 (Jan-Nov)	0	1,709	30
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T-8 4ft 2 lamp replacing T-12 High Output 8ft 1 lamp (Jan-Nov)	6	28,521	177
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 2 lamp, replacing standard T8 (Jan-Nov)	0	695	17
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 2 lamp, replacing T12-HPT8 (Jan-Nov)	27	132,012	1,723
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 2 lamp, replacing T12-HPT8 (Dec)	2	11,514	78
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 3 lamp, replacing standard T8 (Jan-Nov)	0	877	19
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 3 lamp, replacing T12-HPT8 (Jan-Nov)	13	63,106	492
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 3 lamp, replacing T12-HPT8 (Dec)	5	31,631	128
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T-8 4ft 4 lamp replacing T-12 High Output 8ft 2 lamp (Jan-Nov)	136	674,509	2,282
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T-8 4ft 4 lamp replacing T-12 High Output 8ft 2 lamp (Dec)	27	162,295	285
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 4 lamp, replacing T12-HPT8 (Jan-Nov)	61	300,570	2,059
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS High Performance T8 4ft 4 lamp, replacing T12-HPT8 (Dec)	13	77,624	276
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Low Watt T8 lamps replacing standard 32 Watt T-8's (Jan-Nov)	380	1,900,586	96,128
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Low Watt T8 lamps replacing standard 32 Watt T-8's (Dec)	36	216,427	5,682
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Occupancy Sensors over 500 Watts (Jan-Nov)	336	1,652,276	1,261
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Occupancy Sensors over 500 Watts (Dec)	4	8,826	12
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Occupancy Sensors under 500 Watts (Jan-Nov)	2,366	11,404,778	21,791
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Occupancy Sensors under 500 Watts (Dec)	40	89,727	305
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	BONUS Pulse Start Metal Halide (retrofit only)	4	21,655	48
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Ceramic Metal Halide 20-100W	23	111,657	198
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	CFL Reflector Flood	39	189,190	780
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	CFL Screw high wattage	78	383,947	781
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	CFL Screw in, Specialty	4	17,475	115
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Compact Fluorescent Fixture	64	315,662	744
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Compact Fluorescent Screw in	174	854,908	4,721
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Delamping T12 3ft to T-8	4	20,083	138
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Exterior HID replacement above 175W to 250W HID retrofit		139,887	317
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Exterior HID replacement above 250W to 400W HID retrofit		473,473	625
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Exterior HID replacement above 400W HID retrofit		399,473	293
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Exterior HID replacement to 175W HID retrofit		120,269	402
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Garage HID replacement above 175W to 250W HID retrofit	39	343,590	341
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Garage HID replacement above 250W to 400W HID retrofit	65	568,103	328
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Garage HID replacement above 400W HID retrofit	2	15,584	5
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Garage HID replacement to 175W HID retrofit	189	1,652,977	2,421
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	High Performance T8 4ft 2 lamp, replacing T12 8ft 1 lamp (Jan-Nov)	4	20,820	284
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	High Performance T8 4ft 4 lamp, replacing T12 8ft 2 lamp (Jan-Nov)	0	1,152	38
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	High Performance T8 4ft 4 lamp, replacing T12 8ft 2 lamp (Dec)	0	1,869	32
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Auto Traffic Signals	-	490,566	1,643
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Case lighting	38	448,176	913
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Case lighting sensor control	1	14,509	44
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Downlight	78	383,004	1,490
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Exit Signs Electronic Fixtures (Retrofit Only)	46	336,643	1,377
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Lamps	810	3,987,199	17,089
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LED Pedestrian Signals	18	62,447	388
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 1 lamp, Replace T12 (Jan-Nov)	4	17,880	295
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 1 lamp, Replace T12 (Dec)	0	234	2
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 2 lamp, Replace T12 (Jan-Nov)	168	823,131	10,285
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 2 lamp, Replace T12 (Dec)	4	24,979	162
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 3 lamp, Replace T12 (Jan-Nov)	39	191,692	1,317
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 3 lamp, Replace T12 (Dec)	8	49,354	176
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 4 lamp, Replace T12 (Jan-Nov)	191	937,375	5,682
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	LW HPT8 4ft 4 lamp, Replace T12 (Dec)	0	1,271	4
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	Occupancy Sensors over 500 Watts (Jan-Nov)	0	1,310	1
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 2ft 1 lamp (Jan-Nov)	0	1,067	22
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 2ft 2 lamp (Jan-Nov)	48	236,340	2,030

Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 2ft 3 lamp (Jan-Nov)	3	16,881	290
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 2ft 4 lamp (Jan-Nov)	1	5,700	25
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 3ft 1 lamp (Jan-Nov)	1	3,190	47
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 3ft 2 lamp (Jan-Nov)	4	19,645	166
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 3ft 4 lamp (Jan-Nov)	1	6,418	21
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 4ft 2 lamp (Jan-Nov)	1	2,581	82
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 4ft 4 lamp (Jan-Nov)	12	57,101	736
Smart $aver Non Residential Prescriptive	Non-Res	NRLTG	T-8 8ft 2 lamp (Jan-Nov)	0	830	25
Smart $aver Non Residential Prescriptive	**Non-Res**	**NRLTG Total**		**8,226**	**44,421,596**	**232,918**
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	5 Horse Power High Efficiency Pumps	0	2,149	2
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	7.5 Horse Power High Efficiency Pumps	1	3,224	2
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	VFD HVAC Fan (Jan-Nov)	540	3,442,959	2,593
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	VFD HVAC Fan (Dec)	11	158,895	147
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	VFD HVAC Pump (Jan-Nov)	287	3,298,515	872
Smart $aver Non Residential Prescriptive	Non-Res	NRP&M	VFD Process Pump 1-50 HP (Jan-Nov)	143	640,215	658
Smart $aver Non Residential Prescriptive	**Non-Res**	**NRP&M Total**		**982**	**7,545,958**	**4,274**
Smart $aver Non Residential Prescriptive	Non-Res	NRPROC	VSD Air Compressors	81	335,446	499
Smart $aver Non Residential Prescriptive	**Non-Res**	**NRPROC Total**		**81**	**335,446**	**499**
Smart $aver Non Residential Prescriptive Total				**11,559**	**58,020,589**	**415,520**
Smart $aver Residential	Res	RCFL	RCFL Opt-In Free CFLs	3,169	28,595,756	777,513
Smart $aver Residential	**Res**	**RCFL Total**		**3,169**	**28,595,756**	**777,513**
Smart $aver Residential	Res	RCFLPM	Property Manager 13WCFL (Jan-Feb)	14	122,712	2,904
Smart $aver Residential	Res	RCFLPM	Property Manager 13WCFL (March-Dec)	99	891,154	18,239
Smart $aver Residential	**Res**	**RCFLPM Total**		**112**	**1,013,866**	**21,143**
Smart $aver Residential	Res	SSAC	Smart Saver - Central Air Conditioner	859	1,604,412	2,478
Smart $aver Residential	**Res**	**SSAC Total**		**859**	**1,604,412**	**2,478**
Smart $aver Residential	Res	SSACTU	Smart Saver - Central Air Conditioner Tune UP	2	1,923	12
Smart $aver Residential	**Res**	**SSACTU Total**		**2**	**1,923**	**12**
Smart $aver Residential	Res	SSAIAS	Smart Saver - Attic Insul & Air Seal	42	136,565	110
Smart $aver Residential	**Res**	**SSAIAS Total**		**42**	**136,565**	**110**
Smart $aver Residential	Res	SSDINS	Smart Saver - Duct Insulation	3	3,744	4
Smart $aver Residential	**Res**	**SSDINS Total**		**3**	**3,744**	**4**
Smart $aver Residential	Res	SSDSEA	Smart Saver - Duct Sealing	15	16,646	38
Smart $aver Residential	**Res**	**SSDSEA Total**		**15**	**16,646**	**38**
Smart $aver Residential	Res	SSHP	Smart Saver - Heat Pump	621	3,824,234	1,362
Smart $aver Residential	**Res**	**SSHP Total**		**621**	**3,824,234**	**1,362**
Smart $aver Residential	Res	SSHPTU	Smart Saver - Heat Pump Tune UP	0	1,372	2
Smart $aver Residential	**Res**	**SSHPTU Total**		**0**	**1,372**	**2**
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs 3 Way	23	202,676	3,250
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs A Line	35	315,094	7,417
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs A Line Dimmable	15	134,429	1,941
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Candelabra	35	174,003	7,555
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Globe	29	256,302	9,463
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Recessed	70	622,603	13,937
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Recessed Dimmable	7	63,730	1,446
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Recessed LED	1	8,626	274
Smart $aver Residential	Res	RCFLSP	Specialty Bulbs Recessed Outdoor	6	331,689	2,784
Smart $aver Residential	*Res*	*RCFLSP*	*Specialty Bulbs A Line LED*	13	112,278	2,628
Smart $aver Residential	**Res**	**RCFLSP Total**		**234**	**2,221,430**	**50,695**
Smart $aver Residential Total				**5,058**	**37,419,948**	**853,357**
Grand Total				**15,127**	**143,385,174**	**1,658,294**

Notes:

Impacts were updated and applied in 2013 per EM&V evaluations for the following: Energy Efficiency Education Program for Schools in April, Residential Energy Assessments - Home Energy House Call in May, Smart $aver Property Manager in March and Non-Residential Smart $aver Prescriptive in December and are noted above by displaying the data for previous impacts and adjusted impacts.

Impacts were updated per EM&V evaluations in December for a number of measures that received zero participation in that month. The new impacts, as stated in the Smart Saver®Non-Residential Prescriptive Impact Evaluation – Appendix F, will be applied in 2014 as participation is recognized.

AFFIDAVIT
OF
THOMAS J. WILES

COMES NOW Thomas J. Wiles being duly sworn, deposes and says:

1. My name is Thomas J. Wiles. I am employed by Duke Energy Business Services, Inc. as Director Analytics.

2. This Affidavit will be filed with the Ohio Public Utilities Commission in support of Duke Energy Ohio's Annual Energy Efficiency Portfolio Status Report (the Report) which is required by Ohio Administrative Code §4901:1-39-05(C).

3. As Director Analytics, I have responsibility for demand side management analytics and load management analytics. As part of my professional responsibilities I assisted with the underlying analysis and preparation of Duke Energy Ohio's Report.

4. The information contained within the Report is true and accurate to the best of my knowledge.

5. The performance detailed in the Report demonstrates that Duke Energy Ohio has complied with the statutory benchmarks contained in Ohio Revised Code 4928.66.

FURTHER AFFIANT SAITH NOT.

Thomas J. Wiles

State of Ohio)
) SS:
County of Hamilton)

Subscribed to and sworn to before me this 11TH day of March 2014.

Adele M. Frisch
Notary Public

ADELE M. FRISCH
Notary Public, State of Ohio
My Commission Expires 01-05-2019

Annual Summary of Planned 2014 EM&V Activities for Duke Energy's Energy Efficiency and Demand Response Programs in Ohio

Appliance Recycling, Energy Management Information Systems, Energy Efficiency Education Program for Schools, Low Income Neighborhood Program, Low Income Services, My Energy Manager, My Home Energy Report, Smart $aver® Residential HVAC, Smart $aver® Residential: Online Savings Store (Specialty Bulbs), Smart $aver® Residential: Property Manager Program, Non-Residential Smart $aver® Prescriptive and Custom, Power Manager®, and PowerShare®

Prepared for
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Introduction and Program Background

This section presents program descriptions, end uses/measures covered, markets targeted, program implementation activities (marketing efforts, delivery channels, financial incentives), EM&V budgets, expected program participation (number of participants (or units), number of measures, expected savings, and share of savings by program relative to EE/DR portfolio). A summary of the programs offered to Duke Energy Ohio customers is provided below.

Program Offered by Duke Energy Ohio	What is in this Document
2012-2013 Appliance Recycling Program	This evaluation is in progress. This document presents the final stages of the evaluation.
2014-2015 Appliance Recycling Program	Partial Evaluation Plan: No evaluation activities will be conducted in 2014.
2014-2015 Energy Efficiency Education Program for Schools	Full Evaluation Plan
2014-2015 Energy Management Information Services (EMIS)	Methodologies to be determined in late 2014.
2013-2014 Low Income Neighborhood Program	This evaluation is in progress, but a Full Evaluation Plan is presented.
2014-2015 Low Income Services Pilot Program	Full Evaluation Plan
2014-2015 My Energy Manager (Home Energy Solutions)	Partial Evaluation Plan: No evaluation activities will be conducted in 2014.
2014-2015 My Home Energy Report (MyHER)	This program will not be evaluated in 2014. The latest report "OH - MyHER - Final Process and Impact Evaluation Report - Nov 22 2013" covers the period between April of 2011 and March of 2013. Please see the final report for methodologies used and evaluation findings. The next evaluation of the MyHER program will launch in 2015.
2012-2013 Smart $aver® Residential HVAC	This evaluation is in progress. This document presents the final stages of the evaluation.
2014-2015 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)	Full Evaluation Plan
2014-2015 Smart $aver® Residential, Property Manager Program	Full Evaluation Plan
2014-2015 Non-Residential Smart $aver® Prescriptive	This evaluation is in progress, but a Full Evaluation Plan is presented.
2014-2015 Non-Residential Smart $aver® Custom	This evaluation is in progress, but a Full Evaluation Plan is presented.
2013 Power Manager®	This evaluation is in progress. This document presents the final stages of the evaluation.
2014 Power Manager®	Full Evaluation Plan
2013 PowerShare®	This evaluation is in progress. This document presents the final stages of the evaluation.
2014 PowerShare®	Full Evaluation Plan

2012-2013 Appliance Recycling

The 2012-2013 Appliance Recycling Program offered appliance recycling services to residential customers by providing an incentive to customers that responsibly disposed of functional refrigerators and freezers. The program has removed the kWh of inefficient refrigerators and freezers from the grid and also responsibly handled the hazardous materials contained in the older appliances.

End uses, measures covered

Primary and/or secondary working refrigerators and freezers.

Markets targeted

Residential customers served on Duke Energy Ohio's residential rate schedules.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

This is presented in the final report, scheduled to be completed in Q1 of 2014.

2014-2015 Appliance Recycling

Appliance Recycling provides appliance recycling services to residential customers by providing an incentive to customers that turn in their primary and/or secondary working refrigerator or freezer for recycling. The program has removed the kWh of inefficient refrigerators and freezers from the grid and also responsibly handled the hazardous materials contained in the older appliances.

End uses, current measures covered

Primary and/or secondary working refrigerators and freezers.

Markets targeted

Residential customers served on Duke Energy Ohio's residential rate schedules.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The marketing strategy for this program will focus on a grassroots approach. Some of the marketing tactics planned to be utilized to meet participation goals are direct mail, bill inserts and messages, digital and broadcast media, social media, press releases, community presentations, special events and promotions, and partnerships, and inclusion in community publications, such as newsletters, and any marketing tactics that the selected program administrator has found to be successful with this type of program. A monetary incentive will be given to participants.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million[1].

Table 1. Expected Program Participation: 2014[2] Appliance Recycling

Number of Participants	4,875
Number of Measures	2
Expected Savings	8,135,724 kWh and 2,189 kW
Share of Savings Relative to EE/DR Portfolio	7.02% kWh and 8.11% kW

2014-2015 Energy Efficiency Education Program for Schools

The Energy Efficiency Education Program for Schools provides energy efficiency informational and educational support and resources to Kindergarten through eighth grade students enrolled in public and private schools and who reside in households served by Duke Energy Ohio The goal of the program is to use students as an information route to achieve cost effective savings in the homes of the children using the support and assistance of the parents.

End uses, current measures covered

- 1.5 GPM low flow shower head
- 1.5 GPM kitchen faucet aerator with swivel and flip valve
- Water flow meter bag
- Water temperature gauge card (Hot Water Temp Card)
- 13 watt Energy Star rated mini compact fluorescent (60 watt incandescent equivalent)
- 18 watt Energy Star rated mini compact fluorescent (75 watt incandescent equivalent)
- 1.0 GPM needle spray bathroom faucet aerator
- Combination Pack of switch and outlet gasket insulators (12/pack)
- Energy Efficient Limelight style night light
- Duke Energy labeled DOE "Energy Savers" booklet
- Roll of Teflon tape for showerhead
- Product information and instruction sheet
- Duke Energy Business Reply Card

Non-Duke Energy customers receive a smaller kit containing:

- Water flow meter bag (Hot Water Temp Card)
- 13 watt Energy Star rated mini compact fluorescent (60 watt incandescent equivalent)
- Outlet gasket insulators
- Duke Energy labeled DOE "Energy Savers" booklet

[1] Participation, program budgets, and EM&V budgets are living documents that are periodically revisited and adjusted for actual versus projected participation, changes in program offerings, etc. To this end, estimates of 2014 participation have been included coupled with anticipated spend rate for 2014. Typically the EMV spend per program is relative to either or both the program administrative costs and/or the share of savings relative to the portfolio. However, new programs require a higher percentage of EMV expenditures to accurately measure the market, though these costs are still within the bounds of the total EMV portfolio budget. *It should be noted that many evaluation activities extend beyond the calendar year of the program and may not precisely* track the program cycle budgets as a fraction of the implementation budget for the calendar year.

[2] Please note that these tables provide counts for 2014 only, not 2014-2015.

- Product information and instruction sheet

Markets targeted

The Energy Efficiency Education Program for Schools targets schools attended by students from households served by Duke Energy Ohio.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The Energy Efficiency Education Program for Schools provides principals and teachers with innovative math and science related curriculum that educate students about energy, resources, electricity, ways energy is wasted and how to use our resources wisely. Education materials focus on concepts such as energy, renewable fuels, and energy conservation through classroom and take home assignments to engage student's families. Curriculum materials are enhanced with a live 25 minute theatrical production for elementary students and a live 40 minute theatrical production for middle school students, both performed by two professional actors. The current program is developed to educate students in kindergarten through eighth grade. School principals are the main point of contact and will schedule the performance at their convenience for the entire school. Participants complete a home energy use survey with their family and receive an energy efficiency starter kit.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 2. Expected Program Participation: 2014 Energy Efficiency Education Program for Schools

Number of Participants	8,000
Number of Measures (kits)	1
Expected Savings	2,025,724 kWh and 229 kW
Share of Savings Relative to EE/DR Portfolio	1.75% kWh and 0.85% kW

2014-2015 Energy Management Information Services (EMIS)

The Energy Management and Information Services (EMIS) pilot will use a combination of analytical energy software (using interval meter data) and an onsite building energy assessment to deliver a target of 6% energy savings from low-cost operational measures in a customer's building. Duke Energy Ohio will pay up to 50% of the cost of the software and the assessment in Year 1, as well as 50% of the software license and quarterly check-ins/coaching in Years 2, 3 and 4. The installation of the low-cost measures will be funded by the customer.

End uses, current measures covered

Low cost operational measures usually found in the customer's building controls system and HVAC (heating, ventilation and air-conditioning) systems.

Markets targeted

The EMIS Pilot targets Non-Residential customers served on Duke Energy Ohio's non-residential rate schedules. In order to qualify for the EMIS pilot program, the building space must fall into one of the following categories: office space (private, commercial real estate, government, institutional); college/university (individually metered administrative and classroom buildings); small hospitals (less than 7,000,000 kWh/year) and medical office buildings; large retail (big box or anchor stores); and K-12 schools. Additional targeting criteria include: the building's annual electric energy usage must be greater than 850,000 kWh; customer must have an existing building management system (BMS) in good working condition; and the building must have a Duke Energy Ohio billing meter that records interval data (e.g., 15-minute or 30-minute intervals). In addition, the Customer must not be opted out of the EE rider.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Since there will be a very limited number of customers in the pilot, the EMIS team will use a targeted marketing approach to acquire customers for the pilot. First, Duke Energy Ohio will pre-screen for customers based on customer SIC code and annual energy usage. Next, the Large Account Management team will recommend customers for the offer. The team is planning to use a short video to describe the program to potential customers at a high level. Finally, customers who view the video can express interest by filling out a web form or signing up for one of 3 webinars, which will answer any remaining questions that they may have about the program.

The incentive is comprised of Duke Energy Ohio paying up to 50% of the cost of the software and the assessment in Year 1, as well as 50% of the software license and quarterly check-ins/coaching in Years 2, 3 and 4.

Table 3. Expected Program Participation: 2014 Energy Management Information Services

Number of Participants	1,938[3]
Number of Measures	10
Expected Savings	1,974,145 kWh and 426 kW
Share of Savings Relative to EE/DR Portfolio	1.70% kWh and 1.58% kW

2013-2014 Low Income Neighborhood Program

The Low Income Neighborhood Program assists low-income customers in reducing energy costs through energy education and by installing energy efficient measures into customers' homes.

End uses, current measures covered (including but not limited to)

The following energy saving measures are examples of what will be installed or performed as appropriate:

- CFLs
- Water heater and pipe wrap
- Low-flow shower/faucet aerators
- HVAC filters/replacement
- Air sealing to include doors and windows

[3] Participant unit is per 1,000 sq ft.

Markets targeted

The Low Income Neighborhood program will target residential neighborhoods with a high percentage of low income residential customers. Home owners and renters in single and multi-family dwellings that have electric service provided by Duke Energy Ohio are allowed to participate. Approximately 50% of homes in each targeted area have household income equal to or less than 200% of the federal poverty level as established by the U. S. Government. The program is available to all customers in defined areas and is marketed as the "Residential Neighborhood Program."

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The Low Income Neighborhood Program will recruit participants through community engagement activities, direct mail, and neighborhood canvassing. A community-based kick-off event will be held for targeted neighborhoods, followed by energy assessments completed in the customers' homes and the appropriate energy saving measures will be installed. Customers will receive education on the proper use of the installed measures, as well as energy saving tips they can adopt to help lower their energy costs.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 4. Expected Program Participation: 2014 Low Income Neighborhood Program

Number of Participants	1,339
Number of Measures	1 package selected from list above
Expected Savings	1,261,802 kWh and 339 kW
Share of Savings Relative to EE/DR Portfolio	1.09% kWh and 1.26% kW

2013-2014 Low Income Services

Duke Energy has partnered with People Working Cooperatively (PWC) for an electric pilot program. The program targets low income customers and focuses on energy efficiency. Customers receive whole-house weatherization services which include installation of energy efficiency measures and education.

End uses, current measures covered (including but not limited to)

- Refrigerator Replacement
- CFL
- Faucet Aerator (1.5 GPM assumed)
- Energy Efficient Shower Head (1.625 GPM Avg Assumed)
- Water Heater Tank Wrap
- Water Heater Pipe Insulation
- Water Heater Replacement (Electric)
- Water Heater Replacement (Gas – impacts not evaluated)
- Attic/Ceiling/Roof Insulation (Space Heating Only)

- Attic/Ceiling/Roof Insulation (Space Cooling Only)
- Wall Insulation (Space Heating Only)
- Wall Insulation (Space Cooling Only)
- Floor Insulation (Space Heating Only)
- Floor Insulation (Space Cooling Only)
- Foundation Insulation (Space Heating Only)
- Air Sealing (Space Heating Only)
- Air Sealing (Space Cooling Only)

Markets targeted

Program is offered to low income customers with household income up to 200% of the federal poverty level.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

PWC identifies customers and manages the installation of energy efficiency measures and education. Duke Energy purchases and recognizes the energy and demand savings achieved through the whole-home weatherization in the Duke Energy Ohio service territory that are currently funded by leveraged funds.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 5. Expected Program Participation: 2014 Low Income Services

Number of Participants	85
Number of Measures	1 package selected from list above
Expected Savings	107,938 kWh and 17 kW
Share of Savings Relative to EE/DR Portfolio	0.09% kWh and 0.06% kW

2014-2015 My Energy Manager (Home Energy Solutions)

Home Energy Solutions (HES) is a technology based approach to delivering energy efficiency solutions to customers in a way that combines a number of energy efficient measures into more valuable solutions. HES will combine energy usage information and savings recommendations with the ability to leverage potential pricing options and customized energy management offerings into convenient in-home solutions.

End uses, current measures covered

At the center of the program is Home Energy Manager (HEM), a smart grid enabled consumer technology that will allow customers and Duke Energy Ohio to optimize in-home devices while delivering energy efficiency savings related information. Customer participation in HES also *includes a demand response component, enabled through air conditioning unit control.* The initial technology component distribution focus is on the customer thermostat. HEM, the program software will integrate with other devices in the home over time, offering customers critical feedback and control of high use energy devices.

Markets targeted

The audience is residential Duke Energy Ohio customers. These customers reside in individually-metered, owner-occupied, single-family residences receiving concurrent electric service from Duke Energy. In addition, participating customers are required to have a wireless broadband internet connection, central heating/AC system, and twelve months of historical energy usage information. Any Duke Energy Ohio customer that has a wireless broadband connection, central heating/AC and twelve months energy usage is eligible regardless of income level.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The marketing strategy for this program will follow a more traditional consumer electronics industry model. To meet participation goals, planned marketing tactics include direct mail, email, bill insert, social media, press releases and radio/TV advertisements.
Participating customers will receive the necessary equipment and installation at no charge. There is an annual fee of no more than $5.99 that is assessed, and is dependent on the demand response program participation level selected. Customers will have the opportunity to lower their monthly energy bill by receiving the information, education, and customer support necessary to enable them to create and maintain greater energy efficiency or conservation as well as the opportunity to participate in demand response events.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 6. Expected Program Participation: 2014 My Energy Manager

Number of Participants	1,725
Number of Measures	1
Expected Savings	1,009,977 kWh and 638 kW
Share of Savings Relative to EE Portfolio[4]	0.87% kWh and 2.36% kW

Table 7. Expected Program Participation: 2014 My Energy Manager-DR

Number of Participants	1,725
Number of Measures	1
Expected Savings	0 kWh and 1,843 kW
Share of Savings Relative to DR Portfolio	0% kWh and 6.83% kW

2014-2015 My Home Energy Report (MyHER)

My Home Energy Report (MyHER) is a periodic comparative usage report that compares a customer's energy use to similar residences in the same geographical area based upon the age, size and heating source of the home. Specific energy saving recommendations are included in

[4] Demand Response programs impacts represent incremental program participation from the prior filing period to be consistent with achievements.

the report to encourage energy saving behavior. The program vendor, through proprietary techniques, compiles energy usage and publicly available information (location, size, home age, occupancy) on nearby similar homes to develop the comparisons. Reports are mailed to the residence up to 12 times per year.

End uses, current measures covered

This is an informational program only. No measures are provided.

Markets targeted

The program is structured to target a sample of customers whose eligibility requirements include residing in individually-metered, owner-occupied, single-family residences served on Duke Energy Ohio's residential rate schedules.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

Reports contain personalized tips and messages based on customers' energy usage patterns, information about their homes, as well as follow up opportunities such as an offer to participate in Duke Energy's energy efficiency programs. There are no program incentives.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 8. Expected Program Participation: 2014 My Home Energy Report

Number of Participants	253,000
Number of Measures	1
Expected Savings	457,667 kWh and 136 kW
Share of Savings Relative to EE/DR Portfolio[5]	0.40% kWh and 0.50% kW

2013 Power Manager®

Power Manager is a voluntary residential demand response program, available to homeowners with central air conditioning (AC) and heat pumps. During times of peak energy demand, Duke Energy can remotely call upon participant's air conditioning units to cycle systems off for a period of time.

End uses, current measures covered

Duke Energy installs a load management switch device that controls the participant's air conditioner. When events are initiated by Duke Energy, the radio-controlled device cycles the air conditioner off and on during peak load periods. Power Manager demand response event participation typically occurs between May and September.

Markets targeted

[5] My Home Energy Report program impacts represent incremental program participation from the prior filing period to be consistent with achievements.

Duke Energy residential customers that own a single-family home with a functional central air conditioning unit with an outside compressor.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The program is promoted using various marketing channels with an emphasis on telemarketing, direct mail, email, and web-based promotions.

Participating customers receive a sign-up incentive as well as an individual monthly credit for demand response program participation.

2014 Power Manager®

Power Manager is a voluntary residential demand response program, available to homeowners with central air conditioning (AC) and heat pumps. During times of peak energy demand, Duke Energy can remotely call upon participant's air conditioning units to cycle systems off for a period of time.

End uses, current measures covered

Duke Energy installs a load management switch device that controls the participant's air conditioner. When events are initiated by Duke Energy, the radio-controlled device cycles the air conditioner off and on during peak load periods. Power Manager demand response event participation typically occurs between May and September.

Markets targeted

Duke Energy residential customers that own a single-family home with a functional central air conditioning unit with an outside compressor.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The program is promoted using various marketing channels with an emphasis on telemarketing, direct mail, email, and web-based promotions.

Participating customers receive a sign-up incentive as well as an individual monthly credit for demand response program participation during the cooling season.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 9. Expected Program Participation: 2014 Power Manager

Number of Participants	46,742[6]
Number of Measures	1
Expected Savings	0 kWh and 4,470 kW

[6] Number of switches at the end of January, 2014.

Share of Savings Relative to DR Portfolio[7]	0% kWh and 16.56% kW

2013 PowerShare

PowerShare is a non-residential demand response program designed to reduce customers' energy use during periods of high energy prices or during periods where generation, transmission, or distribution systems are constrained. In both these situations, the PowerShare program allows Duke Energy to call upon, and purchase capacity from their customers by paying participants an incentive to reduce their energy demand for a period of time.

End uses, current measures covered

The PowerShare program pays participants an incentive that allows Duke Energy to call upon them to reduce their energy demand for a period of time.

Markets targeted

Non-residential customers that are able to demonstrate the ability to curtail a minimum of 100 kW and have an individual interval meter.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The PowerShare program is promoted mainly by Duke Energy program account managers. Account managers market to large business customers on a one-on-one basis to evaluate and determine the suitability of prospective candidates.

Incentives paid to participating customers are dependent upon the curtailment option chosen.

2014 PowerShare

PowerShare is a non-residential demand response program designed to reduce customers' energy use during periods of high energy prices or during periods where generation, transmission, or distribution systems are constrained. In both these situations, the PowerShare program allows Duke Energy to call upon, and purchase capacity from their customers by paying participants an incentive to reduce their energy demand for a period of time.

End uses, current measures covered

The PowerShare program pays participants an incentive that allows Duke Energy to call upon them to reduce their energy demand for a period of time.

Markets targeted

Non-residential customers that are able to demonstrate the ability to curtail a minimum of 100 kW and have an individual interval meter.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

[7] Demand Response programs impacts represent incremental program participation from the prior filing period to be consistent with achievements.

The PowerShare program is promoted mainly by Duke Energy program account managers. Account managers market to large business customers on a one-on-one basis to evaluate and determine the suitability of prospective candidates.

Incentives paid to participating customers are dependent upon the curtailment option chosen.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 10. Expected Program Participation: 2014 PowerShare

Number of Participants	30[8]
Number of Measures	5
Expected Savings	0 kWh and (384) kW
Share of Savings Relative to DR Portfolio[9]	0% kWh and -1.42% kW

2012-2013 Smart $aver® Residential, HVAC

The Duke Energy Residential Smart $aver® HVAC program provides rebates for installations of higher efficiency heating and cooling measures in new or existing homes.

End uses, current measures covered

The program provides incentives for central air conditioners (CAC) with electronically commutated fan motors (ECM)s, and heat pumps with ECMs, A/C or heat pump system tune-ups, and a package of attic and duct system insulation and leakage sealing measures.

Markets targeted

The main method of marketing the program to residential customers is through the trade ally network.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

Qualified purchases by residential customers are eligible for rebates of $200 to the homeowner, and $100 to the HVAC contractor/dealer. Home builders who install qualified equipment are eligible for rebates of $300 that they may choose to pass on to the home buyers. Through additional measures offered through the HVAC program, eligible customers receive a $50 incentive for tuning up a heat pump or air conditioning, installation of attic insulation and completion of air sealing will result in a $250 incentive, installation of duct insulation will result in a $75 incentive, and completion of duct sealing will result in a $100 incentive.

2013-2014 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)

The online savings store offers include specialty bulbs such as recessed lights, candelabras, globe, three-way bulbs, capsules and dimmable bulbs. The products are offered at a negotiated

[8] As of February, 2014.

[9] Demand Response programs impacts represent incremental program participation from the prior filing period to be consistent with achievements.

price and include a discount reflecting the amount of incentive offered by Duke Energy Ohio. The web-based e-commerce store launched on April 26th, 2013 and provides discounted specialty lights and ships directly to the home.

End uses, current measures covered (including but not limited to)

- Specialty Bulbs 3 Way
- Specialty Bulbs A Line
- Specialty Bulbs A Line Dimmable
- Specialty Bulbs A Line LED
- Specialty Bulbs Candelabra
- Specialty Bulbs Globe
- Specialty Bulbs Recessed
- Specialty Bulbs Recessed Dimmable
- Specialty Bulbs Recessed LED
- Specialty Bulbs Recessed Outdoor

Markets targeted

The audience is residential Duke Energy Ohio customers.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The online Savings Store is promoted through various channels including Email, Bill Messages, Bill Envelopes, Social Media, Direct Mail, Printed Collateral, Earned Media, and other Duke Energy Program collaboration efforts.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 11. Expected Program Participation: 2013-2014 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)

Number of Participants	74,448
Number of Measures	10
Expected Savings	3,488,548 kWh and 331 kW
Share of Savings Relative to EE/DR Portfolio	3.01% kWh and 1.23% kW

2014-2015 Smart $aver® Residential, Property Manager Program

Property Managers of multi-family residential buildings have the ability to 'opt-in' and order free CFLs on the Duke Energy Website for installation in residential units (not common areas). Beginning in March 2014, the Property Manager program will include energy efficient lighting and water saving measures including: kitchen and bath aerators, low flow shower heads and pipe wrap for electric water heated units. An additional change in March of 2014 is that the program will offer property managers the choice of either a vendor-install option or a property manager-install option for the installations.

End uses, current measures covered

Energy efficient lighting and water measures.

Markets targeted

Multi-family property managers.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The program vendor is responsible for all marketing and property manager outreach. Duke Energy will use a promo box and scrolling banners on the Duke-Energy.com website to promote the program to Property Managers. When users click on these they will be taken to the program landing page where additional information is available.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 12. Expected Program Participation: Smart $aver Residential, Property Manager Program

Number of Participants	8,750
Number of Measures (kits)	1
Expected Savings	427,523 kWh and 47 kW
Share of Savings Relative to EE/DR Portfolio	0.37% kWh and .18% kW

2014-2015 Smart $aver® Non-Residential Custom

The Smart $aver® Custom Incentive program is designed to meet the needs of Duke Energy customers with electrical energy saving projects involving more complicated or alternative technologies, or those measures not covered by standard Prescriptive Smart $aver® Incentives. Unlike the Prescriptive Incentives, Custom Incentives require approval prior to the customer's decision to implement the project.

End uses, current measures covered

Includes, but not limited to, high-efficiency lighting, HVAC, pumps, variable frequency drives, food services, process equipment, and information technology equipment.

Markets targeted

Commercial and Industrial customers.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

Coordinated with the Smart $aver prescriptive program, the custom program is marketed to trade allies and vendors using a combination of brochures, website resources, cold calls, and speaking engagements, and they in turn market the program to end-use customers. Trade allies have access to a collateral tool kit in addition to white papers and case studies. Trade ally company names and contact information appear on the trade ally search tool located on the Smart $aver®

website. Additionally, Duke Energy markets to the end-use customer through website resources, direct outreach, and other marketing strategies. Financial incentives are in the form of rebates.

Table 13. Expected Program Participation: 2014 Non-Residential Smart $aver Custom

Number of Participants	18,743
Number of Measures	1
Expected Savings	28,027,318 kWh and 3,199 kW
Share of Savings Relative to EE/DR Portfolio	24.19% kWh and 11.85% kW

2014-2015 Smart $aver® Non-Residential Prescriptive

The Smart $aver® Non-residential Prescriptive Incentive Program provides incentives to commercial and industrial consumers for installation of energy efficient equipment in applications involving new construction, retrofit, and replacement of failed equipment. The program also uses incentives to encourage maintenance of existing equipment in order to reduce energy usage.

End uses, current measures covered

High-efficiency lighting, HVAC, pumps, variable frequency drives, food services, chiller tune-ups, process equipment, and information technology equipment.

Markets targeted

Commercial and Industrial customers.

Program implementation activities (marketing efforts, delivery channels, financial incentives)

The program is marketed to trade allies and vendors using a combination of brochures, website resources, cold calls, and speaking engagements, and they in turn market the program to end-use customers. Trade allies have access to a collateral tool kit in addition to white papers and case studies. Trade ally company names and contact information appear on the trade ally search tool located on the Smart $aver® website. Additionally, Duke Energy markets to the end-use customer through website resources, direct outreach, and other marketing strategies. Financial incentives are in the form of rebates.

Program Implementation and EM&V budgets

The 2014 EM&V portfolio budget for the 2014 program year represents 5% of total portfolio program costs, pursuant to Duke Energy's energy efficiency cost recovery mechanism. Total utility costs for program implementation are $29.9 million.

Table 14. Expected Program Participation: 2014-2015 Non-Residential Smart $aver Prescriptive

Number of Participants	344,039
Number of Measures	347
Expected Savings	55,055,658 kWh and 10,686 kW
Share of Savings Relative to EE/DR Portfolio	47.52% kWh and 39.58% kW

Evaluation Objectives

This section provides an overview of the Research Questions that will be addressed in each of the following evaluation components.

a) Impact Evaluation Research Questions
b) Process Evaluation Research Questions
c) Additional Research Questions (if needed)

Impact Evaluation Research Questions

For the program during the participation period being evaluated in 2014,

1. What is the baseline for each measure (as appropriate for the program being evaluated)?
2. What are the per-unit or per-home/facility electricity savings, less savings from any other Duke Energy program participation?
3. What are the demand savings (coincident and non-coincident) by measure?
4. What is the level of freeridership with this program?

Process Evaluation Research Questions

1. Are the program management and operations efficient and effective?
2. Are program participants satisfied with the program?
3. Is the program's customer targeting, marketing and outreach effective to meet program goals?
4. What are the reasons for participating and barriers to participation?
5. Are the incentive/rebate levels effective and influential?
6. Are vendors and stakeholders satisfied with the program?
7. What are the evaluation contractor's recommendations for improvements?
8. What is the approach to determining freeridership and spillover associated with this program?

Additional Research Questions (if needed)

There are no plans for market assessments, market transformation evaluation, baseline research, or non-energy benefits research at this time. However, we will include additional research questions as needed and identified through the program evaluation planning process.

Overall Evaluation Approaches

All programs receive periodic process evaluations and impact evaluations. An impact evaluation for a program/measure will involve a billing analysis, an engineering analysis, or a combination of the two approaches. The evaluation approaches described in this evaluation plan are significantly consistent with the draft Ohio TRM guidelines as set forth in the Commission's July 31, 2013 order on the TRM.[10] As a result of the Commission order creating a "safe harbor" for those utilities that rely on the TRM, Duke Energy has directed the third-party evaluators to consider the algorithms and parameters presented in the TRM.

Billing Analysis

For programs that are to be evaluated using a billing data analysis, the standard procedure that will be used involves estimating a fully-specified, monthly fixed-effect panel model.[11] This model uses data from Ohio customers both across households/facilities (i.e., cross-sectional) and over time (i.e., time-series). With these types of data, it becomes possible to control, simultaneously, for differences across households/facilities as well as differences across periods in time. The fixed-effect refers to the model specification aspect that differences across homes/facilities that do not vary over the estimation period (such as square footage, heating system, etc.) which can be explained, in large part, by customer-specific intercept terms.

In the model, the dependent variable is the customer's monthly energy usage obtained from billing data normalized by number of days in the month (to account for differences in days across months). These data will span both the pre- and post-participation period for the customer. Because the consumption data in the panel model include months before and after the installation of measures through the program, the period of program participation (or the participation window) may be defined specifically for each customer. This feature of the panel model allows for the pre-installation months of consumption to effectively act as controls for post-participation months for those that do not require the use of a non-participating control group. In addition, this model specification, unlike annual pre/post-participation models such as annual change models, does not require a full year of post-participation data for all participants. (Though some participants will have a full year of post data, and it is preferable if all do.) Effectively, the pre-participation data for participants are used as the control group (i.e., used to estimate the baseline), thus eliminating the need for a non-participant group. Note that this approach requires a variation in the date of participation, so it is not appropriate for programs like MyHER[12], in which a majority of the customers have the same treatment dates. In that case, the billing data analysis will use a randomly assigned control group.

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[10] As outlined in the Commission order in Case Number 09-512-GE-UNC dated July 31, 2013, the Commission stated an intention to treat the 2010 Draft TRM as a "safe harbor" and set of guidelines rather than a mandate. The Commission also stated that where utilities "seek to utilize any other method of determining energy savings and demand reductions, *the Commission* will review the utility's request on a case-by-case basis, and the utility will bear the burden of demonstrating that its alternative method is just and *reasonable (emphasis added)." In the Matter of Protocols for Measurement and Verification of Energy Efficiency and Peak Demand Reduction Measures,* Case No. 09-512-GE-UNC, Entry on Rehearing, (July 31, 2013).

[11] While this is the standard methodology, some program evaluations may involve an alternative analytical approach. These approaches, if applicable, will be described in the program-specific sections of the plan.

[12] MyHER is the My Home Energy Report program, which provides regular mailings to customers allowing them to compare their home's usage to similar homes in their area and offers energy efficiency tips.

The fixed effects model the TecMarket Works (TMW) team employs is a peer-reviewed[13] model that complies with all current evaluation protocols[14]. This model is a differencing model in which all characteristics of the home/facility, which (1) are independent of time and (2) determine the level of energy consumption, are captured within the customer-specific constant terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique household/facility.

Algebraically, the fixed-effect panel data model is described as follows:

$$y_{it} = \alpha_i + \lambda_t + \beta x_{it} + \delta \cdot Part_{it} + \gamma \cdot EE_{it} + \varepsilon_{it} \tag{1}$$

where:

- y_{it} = energy consumption for customer *i* during month *t*
- α_i = constant term for customer *i*
- λ_t = monthly indicator variable for time *t*
- β = vector of coefficients
- x = vector of variables that represent non-program factors causing changes in energy consumption for site *i* during month *t* (specifically weather terms)
- δ = estimated program impact
- $Part_{it}$ = an indicator variable that equals 1 if site *i* was a participant in the program during month *t*
- *EEit* = indicator variables that equals 1 if site *i* was a participant other Duke energy efficiency programs during month *t*
- ε_{it} = error term for site *i* during month *t*.

With this specification, the weather data and the monthly indicator variables capture the effect of those non-program factors that vary month to month and affect energy use for each customer. In each report, definitions of variables used in the models will be provided as well as explanations of any required data cleaning.

Omitted variable bias

The effect of omitted variables on the estimated savings depends upon the correlation between the participation variable and the variables that are omitted. Changes to buildings, occupancy or households do occur over time, but they are likely to be occurring in only a small fraction of the

[13] Given that the TRM is silent on audit and behavior programs, the Duke Energy Ohio evaluation team has requested peer reviews to demonstrate that the approach being employed is "reasonable" from two highly-qualified professors of statistics and economics. Both have agreed with the validity of the models employed by the TecMarket team. Economics Professor Don Waldman, PhD is the Associate Chair of Graduate Studies at the University of Colorado at Boulder. He has a focus on micro-economic models of the sort being employed in the Audit and Comparison Report Programs (Personal Communication 1/8/2013). In addition, Professor of Statistics, Martin Levy, Pd.D., of the University of Cincinnati has also reviewed the Home Energy Comparison Model in particular and agreed with the analytical approaches employed (Personal Communication 8/20/2010).

[14] TecMarket Works et al. "California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals." April 2006. The Ohio TRM is silent on behavior.

population, so any potential bias is small. In addition, collecting information on these changes suffers from the following issues:

- It is generally not cost-effective to survey all participants in a program, thus an analysis using surveyed data will involve only a sample of participants, which opens up the possibility of sampling errors.
- It is impossible to design a cost-effective survey that will address all the potential actions that can be undertaken by participants outside the program, thus a participant survey will not eliminate the potential for omitted variable bias.
- Surveys rely upon customer self-reports on what actions they undertook in the past and the reasons for which those actions are taken. It is improbable that participants will accurately recall and report all actions taken during the analysis period and report when each action was taken, thus introducing errors in variable assessment and analysis.

Controlling for participation in other energy efficiency programs

It is standard practice to include in the model indicator variables denoting participation in other energy efficiency programs by Duke Energy. These will control for any possible cross-program impacts.

Engineering Estimates

As a result of the Commission's direction on the TRM in July of 2013, Duke Energy has directed the third-party evaluators to consider the algorithms and parameters presented in the TRM. However, TRMs are snap-shot documents that provide an ex ante program-planning estimation approach based on the known program, weather, market and participant conditions at the time of the drafting of the TRM. These documents are routinely updated as the field of evaluation develops better and more reliable evaluation approaches. Thus, the development and updating of TRMs follow the field of evaluation as evaluation professionals identify and apply more reliable approaches, allowing for field-tested improvements to the TRM over time. The evaluation team will either use the TRM or an alternative method as appropriate to meet the needs of the evaluation. An alternative method may adopt TRM algorithms and substitute program-specific primary data collection or more recent secondary data sources for certain deemed parameters, or utilize a different approach, such as conducting building energy simulation modeling or billing analysis rather than relying on simple engineering equations. The updates or changes to the TRM algorithms and deemed parameters will be documented in the evaluation report.

Engineering Algorithms

Engineering algorithms for simple measures such as lighting follow the basic form:

$$kWh = units^{15} \times (Watts_{base} - Watts_{ee}) / 1000 \times hours \times (1+WHF_e)$$

$$kW = units \times (Watts_{base} - Watts_{ee}) / 1000 \times (1+WHF_d) \times CF$$

where:

[15] Units include the In Service Rate, as appropriate.

$Watts_{base}$ = baseline watts per unit
$Watts_{ee}$ = efficient watts per unit
hours = annual lighting operating hours
WHF_e = waste heat factor for energy
WHF_d = waste heat factor for demand
CF = coincidence factor

For some measures, unit energy savings will be derived from building energy simulation models:

$$\Delta kWh = units \times (\Delta kWh/unit)$$
$$\Delta kW_S = units \times (\Delta kW/unit) \times CF_S$$

where:

ΔkW = gross coincident demand savings
ΔkWh = gross annual energy savings
units = quantity of measures installed
CF = coincidence factor
$\Delta kW/unit$ = electricity demand savings per unit derived from simulation modeling
$\Delta kWh/unit$ = electricity consumption savings per unit derived from simulation modeling

Directly-Measured Approach using Regression Models

Some measures will be evaluated using regression models developed from direct measurements, utilizing IPMVP[16] Options A or B. The baseline and post-construction energy consumption will be predicted as a function of an independent variable (typically outdoor temperature) and extrapolated to the annual consumption. Savings will be estimated as the difference between the baseline and post-construction consumption.

$$\Delta kWh = \sum (daily\ kWh_{base}\ (T_{ave}) - \ daily\ kWh_{post}\ (T_{ave})) \ \times \ n_{day}(T_{ave})$$

$$\Delta kW = (kWbase\ Tpk - kWpost\ Tpk)$$

where:

ΔkWh = gross annual energy savings
daily kWh_{base} (T) = daily baseline kWh at temperature T
daily kWh_{post} (T) = daily post-construction kWh at temperature T
T_{ave} = daily average temperature
T_{pk} = temperature under peak conditions
n_{day} (T) = number of days per year at temperature T

[16] International Performance Measurement and Verification Protocol (IPMVP) available at www.evo-world.org.

Pre/post measurements will be attempted on custom projects; when access for collecting pre-construction data is not possible, the baseline will be established using a combination of post-construction monitored data and engineering analysis.

An example of a regression model developed from direct measurements of an HVAC central plant is shown below:

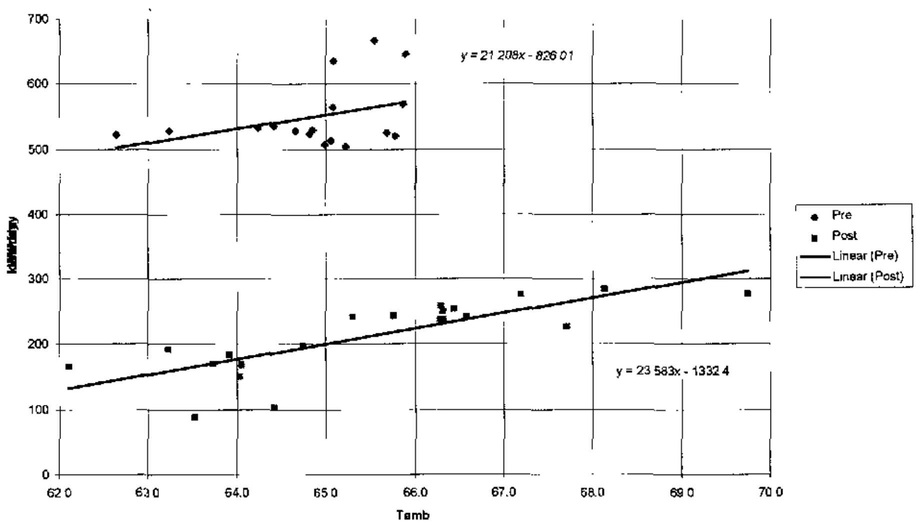

Figure 1. Example of Regression Model Developed from Direct Metering

Building Energy Simulation Modeling

Building energy simulations will be used to estimate savings of individual projects, or to develop parameters used in engineering algorithms. The DOE-2.2 building energy simulation program will be used. When developing engineering parameters, the simulations will be conducted using a set of prototypical building models. The prototypical simulation models will be derived from the residential and commercial building prototypes used in the California Database for Energy Efficiency Resources (DEER) study, with adjustments made for local building practices and climate. Simulations will be driven by the TMY3 long-term average weather data for CVG, the Greater Cincinnati Ohio airport. Prototypical engineering models are commonly used to estimate HVAC interactive effects for measures such as lighting and appliances located in a conditioned space.

Building specific models will be developed for selected sites in the Non-Residential Smart $aver Custom program, following the IPMVP Option D Calibrated Simulation Model approach. The models will be calibrated to a combination of measure performance and metered data.

Impact Analysis Reconciliation

For programs that involve a billing data analysis as well as an engineering analysis to determine program impacts, a comparison between the results of the two will be made to determine if there is a statistically significant difference. If there is, then the model equation will change the participation variable from an indicator variable to the engineering-based savings for that customer (i.e., a statistically-adjusted engineering or SAE model). This will provide further information on the difference between the estimates. Since the billing data use all participants[17] (rather than a sample as is usually the case with the engineering analysis), and uses actual usage to derive impacts, for cases where there are statistically significant differences, the billing analysis is often assumed to provide the most accurate estimate of the effect of the program.

Since the billing data are based upon monthly energy use (kWh), it is not possible to derive the demand (kW) savings from this analysis. To develop these estimates, the ratio of the kW to kWh savings found in the engineering analysis will be applied to the kWh estimates from the billing analysis to get a statistically adjusted estimate of demand. Billing analysis observes the differences in consumption between pre-existing equipment and new equipment installed under the program, thus in a typical billing analysis, the existing equipment serves as the baseline. When existing equipment serves as the baseline, this scenario is often referred to as "early replacement." When the program baseline is defined by code or industry standard practices, this scenario is often referred to as "normal replacement." Engineering analysis is used to adjust the savings derived from a billing analysis to the savings resulting from a normal replacement baseline. Billing analysis also provides the evaluation team with a means to assess program impacts so that all program-related energy impacts, including the theoretically possible take-back effect, are automatically accounted for within the period of the study.

Process Evaluations

The process evaluation efforts will be somewhat different for each program. However, to a certain extent these studies will follow a similar approach. The process evaluation will consist of program-specific efforts designed to address each program's researchable issues, but will, in general, include the following efforts:

1. Reviewing program materials and methods of operation in the state of Ohio,
2. Holding an evaluation project initiation meeting with Duke Energy to review all study objectives,
3. Conducting interviews with program managers and implementers about program operations in Ohio,
4. Conducting interviews with Ohio trade allies, partners, key managers and implementers,
5. Designing interview and survey instruments,
6. Conducting surveys with participants and/or non-participants in the state of Ohio,
7. Analyzing process evaluation data, and
8. Developing process evaluation reports.

[17] Unless otherwise noted in the report. Data cleaning is not typically included in billing analysis. If data cleaning is performed, the methodology will be reported.

These activities are described below and apply to the evaluation efforts associated with the process evaluation for each program being assessed in 2014. During the planning process, the specific researchable issues on which each study will focus will be established and the process evaluation plan will be designed to specifically address those issues.

1. **Review program materials and methods of operation**

Early in the evaluation process, the evaluation team will request program materials and begin a review of all available information to familiarize our team with the operations of the program. This includes reviewing all Ohio program-specific documents and incorporating this information with the verbal information obtained during discussions with Duke Energy and the program implementers.

The review of the documents linked with the verbal information obtained from managers provides the foundation for a number of activities, including: 1) identification of researchable issues for the process evaluation, 2) obtainment of information needed to start the development of interview and survey protocols and instruments, 3) identification of appropriate analytical methods.

2. **Hold an evaluation project initiation meeting to review study objectives**

The evaluation team will meet with Duke Energy to review the evaluation efforts, finalize general evaluation plans, and develop program-specific plans. The project initiation meeting will be preceded by a conference call with the Duke Energy evaluation managers to review each project and discuss any desired refinements to the overall activities.

The evaluation team will work to identify key individuals that will serve as information sources. Typically these are the Duke Energy evaluation and program managers. These are often the same people who are responsible for cost-effective program operations and program delivery and interaction with the market. If possible, the evaluation team will want to hear from several of these individuals during the initiation meeting, but the evaluators will follow up with all identified individuals as necessary.

During the meeting the evaluators will review the upcoming work in detail. The team will discuss the program's design, operation, and timing, and will work with Duke Energy to identify researchable issues for each program with the program implementers (through follow up discussions as necessary) to reach an agreement on the issues that will be incorporated into each program's evaluation. The researchable issues will be the dominant focus of the process evaluation efforts.

3. **Conduct interviews with program managers and implementers**

The evaluation team will also conduct formal interviews with program managers and implementers to obtain a detailed level of knowledge about each program and how it operates in Ohio.

Through the formal interviews, the evaluation team will discuss program designs, operational procedures, marketing and outreach efforts, tracking and data handling systems, interactions with contractors, allies, and participants' application procedures.

To guide these interviews, the evaluation team will develop interview protocols that identify who will be interviewed, and each of the questions to be asked of each manager. This protocol will be provided to the managers prior to the interview.

While these interviews are primarily to serve as the initial program-level process evaluation information gathering task, it is also the time at which the evaluation team will go over the program theories and logic models (if available) with the program managers to identify needed changes and discuss what is working well. The interview questions and the manager's responses will serve as one of the data sources for the process evaluation's analysis efforts. The responses will also help set the stage for the identification of the issues to be addressed during the interactions with the trade allies, contractors, participants, and non-participants, as appropriate for the program being evaluated.

4. **Conduct interviews with trade allies, partners, key managers, and implementers in Ohio (as feasible[18])**

When applicable, interviews will be conducted with a sample of partners, trade allies and program implementation staff (note that the specific programs and targeted groups will be identified in the program-by-program planning process). These interviews will focus on the program's design, operations, operational conditions, the interaction between the ally, the program and the participant, the service stream and the activities in that stream, the influence of the program and the ally on the participants' decision to take actions, and other considerations. In addition, the interviews will focus on the interviewee's opinions about which parts of the program work best and least well, and what kind of recommendations are suggested by the interviewee.

The evaluation team will work with Duke Energy to identify the population of key allies for the interview sample. The key ally sample will be a targeted sample drawn to select allies that are most involved with the program being evaluated. This allows the identification of "must interview" allies that have been or are currently significantly involved in the program. The remaining allies not included in the interview sample will be put in the non-key ally sample and a random assignment of the non-key ally sample will be conducted to develop a list of sample targets for the ally survey. These approaches allow the evaluators to obtain a strong key ally sample and follow-up with a strong ally sample.

The interviews will follow a prescribed protocol that guides the interview to address the key researchable issues. The protocol and the questions to be asked will be developed by the evaluation team and reviewed by Duke Energy managers prior to field implementation. The interviews will be scheduled by the evaluation team to be convenient to the interviewee. The interviews may be recorded to preserve a record to support the analysis, but maintained as confidential information. Process evaluation results are typically confidential so that the interviewees will provide opinions and information that are objective and accurate, without

[18] For some programs, operations are identical across all states that Duke Energy operates in. If there is a shortage of vendors in any particular state but the evaluation team wishes to achieve statistical significance for a finding (or simply to have more data), Duke Energy and the evaluation team may opt to combine results from two or more states. The methodology and reasoning for this approach will be presented in each report as appropriate.

concern that their comments will be linked to them as individuals. However, all issues, comments, and concerns, as well as interviewee recommendations for program changes, are reported to Duke Energy.

5. **Design interview and survey instruments**

A separate interview or survey protocol and instrument will be drafted for each of the targeted programs and survey groups as appropriate for each program (allies, participants, and non-participants). The protocols and instruments for the allies will focus on a wide range of design, management, and operational issues. The surveys with participants will focus on the participation experience, the ability of the program to improve the customer, program and program-component satisfaction, ability of the program to identify the reasons for participation, actions that would have been taken without the program, and services that the participants find to be of value. The development of the participant survey instruments will also be fed by the results of the program managers' interviews and the trade ally interviews and surveys. Typically these interviews and surveys identify a range of issues that need to be tested or assessed in the participant survey.

The development of the participant surveys will be coordinated with the impact evaluation team to make sure impact questions are included in the survey as needed. This is particularly important for evaluations that use engineering analysis and modeling approaches that must be calibrated to the participants' use conditions.

The non-participant survey will focus on customer perceptions of the program, the value of the program, the ability of the program management to understand and serve customers' needs, program design and operational issues, and reasons for non-participation. This survey will also explore program changes that may increase participation and satisfaction rates among the non-participants. In addition, all non-participant surveys will be coordinated with any planned market assessment efforts to minimize data collection costs.

These instruments and protocols will be used to guide all data collection efforts. The primary data collection approaches will employ in-depth interviews and surveys, linked to document and records reviews and analysis. All data collection efforts involving key managers or staff, contractors, customers and trade allies will be guided by protocols and instruments that will be reviewed by Duke Energy prior to their use. This step identifies the information that will be collected to feed the process analysis and recommendation efforts.

6. **Conduct surveys with Ohio program participants and/or non-participants**

In this task we will conduct the process surveys with the participants and non-participants, as appropriate.

At the project initiation meeting the evaluation team will discuss and confirm with Duke Energy the contact standards in which the process or the impact evaluation should be conducted. Participants are given an option to participate in the evaluation effort (any part of it). Typically, the evaluation team employs four contact attempts at different times and days of the week. After the fourth failed attempt to contact, that contact is dropped from the sample.

Participant sample sizes will be determined based on participation in the programs (as well as by measure, if needed). Generally, where ramp up of the program is slow, sample sizes are small. Participant sampling for process evaluation efforts will employ a 90% +/- 10% level of precision at the program level, but may be expanded or contracted depending on the level of reliability needed for each program, the needs of the impact evaluation effort (specifically NTG estimates), and the available budget for that effort.

The evaluation may also include non-participant surveys, as necessitated by the researchable issues for the process evaluation effort. When non-participant surveys are indicated, we will identify the best approach for selecting the non-participant population for each program.[19]

7. Analyze process evaluation data

This task covers the wide range of analytical efforts required to address the researchable issues identified for the assessment. The evaluation team employs analysis strategies and systems it has used successfully for many years, and on which the California Evaluation Protocols are based. The analysis allows documentation of the program's structure and operation, an assessment of program conditions and the development of program recommendations.

This assessment includes:

- ✓ Analysis of program materials, manager interviews, ally interviews and surveys, participant and non-participant surveys to understand the organization and operations of the programs in order to identify strengths and weaknesses and make recommendations for program changes.
- ✓ Analysis of marketing materials (when requested) to determine their strengths and weaknesses and coverage to make recommendations on ways to improve the marketing efforts or materials.
- ✓ Analysis of ally interview and survey results to identify strengths and weaknesses in the relationships and operational conditions between the programs and the contractors and allies who help make the programs work well for their customers, the utility, and themselves.
- ✓ Analysis of the participant information and survey results to identify drivers of satisfaction and their experiences with the programs from the view of the most important person in the chain of events: the customer who participates. This involves assessing a wide range of participant information and understanding their personal experiences and opinions about the programs, including ways that they think the program can be improved.
- ✓ Analysis of any non-participant information collected to identify the barriers to participation and to assess the program's ability to satisfy customer needs. This analysis will result in the development of recommendations that can be expected to increase participation rates and strengthen program acceptance.

The primary purpose of the analysis is to feed the development of actionable program change recommendations that can be expected to improve the performance and cost effectiveness of the programs.

[19] Approaches, if applicable, will be described in the program-specific sections of the plan.

8. Develop Process Evaluation Reports

The evaluation team delivers the final process evaluation for each program to Duke Energy. The evaluation team is open to comments from key Ohio or program/portfolio-associated stakeholders including Commission contractors who may oversee evaluation efforts.

Impact Evaluation Methods by Program

This section describes the impact evaluation methods by program (and measure if appropriate) and discusses why the selected method was chosen over other reasonable alternatives.

2012-2013 Appliance Recycling

The impact evaluation used an engineering analysis approach on participants that recycled their units between September 26, 2012 and July 13, 2013 to evaluate the energy impacts of the program, linked to a new and used market effects impact adjustment for estimating net grid-based energy impacts. The assessment included an in situ metering assessment conducted in the Spring of 2013 to determine the energy consumption of the appliance collected from the home.

2014-2015 Appliance Recycling

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 Energy Management Information Systems

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 Energy Efficiency Education for Schools Program

There are no impact evaluation activities planned in 2014 for this program.

2013-2014 Low Income Neighborhood Program

The billing analysis for this program will use the specification expressed in equation 1.

Engineering analysis for the Low Income Neighborhood program will use a simplified engineering approach that incorporates program tracking records and participant surveys. The availability of field monitored data collected by program implementers as a component of the home audit makes the engineering approach feasible. Both approaches will be used and the results will be combined as necessary.

2013-2014 Low Income Services

Evaluation of this program will consist of a review of program tracking data, measure installation verification reports from the independent inspector, and workpapers supporting the deemed energy savings values assigned to each measure. Results of the installation verification reports will be used to adjust the measure installation counts reported in the tracking data. Proper assignment of the deemed savings values to the measures reported in the tracking data will be verified. The workpapers used to establish the deemed savings values per measure will be reviewed, and recommendations for revisions to the deemed savings values will be prepared.

2014-2015 My Energy Manager (Home Energy Solutions)

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 My Home Energy Report

There are no impact evaluation activities planned in 2014 for this program.

2012-2013 Smart $aver® Residential, HVAC

An impact evaluation for the 2012-2013 program is in progress for Ohio customers that participated between January 26, 2012 and November 27, 2013. This evaluation is scheduled to be completed in Q2 of 2014.

The billing analysis for this program used the specification expressed in equation 1 on page 21.

The engineering analysis conducted for the Residential Smart $aver program consisted of building energy simulation modeling of prototypical homes, with key engineering parameters developed from post monitoring of a sample of HVAC units. The models were also calibrated to the post-monitored data.

The combined billing and engineering analysis was done to provide independent estimates of savings. The billing analysis is based on actual consumption data, and will be the primary evaluation method that incorporates occupant behavior relative to the use of the HVAC system. The engineering analysis is being incorporated into the billing analysis as engineering priors in a statistically adjusted engineering (SAE) analysis.

2013-2014 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)

The engineering analysis conducted for the Specialty Bulb program will consist of simplified engineering equations, with key parameters developed from field monitoring. Customer surveys will be used to estimate the in-service rate.

Billing analysis will not be used, since the impact of a CFL is small relative to the total consumption, and may not be observable in a billing analysis. The engineering analysis will be supported by field M&V, consistent with the IPMVP.

2014-2015 Smart $aver® Residential, Property Manager Program

The engineering analysis conducted for the CFL portion of the Smart $aver Property Manager program will consist of simplified engineering equations, with key parameters developed from field monitoring. Customer surveys will be used to estimate the CFL in-service rate.

Billing analysis will not be used, since the impact of a CFL is small relative to the total consumption, and may not be observable in a billing analysis. The engineering analysis will be supported by field M&V, consistent with the IPMVP. Evaluation of the water saver measures will be based on the Ohio TRM, with field verification of faucet aerator and showerhead installations and flow rates conducted at a sample of sites selected for CFL field monitoring.

2014-2015 Smart $aver® Custom

Engineering analysis for the Non-Residential Smart $aver program will use a combination of engineering equations, direct metering, and building energy simulation modeling. The Custom component of the program is expected to include lighting measures not covered under the prescriptive component, HVAC equipment and controls, new construction projects, and industrial processes. Field measurements will support the engineering analysis consistent with the IPMVP.

Engineering approaches were selected over billing analysis to provide better insight into individual measure savings. Given the wide variety of program participants and affected facilities, it is not clear the savings will be sufficient as a fraction of the total consumption to support a billing analysis.

2014-2015 Smart $aver® Prescriptive

Engineering analysis for the Non-Residential Smart $aver program will use a combination of engineering equations, direct metering, and building energy simulation modeling. Important measures in the prescriptive component of the program are expected to include commercial lighting and variable speed drives. Field measurements will support the engineering analysis consistent with the IPMVP.

Engineering approaches were selected over billing analysis to provide better insight into individual measure savings. Given the wide variety of program participants and affected facilities, it is not clear the savings will be sufficient as a fraction of the total consumption to support a billing analysis.

2013 Power Manager

An impact evaluation for the 2013 Power Manager program is in progress and is scheduled to be completed in Q2 of 2014.

2014 Power Manager

The TecMarket Works team is not responsible for the impact evaluation of this program. Duke Energy conducts its own internal impact evaluation. The TecMarket Works team reviews the impact evaluation to ensure that the approach is consistent with accepted evaluation procedures.

Duke Energy impact estimates during Power Manager load control periods are based upon models developed for the natural duty cycle of AC units. Distinct parameters are estimated for each hour of interest of typical load control hours. The modeled natural duty cycle results are combined with the population weights to estimate average load reduction per household in the Power Manager population. The potential load impacts estimated in this manner represent the load reduction which would be achieved if all switches controlled as expected.

2013 PowerShare

An impact evaluation for the 2013 PowerShare program is in progress and is scheduled to be completed in Q2 of 2014.

2014 PowerShare

The TecMarket Works team is not responsible for the impact evaluation of this program. Duke Energy conducts its own internal impact evaluation. The TecMarket Works team reviews the impact evaluation to ensure that the approach is consistent with accepted evaluation procedures.

The approach used by Duke Energy consists of an estimation of a baseline load shape for each participating PowerShare customer. The load shed by the participating customer during an event is estimated by using a baseline to simulate the customer's load during the event period. This baseline and the actual metered load of the customer during the PowerShare event are used to determine the amount of load shed.

Duke Energy uses a variety of methods to calculate the baseline for MISO and PJM settlement, regulatory reporting purposes, and/or to verify that pledged reduction levels are achieved by the participating customer.

Impact Evaluation: Data Collection Methods

This section presents the data collection methods used to address each Impact Evaluation Research Question above.

2012-2013 Appliance Recycling

The impact evaluation used an engineering analysis approach on participants that recycled their units between September 26, 2012 and July 13, 2013 to evaluate the energy impacts of the program, linked to a new and used market effects impact adjustment for estimating net grid-based energy impacts. The assessment included an in situ metering assessment conducted in the Spring of 2013 to determine the energy consumption of the appliance collected from the home.

2014-2015 Appliance Recycling

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 Energy Management Information Systems

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 Energy Efficiency Education for Schools Program

Table 15. Impact analysis method and data collection method for each Impact Evaluation Research Question for the Energy Efficiency Education for Schools Program

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	N/A	
per-home/building energy savings	Billing Analysis	• Pre/post billing from all participants • Weather data (temperature, humidity, dew point, HDD, CDD) for the entire period. • Participant date for each customer.
per-home/building energy savings	Engineering Analysis	Mail survey of homes receiving kit
demand savings (coincident and non-coincident)	Engineering Analysis	kW per kWh factor derived from engineering analysis applied to billing analysis

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Energy Efficiency Education for Schools Program

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2013-2014 Low Income Neighborhood Program

Table 16. Impact analysis method and data collection method for each Impact Evaluation Research Question for the Low Income Neighborhood Program

With sufficient participants, a billing analysis will be conducted where energy usage for each customer will be analyzed before and after their participation to determine if they have decreased their energy consumption as a result of their participation. If participation is lower than expected, savings estimates based on engineering algorithms and participant surveys.

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-home/building energy savings	Billing analysis	• Pre/post billing from all participants • *Weather data* (temperature, humidity, dew point, HDD, CDD) for the entire period. • Participant date for each customer.
demand savings (coincident and non-coincident)	kW/kWh factor derived from engineering analysis	kW per kWh factor derived from engineering analysis applied to billing analysis

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for the Low Income Neighborhood Program

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

<u>2013-2014 Low Income Services</u>

Table 17. Impact analysis method and data collection method for each Impact Evaluation Research Question for Low Income Services

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	*Engineering analysis review*	Review of workpaper *assumptions using* secondary data sources.
per-home/building energy savings	Tracking data review with installation count adjustments	Measure installation verification data from independent inspector
demand savings (coincident and non-coincident)	Engineering analysis of *demand savings*	Review of workpaper assumptions using secondary data sources.

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for the Low Income Services

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2014-2015 My Home Energy Report

There are no impact evaluation activities planned in 2014 for this program.

2014-2015 My Energy Manager (Home Energy Services)

There are no impact evaluation activities planned in 2014 for this program.

2012-2013 Smart $aver® Residential, HVAC

An impact evaluation for the 2012-2013 program is in progress and is scheduled to be completed in Q2 of 2014.

2013-2014 Smart $aver® Residential: Online Savings Store (Specialty Bulbs)

Table 18. Impact analysis method and data collection method for each Impact Evaluation Research Question for Smart $aver® Residential: Online Savings Store (Specialty Bulbs)

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	Engineering equations	Phone survey of a sample of participants; light logging at a subsample of participants
per-home/building energy savings	Engineering equations	Same as above
demand savings (coincident and non-coincident)	Engineering equations	Same as above

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Smart $aver® Residential: Online Savings Store (Specialty Bulbs)

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2014-2015 Smart $aver® Residential, Property Manager Program

Table 19. Impact analysis method and data collection method for each Impact Evaluation Research Question for Residential Smart Saver CFLs: Property Managers

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	Engineering equations	Phone survey of a sample of participants; light logging, water measure installation and flow rate verification at a subsample of participants
per-home/building energy savings	Engineering equations	Same as above
demand savings (coincident and non-coincident)	Engineering equations	Same as above

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Smart $aver® Residential, Property Manager Program

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2014-2015 Smart $aver® Prescriptive

Table 20. Impact analysis method and data collection method for each Impact Evaluation Research Question for Smart $aver Prescriptive

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	Engineering equations, direct metering, and building energy simulation modeling	Onsite surveys and field monitoring at a sample of participant sites of key engineering parameters for engineering equations. Whole building on-site surveys and billing data collected for building energy simulations.
per-home/building energy savings	Sum of savings by building.	Same as above
demand savings (coincident and non-coincident)	Engineering equations, direct metering, building energy simulation modeling.	Field monitoring of key engineering parameters for engineering equations.
Non-code measures	*A subset of the impact* evaluation method.	*Secondary research and* interviews with design professionals and trade allies to establish common practice.

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Smart $aver Prescriptive

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2014-2015 Smart $aver® Custom

Table 21. Impact analysis method and data collection method for each Impact Evaluation Research Question for Smart $aver Custom

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	Engineering equations, direct metering, and building energy simulation modeling	On-site surveys and field monitoring at a sample of approximately 10 participant sites (per program year) of key engineering parameters for engineering equations. Whole building onsite surveys and metered data for building energy

		simulations.
per-home/building energy savings	Whole building simulation model or sum of savings by building.	Same as above
demand savings (coincident and non-coincident)	Engineering equations, direct metering, and building energy simulation modeling	Field monitoring of key engineering parameters for engineering equations and building energy simulations. Whole building onsite surveys and billing data for building energy simulations
Non-code measures	A subset of the impact evaluation method.	Secondary research and interviews with design professionals and trade allies to establish common practice.

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Smart $aver Custom

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2013 Power Manager

An impact evaluation for the 2013 program is in progress and is scheduled to be completed in Q2 of 2014.

2014 Power Manager

Table 22. Impact analysis method and data collection method for each Impact Evaluation Research Question for Power Manager

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	N/A	
per-home/building energy savings	N/A	
demand savings (coincident and non-coincident)	Review of Duke Energy's evaluation	

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for Power Manager

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

2013 PowerShare

An impact evaluation for the 2013 program is in progress and is scheduled to be completed in Q2 of 2014.

2014 PowerShare

Table 23. Impact analysis method and data collection method for each Impact Evaluation Research Question for PowerShare

Impact Evaluation Research Question	Impact Analysis Method	Data Collection Method
per-unit energy savings	N/A	
per-home/building energy savings	N/A	
demand savings (coincident and non-coincident)	Review of Duke Energy's evaluation	

Source of data and analysis plan for determining inputs for TRC cost effectiveness test for PowerShare

Duke Energy conducts the TRC analysis internally using the evaluation team's inputs of program impacts and freeridership.

Process Evaluation Methods By Program

This section describes the process evaluation methods by program and discusses why the selected method was chosen over other reasonable alternatives.

2012-2013 Appliance Recycling

The process evaluation is currently in progress for participants from September 26, 2012 through July 25, 2013. The evaluation is scheduled to be completed in Q2 of 2014.

2014-2015 Appliance Recycling

There are no process evaluation activities planned in 2014 for this program.

2014-2015 Energy Management Information Systems

There are no process evaluation activities planned in 2014 for this program.

2014-2015 Energy Efficiency Education Program for Schools

Participant surveys are conducted through an online survey that focuses on program satisfaction and kit measure use and conditions.

In-depth management interviews with program management, third-party implementers (National Theatre for Children), and other third-party vendors will be conducted to assess program operations. In addition, a random sample of teachers and administrators from participating schools and administrators will be selected for short surveys to assess program operations, materials, and incentives.

2013-2014 Low Income Neighborhood Program

The process evaluation is currently in progress for participants from program launch through February 15, 2014. The evaluation is scheduled to be completed in Q2 of 2014.

The process evaluation includes interviews with program management, program implementation staff and third party contractors assisting with the program operations. Participant surveys will also be conducted to assess customer satisfaction, Duke Energy partner communications and staff, their interactions and expectations with the partners, satisfaction with the services and measures provided and questions about behavioral changes made to reduce consumption. Non-participant surveys are being conducted to assess barriers to participation.

2013-2014 Low Income Services

There are no process evaluation activities planned in 2014 for this program.

2014-2015 My Energy Manager (Home Energy Services)

There are no process evaluation activities planned in 2014 for this program.

2014-2015 My Home Energy Report (MyHER)

There are no process evaluation activities planned in 2014 for this program.

2012-2013 Smart $aver® Residential, HVAC

The process evaluation is currently in progress for participants that received rebates from January 2012 through June 2013. The evaluation is scheduled to be completed in Q2 of 2014.

2013-2014 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)

In-depth management interviews with program management and third-party vendors will be conducted to assess program operations. A customer survey will be conducted to obtain information about the CFLs, installation rates, and their satisfaction with the program and Duke Energy.

The tentatively non-participant survey will ask the customer for information about CFLs, light bulb preferences, barriers to participation, and their satisfaction with Duke Energy.

2014-2015 Smart $aver® Residential, Property Manager Program

In-depth management interviews with program management and third-party vendors will be conducted to assess program operations. A customer survey will be conducted with occupants of the multi-family units to obtain information about the measures, installation rates, and their satisfaction with the program and Duke Energy.

A customer survey for the program participants (property managers) will be implemented after the vendor has installed the measures.

2014-2015 Smart $aver® Custom

In-depth management interviews with program management will be conducted to assess program operations. A customer survey for the program participants will be implemented after they have had time to work with the new measures installed at their business or facility.

2014-2015 Smart $aver® Prescriptive

In-depth management interviews with program management will be conducted to assess program operations. A customer survey for the program participants will be implemented after they have had time to work with the new measures installed at their business or facility.

2013 Power Manager

The process evaluation is currently in progress for 2013 participants. The evaluation is scheduled to be completed in Q2 of 2014.

2014 Power Manager

There is no need for a full process evaluation of Power Manager in 2014. The evaluation team will conduct two customer surveys for the program participants. The first (Event and Non-Event surveys) will be implemented within 3 days after they have experienced a control event (or high temperatures on a non-event day) and will include questions regarding the impact of the events on their use of their air conditioner and/or the impact of the event on their comfort. A full participant survey will be conducted at the end of the cooling season to assess use conditions and customer satisfaction with the program and with Duke Energy.

2013 PowerShare

The process evaluation is currently in progress for 2013 participants. The evaluation is scheduled to be completed in Q2 of 2014.

2014 PowerShare

There are no process evaluation activities planned in 2014 for this program.

Process Evaluation: Data Collection Methods

2012-2013 Appliance Recycling

The process evaluation is currently in progress for 2013 participants. The evaluation is scheduled to be completed in Q2 of 2014.

2014-2015 Appliance Recycling

There are no process evaluation activities planned in 2014 for this program.

2014-2015 Energy Management Information Systems

There are no process evaluation activities planned in 2014 for this program.

2014-2015 Energy Efficiency Education for Schools Program

Table 24. Process analysis method and data collection method for each Process Evaluation Research Question for Energy Efficiency Education for Schools Program

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method
operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews
participant satisfaction	Qualitative and quantitative assessment of interview results	Participant surveys Teacher and school administrator surveys
marketing effectiveness		Management interviews Third-party vendor interviews Teacher and school administrator surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Teacher and school administrator surveys Participant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Participant surveys Teacher and school administrator surveys Third-party vendor interviews
vendor/stakeholder satisfaction	Qualitative assessment of interview results	Teacher and school administrator surveys Third-party vendor interviews
recommendations	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Teacher and school administrator surveys Participant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Participant surveys

2013-2014 Low Income Neighborhood Program

Table 25. Process analysis method and data collection method for each Process Evaluation Research Question for the Low Income Neighborhood Program

Process Evaluation Research Question	*Process Analysis Method*	Process Data Collection Method
operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews CAP agency interviews
participant satisfaction	Qualitative and quantitative assessment of interview results	CAP agency interviews Third-party vendor interviews Participant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews CAP agency interviews Participant surveys Non-participant surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews CAP agency interviews Participant surveys Non-participant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews CAP agency interviews Participant surveys Non-participant surveys
vendor/stakeholder satisfaction	Qualitative assessment of interview results	CAP agency interviews Third-party vendor interviews
recommendations	Qualitative and quantitative assessment of interview results	Management interviews CAP agency interviews Third-party vendor interviews Participant surveys Non-participant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Participant surveys

2013-2014 Low Income Services Program

There are no process evaluation activities planned in 2014 for this program.

2014-2015 My Energy Manager (Home Energy Solutions)

There are no process evaluation activities planned in 2014 for this program.

2014-2015 My Home Energy Report

There are no process evaluation activities planned in 2014 for this program.

2012-2013 Smart $aver® Residential, HVAC

The process evaluation is currently in progress for participants that received rebates from January 2012 through June 2013. The evaluation is scheduled to be completed in Q2 of 2014.

2014-2015 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)

Table 26. Process analysis method and data collection method for each Process Evaluation Research Question for Smart $aver Residential: Online Savings Store (Specialty Bulbs)

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method
operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
participant satisfaction	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys Tentative Non-participant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys Tentative Non-participant surveys
vendor/stakeholder satisfaction	Qualitative assessment of interview results	Third-party vendor interviews
Recommendations	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys Tentative Non-participant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Participant surveys

2014-2015 Smart $aver® Residential, Property Manager Program

Table 27. Process analysis method and data collection method for each Process Evaluation Research Question for Smart $aver Residential, Property Manager Program

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method

operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys
participant satisfaction	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys Occupant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys Occupant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys
vendor/stakeholder satisfaction	Qualitative assessment of interview results	Third-party vendor interviews Property Manager surveys
Recommendations	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Property Manager surveys Occupant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Property Manager surveys

2014-2015 Smart $aver® Custom

Table 28. Process analysis method and data collection method for each Process Evaluation Research Question for Smart $aver Custom

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method
operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews
participant satisfaction	Qualitative and quantitative assessment of interview results	Third-party vendor interviews Participant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
incentive effectiveness	Qualitative and quantitative	Management interviews

	assessment of interview results	Third-party vendor interviews Participant surveys
vendor/stakeholder satisfaction	Qualitative assessment of interview results	Third-party vendor interviews
Recommendations	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Third-party vendor interviews Participant surveys Application review

2014-2015 Smart $aver® Prescriptive

Table 29. Process analysis method and data collection method for each Process Evaluation Research Question for Smart $aver Prescriptive

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method
operational efficiency/effectiveness	Qualitative assessment of interview results	Management interviews Third-party vendor interviews
participant satisfaction	Qualitative and quantitative assessment of interview results	Third-party vendor interviews Participant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
reasons/barriers to participate	Qualitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
vendor/stakeholder satisfaction	Qualitative assessment of interview results	Third-party vendor interviews
Recommendations	Qualitative and quantitative assessment of interview results	Management interviews Third-party vendor interviews Participant surveys
program freeridership/spillover	Qualitative and quantitative assessment of interview results	Third-party vendor interviews Participant surveys

2013 Power Manager

The process evaluation is currently in progress for 2013 program participants. The evaluation is scheduled to be completed in Q2 of 2014.

2014 Power Manager

Table 30. Process analysis method and data collection method for each Process Evaluation Research Question for Power Manager

Process Evaluation Research Question	Process Analysis Method	Process Data Collection Method
operational efficiency/effectiveness	N/A	
participant satisfaction	Qualitative and quantitative assessment of interview results	Event and Non-event surveys Participant surveys
marketing effectiveness	Qualitative and quantitative assessment of interview results	Participant surveys
reasons/barriers to participate	Qualitative and quantitative assessment of interview results	Participant surveys
incentive effectiveness	Qualitative and quantitative assessment of interview results	Participant surveys
vendor/stakeholder satisfaction	N/A	
Recommendations	Qualitative and quantitative assessment of interview results	Participant surveys
program freeridership/spillover	N/A	

2013 PowerShare

The process evaluation is currently in progress for 2013 program participants. The evaluation is scheduled to be completed in Q2 of 2014.

2014 PowerShare

There are no process evaluation activities planned in 2014 for this program.

Net to Gross Approaches

Studies conducted by TecMarket Works prior to 2013 used standardized billing analysis techniques linked to net analysis adjustment methods to estimate net impacts for all residential measures without differentiating between low-cost standard consumable measures (part of normal purchase behaviors because first cost, product availability and transaction barriers are not significant) and measures with significant acquisition barriers. In the last few years the field has differentiated analysis approaches associated with routinely acquired, low purchase barrier, low-cost item purchase behavior measures (CFLs, aerators, shower heads, caulking, etc.) from products that have significant cost and other purchase barriers (furnaces, air conditioners, compressors, etc.). Impact analysis approaches associated with low-cost, low-barrier products that have few if any significant purchase barriers can produce net savings directly from a pre-post participation billing analysis which controls for weather and pre-existing (before the program) changes in market conditions over the evaluation period. In these approaches, the use of a rolling pre-program billing period, consisting of all participants' consumption before they enroll in a program, can be effectively used as a control group and as a result, that analysis produces net savings without identifying gross savings. For these analyses there is no need to adjust savings to account for freeriders. However, for large impact measures that are procured only a few times during a lifetime, the same participant-only analysis approach produces gross savings that have to be adjusted for freeriders. As a result, our billing analysis approach for these low-cost low barrier measures are net of freerider savings and include impacts associated with short-term spillover as well.

The field of evaluation developed the controlled fixed effects net billing analysis approach to be more reliable than the pre- versus post-billing analysis approach and the typical engineering approach, and less costly than the industry's experimental or quasi experimental approaches.

The Controlled Fixed Effects Billing Analysis with and without Net Adjustment approach provides savings estimates when a control or comparison group is not available or advisable because of cost considerations or reliability issues. In this approach, the participant's energy use data is used to econometrically model the energy savings for the participant by employing a rolling comparison time period using the time before customers participated in a program as the comparison period, forming a proxy comparison group. Because customers come into a program at a specific time, the time before that enrollment is grouped with other pre-program periods of all participants. Because the customer's pre-program period is used to control for normal energy changes over time at the population level, it is more reliable than the use of a comparison group. That is, the participants are exactly matched to the comparison group because they are the same individuals. Therefore, there is no selection bias because there is no selection into a control or comparison group. Because only the pre-program energy use is used as the proxy comparison group, there is no program influence on that period of time that is used for the savings estimation. With participants coming into the program at different times, essentially providing a full analytical period (timeline) of non-participating energy consumption, the entire pre-program period can be used as the comparison group over the pre- and post-analytical program period. This analytical approach can also control for the effects of participating in other energy efficiency programs so that the savings achieved via multiple program participation is only counted once and credited to only one program. In cases in which there are multiple program participants, the savings associated with participants who have participated in multiple programs is subtracted from the savings identified within the billing analysis approach by subtracting out the typical savings associated with the typical installation in proportion of their occurrence in the participating population. A further benefit of this approach is that the analysis is conducted over the entire population of participants, thus eliminating any potential sampling error.

This approach can be used for both residential and non-residential programs when there is an absence of non-normal energy consumption trends that would tend to impact population-wide energy consumption during only the pre- or post-implementation periods.

This approach has gained considerable use within the evaluation community and has been adopted as standard practice by several of the leading evaluation firms in the United States for energy efficiency program evaluation. The approach has also been peer reviewed within the evaluation community and accepted as one of the more reliable evaluation approaches. While this approach is not as reliable as the experimental design approaches, it is typically more reliable than our industry's quasi-experimental design approaches because it reduces the bias associated with comparison group selection.

The net analysis approaches used in our engineering analysis, when used for residential or non-residential programs, produce gross savings estimates and therefore require a net-to-gross adjustment when net energy impacts are required. The net adjustment approaches for these studies typically employ survey or interview self-report techniques that are consistent with the California Evaluation Protocols (TecMarket Works et al, April 2006).

Tracking System Review

For all programs, the tracking data will be reviewed to characterize the program participation and prioritize data collection activities.

For engineering-based impact evaluations, the important measures will be identified and the impact evaluation activities will be designed to estimate savings for the measures making up the majority of the program savings. The tracking data review will include an overall assessment of data quality, identification of key missing data, and a review of the energy savings estimates and algorithms used by the tracking system. Energy savings estimates for each measure in the tracking system will be compared to program design estimates. Variations will be investigated and resolved. Hardcopy program documents will be requested to fill in key missing data and verify the accuracy of the data entry. Recommendations will be made to identify additional tracking data elements that can be used to assist in future evaluation activities.

Sampling Plan

The sampling plan is consistent across programs, and is based upon standard statistical sample design approaches. The details of the sample design are presented in the following table.

	Participants	Non-Participants	Metering
Sample frame	All participants during the year in question	Customers who meet the program eligibility but did not participate in the program	Participants installing measures identified in evaluation plan
Sample size	Based upon statistical sampling size equations. If prior information on the mean and variance of key variables is available, the sample size for a proportion is used, with a small population correction as appropriate	Based upon statistical sampling size equations. If prior information on the mean and variance of key variables, the sample size for a proportion is used, with small population correction as appropriate	Simple random sample or stratified random sample designs are used. Sample size based on target confidence and precision, expected variation in the population and total population size, with small population correction as appropriate
Relative Precision	The targeted level of precision for the completed surveys is ±10 at a 90% level of confidence. Target precision at the program level varies according to the relative proportion of the program savings to the total portfolio savings.	The targeted level of precision for the completed surveys is ±10 at a 90% level of confidence. Target precision at the program level varies according to the relative proportion of the program savings to the total portfolio savings.	The targeted level of precision for the completed surveys is ±10 at a 90% level of confidence at the program level. Target precision at the measure level varies according to the relative proportion of the measure savings to the total program savings.

These general sample design guidelines are not a factor in the billing data analysis. For the billing data analysis, the general sample design is to estimate the model over all participants in the program. As such, there is no sample design.

Program	Data Collection Method	Sampling and Precision[20]
2013-2014 Low Income Neighborhood Program	Process: participant and non-participant surveys Impact: engineering estimates	Process: survey 80 out of 1,339 participants for 8.9% precision at 90% CI. Impact: survey 80 out of 1,339 participants for 8.9% precision at 90% CI.
2014-2015 Low Income Services Program	Impact: desk review	Desk reviews conducted on census of participants. Sampling error not applicable.
2014-2015 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)	Process: participant surveys (tentative non-participant surveys not included here)	Process: survey 80 out of 74,448 participants for 9.2% precision at 90% CI.

[20] The number of participants provided in this table is the expected participation for 2014 when there are evaluation activities planned for 2014. It does not include 2015 expected participation for evaluations that cover 2014-2015 program years.

	Impact: engineering estimates	Impact (engineering): survey 80 out of 74,448 participants for 9.2% precision at 90% CI.
Smart $aver® Residential, Property Manager Program	Process: occupant surveys and property manager surveys Impact: engineering estimates	Process: survey 80 out of 8,750 occupants for 9.2% precision at 90%. Survey 15 out of 17[21] property managers for 7.5% precision at 90%. Impact: survey 80 out of 8,750 occupants for 9.2% precision at 90%.
Smart $aver Prescriptive	Process: participant surveys Impact: engineering estimates Impact: metering	Process: survey 80[22] out of 344,039 participants for 9.2% precision at 90% % CI. Impact: survey 80 out of 344,039 participants for 9.2% precision at 90% % CI. Metering and engineering analysis. Measures and sample sizes depend on participation.
Smart $aver Custom	Process: participant surveys Impact: engineering estimates Impact: metering	Process: survey 25 out of 18,743 participants in 2014 for 16.4% precision at 90% CI. More surveys will be conducted in 2015. Impact: Stratified sample of 10 2012 program year participants with a varying number of measures per participant for Target 10% precision at 90% CI. Metering and engineering analysis.
2014 Power Manager®	Process: participant, event and non-event surveys Impact: runtime data analysis	Process: survey 80 of each group out of 46,742[23] participants for 9.2% precision at 90% CI. Impact: sample of 140 households out of 46,742 participants, analyzing runtime data from the thermostat providing 6.9% precision at 90% CI.
2014 PowerShare®	Impact: meter data analysis	Impact: meter data analysis includes all participants.

[21] The program had 17 participating properties in 2011-2012; the survey sampling and precision will be revised as needed based on the number of unique property managers in the evaluation period.
[22] Eighty participants will be surveyed over the 2014-2015 evaluation (not all will be conducted in 2014), though the total participants is based on expected 2014 participation.
[23] Number of switches at the end of January, 2014.

Reporting

The report outline follows PUCO's Evaluation Report Template. TecMarket Works developed a report template that includes all of PUCO's required information. The outline of the report template is presented in the three images below, and will be modified accordingly for the type of evaluation and the methodologies therein.

Executive Summary

Key Findings and Recommendations

The key findings and recommendations identified through this evaluation are presented below.

1.

Implementation Rates: Key Findings

Engineering Impact Estimates: Key Findings

Table 1. Summary of Program Savings by Measure

Measure	Participation *Count*				

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Program Participation

Program	Participation Count for DATE to DATE

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Description of baseline assumptions, methods and data sources

Description of measures and selection of methods by measure(s) or market(s)

Use of TRM values and explanation if TRM values not used

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Conclusions and Recommendations for Program Changes

Appendix A: Required Savings Tables

The required table showing measure-level participation counts and savings for each program is below. **Also include tables showing calculations done to achieve Adjusted Gross Savings for each program.**

Required tables will include the following (see Excel file for details):

1. Participation counts and ex ante savings estimates at the measure level for each program
2. Gross savings calculations at the measure level for each program.
   - At a minimum, *Gross Verified Savings* must be reported.
   - If additional adjustments are made, *Adjusted Gross Savings* can be reported using Option A, B, C only.

Measure	Participation Count	Verified Per unit kWh impact	Verified Per unit kW impact	Gross Verified kWh Savings	Gross Verified kW Savings

Evaluation Schedule

Evaluation schedules are periodically adjusted for changes in program offerings, researchable issues, or evaluation goals. Below are the schedules as planned in March, 2014. However, some of the evaluation activities may be re-scheduled, added, or canceled, particularly for tasks and reports scheduled for any dates in 2015 or later.

Program Offered by Duke Energy Ohio	Field Activities for 2014	Expected Final Report Date
2012-2013 Appliance Recycling Program	Complete	Q1 2014
2014-2015 Appliance Recycling Program	None	Q4 2015
2014-2015 Energy Efficiency Education Program for Schools	None	Process: Q3 2015 Impact: Q4 2015
2014-2015 Energy Management Information Systems	None	Q4 2015
2013-2014 Low Income Neighborhood Program	*Surveys Q1 2014*	Process: Q2 2014 Impact: Q1 2015
2014-2015 Low Income Services Program	None	Desk Review: Q2 2014
2014-2015 My Energy Manager (Home Energy Solutions)	None	Process: Q4 2015 Impact: Q2 2016
2014-2015 My Home Energy Report (MyHER)	None	Process: Q3 2015 Impact: Q3 2015
2012-2013 Smart $aver® Residential HVAC	Complete	Process: Q2 2014 Impact: Q2 2014
2014-2015 Smart $aver® Residential, Online Savings Store (Specialty Bulbs)	Surveys Q3 2014	Process: Q1 2015 Impact: Q1 2015
2014-2015 Smart $aver® Residential, Property Manager Program	Surveys Q3-Q4 2014 Logger Study: Q3 2014	Process: Q1 2015 Impact: Q2 2015
2014-2015 Non-Residential Smart $aver® Prescriptive	Surveys Q2-Q3 2014 Monitoring: Q2 2014-Q2 2015	Process: Q4 2014 Phase 1 Summary: Q2 2015 Impact: Q4 2015
2014-2015 Non-Residential Smart $aver® Custom	Surveys Q2 2014-Q2 2015 Monitoring: Q2 2014-Q2 2015	Process: Q4 2015 Phase 1 Summary: Q4 2014 Impact: Q4 2015
2013 Power Manager®	Complete	Process: Q1 2014 Impact: Q2 2014
2014 Power Manager®	Surveys Q1-Q3 2014	Process: Q1 2015 Impact: Q1 2015
2013 PowerShare®	Complete	Process: Q2 2014 Impact: Q2 2014
2014 PowerShare®	None	Impact: Q1 2015

Final Report

Impact Evaluation and Review of the 2012 Power Manager® Program in Ohio and Kentucky

Prepared for
Duke Energy
139 East Fourth Street
Cincinnati, OH 45201

June 17, 2013

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Executive Summary

Summary of Findings

The approach used by Duke Energy for estimating the effect of the Power Manager® program is very reasonable and defensible. One particularly noteworthy feature is that they use an extensive history to estimate the model, rather than relying on only a handful of days as is common in many utilities which use less rigorous approaches (i.e., approaches that compare average usages from a pre-event period, for example, rather than conducting a multivariate regression model, as Duke Energy is doing).

In 2011, the behavior of some Cannon switches to deviate substantially from the shed times expected for the Target Cycle method was an issue since it increases the uncertainty of the program impacts. Duke Energy and Cooper determined that the root cause was a firmware flaw in the Target Cycle algorithm. Duke Energy and Cooper worked together to develop a solution that utilized radio signal communications (via the paging network) that changed the affected switches from the flawed Target Cycle algorithm to the True Cycle algorithm. This conversion of the affected switches was completed prior to the start of the 2012 event season. Therefore, inverse shed is no longer an issue.

Overall, based on our review, Duke Energy's impact evaluation is a very complete and innovative approach, and should result in accurate estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized in Table 7 on page 13.

Introduction and Purpose of Study

This document presents the evaluation report for Duke Energy's Power Manager Program as it was administered in Ohio and Kentucky.

The evaluation was conducted by Duke Energy and the TecMarket Works evaluation team. Duke Energy conducted the impact analysis, and Integral Analytics (a TecMarket Works subcontractor) conducted the review of the methodology and results.

Summary Overview

This document presents a review of the impact evaluation for the Power Manager (PM) program conducted by Duke Energy as it was administered in Ohio and Kentucky.

Summary of the Evaluation

Power Manager is a voluntary residential program, available to homeowners with central air conditioning (AC). On days where energy demand and/or energy costs are expected to be high, Power Manager participants have agreed to allow Duke Energy to cycle their air conditioning off for a period of time.

The impact evaluation conducted by Duke Energy developed an air conditioner (AC) duty cycle model based on information from a sample of PM participants. This duty cycle was then used to simulate the expected natural duty cycle during the PM event days and under peak normal weather conditions for different PM program options and load control technologies to produce estimates of the potential load reduction. These estimates were then de-rated by the results of operability studies to give estimates of the realized load reductions.

Evaluation Objectives

The purpose of this evaluation was two-fold. The first objective is to summarize the actual kW and expected peak normal kW impacts determined by Duke Energy for 2012. The second objective is to determine if the approach used by Duke Energy in estimating these impacts is consistent with commonly accepted evaluation principles.

Summary of Review

The approach used by Duke Energy for estimating the effect of the Power Manager® program is very reasonable and defensible. One particularly noteworthy feature is that they use an extensive history to estimate the model, rather than relying on only a handful of days as is common in many utilities which use less rigorous approaches (i.e., approaches that compare average usages from a pre-event period, for example, rather than conducting a multivariate regression model, as Duke Energy is doing).

Overall, based on our review, Duke Energy's impact evaluation is a very complete and innovative approach, and should result in accurate estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized in Table 7 on page 13.

Description of Program

Power Manager is a voluntary residential program, available to homeowners with central air conditioning (AC). On days where energy demand and/or energy costs are expected to be high, Duke Energy has permission from Power Manager participants to cycle their air conditioning off for a period of time.

When customers enroll, Duke Energy installs a switch that allows the AC unit to be cycled off and on in response to signals sent over Duke Energy's paging system.

Within Duke Energy's portfolio, Power Manager is currently the only residential demand response program[1]. The Power Manager program plays a key role in capacity planning; every year, Power Manager provides an estimate as to how much capacity it can provide during the summer season, and this information is taken into account by the capacity planners.

Program Participation

Program	Participation Count for 2012
Power Manager Ohio	EOM Sept. 2012 = 42,597
Power Manager Kentucky	EOM Sept. 2012 = 9,086

[1] Not including pilot programs.

Methodology

Overview of the Evaluation Approach

The impact evaluation for the Power Manager (PM) program was conducted by Duke Energy staff. The results presented in this report include a review by Integral Analytics of the impact evaluation methodology and results.

The impact evaluation developed an air conditioner (AC) duty cycle model based on information from a sample of PM participants. This duty cycle model was then used to simulate the expected natural duty cycle during the PM event days for estimates of event load reduction impacts and under peak normal weather conditions for different PM program options and load control technologies to produce estimates of the potential load reduction on a peak normal day. These estimates were then de-rated by the results of operability studies to give estimates of the realized load reductions.

The approach used by Duke Energy staff is nearly identical to the approach used in the prior evaluations reviewed by the TMW team.

This general approach is well established in the industry and the actual analysis was very thorough and well thought out. The resulting impact estimates are reasonable and accurate.

Data collection methods, sample sizes, and sampling methodology

The 2012 Power Manager M&V sample in the Midwest consists of 283 households with 307 air-conditioner (AC) units. This includes 117 households from Ohio and 26 households from Kentucky, closely reflecting the relative numbers of PM participants in each state. The 2012 Ohio and Kentucky M&V sample is representative of the PM population within the two states and includes 95 new households randomly selected from the PM population in February, 2012, and 48 holdovers from the 2011 M&V sample that were randomly selected in either 2010 or 2011. The samples are designed to target at 10% relative precision at 90% confidence level with additional households to compensate loss of the sample due to data issue or removal of the switch through the summer.

At households selected for the M&V sample, any older load control device was replaced by a Cannon load control device. The purpose of this study is to determine the load reduction achieved when the load control device functions as expected, so this device replacement does not introduce bias into the results. Completely separate operability studies are conducted to determine deviation from expected performance (the de-rating factor) for each load control technology. The M&V samples were used for both fixed and target cycling.

PM M&V samples are stratified into high, medium and low groups according to premise monthly kWh usage from the previous summer. The Dalenius-Hodges technique for selecting strata boundaries and the Neyman method for optimum sample allocation were employed to achieve reduced sample variance of load reduction estimates. Stratification analysis was performed together for Ohio and Kentucky. The resulting stratification of PM M&V samples is shown in Table 1.

Table 1. M&V Sample Stratification

	Sample allocation			Population weight		
	High	Medium	Low	High	Medium	Low
OH & KY	46	49	48	14.4%	46.8%	38.8%

Hourly run-time of AC units in the M&V samples was collected during 2012 summer months (May through September). This was accomplished with Cannon load control devices, which record hourly run-time (in minutes) of the AC unit to which they are attached. Data collection from M&V Cannon devices were conducted in June and the end of September. In addition to hourly run-time, the Cannon device scan data includes hourly shed minutes and the contents of many device registers. Information about the AC unit is also recorded, including rated amps for the compressor and fan.

Households in the M&V samples are equipped with load research interval meters, and 15-minute or 30-minute premise interval usage (kWh) was collected for 2012 summer months.

Number of completes and sample disposition for each data collection effort

See "Table 1. M&V Sample Stratification" above.

Expected and achieved precision

The 2012 M&V sample is representative of the PM population and is designed to target at 10% relative precision at 90% confidence level.

The final sample sizes for OH & KY were adequate to produce estimates at 20% relative precision at 90% confidence level.

Description of baseline assumptions, methods and data sources

The baseline is developed from the duty-cycle of the sampled AC units based upon the observed AC usage during non-holiday, non-weekend, and non-control days.

Description of measures and selection of methods by measure(s) or market(s)

The PM program is an AC cycling program, so the only measure in question is the AC units.

Use of TRM values and explanation if TRM values not used

The analysis provides estimate of the savings that were achieved by participating households, thus there was no need to use TRM values.

Threats to validity, sources of bias and how those were addressed

The approach used in the evaluation relied upon actual measurement of AC usage, and is therefore not subject to any reporting or self-selection bias.

Evaluation Findings

Validation of AC Duty Cycle Data

Hourly air conditioner (AC) run-time collected from Cannon M&V devices is compared to corresponding premise interval kWh to verify that it accurately reflects operation of the attached AC unit. The validation process is accomplished through a sequence of computer programs that: 1) convert the hourly A/C run-time data into hourly duty cycle; 2) display time series plots of premise kWh and duty cycle with control over time resolution enabling visual comparison of plot detail; 3) calculate cross-correlation between hourly kWh and hourly duty cycle and display cross-plots of kWh vs. duty cycle. Each run-time data file collected for an AC in the 2012 M&V sample is reviewed in this fashion, and the AC duty cycle is added to the model database if it passes the validation process.

In the Ohio and Kentucky sample, Duke Energy could not obtain the 2012 data needed to apply validation procedures for 8 ACs due to the inability to retrieve scan data (6), disconnection (1), or no access to the switch (1). In the validation process, run-time data was rejected for 2 ACs in the Ohio and Kentucky sample. These cases appear to be due to equipment sensitivity issues, where the AC is reported to have no run-time or to be always running. The final sample sizes include 135 households with 143 devices for OH & KY. This is still adequate to produce estimates at 20% relative precision at 90% confidence level, which is required by PJM for OH and KY.

Table 2 summarizes the 2012 M&V sample.

Table 2. M&V Sample

	Midwest	
	Ohio	Kentucky
Households	117	26
Total AC Units	153	
Missing data	8	
Invalid Data	2	
Final AC Sample	143	
Final Households	135	

AC Duty Cycle Models

Impact estimates during PM load control periods are based upon models developed for the natural duty cycle of M&V AC units. These models are developed from 2012 duty cycle data described above, and similar duty cycle data from the two prior summers (2010, 2011) for AC units that are holdovers from previous M&V samples. Weekends and holidays are not used in the models, and hours during load control and for the remainder of the day are not used. As addressed above, Duke Energy staff was able to develop duty cycle models for AC units at 135 households in the Ohio and Kentucky M&V sample.

Natural duty cycle models are specified and estimated individually for M&V AC units to better capture the unique dependence of duty cycle on the temperature and humidity characteristics of each AC unit. A limited dependent variable model specification is adopted for hourly duty cycle, the dependent variable in the models. Candidate specifications for independent variables in the models include temperature averaged over the prior 2-hour, 4-hour, and 6-hour intervals, and a weighted temperature average with declining weights over the previous six hours. Candidate specifications also include similar sets of averages based on temperature-humidity index (THI) and heat index (16-element polynomial). Models are estimated with the SAS procedure QLIM[2]. The dependent variable specification selected for an AC unit is based on fit diagnostics from hourly model fits over the typical load control hours, 2:00–6:00 PM. For the selected model, distinct parameters are estimated in each hour of interest, resulting in a set of hourly natural duty cycle fits for each M&V AC.

PM Load Control Strategies

The PM program employs two generic types of load control devices which require somewhat different treatment for load impact evaluation. The newer switch types (Cannon LCR 4700) in OH and KY operate with an adaptive control strategy called Target Cycle (TC). For each hour of load control, the Target Cycle switch calculates a unique shed time (or percentage) based on characteristics of the attached AC unit. The older switch type (CSE) in KY uses traditional fixed cycling control, where all devices on the same program shed the same amount of time during the control period. In Ohio and Kentucky, the principal PM program options are 1.5 kW and 1.0 kW, and Target Cycle switches are configured with these load reduction targets constrained by the maximum shed time of 24 minutes per 30-minute control period. Fixed Cycling (FC) devices limit the AC run-time to 7.5 minutes (1.5 kW) or 15 minutes (1.0 kW) of each 30-minute control period. Equivalently, PM CSE devices are operated with fixed cycling percentages of 75% (FC 75%) for 1.5 kW, or 50% (FC 50%) for 1.0 kW. The third program option is 0.5 kW. Due to the limited number of participants on this option, we scale the impact estimate for it based on the results for 1.0 kW. Table 3 summarizes PM load control technology and strategy used in different states.

Table 3. PM Load Control Devices and Strategies

		Strategy			
Device	Period	OH		KY	
	(min)	1.5 kW	1.0 kW	1.5 kW	1.0 kW
Cannon	*30*	*TC 1.5*	*TC 1.0*	*TC 1.5*	*TC 1.0*
CSE	30			FC 75%	FC 50%

The Target Cycle control strategy puts more functionality in the switch itself. Rated amps of the attached AC unit is entered into the switch at installation, and used to determine connected load for the unit. The switch also records hourly duty cycle of attached AC unit and builds a profile (historical profile) of the expected hourly duty cycle under weather conditions typical for load control. The historical profile can be scaled (globally) by adjusters included in the commands sent to switches for load control. The connected load and adjusted historical profile are used to

[2] QLIM: qualitative and limited dependent variable model.

calculate hourly cycling percentages for the attached AC unit expected to achieve the appropriate load reduction target. The shed percentage is calculated in the switch for each load control hour as shown below for Target Cycle:

AmpKW = 0.85*DeviceAmp*230/1000
Shedpct = Min(1-scaled_profile/100+Target kW/AmpKW, MaxAllowed_Shed)

Impact analysis for PM in 2011 revealed that shed times for some of the Cannon switches deviated substantially from the expected shed times for the target cycle method. Instead these switches appeared to shed more like an "inverted" pattern, relative to the pattern expected. Further investigation by Cooper Power Systems (Cannon) discovered that the cause of this issue was due to a firmware flaw in these defective switches. An alternate adaptive cycling approach, True Cycle, was developed to solve the inverted shed issue. For the True Cycle approach, a cycling percentage called a gear is estimated using the duty cycle model and is sent to switches for load control. This gear and the scaled historical profile are then used to calculate hourly shed percentages for the attached AC unit expected to achieve the appropriate load reduction target (1.5 kW or 1.0 kW). The main difference between target cycle and true cycle is that the latter does not use rated amps to calculate connected load for the attached unit. The shed percentage is calculated in the switch for each load control hour as below for True Cycle:

Shedpct = Min(1-scaled_profile/100+gear, MaxAllowed_Shed)

Factors that determine Target Cycle and True Cycle shed percentages for M&V AC units during control periods are known, except for contents of hourly historical profile registers on those days. Values in these registers change frequently during the summer as they are updated with the AC hourly run-time on "saved" days, which are selected with weather conditions sufficiently close to a typical load control day. Hourly run-time profiles on 2012 control days for M&V AC units are determined from the contents at the end of the 2012 control season (when available), and the unit run-time on 2012 saved days. The impact for both of the cycling strategies are estimated and the proportions of True Cycle switches are used to determine the overall shed per switch attributable to Cannon switches.

AC Connected Load

Connected load is the average power demand (kW) of a running AC unit over a full cycle. It determines the load reduction (kWh) achieved when AC run-time is reduced. Connected load is specified for M&V AC units through the basic engineering formulas:

*Apparent Power (kVA) = (Compressor Amps + Fan Amps) * 230 Volts / 1000*

*Connected Load (kW) = Power Factor * Apparent Power*

Rated amps for the compressor (FLA) and fan (RLA) are typically listed on the AC faceplate.

Power factor in this formula is actually different for different AC units, and even varies somewhat for different cycles of the same unit, increasing at high temperature and humidity.

Duke Energy has analyzed synchronous AC run-time and premise interval kWh collected for the M&V samples to determine an appropriate overall power factor within each sample. Results are 0.83 for the Ohio and Kentucky M&V sample. These power factor values are used to calculate connected loads for impact evaluation.

Simulation Method for PM Impact Evaluation

Simulation with M&V natural duty cycle models is used to determine average load reduction per household within M&V strata during each hour of load control and for each PM cycling strategy. These strata results are combined with the population weights given in Table 1 to estimate average load reduction per household in the PM populations in OH and KY. The potential load impacts estimated in this manner represent the load reduction which would be achieved if all switches controlled as expected. Impact results for PM load control are obtained by simulation with the OH/KY M&V samples.

The simulation procedure is very similar for the basic PM control strategies: Target/True Cycle and Fixed Cycling. In a fixed cycling simulation, the same specified shed percentage is applied to all ACs to evaluate load impact. In a Target/True Cycle simulation for a particular program option, or load reduction target, and during a specified hour (and day) of load control, a customized shed percentage is calculated for each AC unit from information specific to that unit. The resulting unit-specific shed percentages remain fixed in all simulated realizations for that load reduction target and load control hour.

A single realization in the simulation is generated by a random draw of residuals for each of the M&V natural duty cycle model fits, which are evaluated at the temperature and humidity of the control hour (and day). This gives a set of simulated natural duty cycles appropriate for the control hour. Load reduction for each M&V AC is calculated as follows:

Duty cycle reduction = MAX[Duty cycle - (1 – Shed percentage), 0]

*Load reduction = Connected load * Duty cycle reduction*

For households with multiple ACs, realized load reduction is aggregated to the household level by summing load reduction from all household ACs. These realized load reductions are averaged within the strata to produce single realizations of average load reduction per household within high, medium, and low strata. These three sample averages constitute the result from one pass through the simulation corresponding to one draw of model residuals.

Two thousand passes through the simulation are performed to adequately capture the variation in average load reduction within strata that is consistent with our duty cycle models and M&V sample sizes. The results accumulate into distributions of sample averages for all three strata. The grand means of these distributions are the most significant output from a simulation run. They are the estimates of average load reduction per household in each stratum for the specified control hour and cycling strategy. The spread of these distributions (e.g., variance) characterizes the uncertainty in the load reduction estimates, and is inversely related to the M&V sample sizes.

Load Impact Results

Load impacts described in this section are computed with population estimates of load reduction per switch, rather than load reduction per household. Simulation results are converted to load reduction per switch using the factors 1.04 switches per household for Ohio and Kentucky results. Population estimates of load reduction per household are divided by these factors to get corresponding population estimates of load reduction per switch. The estimates of switches per household are determined from the M&V samples in Ohio and Kentucky.

Power Manager hourly results for OH and KY are given in Table 5. These results are adjusted for distribution and transmission line losses. Both Cannon and CSE load control devices are installed in KY. Only Cannon devices are installed in OH.

Table 4 shows de-rating factors used for the 2012 impact evaluation. The CSE factor in KY was determined by an operability study conducted in 2009. The factors for Cannon in OH and KY were determined by an operability study conducted in 2010. We will conduct operability studies for Cannon in OH and KY in 2013.

Table 4. De-rating Factors for Impact Evaluation

Switch Type	OH	KY
Cannon	0.931	0.931
CSE		0.541

Table 5. 2012 PM Impact Results for OH and KY

Event Date	Hour	PM Impact (MW)	
		OH	KY
6/20/2012	15	36.6	9.5
	16	26.8	9.7
	17	27	9.9
6/21/2012	15	37.2	9.5
	16	39.2	10.1
	17	39.8	10.3
6/28/2012	16	39.2	
	17	40.3	10.3
	18	40.4	10.4
	19		10.6
6/29/2012	16	43	10.7
	17	43.1	10.9
7/5/2012	16	35.3	8.7
	17	34.2	8.7
	18	35.5	9
7/6/2012	16	39.4	9.8
	17	39.6	10
	18	40.4	10.2
7/17/2012	16	47.8	11.5
	17	49.2	12
	18	48.5	11.9

PM load control was activated in OH and KY on 7 days during the summer of 2012, including both CSE and Cannon devices on all days. Table 5 gives hourly impact results in OH and KY for each control day. The highest hourly impact in Ohio was 49.2 MW, and in Kentucky, 12 MW, both in hour 17 (5:00 – 6:00 pm EDT) on July 17 adjusted for line losses.

Table 6 gives estimated load reduction per switch not adjusted for line losses under peak normal weather conditions and load control technologies. **Table 7 shows the summer monthly load reduction adjusted for line losses under peak normal weather conditions.** Table 8 shows the peak normal weather conditions used to calculate the results in Table 6. The system peak is assumed to occur in the hour 5:00 – 6:00 pm EDT (identified as hour 18 in this report).

Table 6. Shed kW/switch with Peak Normal Weather

Switch Type	Control Strategy	Potential Impact	De-rated Impact
		OH/KY	OH/KY
Cannon	TC 1.5	1.52	1.42
	TC 1.0	1.01	0.94
CSE	FC 75%	1.81	0.98
	FC 50%	1.07	0.58

Table 7. Monthly Peak Normal Weather Load Reduction De-rated Impact by State Adjusted for Line Losses for Cycling

State	Control Strategy	June	July	August	September	Summer Capability
Ohio	Cycling	44.6	44.7	45.3	45.5	44.9
Kentucky	Cycling	11	10.9	10.9	10.9	10.9

Table 8. Peak Normal Weather

Hour	OH / KY	
	Temp	Dewpt
11	85.3	71.8
12	87.6	71.9
13	89.9	71.9
14	92.0	71.5
15	93.1	70.7
16	93.9	70.5
17	92.5	70.0
18	92.4	69.5

The last column of Table 7 shows the weighted average capability of the Power Manager program across the summer months in 2012 for each state. These weighted average values are calculated using the summer monthly values and weighting them based on the probability of experiencing an annual peak load in that month in each state. However, for revenue recovery purposes, Duke Energy also calculates a value called a P&L value. The P&L value is calculated from monthly capability values in each state. The P&L value is the value proposed by Duke Energy to be used for revenue recovery since it is consistent with accounting guidelines. The P&L values for 2012 are 44.9 MW Ohio and 11.0 MWs Kentucky. A further explanation of the P&L value is provided below.

P&L Value (Revenue Recovery Value) – the process can be summarized as follows.

- Using the processes described above and the program participants for a particular month, calculate the monthly capability of those participants using summer peak normal weather. For Power Manager, these values, for the summer months, are the same values as provided above in Table 7.
- The monthly values receive accounting adjustments if applicable.
- The revised monthly values are averaged across the months during which the program is available for curtailment. For the Power Manager program, this would include the months of May – September in OH and KY.

Review Results

The approach used by Duke Energy for estimating the effect of the Power Manager® program is very reasonable and defensible. One particularly noteworthy feature is that they use an extensive history to estimate the model, rather than relying on only a handful of days as is common in many utilities which use less rigorous approaches (i.e., approaches that compare average usages from a pre-event period, for example, rather than conducting a multivariate regression model, as Duke Energy is doing).

Overall, based on our review, Duke Energy's impact evaluation is a very complete and innovative approach, and should result in accurate estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized in Table 7 on page 13.

Final Report

Impact Evaluation and Review of the 2012 PowerShare® Program in Ohio

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TECMARKET Works

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Executive Summary

Introduction and Purpose of Study

This document presents the evaluation report for Duke Energy's PowerShare® Program as it was administered in Ohio.

Duke Energy performed the calculations and conducted the impact analysis, and Integral Analytics (a TecMarket Works' Subcontractor) conducted the review of the methodology and results.

Summary of the Evaluation

The impact analysis of the PowerShare program was conducted by Duke Energy. The basic approach for determining the impacts, capabilities, and profit and loss (i.e., P&L, the MW values used for revenue recovery) involves combining actual weather data with hourly load data from all enrolled customers, collected for the previous month(s), as appropriate. A regression model is developed using the combined data to provide an estimate of what the load would have been for the customer, absent an event. This is compared to the actual customer load to determine the impacts from an event.

Evaluation Objectives

The purpose of this evaluation is two-fold. The first objective is to summarize the actual kW and expected peak normal kW impacts determined by Duke Energy for 2012. The second objective is to determine if the approach used by Duke Energy in estimating these impacts as well as the capacity values are consistent with commonly accepted evaluation principles.

Recommendations

Overall, based on our review, Duke Energy's impact evaluation is a very complete and innovative approach, and it should result in accurate estimates of Event impacts (i.e., settlement with customers, M&V results for an event, capability values, and P&L values).
In general, the model specifications in all the processes includes the key determinates of energy usage, so there is little likelihood of any bias in the results from omitted variables. One particularly noteworthy feature is that Duke Energy uses an extensive history to estimate the model, rather than relying on only a handful of days as is common in many utilities which use less rigorous approaches. In addition, using a multivariate regression model in the Capabilities, P&L, and M&V processes is generally preferred over approaches that are based on average loads from a pre-event period.

In addition, the technical approach used by Duke Energy in developing settlement calculations for the customer day-ahead Pro forma load (PFL) and the M&V event impacts are very well thought out and developed. The use of multiple methods and determining the Best of Breed (BoB) in the PFL is noteworthy in that it assures that the most accurate approach will be used in developing the PFL – a step which, to the best of our knowledge, is not used by any other entity.

In addition, there appears to be no direct link between the customer payments (based on the day-ahead PFL) and the overall program impacts (based on the M&V and Capability process). Since the day-ahead PFL is based on the BoB approach, while the other processes are based on regression models, it may be that there is a marked difference between the two estimates of load impacts. Therefore, it is our recommendation that Duke Energy investigate a mechanism that will produce all the required reports for customers, internal use, and regulatory requirements, using a single, unified process for the PFLs and the other reports. An example might be to store the day ahead PFLs associated with an event for developing the Capability and M&V processes for appropriate programs.

Relatedly, it is not clear why there are so many different processes involved. While it is obvious that a distinction be made between actual weather and peak normal weather, it is not clear why that requires two distinct processes. It seems possible to combine the Capability and M&V process into one process, where the regression models are estimated once, and for the weather sensitive customers, estimates of both actual and weather normal impacts are estimated from the same model (just using different weather values). In addition, for Ohio, there does not appear to be any substantial difference between the Capability and P&L process, so these two can be combined. Therefore, our continued recommendation is that Duke Energy reviews the need for each process to see if they are truly required. In terms of P&L process results, the use of these results may be appropriate in the revenue recovery process but that is best addressed by Duke Energy and the state regulatory entities. In response to the same recommendations made in previous evaluations, Duke Energy has reviewed each process and believes that the capability, M&V, and P&L underlying calculation processes can be consolidated. Duke Energy will notify TecMarket Works when changes are implemented.

Description of Program

PowerShare® is the brand name given to Duke Energy Ohio's Peak Load Management Program (Rider PLM, Peak Load Management Program P.U.C.O. Electric No. 19, Sheet No. 87.1). A revised version of this Rider was accepted in PUCO Case No. 12-1682-EL-AIR. All information in this report refers to the Rider PLM effective for the year 2012. The PLM Program is voluntary and offers customers the opportunity to reduce their electric costs by managing their electric usage during the Company's peak load periods. Customers and the Company will enter into a service agreement under this Rider, specifying the terms and conditions under which the customer agrees to reduce usage.

There are three product options offered for PowerShare® - CallOption®, AutoDR, and QuoteOption®:

- CallOption®
    - A customer served under a CallOption® product agrees, upon notification by the Company, to reduce its demand.
    - Each time the Company exercises its option under the agreement, the Company will provide the customer a credit for the energy reduced.
    - There are two types of events.
        - Economic events are primarily implemented to capture savings for customers and not necessarily for reliability concerns. Participants are not required to curtail during economic events. However, if participants do not curtail, they must pay a market based price for the energy not curtailed. This is called "buy through energy."
        - Emergency events are implemented due to reliability concerns. Participants are required to curtail during emergency events.
    - If available, the customer may elect to buy through the reduction at a market-based price. The buy through option is not always available as specified in the PowerShare® Agreements. During PJM Interconnection, LLC-declared emergency events, customers are not provided the option to buy through.
    - In addition to the energy credit, customers on the CallOption® will receive an option premium credit.
    - For the 2012/13 PowerShare® program, there were three different enrollment choices for customers to select among. All three choices require curtailment availability for up to ten emergency events per PJM requirements for capacity participation. The number of economic events varies among the choices. Customers can select exposures of zero, five or ten economic events.
    - Only customers able to provide a minimum of 100 kW load response qualify for CallOption®. Aggregation of customer's accounts is permitted with a minimum of 1 MW load response.

- AutoDR
    - AutoDR is essentially the same program as CallOption 10/10 (i.e., 10/10 meaning 10 economic events and 10 emergency events). However, the implementation mechanism is very different. For CallOption programs an

automated messaging system contacts customers to notify them of an event. AutoDR could be classified as a direct load control program because implementation is controlled through messages sent directly to the participant's energy management system (EMS). These messages adjust the EMS settings to accomplish the load reduction enrolled.
  - Load impacts for this program are calculated exactly the same as the CallOption programs.

- QuoteOption®
  - Under the QuoteOption® products, the Company may notify the customer of a QuoteOption® event and provide a Price Quote to the customer for each event hour.
  - The customer will decide whether to reduce demand during the event period. If they decide to do so, the customer will notify the Company and provide an estimate of the customer's projected load reduction.
  - Each time the Company exercises the option, the Company will provide the participating customer who reduces load an energy credit.
  - There is no option premium for the QuoteOption® product since customer load reductions are voluntary.
  - Only customers able to provide a minimum of 100 kW load response qualify for QuoteOption®. Aggregation of customer's accounts is permitted with a minimum of 1 MW load response.
- Other
  - Note that another large commercial and industrial demand response program is offered in Ohio. This program is called the Ohio Transmission Voltage Demand Response Program. This program does not receive state approved incentives and is not included in this report.

PowerShare® 2012-2013 Participation Summary

The PowerShare program has an annual enrollment for participation. This report covers the participation year of 2012. However, customers enroll for 1 year periods from June through May. Therefore, one set of customers participate in PowerShare from January through May, 2012, while a different set of customers are enrolled for June through December, 2012. Duke Energy Ohio is a summer peaking utility and therefore, the most relevant participation period is the summer months of June through September and this report concentrates on those months.

The table below compares account participation levels for summer 2011 and summer 2012, as well as MWs enrolled in the program. The MW values are Duke Energy Ohio's estimate of the load reduction capability across the summer. Additional information is presented below on the different calculations performed for the program including summer load reduction capability (LRC), P&L revenue recovery values, Measurement & Verification (M&V) values, and day-ahead projected load reduction (PFLs).

Ohio PowerShare® Participation Update
Enrolled Customers

CallOption® QuoteOption®

2011	2012	Change	2011	2012	Change
75	**52**	**-23**	**0**	**0**	**0**

Summer Curtailment Capability (MWs)*

CallOption® QuoteOption®

2011	2012	Change	2011	2012	Change
97.9	**65.3**	**-32.6**	**0**	**0**	**0**

*Capability for QuoteOption® is 80% of customer estimated load curtailment

Numbers reported are adjusted for losses

(Note that Duke Energy Ohio also registers DR, Demand Response, with PJM Interconnection, LLC. The values calculated by PJM for registered capacity do not necessarily match the values above since PJM follows a separate calculation process. These values are not documented here. The CallOption values above include AutoDR participants.)

PowerShare® 2012-2013 Program Activity

During the summer of 2012, there were 4 CallOption® events and 0 QuoteOption® events. All CallOption® events were economic events. There were no CallOption® emergency events but there were 2 CallOption PJM test events. These events are required by PJM and each lasted 1 hour. The second event was only for those customers who did not comply with their load reduction amounts during the first event. The table below summarizes event participation.[1]

Date	Hour Ending	Reporting Time Zone EDT/EST	Power-Share 0/10	Power-Share 5/10	Power-Share 10/10	PowerShare CallOption Subtotal (MW)	Quote (no events)	AutoDR	Total (MW)
6/21/2012	14	EDT			2.1	2.1			2.1
6/21/2012	15	EDT			1.6	1.6			1.6
6/21/2012	16	EDT			1.0	1.0			1.0
6/21/2012	17	EDT			0.6	0.6		1.6	2.2
6/21/2012	18	EDT			0.0	0.0		1.6	1.6
6/21/2012	19	EDT			0.0	0.0			0.0

[1] "PowerShare® CallOption® participants are presented with the option to "buy-through" economic events since system reliability is not a concern during economic events. For energy consumed under this buy-through option, customers pay a market based price for energy. Buy-through is not available during emergency events. Also note that there was only 1 CallOption and 3 AutoDR customers enrolled in 2012 for economic events. All other participants were enrolled for emergency events only."

6/28/2012	14	EDT			1.9	1.9		2.8	4.7
6/28/2012	15	EDT			1.4	1.4		2.6	4.0
6/28/2012	16	EDT			1.1	1.1		2.4	3.5
6/28/2012	17	EDT			0.4	0.4		2.0	2.4
6/28/2012	18	EDT			0.0	0.0		2.0	2.0
6/28/2012	19	EDT			0.0	0.0		2.2	2.2
6/29/2012	14	EDT			2.4	2.4			2.4
6/29/2012	15	EDT			2.0	2.0		1.5	3.5
6/29/2012	16	EDT			2.3	2.3		1.2	3.5
6/29/2012	17	EDT			1.2	1.2		1.8	3.0
6/29/2012	18	EDT			0.4	0.4		0.9	1.3
6/29/2012	19	EDT			0.2	0.2			0.2
7/6/2012	15	EDT						1.3	1.3
7/6/2012	16	EDT						0.9	0.9
7/6/2012	17	EDT						0.9	0.9
7/6/2012	18	EDT						1.3	1.3
7/17/2012	15	EDT						1.5	1.5
7/17/2012	16	EDT						1.3	1.3
7/17/2012	17	EDT						1.1	1.1
7/17/2012	18	EDT						1.2	1.2
7/26/2012	14	EDT			2.7	2.7			2.7
7/26/2012	15	EDT			1.8	1.8			1.8
7/26/2012	16	EDT			1.4	1.4			1.4
7/26/2012	17	EDT			1.5	1.5			1.5
7/26/2012	18	EDT			0.1	0.1			0.1
7/26/2012	19	EDT			0.0	0.0			0.0
9/12/2012	15	EDT	76.9		3.3	80.2		2.2	82.4
9/27/2012	16	EDT	0.3			0.3			0.3

Overview of the Evaluation Approach

The impact analysis for the PowerShare programs was conducted by Duke Energy staff and evaluated by Integral Analytics staff. The results presented in this report include a review by Integral Analytics of the impact evaluation methodology and results.

There are many different numbers calculated by the DR Analytics group for PowerShare. A large portion of the effort surrounding analytics for PowerShare falls into four different calculation areas. These calculations can be grouped into 2 categories. These categories and calculation areas are listed below and then described in more detail.

a. Hourly Event Day Impact Estimates
    i. Pro-forma Load Estimations (PFLs) – estimates of participant's hourly electric consumption for the next day. These baseline projections are used to determine potential load reduction for a potential event the next day.
    ii. Measurement and Verification Load Reduction Estimates (M&V) – estimates of actual load reduction provided by participants on an event day.
b. Peak Available Load Reduction Estimates
    i. Load Reduction Capability (LRC) – estimates of load reduction under peak normal weather conditions, if applicable, over a specified period of time such as a month or the entire summer for participants during the period of time in question.
    ii. Revenue Recovery Load Reduction Estimates (P&L) – estimates of summer load reduction under peak normal weather conditions, if applicable, for all participants enrolled in the program during the calendar year.

Note that the PFL process and calculations are projected values used in PowerShare operations. These are not the final estimated baselines for customers. The final baselines are calculated in the M&V process and are used to determine the load reductions during events. The PFL process is significant to the PowerShare program since these values are used for customer settlement calculations and we will discuss them in PowerShare Process evaluation reports.

As the categories above imply, the evaluation of the PowerShare program must meet a diverse set of goals. Specifically, after each event, the level of load reduction must be calculated for each participant. If the participant is on a firm service level reduction agreement, the determination is made if they reduced load from wherever their load would have been absent the event, a baseline, to their actual load during the event period. Another key feature of a firm service level agreement is to determine if the customer's load is at or below the firm service level during the event hours, regardless of the amount of load reduction provided.

If the customer is on a fixed reduction agreement, the evaluation calculates the difference between the baseline and the actual load during the control period to see if the agreed amount of reduction was achieved.

Credits or penalties for events, using PFLs, are calculated within the Energy Profiler Online (EPO) system for PowerShare and recorded on the customer's utility bill. In addition, the results of the various evaluations are used to develop reports for the system operator, load availability projections, summer curtailment projections for state level planning, and event load reduction analysis.

A further requirement related to PFLs is that an economic control event can be called on any non-holiday, non-weekend day and therefore, the PFL calculation must be available on each of these days. The control season runs all year for emergency events; however, economic events, although possible outside the summer season, tend to be limited to the summer season. Regardless of the date, the evaluation needs to be able to assess the load data of all participants so that Duke Energy can calculate the amount of load reduction that is achieved at any time.

An additional complication is related to the use of aggregate accounts. Under this scenario a customer designates two or more accounts whose results are to be aggregated in order to meet the customer's obligations under their contract. In the case of aggregate accounts the estimation processes described below are applied to the individual accounts and the results obtained for the individual accounts are summed to obtain the result at the aggregate level.

These requirements have resulted in an extensive evaluation procedure as described above. This evaluation procedure consists of the following tasks:

Table 1. PowerShare Evaluation Procedures

Process	Purpose	Frequency
PFLs	Settlement with customers and emergency event load reduction projections	Every weekday
M&V	Reporting actual impacts of events to regulatory bodies.	Monthly if an event occurred in the prior month
LRCs	Internal Reporting and input into P&L process	Monthly
P&L	Regulatory filings for revenue recovery	Monthly as needed for internal reporting and a year-end true-up for revenue recovery

A high-level overview of the M&V, Capability, and P&L in Table 1 is given below.

M&V

The steps involved in the calculation of the monthly reports of Capability, P&L, and M&V are all similar but not exactly the same. In addition, for PowerShare Quote Option, the Capability and P&L processes are not performed since they are not relevant to the program. For the M&V process for PowerShare CallOption and for PowerShare Quote Option, hourly load data from all enrolled customers is collected for a particular month. Data is treated similarly but with a few exceptions such as the modeling of quiet periods. Event days and days where participants have reduced load, due to a maintenance shutdown for example, are excluded. However, if an event occurs during a period when the customer is on a maintenance shutdown, the information used in the analysis concentrates only on the information during their shutdown period and requires special handling. This is a rare event though and the typical procedure is described below.

The data is combined with the actual weather for that month. Regression models (one with and one without weather terms) are developed using the combined data. Specifically, the regression equation relates the customer's hourly electricity load to:

- A Fourier transform of hour of the day
- A Fourier transform of hour of the week
- A Fourier transform of hour of the month
- Temperature Humidity Index
- Binary variables for holidays and quiet periods, if appropriate
- Interactions between the Fourier transforms and the other variables

An F-test is calculated for each customer to determine if weather is a significant explanatory variable (unless weather is explicitly excluded for customers known not to be weather sensitive). If so, then the estimated parameters are used to create predicted loads using actual weather conditions on the event days. Thus, the baselines from the M&V process are representative of the actual load the customer would have consumed absent an event. These baselines from event days are then used with actual load data from the event hours and a load reduction is calculated.

However, note that all results are reviewed by DR Analytics. If regression results are clearly not representative of a specific participants load absent the event, an adjustment to the baseline may be applied. In addition, small variances around the baseline expected by typical model variance, above and below, are set to zero and therefore not considered load reduction.

M&V results are shown above in the Introduction section. Please note that the PFL event load reduction estimates are used for settlement with customers. However, M&V load reduction estimates are Duke Energy's best estimate of the load reduction impacts and these impacts are used for regulatory reporting purposes where applicable.

Load Reduction Capability (LRC)

Similar to the M&V regression process described above, Load Reduction Capability (LRC) is calculated on a monthly basis for PowerShare CallOption. For the LRC process, hourly load data from all enrolled customers is collected for a particular month. Event day information is eliminated from the analysis. Quiet periods, for example due to a maintenance shutdown, are included and modeled in the analysis.

The data is combined with actual weather. Regression models are developed using the combined data similar to the hourly regression model discussed above. Similar to above, two models are created: one with weather terms and one without. Specifically, the regression equation relates the customer's hourly electricity load to:

- A Fourier transform of hour of the day
- A Fourier transform of hour of the week
- A Fourier transform of hour of the month
- Temperature Humidity Index

- Binary variables for holidays and quiet periods, if appropriate
- Interactions between the Fourier transforms and the other variables

An F-test is calculated for each customer to determine if weather is a significant explanatory variable (unless weather is explicitly excluded for customers known not to be weather sensitive). If so, then the estimated parameters are used to create predicted loads using peak normal weather conditions for all days of the month. Thus, the baselines from the LRC process are representative of the peak normalized load the customer would have consumed throughout the month. The weekday, non-holiday baselines are then used with the customer's specified fixed reduction amount or firm load level to calculate the load reduction available each hour. By hour, these values are averaged across the month.

However, monthly LRC by participant is typically not of interest for most reporting purposes. Of primary interest is the summer LRC given that Duke Energy Ohio (DEO) is a summer peaking utility. PJM concentrates on this same period of time through their Peak Load Contribution process which is not described or emphasized in this report. Therefore, by hour and by participant, a weighted average of the four monthly LRC values is calculated. Then, by participant, the hourly values for hours ending (HE) Eastern Daylight Time (EDT) 15 through 18 are captured in a calculation to determine the summer LRC of each participant. For firm level participants, these 4 values are averaged. For fixed reduction participants, the minimum of the four values is used. Summing across all participants provides the Summer LRC of the program.

Revenue Recovery Load Reduction Estimates (P&L)

Similar to the LRC regression process described above, P&L is calculated based on capability calculations for all 4 summer months PowerShare CallOption. For the P&L process, hourly load data from all enrolled customers is collected for June through September. Event day information is eliminated from the analysis. Quiet periods, for example due to a maintenance shutdown, are included and modeled in the analysis.

The data is combined with actual weather. Monthly, a regression model is developed using the combined data similar to the hourly regression models discussed above. Specifically, the regression equation relates the customer's hourly electricity load to:

- A Fourier transform of hour of the day
- A Fourier transform of hour of the week
- A Fourier transform of hour of the month
- Temperature Humidity Index
- Binary variables for holidays and quiet periods, if appropriate
- Interactions between the Fourier transforms and the other variables

An F-test is calculated for each customer to determine if weather is a significant explanatory variable (unless weather is explicitly excluded for customers known not to be weather sensitive). If so, then the estimated parameters are used to create predicted loads using peak normal weather conditions for all days of the month. Thus, the baselines from the P&L process are representative of the peak normalized load the customer would have consumed throughout the month for all customers; even if the customer wasn't actually participating in one or more of the summer months. This is where the LRC and P&L processes differ. In LRC, the monthly value for June for a participant who joined the program in July would be 0. However, in P&L, the calculated value would be used for June. The fact that the customer did not participate in June is captured later in the calculation process. Continuing, the weekday, non-holiday baselines are then used with the customer's specified fixed reduction amount or firm load level to calculate the load reduction available each hour. By hour, these values are averaged across the month.

Then, by hour and by participant, a weighted average of the four monthly values is calculated. Then, by participant, the hourly values for hours ending (HE) Eastern Daylight Time (EDT) 15 through 18 are captured in a calculation to determine the summer LRC of each participant. For firm level participants, these 4 values are averaged. For fixed reduction participants, the minimum of the four values is used. This is where the LRC process would terminate after summing across all participants. However, the P&L process now calculates monthly values by taking the sum for each month of only the participants in that month. These monthly values are then delivered to Product Analytics for final calculations of the P&L results. Accounting adjustments are made as needed such as the elimination of all participation through the use of diesel generators. These participants are not included in the incentive structure for PowerShare in Ohio.

Evaluation Findings

Summary

Based on the evaluation performed by Duke Energy staff following the procedures discussed above, each calculation PFL, M&V, LRC, and P&L has a specific purpose. Primarily, PFLs are used for customer settlements for event incentives and operational projections of load reduction available the following day. M&V is used for regulatory and internal reporting of load reduction from events. LRC is used for internal reporting of load reduction available during each monthly period. P&L is used for revenue recovery requests. For this review, the primary focus is on the P&L calculations. Table 2 provides these values including adjustments for line losses for 2012.

Table 2. LRC and P&L values

Program	LRC (MWs)	P&L (MWs)
PS CallOption 0/10	62.9	47.0
PS CallOption 5/10	0.0	0.0
PS CallOption 10/10	1.1	2.1
PS CallOption 15/10	0.0	0.0
PS AutoDR	1.3	*
Total PowerShare CallOption	65.3	49.1

*AutoDR P&L value included in PS CallOption 10/10 P&L value.

Review of Approach

Overall, the technical approach used by Duke Energy in developing the event impacts are very well thought out and developed.

In general, the model specifications in all the processes includes the key determinates of energy usage, so there is little likelihood of any bias in the results from omitted variables. One particularly noteworthy feature is that they use an extensive history to estimate the model, rather than relying on only a handful of days as is common in many utilities which use less rigorous approaches. In addition, using a multivariate regression model in the Capabilities, P&L, and M&V processes is generally preferred over approaches that are based on average loads from a pre-event period.

The one concern we have is that there are multiple processes that essentially measure the same thing. For example, the P&L and Capability processes are essentially both measuring the peak normalized load reduction capability of participants. This appears to be inefficient, as well as confusing, as it is not clear what the actual estimate of impacts is for the program without considerable explanation. Of note, Duke Energy describes the P&L value as follows:

- The PowerShare programs allow the company to reduce load at any point during the year during an emergency. Because of that, the Company recognizes revenue ratably over a 12 month period based on the current summer capability for that month. (Said another way, the Company multiplies its current kW summer capability times the avoided cost of capacity per kW / 12.) The Company accordingly reports its 12-month average summer capability in regulatory true up proceedings for the PowerShare program.

In addition, there appears to be no direct link between the customer payments (based on the day-ahead PFL) and the overall program impacts (based on the M&V and Capability process). Since the day-ahead PFL is based on the BoB approach while the other processes are based on regression models, it may be that there is a marked difference between the two estimates of load impacts.

Relatedly, it is not clear why different processes must be involved. While there appears to be a specific purpose for each process, there may be efficiencies captured by consolidating the processes. While it is obvious that a distinction be made between actual weather and peak normal weather, it is not clear why that requires two distinct processes. It seems possible to combine the Capability and M&V process into one process, where the regression models are estimated once, and for the weather sensitive customers, estimates of both actual and weather normal impacts are estimated from the same model (just using different weather values). In addition, a difference between the Capability and P&L process is that the P&L includes customers who have enrolled after the beginning of summer or potentially participated during the beginning of the year but terminated their participation prior to the summer. Duke Energy clearly wants to capture these enrollments and collect revenues for them during the current year. However, it is our opinion that the P&L process may overstate or understate the actual capability of the program, if for example you are talking about the capability of the program during the summer of 2012. Therefore, our continued recommendation is that the impacts should be based on the Capability calculations, and Duke Energy should review the need for each process to see if they are truly required. In response to the same recommendations made in previous evaluations, Duke Energy has reviewed each process and believes that the capability, M&V, and P&L underlying calculation processes can be consolidated. Duke Energy will notify TecMarket Works when changes are implemented. Once these implementations are incorporated, we will revise our recommendations based upon the new approach.

Overall, based on our review, Duke Energy's impact evaluation is a very complete and innovative approach, and it should result in accurate estimates of event impacts.

Final Report

Impact Evaluation of the Non-Residential Smart $aver® Prescriptive Program in Ohio

Results of an Impact Evaluation for
Linear Fluorescent Lighting, Occupancy Sensors, and VFDs

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Executive Summary

Key Findings and Recommendations

This Executive Summary provides an overview of the key findings identified through this evaluation.

Significant Impact Evaluation Findings for Linear Fluorescent Measures

- Energy and coincident peak demand savings realization rates for kWh and coincident peak kW for linear fluorescent lighting were 1.89 (energy) and 1.61 (demand) respectively, indicating the program planning estimates were conservative estimates of linear fluorescent lighting savings.
- Measurement and verification (M&V) activities conducted for this study produced an estimate of 5,155 lighting equivalent full load hours (EFLH), compared to a program planning estimate of 4,144 EFLH.
- M&V activities estimated a coincidence factor (CF) of 0.80, compared to a program planning estimate of 0.77.
- Although there were some small differences between the quantity of fixtures recorded in the Duke Energy program tracking database versus the number of fixtures in the field, the overall installation verification rate was 1.00.
- Program planning and M&V estimates of baseline fixture wattage were within 1%. M&V estimates of efficient fixture watts were an average of about 7% lower than program planning estimates, indicating conservative values of fixture watts were used during program design.

Significant Impact Evaluation Findings for Occupancy Sensor Measures

- Energy and coincident peak demand savings realization rates for kWh and kW for occupancy sensor measures were 0.56 and 1.21 respectively, indicating the program planning estimates were conservative estimates of occupancy sensor coincident peak kW savings, but overestimated occupancy sensor kWh savings.
- M&V activities conducted for this study produced an estimate of 3,078 lighting equivalent full load hours (EFLH) before the installation of occupancy sensors, compared to a program planning estimate of 4,144 EFLH.
- M&V activities produced an estimate of connected lighting kW per occupancy sensor that was 31% lower than the program assumption. Many of the occupancy sensors in the study were controlling a single fixture, which contributed to the reduced connected watts per sensor.
- M&V activities estimated an average kWh savings of 54% of the uncontrolled consumption and an average kW savings of 46% of the uncontrolled demand, compared to the program estimate of 30% for both kWh and kW. Although the kW savings as a percentage of the baseline estimated from M&V was higher, the connected load per sensor was less, thus the overall demand savings per sensor from M&V was less than the program estimate.

Significant Impact Evaluation Findings for VFD Measures

- VFD energy and coincident peak demand savings realization rates were lower than program planning estimates. On average, the realization rates for energy, non-coincident peak, and peak demand savings were about 62, 46, and 43% respectively. HVAC fans had the highest realization rates, and process pumping had the lowest realization rates.

A summary of the impact findings is presented in the standardized Duke Energy Program Impact Metrics Tables below.

Table 1. Summary of Program Savings by Measure

Measure	Measure Count	Gross Ex Post (Adjusted) Per unit kWh impact	Gross Ex Post (Adjusted) Per unit kW impact	Gross Ex Post (Adjusted) kWh Savings	Gross Ex Post (Adjusted) kW Savings
HPT8 4ft 2 lamp, T12 to HPT8	4,878	191.6	0.033	934,625	161.0
HPT8 4ft 2 lamp, T8 to HPT8	2,705	72.4	0.012	195,842	32.5
Low Watt T8 lamps, 4ft	174,488	35.0	0.006	6,107,080	1,046.9
LW HPT8 4ft 2 lamp, replace T8	7,237	86.0	0.015	622,382	108.6
LW HPT8 4ft 4 lamp, replace T8	4,267	154.8	0.027	660,532	115.2
LW HP T-8 4ft 1L replace T-8 4ft 1L	1,032	60.2	0.010	62,126	10.3
LW HP T-8 4ft 2L replace T-8 4ft 2L	26,249	86.0	0.015	2,257,414	393.7
LW HP T-8 4ft 4L replace T-8 4ft 4L	6,768	154.8	0.027	1,047,686	182.7
T8 2ft 2 lamp	2,161	206.3	0.036	445,814	77.8
T8 4ft 2 lamp	24,674	111.8	0.019	2,758,553	468.8
T8 4ft 4 lamp	21,648	275.1	0.047	5,955,365	1,017.5
T8 8ft 2 lamp	3,553	120.4	0.021	427,781	74.6
Occupancy Sensors under 500 W	28,904	273.5	0.123	7,905,244	3,555.2
Occupancy Sensors over 500 W	10,968	684.8	0.302	7,510,886	3,312.3
VFD HVAC Fan	602	1011.7	0.070	609,043	42.1
VFD HVAC Pump	54	1558.0	0.207	84,132	11.2
VFD Process Pump 1-50 HP	9	270.6	0.033	2,435	0.3

Table 2. Program Impact Metrics Summary

Metric	Result
Number of Program Participants from 1-1-2009 to 2-29-2012	2439 Projects
Gross Coincident Peak kW per unit	kW/unit
HPT8 4ft 2 lamp, T12 to HPT8	0.033
HPT8 4ft 2 lamp, T8 to HPT8	0.012
Low Watt T8 lamps, 4ft	0.006
LW HPT8 4ft 2 lamp, replace T8	0.015
LW HPT8 4ft 4 lamp, replace T8	0.027
LW HP T-8 4ft 1L replace T-8 4ft 1L	0.010
LW HP T-8 4ft 2L replace T-8 4ft 2L	0.015
LW HP T-8 4ft 4L replace T-8 4ft 4L	0.027
T8 2ft 2 lamp	0.036
T8 4ft 2 lamp	0.019

Metric	Result
T8 4ft 4 lamp	0.047
T8 8ft 2 lamp	0.021
Occupancy Sensors under 500 W	0.123
Occupancy Sensors over 500 W	0.302
VFD HVAC Fan	0.070
VFD HVAC Pump	0.207
VFD Process Pump 1-50 HP	0.033
Gross kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	191.6
HPT8 4ft 2 lamp, T8 to HPT8	72.4
Low Watt T8 lamps, 4ft	35.0
LW HPT8 4ft 2 lamp, replace T8	86.0
LW HPT8 4ft 4 lamp, replace T8	154.8
LW HP T-8 4ft 1L replace T-8 4ft 1L	60.2
LW HP T-8 4ft 2L replace T-8 4ft 2L	86.0
LW HP T-8 4ft 4L replace T-8 4ft 4L	154.8
T8 2ft 2 lamp	206.3
T8 4ft 2 lamp	111.8
T8 4ft 4 lamp	275.1
T8 8ft 2 lamp	120.4
Occupancy Sensors under 500 W	273.5
Occupancy Sensors over 500 W	684.8
VFD HVAC Fan	1011.7
VFD HVAC Pump	1558.0
VFD Process Pump 1-50 HP	270.6
Gross therms per unit	N/A
Freeridership rate (program wide)	38.40%
Spillover rate	6.60%
Self Selection and False Response rate	0.00%
Total Discounting to be applied to Gross values	68.20%
Net Coincident Peak kW per unit	kW/unit
HPT8 4ft 2 lamp, T12 to HPT8	0.023
HPT8 4ft 2 lamp, T8 to HPT8	0.008
Low Watt T8 lamps, 4ft	0.004
LW HPT8 4ft 2 lamp, replace T8	0.010
LW HPT8 4ft 4 lamp, replace T8	0.018
LW HP T-8 4ft 1L replace T-8 4ft 1L	0.007
LW HP T-8 4ft 2L replace T-8 4ft 2L	0.010
LW HP T-8 4ft 4L replace T-8 4ft 4L	0.018
T8 2ft 2 lamp	0.025
T8 4ft 2 lamp	0.013
T8 4ft 4 lamp	0.032
T8 8ft 2 lamp	0.014
Occupancy Sensors under 500 W	0.084
Occupancy Sensors over 500 W	0.206
VFD HVAC Fan	0.048
VFD HVAC Pump	0.141
VFD Process Pump 1-50 HP	0.023
Net kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	130.7
HPT8 4ft 2 lamp, T8 to HPT8	49.4
Low Watt T8 lamps, 4ft	23.9

Metric	Result
LW HPT8 4ft 2 lamp, replace T8	58.7
LW HPT8 4ft 4 lamp, replace T8	105.6
LW HP T-8 4ft 1L replace T-8 4ft 1L	41.1
LW HP T-8 4ft 2L replace T-8 4ft 2L	58.7
LW HP T-8 4ft 4L replace T-8 4ft 4L	105.6
T8 2ft 2 lamp	140.7
T8 4ft 2 lamp	76.2
T8 4ft 4 lamp	187.6
T8 8ft 2 lamp	82.1
Occupancy Sensors under 500 W	186.5
Occupancy Sensors over 500 W	467.0
VFD HVAC Fan	690.0
VFD HVAC Pump	1062.6
VFD Process Pump 1-50 HP	184.5
Net therms per unit	N/A
Measure Life	12yr (linear fluorescent) 10yr (occupancy sensor)

Net to Gross

The net to gross analysis is based on participant self-reports and complies with standard evaluation practices and protocols, including the California Evaluation Protocols (TecMarket Works, April 2006). The program-wide net to gross analysis (freeridership = 38.4%+spillover = 6.6%) produced a net to gross ratio of 0.682 at the program level. That is, the program saved 31.8% less than the measures installed via the program incentive because freeridership was particularly high and the program did not induce participants to take many additional energy efficiency actions beyond those incented by the program.

Recommendations

Based on the results of the impact evaluation, the TecMarket Works team has the following recommendations:

1. Conservative estimates of lighting EFLH should be updated with M&V results.
2. The weighted average self-reported operating hours were 4,944 EFLH, which represents a better estimate of lighting EFLH than the standard estimate of 4,144 EFLH. Consider including the self-reported operating hours in the ex-ante estimates of measure savings.
3. The measured coincidence factor of 0.80 was slightly higher than the program planning estimate of 0.77. Consider revising the coincidence factor assumption to 0.80 for future program planning activities.
4. The M&V savings for VFDs was significantly lower than program estimates, especially for HVAC pumps and process pumps. Consider reducing the annual savings estimates to the M&V results.

Introduction and Purpose of Study

This report presents the results of an impact evaluation of the Non-Residential Smart $aver® Prescriptive Program in Ohio. The focus of this study is on linear fluorescent lighting fixtures, occupancy sensors, and VFDs on HVAC fans, HVAC pumps, and process pumping. A previous report examined high-bay lighting fixtures, which were and still are the dominant measure adopted by program participants. As the program has matured, linear fluorescent lighting, occupancy sensors, and VFD savings have increased as a percentage of total program savings. This report was prepared in response to the emergence of these measure types as significant measures in the overall program portfolio.

Summary Overview

Summary of the Evaluation

This report presents the results of an impact evaluation of linear fluorescent lighting, occupancy sensor, and VFD measures offered through Duke Energy's Non-Residential Smart $aver Program in Ohio. The Smart $aver Program provides incentives to customers to upgrade to energy efficient lighting and commercial equipment. The study focuses on participants from January 2009 through February 29, 2012.

The impact evaluation employed a tracking system review, onsite surveys, and short term Measurement and Verification (M&V) of selected lighting fixtures, occupancy sensors, and variable frequency drives (VFD) using portable data loggers.

Evaluation Objectives

The goal of the impact analysis was to estimate program level energy (kWh) and demand (kW) savings. Secondary objectives included estimates of unit energy savings for sampled measures, and overall energy and demand savings realization rates for the three measure groups studied: linear fluorescent lighting, occupancy sensors, and variable frequency drives.

Researchable Issues

Additional researchable issues in this evaluation include:

- Verification of measures as recorded in the Duke Energy program tracking database with field observations.
- Identification of ineligible measures.
- Estimation of average operating hours for commercial lighting fixtures
- Estimation of unit energy savings for VFDs
- Percent energy savings and connected load parameters for occupancy sensors

Program Description

The Non-Residential Smart $aver® Prescriptive program influences business customer decisions for saving energy by providing incentives to install qualifying high-efficiency measures such as lighting, HVAC, and motors. Duke Energy's commercial and industrial customers fund this program by paying an energy efficiency rider based upon their kWh usage. The program has a Custom component as well as the Prescriptive component. This evaluation study looks at the Prescriptive program only. The Custom program will not be evaluated here, but it works hand in hand with the Prescriptive program. In the Prescriptive program, customers may install selected energy efficient measures and then send in an application for rebates, up to 90 days after the installation. Energy efficiency measures that are not part of the Prescriptive program may still earn a rebate, but the installation of these Custom measures must first be approved by Duke Energy through an application process.

Program Participation

Program	Measure Count for 1/1/09 – 2/28/12
Non-Residential Smart $aver Prescriptive	835,342

Methodology

Overview of the Evaluation Approach

Study Methodology

The impact methodology consisted of engineering analysis following the International Performance Measurement and Verification Protocol (IPMVP). The projects were separated into linear fluorescent, occupancy sensor, and variable frequency drives (VFDs) measure groups, and samples were drawn from each category. Site surveys and metering equipment were installed to gather data according to an M&V plan developed for each measure category[1]. Energy and demand savings estimates were developed for each sampled project.

Data collection methods, sample sizes, and sampling methodology

The impact evaluation employed a tracking system review, onsite surveys, and short term Measurement and Verification (M&V) of selected lighting fixtures, occupancy sensors, and variable frequency drives (VFD) using portable data loggers.

For the lighting measures, the sample design specified a minimum sample of 12 linear fluorescent and 13 occupancy sensor projects. A target sample of 25 projects representing 38 individual measures was selected for the study. The sampling plan incorporated a stratified random sample approach, where the projects were stratified according to technology type (linear fluorescents, occupancy sensors), and sampled randomly within each stratum.

VFDs were sampled by measure, not by project since more than one VFD measure is often included in a single project. The target sample included a total of 18 sites comprising 53 VFDs: 37 VFD fans, 9 VFD pumps, and 7 VFD process pumps.

Each sampled site was recruited for the M&V study by TecMarket Works contractors.

Number of completes and sample disposition for each data collection effort

Last minute customer refusals eliminated five of the 25 sites from the final sample lighting resulting in a total of 20 sites, ten each for linear fluorescents and occupancy sensors. Due to oversampling, the achieved sample met or exceeded the minimum sample requirements. For VFDs, total of 18 sites and 44 measures were monitored. The achieved sample exceeded both the minimum and target sample size. The final sample disposition is shown below:

[1] An overall M&V plan was developed for each measure category, with site-specific addenda to address measurement issues at each sampled site.

Table 3. Final Sample Disposition

Group	Minimum Required Sample Size	Target Sample Size	Achieved Sample Size
Linear Fluorescent	8 sites	12 sites	10
Occupancy Sensor	10 sites	13 sites	10
VFD-Fan	15 measures	20 measures	29
VFD-Process	1 measure	3 measures	6
VFD-Pump	4 measures	6 measures	9

Expected and achieved precision

A sample meeting +/- 10% relative precision at 90% confidence at the program level was selected. Due to higher than expected variability in the savings in the M&V sample relative to the program planning values, the achieved relative precision was +/- 23.1%. Planned and sample coefficients of variance are shown below.

Table 4. Planned and Sample Coefficients of Variance

Project Type	Target cv	Actual Sample cv
Linear Fluorescent	0.3	0.94
Occupancy Sensor	0.3	0.61
VFD-Fan	0.5	1.65
VFD-Process	0.5	0.41
VFD-Pump	0.5	0.32
Total		

Description of baseline assumptions, methods and data sources

For linear fluorescent measures, the baseline was the existing lighting system prior to the retrofit. Due to the nature of prescriptive rebate programs, it was not possible to observe the baseline lighting system. The baseline lighting system description was obtained by interviewing the site contacts at each sampled site. Occupancy sensor measures are an "add-on" measure, so the baseline assumption is the observed lighting fixtures without occupancy sensor controls. VFD baseline assumptions were obtained by interviewing site contacts to define the flow control strategy prior to installation of the VFD.

Description of measures and selection of methods by measure(s) or market(s)

The focus of this study is on linear fluorescent lighting fixtures and occupancy sensors, as well as VFDs on HVAC fans, pumps, and process pumping. All projects were evaluated in compliance with the International Performance Measurement and Verification Protocols (IPMVP) Option A – Partially measured, retrofit isolation protocol.

Use of TRM values and explanation if TRM values not used

Engineering algorithms from the Draft Ohio TRM were used to calculate lighting savings. The study relied on primary data collection, so deemed parameters from the TRM were unnecessary.

Building energy simulation modeling was used to calculate HVAC interactive effects multipliers based on the observed HVAC system characteristics. The VFD analysis used primary data collection and regression analysis; deemed values from the TRM were not used.

Threats to validity, sources of bias and how those were addressed

There is the possibility for extrapolation error going from short term measurement to annualized savings. To address this, industry standard protocols were followed in the selection of the duration of the monitoring period in order to capture sufficient workday and weekend operation and also to avoid anomalous operation periods. For weather dependent measures, data were collected during a portion of the year with sufficient temperature variation to establish trends and allow the projection of short term monitored data to annual savings. State of the art engineering analysis techniques, including building energy simulation modeling were employed to reduce engineering bias.

Evaluation Findings

The impact evaluation employed a tracking system review, an engineering review of the lighting and VFD measure savings calculations, and field measurement and verification (M&V) of selected lighting and VFD measures.

Tracking Data Analysis

The tracking system review revealed that a few measures were responsible for the majority of the savings. Tracking data obtained from Duke Energy from January 2009 through February 2012 show the following breakdown of energy savings by measure:

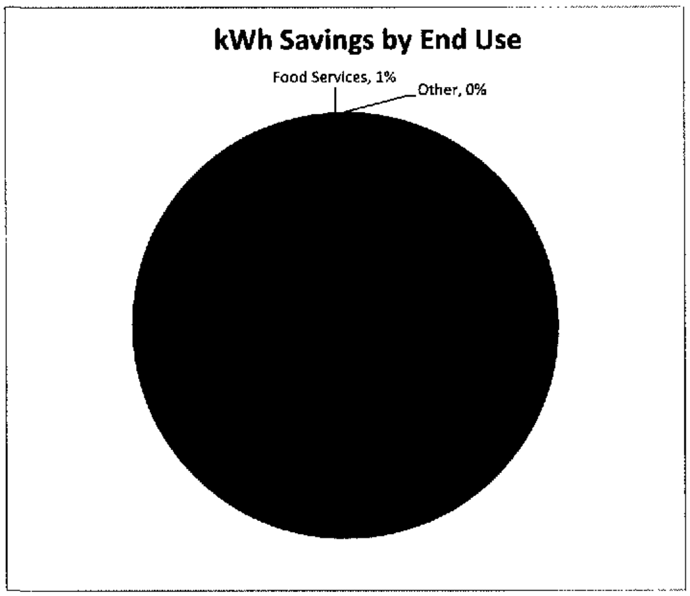


Figure 1. Measure Contribution to C&I Program Savings

Note lighting measures made up 82% of the total reported savings. Lighting was dominated by high-bay applications, making up 47% of the total lighting savings.

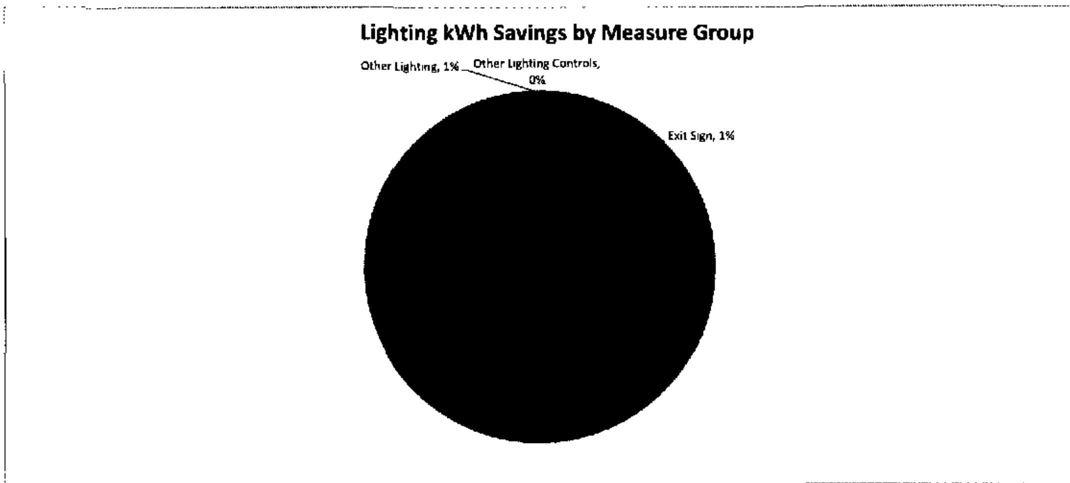


Figure 2. Lighting Measure Savings Distribution

The next largest measure group was Motors, Pumps, and Drives. This group is dominated by variable frequency drives (VFD), comprising over 99% of the energy savings. The breakdown of the VFD applications is shown in Figure 3. Over 96% of the VFD savings were attributed to HVAC Fan and Pump applications.

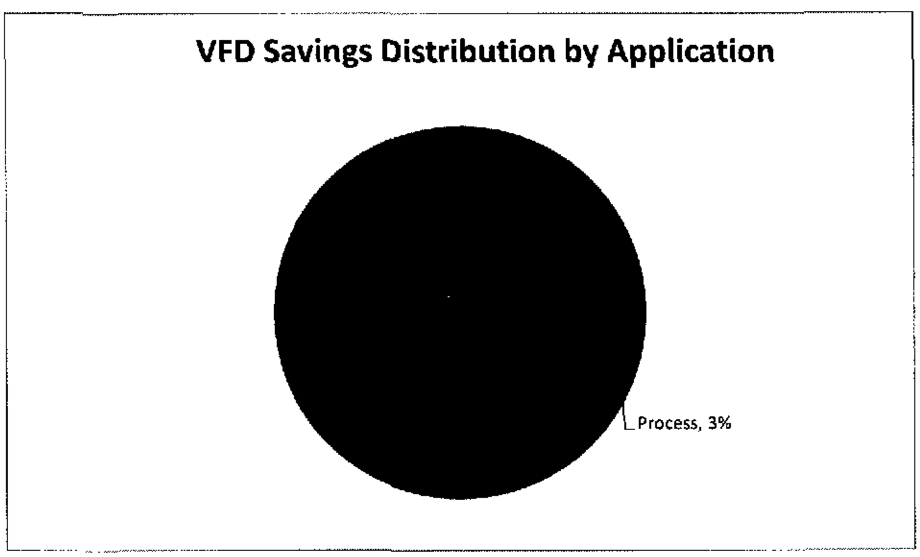


Figure 3. VFD Measure Savings Distribution

The Smart $aver Non-Residential Prescriptive program evaluation report[2] dated August 29, 2010 focused on the high bay applications. For this study, we focused on linear fluorescent lighting, occupancy sensors, and VFDs.

[2] Evaluation of the Non-Residential Smart $aver Prescriptive Program in Ohio, August 29, 2010.

The evaluation team conducted field M&V on a sample of linear fluorescent lighting, occupancy sensor, and VFD participants to estimate savings for these measures. The field M&V for lighting and occupancy sensors consisted of a site visit, verification of the quantity and type of incented lighting fixtures, verification of fixture wattage assumptions against manufacturers' catalog data, interviews with customers to identify the type and quantity of the replaced fixtures, and short-term monitoring of lighting system operation using light loggers to measure operating hours. The field M&V for VFD participants consisted of a site visit, verification of the quantity and type of incented VFDs, verification of VFD capacity, and short-term monitoring of VFDs to measure their performance. The field M&V activities were conducted by TecMarket Works' sub-contractors and the results were forwarded to Architectural Energy Corporation for analysis. The field M&V activities were compliant with the International Performance Measurement and Verification Protocols (IPMVP) Option A – Partially measured, retrofit isolation protocol.

Lighting and VFD program participation records covering the period from January 2009 through the end of February 2012 were obtained from Duke Energy. The data, delivered as an Excel spreadsheet flat file, contained customer name and address, installing vendor contact information, measure descriptions, unit energy savings estimates, number of measures installed, lighting operating hours, installed fixture watts, VFD horsepower, rebate amounts, etc. These data were examined to identify which of the measures promoted by the program were adopted by program participants and in what numbers, and the availability of any customer description data that could be used in the analysis.

Customers indicated the annual operating hours of their lighting systems on the incentive applications. These self-reported lighting system hours of operation are entered into the program tracking database. A tabulation of the average self-reported operating hours for linear fluorescent, CFL and High Bay measures by building type are shown in Table 5. These data do not include occupancy sensor measures. It is worth noting that 4219 average operating hours per year across all building types compares favorably to the estimate of 4144 average operating hours per year used in the program design workpapers[3].

[3] 4,144 average operating hours per year across all building types, from the Ohio Technical Reference Manual: Technical Reference Manual (TRM) for Ohio Senate Bill 221"Energy Efficiency and Conservation Program" and 09-512-GE-UNC, October 15, 2009.

Table 5. Self-Reported Lighting Operating Hours by Building Type

Building Description	Operating hour report frequency by building type	Average self-reported operating hours from program application
Big Box Retail	59	4,788
Education	436	3,219
Grocery	30	6,712
Healthcare	150	4,662
Industrial	804	5,354
Lodging	67	4,809
Office	455	3,743
Other	422	3,134
Public Assembly	263	3,084
Public Order/Safety	254	4,074
Restaurant	47	5,465
Small Box Retail	312	3,691
Warehouse	468	4,158
All Buildings	3767	4,219

The distribution of the self-reported operating hours by building type and fixture type is shown in Table 6.

Table 6. Self-Reported Lighting Operating Hours by Building and Fixture Type

Building Type	CFL	Linear fluorescent	High Bay
Big Box Retail	6,766	5,428	3,948
Education	3,661	2,691	2,997
Grocery	8,068	7,340	5,985
Healthcare	6,118	4,102	5,332
Industrial	6,559	4,969	5,417
Lodging	5,005	3,419	
Office	3,797	3,853	4,146
Other	2,221	3,272	3,741
Public Assembly	2,891	3,083	3,354
Public Order/Safety	4,480	3,991	3,689
Restaurant	5,580	4,436	
Small Box Retail	3,863	4,832	3,203
Warehouse	3,504	3,600	4,201
All Buildings	3,571	4,029	4,617

Sample Design

The sampling plan incorporates a stratified random sample approach, where the projects are stratified according to technology type (linear fluorescent and occupancy sensors), and sampled randomly within each stratum. The total sample size is calculated from the following equation[4]:

$$n = \frac{\left(\sum_k (kWh_k \times cv_k)\right)^2}{\left(\frac{P \times kWh}{Z}\right)^2 + \sum_k \frac{(kWh_k \times cv_k)^2}{N_k}}$$

where:

n	= total sample size required
kWh_k	= estimated savings from group k
cv_k	= assumed coefficient of variation for group k
P	= desired precision
KWh	= total kWh savings
Z	= z statistic (1.645 at 90% confidence)
N_k	= population size of group k

Samples are allocated to each group based on the following equation:

$$n_k = n \times \frac{kWh_k \times cv_k}{\sum_k (kWh_k \times cv_k)}$$

A sample meeting +/- 10% relative precision at 90% confidence at the program level was selected. A coefficient of variation of 0.3 was assumed for the lighting measure population, and 0.5 for the VFD measure population. The Ohio participation (at the time of sample selection) and the resulting sample sizes are summarized in Table 7.

Samples were selected by address to maximize the effectiveness of the M&V field efforts. This often allowed multiple measures to be sampled at a single address (site). The sample design is shown in Table 7 below. Note that the VFDs are sampled by measure, not by address since more than one VFD technology is often located at a single address.

[4] Bonneville Power Administration, *Sampling Reference Guide. Research Supporting an Update of BPA's Measurement and Verification Protocols*, August, 2010.

Table 7. Sample Selection by Measure or Site for Linear Fluorescent, Occupancy Sensor, and VFD

Group	kWh	cv	Total Measures or Sites	Minimum Required Sample Size	Target Sample Size
Linear Fluorescent	20,966,845	0.3	925 sites	8 sites	12 sites
Occupancy Sensor	26,311,741	0.3	672 sites	10 sites	13 sites
VFD-Fan	23,902,375	0.5	195 measures	15 measures	20 measures
VFD-Process	675,467	0.5	14 measures	1 measures	3 measures
VFD-Pump	5,450,294	0.5	54 measures	4 measures	6 measures

VFDs were sampled throughout the duration of the program, including a total of 18 sites comprising 53 VFDs: 37 VFD fans, 9 VFD pumps, and 7 VFD process pumps during 2009 - 2010[5].

A sample of 18 lighting projects and 44 VFD measures were selected for the study. The allocation of the projects across the different technology measures is shown in Table 7 above. Sites were randomly selected within each group. Each sampled site was recruited for the M&V study by TecMarket Works contractors. Backup sites were used when it was not possible to successfully recruit customers in the primary sample.

At the conclusion of the evaluation, several sites were not included in the lighting and occupancy sensor study. Last minute customer refusals and logger failures eliminated five of the sites from the sample. However, the achieved sample met or exceeded the minimum required sample size, as shown in the table below.

Table 8. Status of 2009-2012 Linear Fluorescent and Occupancy Sensor Sample

Group	Minimum Required Sample Size (Sites)	Target Sample Size (Sites)	Completed (Sites)	Notes
Linear Fluorescent	8	12	10	Customer refusal. 1 site dropped.
Occupancy Sensor	10	13	10	Customer refusal, loggers did not record any data. 3 sites dropped.

The achieved sample met or exceeded the target for the VFD measures as shown in Table 9.

[5] Sampling of VFDs within the sites resulted in a total of 44 monitored VFDs.

Table 9. Status of 2009-2012 VFD Sample

Group	Minimum Required Sample Size (Measures)	Target Sample Size (Measures)	VFDs Monitored (Measures)	Notes
VFD-Fan	15	20	29	Monitored VFDs exceeded the Target Sample
VFD-Process	1	3	9	Monitored VFDs exceeded the Target Sample
VFD-Pump	4	6	6	Monitored VFDs equals the Target Sample

A summary of the characteristics of the 10 customers that participated in the linear fluorescent M&V study is shown in Table 10.

Table 10. Linear Fluorescent Lighting M&V Study Participants

Site	Customer Name	Building Type	Total fixtures rebated	Installed Fixture(s)	Baseline Fixture(s)
LF-1	[redacted]	Office	40	T-8 8ft 2 lamp	T-12 8ft 2 lamp
			11	T-8 3ft 4 lamp	T-12 3ft 4 lamp
			9	HP T-8 4ft 2 lamp	T-8 4ft 2 lamp
			32	HP T-8 4ft 2 lamp	T-12 4ft 2 lamp
			52	HP T-8 4ft 2 lamp	T-12 4ft 2 lamp
LF-2	[redacted]	Warehouse	410	T-8 4ft 4 lamp	T-12 4ft 4 lamp
LF-3	[redacted]	Public Assembly	538	LW T-8 4ft (per-lamp replacement)	4 ft 6L F32 high bay (per lamp repl)
LF-4	[redacted]	Office	56	LW T-8 4ft 1 lamp	T-8 4ft 1 lamp
			200	LW T-8 4ft 2 lamp	T-8 4ft 2 lamp
			276	LW T-8 4ft 2 lamp	T-8 4ft 4 lamp
LF-5	[redacted]	Public Order Safety / Institutional	83	HP T-8 4ft 2 lamp	T-8 4ft 2 lamp
			4 (none installed)	High performance low watt lamp T8 fluorescent	Standard T8 fluorescent
			40	T-8 4ft 2 lamp	T-12 4ft 2 lamp
LF-6	[redacted]	Healthcare	15	T-8 4ft 4 lamp	T-12 4ft 4 lamp
LF-7	[redacted]	Industrial	10	LW T-8 4ft 1 lamp	T-8 4ft 1 lamp
			356	LW T-8 4ft 2 lamp	T-8 4ft 2 lamp
			409	LW T-8 4ft 4 lamp	T-8 4ft 4 lamp
LF-8	[redacted]	Office	34	T-8 4ft 4 lamp	T-12 8ft 2 lamp

Site	Customer Name	Building Type	Total fixtures rebated	Installed Fixture(s)	Baseline Fixture(s)
LF-9	[redacted]	Warehouse	6	T-8 4ft 2 lamp	T-12 4ft 2 lamp
			9	Not present	T-12 4ft 4 lamp
LF-10	[redacted]	Small Box Retail	922	LW T-8 4ft (per lamp)	T-8 4ft 2 lamp (per lamp)

The characteristics of the ten sites that participated in the occupancy sensor study are shown in Table 11.

Table 11. Occupancy Sensor M&V Study Participants

Site	Customer Name	Business Type	Number of Occupancy Sensors Rebated	Occupancy Sensor Type
OS-1	[redacted]	Education	29	Occupancy Sensors over 500 W
			54	Occupancy Sensors under 500 W
OS-2	[redacted]	Public Order/Safety	7	Occupancy Sensors under 500 W
OS-3	[redacted]	Warehouse	88	Occupancy Sensors under 500 W
OS-4	[redacted]	Industrial	19	Occupancy Sensors under 500 W
OS-5	[redacted]	Small Box Retail	8	Occupancy Sensors under 500 W
OS-6	[redacted]	Office	2	Occupancy Sensors under 500 W
OS-7	[redacted]	Education	3	Occupancy Sensors under 500 W
			9	Occupancy Sensors under 500 W
OS-8	[redacted]	Education	41	Occupancy Sensors over 500 W
			30	Occupancy Sensors under 500 W
OS-9	[redacted]	Education	33	Occupancy Sensors under 500 W
			40	Occupancy Sensors over 500 W
OS-10	[redacted]	Office	45	Occupancy Sensors under 500 W

The characteristics of the 18 sites that participated in the VFD study are shown in Table 12 below. These sites represent 53 VFDs in the tracking database. 44 of these 53 VFDs were monitored.

Table 12. VFD M&V Study Participants

Site	Customer Name	Building Type	VFDs Monitored			
			VFDs Rebated	VFD HVAC Fan	VFD HVAC Pump	VFD Process Pump 1-50 HP
VFD-1	[redacted]	Healthcare	3	3	0	0
VFD-2	[redacted]	Education K-12	2	2	0	0
VFD-3	[redacted]	Education K-12	2	2	0	0
VFD-4	[redacted]	Healthcare	1	1	0	0
VFD-5	[redacted]	Healthcare	3	0	3	0
VFD-6	[redacted]	Church	5	3	0	0
VFD-7	[redacted]	Office	1	1	0	0
VFD-8	[redacted]	Office	2	2	0	0
VFD-9	[redacted]	Other	6	2	0	4
VFD-10	[redacted]	Office	2	2	0	0
VFD-11	[redacted]	Healthcare	1	1	0	0
VFD-12	[redacted]	Office	2	0	2	0
VFD-13	[redacted]	Grocery	1	0	1	0
VFD-14	[redacted]	Grocery	1	0	1	0
VFD-15	[redacted]	Education	10	3	2	0
VFD-16	[redacted]	Education	2	2	0	0
VFD-17	[redacted]	Office	6	2	0	2
VFD-18	[redacted]	Office	3	3	0	0
	Total		53	29	9	6

Gross Savings Analysis – Linear Fluorescents and Occupancy Sensors

Paper file applications and supporting documentation were obtained for each site. The data in the application files were reviewed and compared to the program tracking database and onsite survey observations. Discrepancies were noted and corrected for the impact evaluation. These discrepancies are reported in Table 13.

Table 13. Tracking System and Paper File Discrepancies

Measure	Site	Discrepancy
Linear Fluorescent	1	3-foot fixtures were installed in lieu of 2-foot fixtures.
	4	4-lamp fixtures were replaced by 2-lamp fixtures
	5	63 fixtures were installed instead of 83 in app
	5	No 4-ft 4-lamp HPT8s were found in monitored building
	14	Rebate provided to replace standard 32W T8 lamps with 28W lamps. Program calcs used lamp watts; A fixture watts value that includes the observed ballast factor was used, normalized per lamp replaced.

Fixture watts reported in the manufacturer's catalogs (where available) were averaged and compared to the standard assumptions used in program design for several popular fixture types. This comparison is shown in Figure 4.

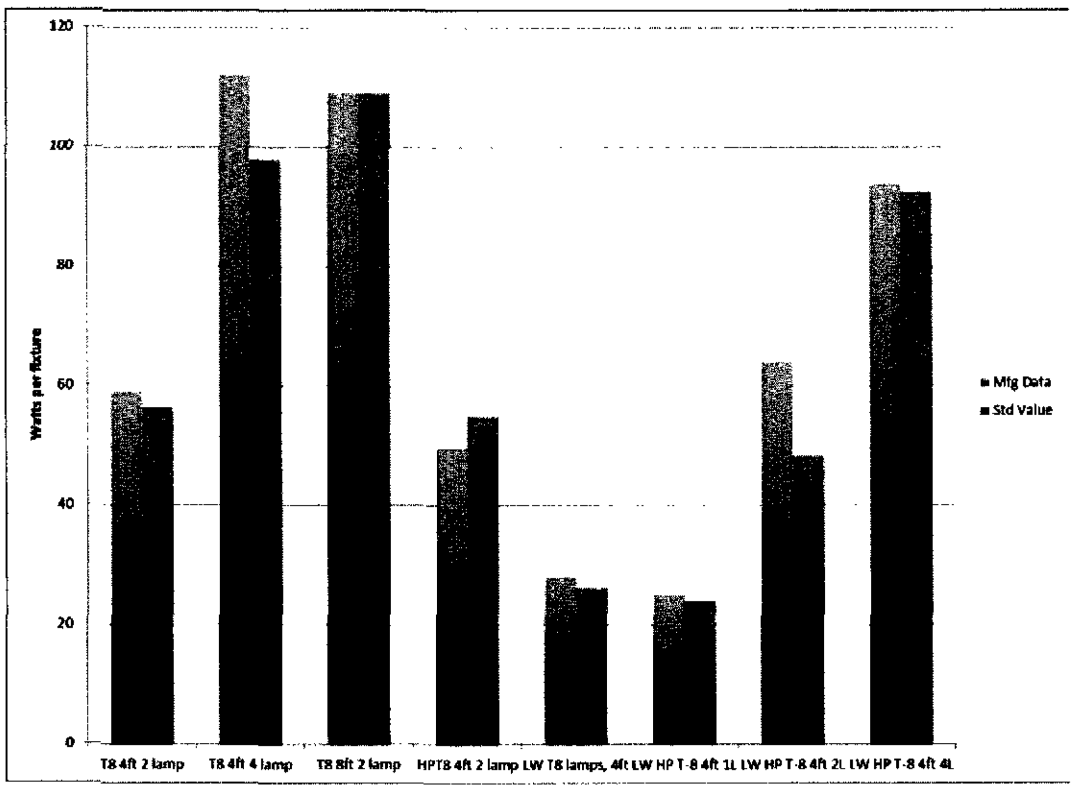


Figure 4. Comparison of Installed Fixture Watts from Manufacturers vs. Standard Assumptions

These data are also shown in Table 14.

Table 14. Comparison of Manufacturer's Fixture Watts with Standard Program Assumptions for Linear Fluorescent Fixtures

Fixture	n	Program Assumption	Mfg Cutsheets
T8 4ft 2 lamp	2	59	56.5
T8 4ft 4 lamp	3	112	98
T8 8ft 2 lamp	1	109	109
HPT8 4ft 2 lamp	3	49.7	55
LW T8 lamps, 4ft	2	28	26.3
LW HP T-8 4ft 1L	2	25	24.2
LW HP T-8 4ft 2L	3	64	48.3
LW HP T-8 4ft 4L	1	94	92.6

In many cases, the program standard assumption exceeds the manufacturers' cut sheet values, indicating conservative values were used in developing the program estimates of fixture savings. Where the M&V values exceed the program assumption, the M&V values are based on in-situ measurements, where ballast factors may be different than program assumptions.

The fixture quantities installed at the sampled sites along with the number of light loggers deployed are shown in Table 15 and Table 16. Light loggers were deployed to monitor the on/off behavior of the lighting systems based on the circuiting and switching of the lighting systems. At some sites, recording current loggers were installed to measure time series current on selected lighting circuits.

Table 15. Logger Installations at Linear Fluorescent M&V Study Sites

Site	Customer Name	Business Type	Total fixtures rebated	Loggers installed
LF-1	[redacted]	Office	144	11
LF-2	[redacted]	Warehouse	410	12 Current
LF-3	[redacted]	Public Assembly	538	6 Current
LF-4	[redacted]	Office	532	10
LF-5	[redacted]	Public Order Safety / Institutional	127	5 Current
LF-6	[redacted]	Healthcare	15	5
LF-7	[redacted]	Industrial	775	16
LF-8	[redacted]	Office	34	4 Current
LF-9	[redacted]	Warehouse	15	1 Current
LF-10	[redacted]	Small Box Retail	922	2 Current

Table 16. Logger Installations at Occupancy Sensor M&V Study Sites

Site	Customer Name	Business Type	Total Occupancy Sensors rebated	Loggers installed
OS-1	[redacted]	Education	83	7
OS-2	[redacted]	Public Order/Safety	7	6
OS-3	[redacted]	Warehouse	88	15
OS-4	[redacted]	*Industrial*	19	2
OS-5	[redacted]	Small Box Retail	8	7
OS-6	[redacted]	Office	2	2
OS-7	[redacted]	Education	12	8
OS-8	[redacted]	Education	71	18
OS-9	[redacted]	Education	73	19
OS-10	[redacted]	Office	45	8

The light logger data were downloaded by the TecMarket Works contractors. These data were processed by engineers from Architectural Energy Corporation. The results are summarized in Table 17 and Table 18. Average weekday and weekend load shapes for each site from the logger study are also shown in Appendix A: Load Shapes.

Table 17. Lighting Logger Study Results

Site	Customer Name	Business Type	Application self-reported annual operating hours	Logger study annual operating hours	Ratio logged / self report	Coincident demand factor[6]
LF-1	[redacted]	Office	4,199	7,103	1.69	1.00
LF-2	[redacted]	Warehouse	2,600	2,997	1.15	0.75
LF-3	[redacted]	Public Assembly	3,016	1,255	0.42	0.40
LF-4	[redacted]	Office	3,131	8,109	2.59	0.98
LF-5	[redacted]	Public Order Safety / Institutional	4,000	2,157	0.54	0.77
LF-6	[redacted]	Healthcare	2,480	4,072	1.64	0.89
LF-7	[redacted]	Industrial	8,760	2,852	0.33	0.57
LF-8	[redacted]	Office	2,080	2,081	1.00	0.48

[6] Coincidence factor is defined as the fraction of the total connected load operating at the coincident peak hour, which is defined as the hour between 4pm and 5pm on the hottest summer workday.

LF-9	[redacted]	Warehouse	5,000	2,055	0.41	0.04
LF-10	[redacted]	Small Box Retail	8,736	8,183	0.94	0.97
	Wt. Average[7]		4,944	5,155	1.04	0.80

Table 18. Occupancy Sensor Logger Study Results

Site	Customer Name	Business Type	Connected kW	EFLH		DF[8]	
				Pre	Post	Pre	Post
OS-1	[redacted]	Education	19.01	3,063	1,767	0.88	0.37
OS-2	[redacted]	Public Order/Safety	1.04	5,384	3,720	0.73	0.56
OS-3	[redacted]	Warehouse	19.89	2,167	196	0.50	0.03
OS-4	[redacted]	Industrial	6.67	2,899	522	0.50	0.01
OS-5	[redacted]	Small Box Retail	2.95	2,176	989	0.51	0.25
OS-6	[redacted]	Office	0.67	3,862	2,131	1.00	0.65
OS-7	[redacted]	Education	3.66	3,399	2,008	1.00	0.67
OS-8	[redacted]	Education	33.75	2,611	1,445	0.90	0.42
OS-9	[redacted]	Education	36.38	3,147	2,138	0.87	0.44
OS-10	[redacted]	Office	6.62	6,571	4,345	1.00	0.73
	Wt. Average			3,078	1,547	0.81	0.36

On average, the light logger study predicted about 4% more operating hours for linear fluorescent measures than the customer self-reported values, and 24% more operating hours than the 4,144 EFLH assumption used in the program design estimates. The light logger study for occupancy sensors predicted about 25% fewer uncontrolled operating hours than the 4,144 EFLH assumption used in the program design estimates.

For linear fluorescent measures, the light logger results were combined with the verified fixture counts and verified installed fixture watts to estimate the actual energy and peak demand savings, using the equations shown below.

$kWh_{savings} = (Watts_{base} - Watts_{ee}) / 1000 \times EFLH_{post} \times (1+WHF_e)$

[7] Individual site operating hours were weighted by kWh savings per site to obtain kWh savings weighted average operating hours. Individual site coincidence factors were weighted by kW savings per site to obtain a kW savings weighted coincidence factor.

[8] The diversity factor is defined as the fraction of the total connected load operating at any particular hour. The diversity factor at the coincident peak hour is defined as the fraction of the total connected load operating during the hour between 4pm and 5pm on the hottest summer workday.

$kW_{savings} = (Watts_{base} - Watts_{ee}) / 1000 \times CF \times (1+WHF_d)$

where:

$Watts_{base}$ = baseline fixture watts
$Watts_{ee}$ = efficient fixture watts
$EFLH_{post}$ = equivalent full-load lighting operating hours after retrofit
CF = coincidence factor
= fraction of total connected load operating at the utility coincident peak hour
= defined as hour ending at 4pm
WHF_e = waste heat factor for energy
WHF_d = waste heat factor for demand

For occupancy sensor measures, the light logger results were combined with the verified fixture counts and verified installed fixture watts to estimate the actual energy and peak demand savings, using the equations shown below.

$kWh_{savings} = Watts_{controlled} \times (EFLH_{pre} - EFLH_{post}) / 1000 \times (1+WHF_e)$

$kW_{savings} = Watts_{controlled} / 1000 \times (DF_{pre} - DF_{post}) \times (1+WHF_d)$

where:

$Watts_{controlled}$ = controlled fixture watts
$EFLH_{pre}$ = equivalent full-load lighting operating hours without occupancy sensor
$EFLH_{post}$ = equivalent full-load lighting operating hours with occupancy sensor
DF_{pre} = diversity factor without occupancy sensor
= fraction of total connected load operating without occupancy sensor controls
DF_{post} = diversity factor with occupancy sensor
= fraction of total connected load operating once occupancy sensor controls have been installed

Waste heat factors were calculated using building energy simulation models derived from the commercial building prototypes used in the California Database for Energy Efficiency Resources (DEER) study[9], with adjustments made for local building practices and climate. The commercial prototypes were using long-term average weather data for Cincinnati. The results of the interactive effects simulations are shown in Appendix B: Results of HVAC Interactive Effects Simulations.

[9] Itron, 2005. "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report," Itron, Inc., J.J. Hirsch and Associates, Synergy Consulting, and Quantum Consulting. December, 2005. Available at http://eega.cpuc.ca.gov/deer.

Based on the observed building and HVAC system type, the interactive effects multipliers used for each of the sites in the study are shown below:

Site	Customer Name	Business Type	HVAC System Type	WHF_e	WHF_d
LF-1	[redacted]	Office	Office/DX no econ gas heat + Garage	0.061	0.111
LF-2	[redacted]	Warehouse	Lt Industrial/DX no econ gas heat	0.080	0.210
LF-3	[redacted]	Public Assembly	Assembly/DX no econ gas heat	0.154	0.246
LF-4	[redacted]	Office	Small Office/DX with econ gas heat	0.080	0.184
LF-5	[redacted]	Public Order Safety / Institutional	Office/DX no econ gas heat	0.104	0.136
LF-6	[redacted]	Healthcare	Office/Heat pump no econ	0.077	0.136
LF-7	[redacted]	Industrial	Office2/3 /DX with econ gas heat+ Manufacturing-heat only	0.053	0.122
LF-8	[redacted]	Office	Warehouse/DX no econ gas heat	0.085	0.317
LF-9	[redacted]	Warehouse	Warehouse/DX with econ gas heat	0.080	0.210
LF-10	[redacted]	Small Box Retail	Retail/DX with econ gas heat	0.076	0.268
OS-10	[redacted]	Education	School/AC econ gas heat	0.032	0.263
OS-2	[redacted]	Public Order/Safety	Office/AC no econ gas heat	0.080	0.184
OS-3	[redacted]	Warehouse	Warehouse/No AC Gas Heat	0.000	0.000
OS-4	[redacted]	Industrial	Warehouse/No AC Gas Heat	0.000	0.000
OS-5	[redacted]	Small Box Retail	Office/AC econ gas heat	0.103	0.136
OS-6	[redacted]	Office	Office/heat pump no econ	0.023	0.190
OS-7	[redacted]	Education	School/AC no econ gas heat	0.072	0.263
OS-8	[redacted]	Education	School/AC no econ gas heat	0.072	0.263
OS-9	[redacted]	Education	School/AC no econ electric heat	-0.808	0.266
OS-10	[redacted]	Office	Warehouse/no cool/Gas heat	0.000	0.000
	Wt. Average			0.003	0.164

Gross Impact Results – Linear Fluorescents and Occupancy Sensors

These results of the energy and demand savings calculations are shown in Table 19 and Table 20. These results were compared to the tracked savings based on the fixture counts and standard per fixture kW and kWh savings estimates from program design work papers. The ratio of the evaluated savings to the program planning estimated savings is expressed as a realization rate (RR) for kWh, non-coincident peak (NCP) kW, and coincident peak (CP) kW.

Table 19. Results of Linear Fluorescent Lighting M&V Study

Site		Building Type	kWh Savings			NCP kW Savings			CP kW Savings		
			M&V	Program Planning	RR	M&V	Program Planning	RR	M&V	Program Planning	RR
LF-1	[redacted]	Office	16,172	12,596	1.28	2.38	3.33	0.72	2.38	2.56	0.93
LF-2	[redacted]	Warehouse	63,699	59,643	1.07	23.81	15.74	1.51	17.86	12.12	1.47
LF-3	[redacted]	Public Assembly	3,896	9,783	0.40	3.35	2.58	1.30	1.34	1.99	0.67
LF-4	[redacted]	Office	172,737	33,458	5.16	23.35	8.83	2.64	22.89	6.80	3.37
LF-5	[redacted]	Public Order Safety / Institutional	1,867	6,464	0.29	0.89	1.71	0.52	0.69	1.31	0.52
LF-6	[redacted]	Healthcare	2,763	2,182	1.27	0.72	0.58	1.24	0.64	0.44	1.44
LF-7	[redacted]	Industrial	36,890	49,969	0.74	13.78	13.19	1.04	7.86	10.16	0.77
LF-8	[redacted]	Office	2,073	4,946	0.42	1.21	1.31	0.93	0.58	1.01	0.58
LF-9	[redacted]	Warehouse	320	1,664	0.19	0.17	0.44	0.40	0.01	0.34	0.02
LF-10	[redacted]	Small Box Retail	73,063	16,766	4.36	10.52	4.43	2.38	10.21	3.41	3.00
		Total	**373,480**	**197,472**	**1.89**	**80.19**	**52.13**	**1.54**	**64.44**	**40.14**	**1.61**

Table 20. Results of Occupancy Sensor M&V Study

Site		Building Type	kWh Savings			NCP kW Savings			CP kW Savings		
			M&V	Program Planning	RR	M&V	Program Planning	RR	M&V	Program Planning	RR
OS-1	[redacted]	Education	25,442	62,092	0.41	5.89	16.52	0.36	12.39	12.72	0.97
OS-2	[redacted]	Public Order/Safety	1,862	3,433	0.54	0.38	0.92	0.41	0.21	0.71	0.29
OS-3	[redacted]	Warehouse	39,196	43,157	0.91	15.99	11.62	1.38	9.41	8.94	1.05
OS-4	[redacted]	Industrial	15,849	9,318	1.70	5.26	2.51	2.10	3.27	1.93	1.69
OS-5	[redacted]	Small Box Retail	3,869	3,923	0.99	0.59	1.06	0.56	0.86	0.81	1.06
OS-6	[redacted]	Office	1,190	981	1.21	0.24	0.26	0.89	0.28	0.20	1.38
OS-7	[redacted]	Education	5,461	5,885	0.93	1.45	1.58	0.91	1.51	1.22	1.24
OS-8	[redacted]	Education	42,181	65,057	0.65	10.92	17.24	0.63	20.37	13.28	1.53
OS-9	[redacted]	Education	7,058	65,300	0.11	3.59	17.32	0.21	19.89	13.33	1.49
OS-10	[redacted]	Office	14,729	22,069	0.67	0.44	5.94	0.07	1.79	4.57	0.39
		Total	**156,838**	**281,215**	**0.56**	**45**	**75**	**0.60**	**70**	**58**	**1.21**

A comparison of the assumptions used in the calculations for linear fluorescent measures is shown in Table 21. Total installed measure count, baseline fixture watts, and installed fixture watts assumptions from the program tracking database or program design work papers were compared to verified values from the M&V study. Although there were some small differences between the number of fixtures recorded in the program tracking database versus the number of fixtures in the field, the overall installation verification rate was very close to 1. Program planning and M&V estimates of baseline fixture wattage were within 4%, due largely to a discrepancy in the baseline fixture type at site LF-1, which had 3 foot fixtures as baseline rather than the 2 foot fixtures listed in database. M&V estimates of efficient fixture watts were an average of about 25% lower than program planning estimates, due primarily to a discrepancy in the efficient fixture type at site LF-4, where 2-lamp fixtures were installed rather than 4 lamp fixtures, and the use of conservative values of fixture watts during program design.

A comparison of the assumptions used in the calculations for occupancy sensor measures is shown in Table 22. Total installed measure count, sensor connected load, energy savings and demand savings factor assumptions from the program tracking database and program design work papers were compared to verified values from the M&V study. The number of occupancy sensors verified in the field is very close to 1. Verified connected load was on average about 31% lower than program design assumptions. Energy savings (a percentage of the uncontrolled energy consumption) was 54%, or about 1.8 times larger than the program design assumption of 30%. Coincident demand savings (as a percentage of connected kW) was 46%, or about 1.5 times larger than the program design assumption of 30%.

Table 21. Comparison of Linear Fluorescent Measure Savings Assumptions

Site	Customer Name	Building Type	Duke Name	Quantity			Baseline Fixture Watts			Efficient Fixture Watts		
				M&V	Tracking	Ratio	M&V	Program	Ratio	M&V	Program	Ratio
LF-1	[redacted]	Office	T8 8ft 2 lamp	40	40	1.00	123.0	123.0	1.00	109.0	109.0	1.00
			T8 2ft 2 lamp	11	11	1.00	81.0	56.0	1.45	46.0	32.0	1.44
			HPT8 4ft 2 lamp, T8 to HPT8	9	9	1.00	59.0	58.0	1.02	47.0	49.7	0.95
			HPT8 4ft 2 lamp, T12 to HPT8	32	32	1.00	72.0	72.0	1.00	59.0	49.7	1.19
			HPT8 4ft 2 lamp, T12 to HPT8	52	52	1.00	72.0	72.0	1.00	59.0	49.7	1.19
LF-2	[redacted]	Warehouse	T8 4ft 4 lamp	410	410	1.00	144.0	144.0	1.00	96.0	112.0	0.86
LF-3	[redacted]	Public Assembly	Low Watt T8 lamps, 4ft	538	538	1.00	37.0	32.0	1.16	32.0	28.0	1.14
LF-4	[redacted]	Office	LW HP T-8 4ft 1L replace T-8 4ft 1L	56	56	1.00	31.0	32.0	0.97	25.0	25.0	1.00
			LW HP T-8 4ft 2L replace T-8 4ft 2L	200	200	1.00	59.0	59.0	1.00	49.0	49.0	1.00
			LW HP T-8 4ft 4L[10] replace T-8 4ft 4L	276	276	1.00	112.0	112.0	1.00	49.0	94.0	0.52
LF-5	[redacted]	Public Order Safety / Institutional	LW HPT8 4ft 2 lamp, replace T8	63	83	0.76	59.0	59.0	1.00	51.0	49.0	1.04
			LW HPT8 4ft 4 lamp, replace T8	0	4	0.00	NA	112.0	0.00	0.0	94.0	NA
			T8 4ft 2 lamp	40	40	1.00	72.0	72.0	1.00	65.0	59.0	1.10
LF-6	[redacted]	Healthcare	T8 4ft 4 lamp	15	15	1.00	144.0	144.0	1.00	102.0	112.0	0.91
LF-7	[redacted]	Industrial	LW HP T-8 4ft 1L replace T-8 4ft 1L	10	10	1.00	31.0	32.0	0.97	23.3	25.0	0.93
			LW HP T-8 4ft 2L replace T-8 4ft 2L	356	356	1.00	59.0	59.0	1.00	47.0	49.0	0.96

[10] M&V Survey found that 2-lamp fixture was installed, rather than 4-lamp fixture. Values shown on this line compare program planning 4-lamp fixture to existing 2-lamp fixture.

Site	Customer Name	Building Type	Duke Name	Quantity			Baseline Fixture Watts			Efficient Fixture Watts		
				M&V	Tracking	Ratio	M&V	Program	Ratio	M&V	Program	Ratio
			LW HP T-8 4ft 4L replace T-8 4ft 4L	409	409	1.00	112.0	112.0	1.00	92.6	94.0	0.99
LF-8	[redacted]	Office	T8 4ft 4 lamp	34	34	1.00	123.0	144.0	0.85	96.0	112.0	0.86
LF-9	[redacted]	Warehouse	T8 4ft 2 lamp	6	6	1.00	72.0	72.0	1.00	48.0	59.0	0.81
			T8 4ft 4 lamp	0	9	0.00	NA	144.0	NA	NA	112.0	NA
LF-10	[redacted]	Small Box Retail	Low Watt T8 lamps, 4ft	922	922	1.00	29.5	32.0	0.92	20.5	28.0	0.73
		Wt Average				0.99			0.99			0.73
									Efficient Fixture Watts weighted average with 2-lamp fixture comparison.			0.93[11]

Table 22. Comparison of Occupancy Sensor Measure Savings Assumptions

Site	Customer Name	Building Type	Duke Name	Quantity			Connected Load			Energy Savings Factor			Demand Savings Factor		
				M&V	Tracking	Ratio	M&V	Program	Ratio	M&V	Program	Ratio	M&V	Program	Ratio
OS-1	[redacted]	Education	Occ Sensors over 500W	29	29	1	0.23	0.55	0.42	0.42	0.30	1.41	0.52	0.30	1.72
			Occ Sensors under 500W	54	54	1									
OS-2		Public Order/Safety	Occ Sensors under 500W	7	7	1	0.15	0.36	0.41	0.31	0.30	1.03	0.17	0.30	0.56
OS-3		Warehouse	Occ Sensors under 500W	88	88	1	0.23	0.36	0.63	0.91	0.30	3.03	0.47	0.30	1.58
OS-4		Industrial	Occ Sensors under 500W	19	19	1	0.35	0.36	0.98	0.82	0.30	2.73	0.49	0.30	1.63

[11] Updated efficient fixture ratio resulting from replacing 2-lamp fixture for 4-lamp fixture in Program fixture assumption. See Footnote 10 for more information.

Site	Customer Name	Building Type	Duke Name	Quantity			Connected Load			Energy Savings Factor			Demand Savings Factor		
				M&V	Tracking	Ratio	M&V	Program	Ratio	M&V	Program	Ratio	M&V	Program	Ratio
OS-5	[redacted]	Small Box Retail	Occ Sensors under 500W	8	8	1	0.37	0.36	1.03	0.55	0.30	1.82	0.26	0.30	0.86
OS-6	[redacted]	Office	Occ Sensors under 500W	2	2	1	0.34	0.36	0.93	0.45	0.30	1.49	0.35	0.30	1.17
OS-7	[redacted]	Education	Occ Sensors under 500W	8	12	0.67	0.46	0.36	1.27	0.41	0.30	1.36	0.33	0.30	1.09
OS-8	[redacted]	Education	Occ Sensors over 500W	41	41	1	0.48	0.67	0.71	0.45	0.30	1.49	0.48	0.30	1.59
			Occ Sensors under 500W	30	30	1									
OS-9	[redacted]	Education	Occ Sensors under 500W	33	33	1	0.50	0.66	0.76	0.32	0.30	1.07	0.43	0.30	1.44
			Occ Sensors over 500W	40	40	1									
OS-10	[redacted]	Office	Occ Sensors under 500W	45	45	1	0.15	0.36	0.41	0.34	0.30	1.13	0.27	0.30	0.90
			Weighted Average			0.99			0.69	0.54	0.30	1.80	0.46	0.30	1.53

Gross Savings Analysis – Variable Frequency Drives

Paper file applications and supporting documentation were obtained for each site. The data in the application files were reviewed and compared to the program tracking database and onsite survey observations. Discrepancies were noted and corrected for the impact evaluation. These discrepancies are reported in Table 23.

Table 23. Tracking System and Paper File Discrepancies for VFDs

Measure	Site	Discrepancy
VFD	9	200 HP VFD penciled in on paper application and installed onsite; Tracking system listed 50HP VFD.
	6	5 HP VFDs installed instead of 7.5 HP VFDs; 7.5 HP VFDs installed instead of 10 HP VFDs

Since there were relatively few VFDs per site, and they often operated independently, their performance was evaluated on an independent basis, and instead of reporting on a site level, the results are reported on a per-VFD level. In limited cases where multiple VFDs were controlled at the same speed, i.e., cooling tower fans, they are reported on a single line in Table 24. Table 25 summarizes the results for each VFD technology and compares these results to the target savings.

In general, the realization rates were quite low. However, at site VFD-9, a 200HP VFD was installed rather than a 50HP VFD, resulting in a realization rate greater than 6. The high realization rate for this VFD caused the overall weighted energy realization rate for VFD fans to be 81%.

Table 24. Results of VFD M&V Study

Key	Customer	VFD Type	Tracking HP	M&V HP	Target Annual kWh Savings	Target Annual NCP kW	Target Annual CP kW	M&V Energy Savings kWh	M&V NCP Savings kW	M&V CP Savings kW	Energy RR	NCP RR	CP RR
VFD-1	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	13,819	2.08	0.93	0.37	0.26	0.16
VFD-1	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	28,379	7.20	-0.39	0.76	0.89	-0.07
VFD-1	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	176	3.15	-0.83	0.00	0.39	-0.14
VFD-2	[redacted]	HVAC Fan	7.5	7.5	9,321	2.01	1.46	956	0.73	0.00	0.10	0.36	0.00
VFD-2	[redacted]	HVAC Fan	15	15	18,641	4.02	2.92	3,899	7.18	0.00	0.21	1.78	0.00
VFD-3	[redacted]	HVAC Fan	7.5	7.5	9,321	2.01	1.46	1,364	0.87	0.00	0.15	0.43	0.00
VFD-3	[redacted]	HVAC Fan	15	15	18,641	4.02	2.92	4,407	2.40	0.00	0.24	0.60	0.00
VFD-4	[redacted]	HVAC Fan	40	40	49,710	10.73	7.80	43,865	7.71	6.70	0.88	0.72	0.86
VFD-5	[redacted]	HVAC Pump	40	40	141,618	30.57	12.32	54,024	9.46	8.65	0.38	0.31	0.70
VFD-5	[redacted]	HVAC Pump	40	40	141,618	30.57	12.32	88,392	15.78	13.73	0.62	0.52	1.11
VFD-5	[redacted]	HVAC Pump	40	40	141,618	30.57	12.32	62,243	13.64	6.24	0.44	0.45	0.51
VFD-6	[redacted]	HVAC Fan	7.5	5	9,321	2.01	1.46	5,066	0.75	0.60	0.54	0.37	0.41
VFD-6	[redacted]	HVAC Fan	7.5	5	9,321	2.01	1.46	3,242	0.75	0.43	0.35	0.37	0.29
VFD-6	[redacted]	HVAC Fan	10	7.5	12,428	2.68	1.95	7,469	1.14	0.69	0.60	0.42	0.36
VFD-7	[redacted]	HVAC Fan	5	5	6,214	1.34	0.97	6,403	0.62	0.23	1.03	0.46	0.24
VFD-8	[redacted]	HVAC Fan	40	40	49,710	10.73	7.80	5,956	0.67	0.00	0.12	0.06	0.00

Key	Customer	VFD Type	Tracking HP	M&V HP	Target Annual kWh Savings	Target Annual NCP kW	Target Annual CP kW	M&V Energy Savings kWh	M&V NCP Savings kW	M&V CP Savings kW	Energy RR	NCP RR	CP RR
VFD-9	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	33,168	4.46	0.15	0.89	0.55	0.03
VFD-9	[redacted]	HVAC Fan	50	200	62,138	13.41	9.75	376,837	27.96	21.12	6.06	2.08	2.17
VFD-9	[redacted]	Process Pump 1-50 HP	20	20	18,213	4.95	4.06	1,643	0.89	0.85	0.09	0.18	0.21
VFD-9	[redacted]	Process Pump 1-50 HP	30	30	27,320	7.43	6.09	14,896	2.12	1.59	0.55	0.28	0.26
VFD-10	[redacted]	HVAC Fan	20	20	24,855	5.36	3.90	15,179	5.54	5.53	0.61	1.03	1.42
VFD-10	[redacted]	HVAC Fan	5	5	6,214	1.34	0.97	1,357	0.90	0.88	0.22	0.67	0.90
VFD-11	[redacted]	HVAC Fan	20	20	24,855	5.36	3.90	17,729	5.50	0.00	0.71	1.03	0.00
VFD-12	[redacted]	HVAC Pump	10	10	35,405	7.64	3.08	13,720	1.58	1.57	0.39	0.21	0.51
VFD-13	[redacted]	HVAC Pump	25	15	88,512	19.11	7.70	41,817	2.38	2.00	0.47	0.12	0.26
VFD-14	[redacted]	HVAC Pump	20	9	70,809	15.28	6.16	27,443	0.00	0.00	0.39	0.00	0.00
VFD-15	[redacted]	HVAC Fan	15	15	18,641	4.02	2.92	11,108	4.72	3.65	0.60	1.17	1.25
VFD-15	[redacted]	HVAC Pump	40	40	141,618	30.57	12.32	36,912	9.86	7.90	0.26	0.32	0.64
VFD-15	[redacted]	HVAC Pump	30	30	106,214	22.93	9.24	24,444	6.77	6.35	0.23	0.30	0.69
VFD-15	[redacted]	HVAC Fan	10	10	12,428	2.68	1.95	3,823	1.73	1.45	0.31	0.64	0.74
VFD-15	[redacted]	HVAC Fan	15	15	18,641	4.02	2.92	21,365	2.81	1.61	1.15	0.70	0.55
VFD-16	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	2,590	3.56	0.00	0.07	0.44	0.00
VFD-17	[redacted]	HVAC Fan	40	50	49,710	10.73	7.80	16,863	9.17	0.00	0.34	0.86	0.00
VFD-17	[redacted]	Process Pump 1-50 HP	60	80	54,640	14.86	12.17	18,644	2.52	1.84	0.34	0.17	0.15
VFD-	[redacted]	HVAC Fan	60	60	74,566	16.09	11.70	79,643	9.33	7.98	1.07	0.58	0.68

Key	Customer	VFD Type	Tracking HP	M&V HP	Target Annual kWh Savings	Target Annual NCP kW	Target Annual CP kW	M&V Energy Savings kWh	M&V NCP Savings kW	M&V CP Savings kW	Energy RR	NCP RR	CP RR
18	[redacted]												
VFD-18	[redacted]	HVAC Fan	30	30	37,283	8.05	5.85	26,305	6.36	0.00	0.71	0.79	0.00

VFD-9 with a 200HP fan, is greater than the 50HP allowed under the program. However, it provided savings, and so is included in the analysis. Similarly, VFD-18 included VFDs that were factory installed in a new packaged unit. Under the program, this application would not be allowed. However, a rebate was paid and therefore is included in the analysis.

Table 25 summarizes the results by VFD type. Although the energy savings realization rate for HVAC fans is substantially higher than shown for HVAC pumps and process pumps, this is driven largely by the savings attributed to the 200HP VFD-9. If the 200HP VFD-9 is not included in the calculations, the energy realization rate is about 55%.

Table 25. VFD summary by capacity

VFD Type	Target Annual kWh per HP	Target Annual NCP kW/HP	Target Annual CP kW/HP	M&V kWh per HP	M&V NCP kW per HP	M&V CP kW per HP	RR Energy Savings	RR NCP	RR CP
VFD HVAC Fan	1242.8	0.27	0.19	1,011.7	0.16	0.07	0.81	0.61	0.36
VFD HVAC Pump	3540.5	0.76	0.31	1,558.0	0.27	0.21	0.44	0.35	0.67
VFD Process Pump 1-50 HP	910.7	0.25	0.20	270.6	0.04	0.03	0.30	0.17	0.16

Gross Savings Analysis – Overall Realization Rates

The estimated achieved sampling precision in the realization rates for all three measure categories is shown in Table 26. Due to the higher than expected variability in the savings from the M&V activity relative to the program planning values, the achieved relative precision was higher than the targeted value.

Table 26. Realization Rate Achieved Sampling Precision

Project Type	Population Size	Sample Size	*Actual Sample cv*	*Relative Precision*
Linear Fluorescent	925	10	0.94	+/- 49%
Occupancy Sensor	672	10	0.61	+/- 31%
VFD-Fan	195	25	1.65	+/- 51%
VFD-Process	14	3	0.41	+/- 34%
VFD-Pump	54	8	0.32	+/- 17%
Total				+/- 23.1%

There are additional considerations to be made that can improve the relative precision results. The first is examination of the high coefficient of variation (CV) values in this study. The high CV for linear fluorescents is unexpected, but is related to 1) the wide variation in actual operating hours (which ranges from a low of 1,255 to nearly 8,200), and 2) discrepancies between the fixture types discovered during M&V field activities and those recorded in the tracking system. The high CV for the VFD-Fan is driven primarily by the 200HP VFD that was represented in the tracking system as a 50HP VFD. This was an early application from 2009 and was allowed despite the requirements of Prescriptive program. If the CV for the VFD-Fan is recalculated without this measure in the sample, the CV improves to 0.70, which improves the overall precision to 18.6%, as shown in Table 27.

Table 27. Realization Rate Achieved Sampling Precision with Adjusted VFD Coefficient of Variation

Project Type	Population Size	Sample Size	Actual Sample cv	Relative Precision
Linear Fluorescent	925	10	0.94	+/- 49%
Occupancy Sensor	672	10	0.61	+/- 31%
VFD-Fan	195	25	0.70	+/- 21%
VFD-Process	14	3	0.41	+/- 34%
VFD-Pump	54	8	0.32	+/- 17%
Total				+/- 18.6%

Secondly, if the high-bay lighting CV results from the earlier M&V study are included, in addition to the adjusted VFD-Fan CV, the overall precision improves further to 11.7%. The improvement in precision with these adjustments is shown in Table 28.

Table 28. Realization Rate Achieved Sampling Precision including High Bay Sample and Adjusted VFD Coefficient of Variation

Project Type	Population Size	Sample Size	Actual Sample cv	Relative Precision
Lights-Hi Bay	1,134	20	0.39	+/- 14%
Linear Fluorescent	925	10	0.94	+/- 49%
Occupancy Sensor	672	10	0.61	+/- 31%
VFD-Fan	195	25	0.70	+/- 21%
VFD-Process	14	3	0.41	+/- 34%
VFD-Pump	54	8	0.32	+/- 17%
Total				+/- 11.7%

Finally, if the precision is calculated with the original VFD-Fan CV of 1.65 and the high-bay lighting results are added, the overall precision is 13.9%, as shown in Table 29.

Table 29. Realization Rate Achieved Sampling Precision including High Bay Sample

Project Type	Population Size	Sample Size	Actual Sample cv	Relative Precision
Lights-Hi Bay	1,134	20	0.39	+/- 14%
Linear Fluorescent	925	10	0.94	+/- 49%
Occupancy Sensor	672	10	0.61	+/- 31%
VFD-Fan	195	25	1.65	+/- 51%
VFD-Process	14	3	0.41	+/- 34%
VFD-Pump	54	8	0.32	+/- 17%
Total				+/- 13.9%

Net to Gross Analysis

Freeridership

TecMarket Works utilized two different sets of questions asked of each surveyed participant which are scored independently, and then combined to estimate freeridership.

For the first set of calculations, the primary "gateway" question asks if they would have purchased the same equipment without the program and when that would have occurred. The second question within this set asks those who say they would have delayed their purchase to estimate how long they would have delayed the purchase. Together these two questions provide the foundation from the first set of questions used for estimating the level of energy impacts that are attributable to freeridership rather than savings that are program induced (net savings).

The first question within the first set of questions asked survey respondents what their behavior would have been if the Smart $aver rebate had not been available. The four categories of responses were:

a.) bought the same unit at the same time
b.) bought the same unit at a later time
c.) bought a used unit at the same time
d.) continued to use the currently installed unit and not purchase a new or used unit

The breakdown of responses to the gateway question can be seen in Table 30. Participants who indicated that they would have bought the same unit at the same time were assigned 100% freeridership. Participants answering that they would have continued using the currently installed unit were assigned 0% freeridership.

Freeridership for participants who indicated that they would have bought their units at a later time are asked an additional question for determining when they would have purchased the units in the absence of the program. Each response to this question was converted to a foundation freerider percentage as presented in Table 30 separately for Linear Fluorescent Lighting (FL), Occupancy Sensors (OS) and Variable Frequency Drives (VFD).

From the foundational set of questions, the equivalent freerider rate (the number of units that count toward freeridership) in the case of customers who indicated they would have purchased the unit at a later time, is the product of the freerider percentage multiplied by the number of respondents/units (each respondent was surveyed about one recently installed unit).

Table 30. Program Freeridership by Rebated Measure

Gateway Question Response	Linear Fluorescent Lighting Count (Responders)	Occupancy Sensor Count (Responders)	Variable Frequency Drive Count (Responders)
Same unit at same time (100% freerider)	10 (10)	2 (2)	3 (3)
Same unit within 6 months (75% freerider)	0 (0)	0 (0)	0 (0)
Same unit 6-12 months later (50% freerider)	0 (0)	0 (0)	0 (0)
Same unit 12-24 months later (25% freerider)	7 (1.75)	1 (0.25)	0 (0)
Same unit more than 24 months later (0% freerider)	3 (0)	2 (0)	0 (0)
Same unit, don't know when (mean % freerider of the five rows above = 58.8% for Fluorescent Lighting, 45.0% for Occupancy Sensors, 100% for VFD)	4 (2.35)	1 (0.45)	1 (1)
Used unit at the same time or later time (same as row above = 100% for VFD)[12]	0 (0)	0 (0)	1 (1)
Continued using old unit (0% freerider)	10 (0)	6 (0)	1 (0)
TOTAL COUNT	**34**	**12**	**6**
Freeriders	**14.1**	**2.70**	**5**
Freerider %	**41.5%**	**22.5%**	**83.3%**

The second set of freerider calculations is based on an additional set of questions which ask what participants would have done without the Smart $aver incentive, and without the Smart $aver program information and technical assistance.

The three categories of responses to these questions were:

a.) bought unit with at least the same efficiency level
b.) bought a unit with a different efficiency level
c.) not sure what organization would have done

The breakdown of responses to these questions can be seen in Table 31 and Table 32. Participants who indicated that they would have bought the same efficiency level without the incentive or program information were assigned the average freeridership calculated for participants who said they would purchase the same unit in Table 30: 58.8% for Fluorescent Lighting (FL), 45.0% for Occupancy Sensors (OS) and 100% for Variable Frequency Drives

[12] Used VFD units in the category: "Used unit at the same time or later time" are treated as new units in the category: "same unit, don't know when" for computing freeridership.

(VFD). Participants answering that they would have selected a different efficiency level were assigned 0% freeridership.

Table 31. Program Freeridership Based on Financial Incentive by Rebated Measure

Response for "without financial incentive"	Linear Fluorescent Lighting Count (Responders)	Occupancy Sensor Count (Responders)	Variable Frequency Drive Count (Responders)
Would have selected same efficiency level without financial incentive (freerider percent based on planned time of purchase: 58.8% FL, 45.0% OS, 100% VFD)[13]	19 (11.16)	4 (1.80)	4 (4)
Would have made a different choice without financial incentive (freerider 0%)	11 (0)	6 (0)	1 (0)
Not sure what company would have done without financial incentive (freerider percent based on mean of two columns above)	4 (1.49)	2 (0.36)	1 (0.80)
TOTAL COUNT	**34**	**12**	**6**
Freeriders	**12.65**	**2.16**	**4.80**
Freerider %	**37.2%**	**18.0%**	**80.0%**

Table 32. Program Freeridership Based on Information and Assistance by Rebated Measure

Response for "without program information and technical assistance"	Linear Fluorescent Lighting Count (Responders)	Occupancy Sensor Count (Responders)	Variable Frequency Drive Count (Responders)
Would have selected same efficiency level without program information/technical assistance (freerider percent based on planned time of purchase: 58.8% FL, 45.0% OS, 100% VFD)[14]	16 (9.40)	7 (3.15)	4 (4)
Would have made a different choice without program information/technical assistance (freerider 0%)	8 (0)	3 (0)	1 (0)
Not sure what company would have done without program	10 (3.92)	2 (0.63)	1 (0.80)

[13] These percentages represent the average freeridership of respondents indicating they would purchase the same unit as seen in row 5 of Table 30.

[14] These percentages represent the average freeridership of respondents indicating they would purchase the same unit as seen in row 5 of Table 30.

information/technical assistance (freerider percent based on mean of two columns above)			
TOTAL COUNT	**34**	**12**	**6**
Freeriders	**13.32**	**3.78**	**4.80**
Freerider %	**39.2%**	**31.5%**	**80.0%**

Since the program included both an incentive payment and technical assistance/program information, each of which can motivate a decision to go with the more efficient choice, a two path analysis approach was used for assessing freeridership within the second set of questions. One path was scored for the influence of the incentive and another path was scored for the analysis of the effect of the technical assistance or program information. The final per-participant freeridership estimate is the lower of the two estimates from each of the two paths. These results are presented for each measure in Table 31 and Table 32. Thus, freeridership for the Smart $aver program is estimated at 37.2% for Fluorescent Lighting, 18.0% for Occupancy Sensors and 80.0% for Variable Frequency Drives. Note that this freerider analysis was conducted using a sample of surveyed participants. The evaluation plan was not designed to achieve statistically significant estimates of freeridership at the measure level. These values are shown for informational purposes only. Only the overall program freeridership should be used.

Validity and Reliability of the Freerider Estimation Approach

The field of freeridership assessment as specified in the California Evaluation Protocols basic estimation approach requires the construction of questions that allow the evaluation contractor to estimate the level of freeridership. The basic approach used in this evaluation is based on the results of a set of freerider questions incorporated into participant survey instruments that meets the reliability standards for freerider questions. The approach used in this assessment examines the various ways in which the program impacts the customer's acquisition and use of equipment incented as part of the Non-Residential Smart $aver Prescriptive program, and allocates a freeridership factor for each of the types of responses contained in the survey questions. The allocation approach assigns high freeridership values to participants who would have acquired the same equipment on their own, and that factor is influenced by their stated intentions regarding the timing and efficiency level of this acquisition. The scoring approach is proportional to the degree to which the participant would have acquired and used equivalent equipment on their own.

Spillover

In order to estimate the spillover savings attributed to the program several questions were added to the participant questionnaire. These questions were asked to determine the extent to which the program's information and incentives caused additional non-incented spillover actions to be taken by the participants. A total of 52 survey participants answered the net to gross question battery.

Survey participants were asked if they had taken any actions above and beyond those rebated by the program at their company or at any other locations. If the respondent indicated that they had not purchased or installed any other type of high efficiency equipment or made energy efficiency improvements since their participation in the program, the spillover level was set to zero and no spillover credit was provided. Respondents that had taken additional measures were asked about the type of equipment and where it was installed. However, no spillover was provided to those respondents that took additional actions unless they also indicated that their experience with the program caused, to some degree, the action to be taken by rating the influence of their experience with the program on their decision to do so on a scale from one to ten with ten being the most influential. This rating is referred to as the participant's attribution score.

If a participant indicated that the program was influential in their purchase and use decision, then their spillover savings was adjusted by the fractional amount of the strength of their attribution score. That is, if the respondent indicated an attribution score of seven out of ten, then their spillover savings were multiplied by 0.7 to estimate their spillover contribution to the program net to gross ratio.

Table 33. Spillover Measures and Attribution

Measure	Quantity	Attribution Score	EUL[15]	kWh Savings	Spillover kWh Savings
T8 lighting	88	9	12	5,201	4,681
Occupancy sensors	12	9	10	5,884	5,296
Occupancy sensors	80	8	10	39,233	31,386
Occupancy sensors	11	8	10	5,395	4,316
T5 lighting	30	7	12	954	668
T8 lighting	20	10	12	1,182	1,182
T8 lighting	188	10	12	11,111	11,111
Occupancy sensors	10	7	10	4,904	3,433
TOTAL/AVERAGE		**8.5**	**10.5**	**73,865**	**62,073**

Table 33 shows each measure taken by the 52 survey participants for which enough information was provided to calculate energy savings. Spillover energy savings were estimated from the customer description of the measure taken and ex-ante savings estimates from Duke Energy work papers for that measure. The expressed spillover actions taken as a result of the program and the associated savings were not subjected to ex-post evaluation or verification inspections. Actions taken by respondents that provided insufficient data to estimate impact received zero spillover credit. That is, it is likely that spillover savings are higher than those reported above, however, beause of the inability to obtain enough information on the configuration and use of these actons, we do not estimate or credit any savings toward those actions. Actions that were determined, or believed, to be implemented outside of Duke Energy territory also received zero spillover credit. Furthermore, spillover estimates are limited to only those measures that are eligible to receive a rebate through the program. Although the spillover savings were not subject to ex-post evaluation, the approach taken is believed to provide the spillover estimates that are significantly below the actual achieved spillover savings.

Figure 5 graphically shows the estimated spillover impacts over the lifetime of the spillover measures. The only spillover measures reported are linear fluorescents and occupancy sensors.

[15] EUL = Effective Useful Life

Thus, a large drop-off occurs at ten years when the occupancy sensors reach the end of their Effective Useful Life (EUL). Savings continue to year 12, the end of the linear fluorescent EUL.

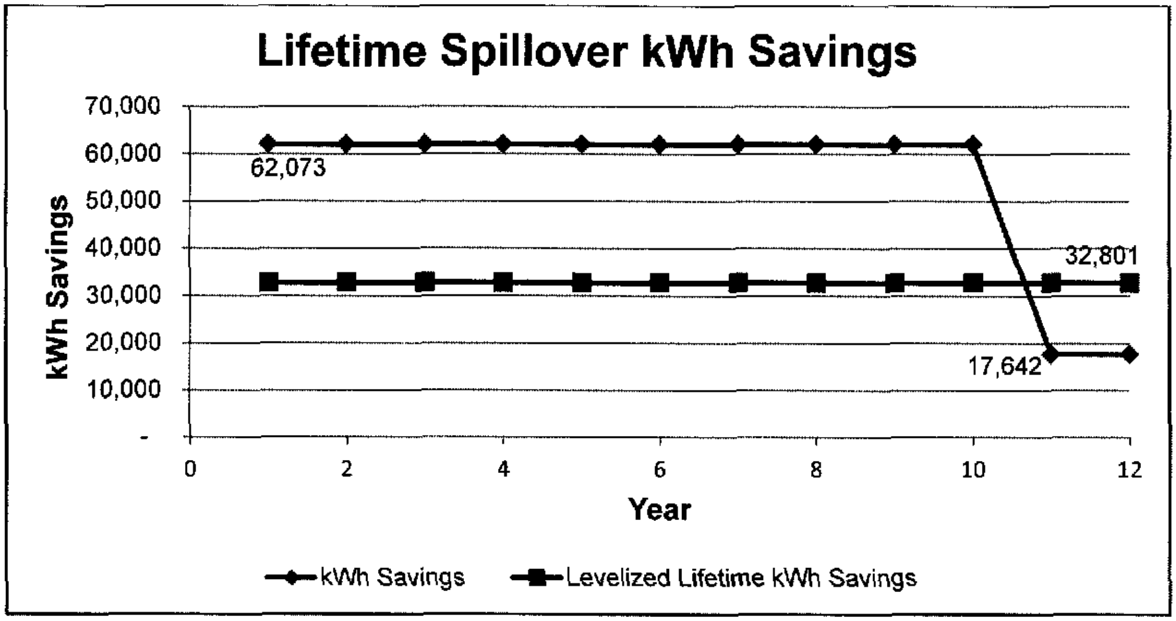


Figure 5. Lifetime Spillover kWh Savings

Table 34 shows the spillover percentage for the program of 6.6%.

Table 34. Spillover Percentage

Survey Respondent kWh Savings Excluding Spillover	Survey Respondent Spillover kWh savings	Spillover Percentage
946,097	62,073	6.6%

While TecMarket Works notes that the spillover savings documented in this report are lower than actually achieved, it should be understood that the assignment of spillover is, to a limited degree, subjective in that its accuracy depends on the ability of the attribution score to accurately estimate the degree of causation as well as the recall ability of the participant. However, the overall average causation score for the assessed spillover cause is high. That is, on average the attribution score provided by participants is 8.5 on a 10 point scale. This score represents that this program has significant influence on participants' actions well beyond those measures incented by the program.

The study of the Non-Residential Smart $aver Prescriptive Program in the Carolina System showed spillover values that were much higher than those observed in Ohio. This is the result of three very large projects that received high attribution scores from survey participants. Efforts were made to eliminate projects from spillover consideration that were rebated through another program or the same program at a later date. Because there was no indication that this was the case with any of the three and there was enough information to estimate spillover, these projects were included. If these three very large projects are not counted, spillover levels between Ohio and the Carolina System look very similar (6.6% compared to 7.3%).

Program Net to Gross Adjustment

To estimate the overall program-level net to gross adjustment, it is necessary to first determine the weighted average program freeridership. For the purposes of this calculation, high bay lighting is included. Including high bay lighting provides a more accurate estimate of the overall program freeridership. Linear fluorescents accounted for 14%, occupancy sensors accounted for 18%, VFDs accounted for 21%, and high bay lighting accounted for 47% of the total kWh savings achieved. The average program wide net to gross ratio for this program is 0.682. It should be noted that this net to gross ratio only includes adjustments for free ridership and short term participant spillover. Estimates for short and long term non-participant spillover and short and long term market effects are not included in this study and would be savings in addition to that documented in this report. While a short term participant net-to-gross ratio of 0.682 indicates the program saved less energy that what is reflected in the gross energy projected savings estimates, this savings level is only part of the savings that are achieved by energy efficiency programs. Additional evaluation efforts are needed to document short and long term non-participant spillover and short and long term market effects.

Freeridership scores presented in this report are weighted by their measure's contribution to overall kWh savings and calculated as follows:

Program Freeridership = (14% * Linear Fluorescent FR) + (18% * Occupancy Sensor FR) + (21% * VFD FR) + (47% * High Bay FR)
= (14% * 37.2%) + (18% * 18.0%) + (21% * 80.0%) + (47% * 28%[16])
= 38.4%

The net to gross ratio is then calculated as follows:

NTGR = 1 + (spillover – freeridership)
= 1+ (0.066 - 0.384)
= 0.682

The program level gross savings is discounted (1 – NTGR) by 31.8% to yield the total net savings.

Total Gross and Net Impacts

The total first year gross and net savings are tabulated for each of the measures studied in the evaluation. These estimates were calculated by applying the gross realization rates for kWh, NCP kW and CP kW to the program planning estimates for each measure. The evaluated first year gross and net impacts are summarized in Table 35.

[16] Evaluation of the Non-Residential Smart $aver Prescriptive Program in Ohio, August 29, 2010.

Table 35. First Year Gross and Net Savings by Measure

Metric	Result
Number of Program Participants from 1-1-2009 to 2-29-2012	2439 Projects
Gross Coincident Peak kW per unit	kW/unit
HPT8 4ft 2 lamp, T12 to HPT8	0.033
HPT8 4ft 2 lamp, T8 to HPT8	0.012
Low Watt T8 lamps, 4ft	0.006
LW HPT8 4ft 2 lamp, replace T8	0.015
LW HPT8 4ft 4 lamp, replace T8	0.027
LW HP T-8 4ft 1L replace T-8 4ft 1L	0.010
LW HP T-8 4ft 2L replace T-8 4ft 2L	0.015
LW HP T-8 4ft 4L replace T-8 4ft 4L	0.027
T8 2ft 2 lamp	0.036
T8 4ft 2 lamp	0.019
T8 4ft 4 lamp	0.047
T8 8ft 2 lamp	0.021
Occupancy Sensors under 500 W	0.123
Occupancy Sensors over 500 W	0.302
VFD HVAC Fan	0.070
VFD HVAC Pump	0.207
VFD Process Pump 1-50 HP	0.033
Gross kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	191.6
HPT8 4ft 2 lamp, T8 to HPT8	72.4
Low Watt T8 lamps, 4ft	35.0
LW HPT8 4ft 2 lamp, replace T8	86.0
LW HPT8 4ft 4 lamp, replace T8	154.8
LW HP T-8 4ft 1L replace T-8 4ft 1L	60.2
LW HP T-8 4ft 2L replace T-8 4ft 2L	86.0
LW HP T-8 4ft 4L replace T-8 4ft 4L	154.8
T8 2ft 2 lamp	206.3
T8 4ft 2 lamp	111.8
T8 4ft 4 lamp	275.1
T8 8ft 2 lamp	120.4
Occupancy Sensors under 500 W	273.5
Occupancy Sensors over 500 W	684.8

Metric	Result
VFD HVAC Fan	1011.7
VFD HVAC Pump	1558.0
VFD Process Pump 1-50 HP	270.6
Gross therms per unit	N/A
Freeridership rate	38.40%
Spillover rate	6.60%
Self Selection and False Response rate	0.00%
Total Discounting to be applied to Gross values	68.20%
Net Coincident Peak kW per unit	kW/unit
HPT8 4ft 2 lamp, T12 to HPT8	0.023
HPT8 4ft 2 lamp, T8 to HPT8	0.008
Low Watt T8 lamps, 4ft	0.004
LW HPT8 4ft 2 lamp, replace T8	0.010
LW HPT8 4ft 4 lamp, replace T8	0.018
LW HP T-8 4ft 1L replace T-8 4ft 1L	0.007
LW HP T-8 4ft 2L replace T-8 4ft 2L	0.010
LW HP T-8 4ft 4L replace T-8 4ft 4L	0.018
T8 2ft 2 lamp	0.025
T8 4ft 2 lamp	0.013
T8 4ft 4 lamp	0.032
T8 8ft 2 lamp	0.014
Occupancy Sensors under 500 W	0.084
Occupancy Sensors over 500 W	0.206
VFD HVAC Fan	0.048
VFD HVAC Pump	0.141
VFD Process Pump 1-50 HP	0.023
Net kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	130.7
HPT8 4ft 2 lamp, T8 to HPT8	49.4
Low Watt T8 lamps, 4ft	23.9
LW HPT8 4ft 2 lamp, replace T8	58.7
LW HPT8 4ft 4 lamp, replace T8	105.6
LW HP T-8 4ft 1L replace T-8 4ft 1L	41.1
LW HP T-8 4ft 2L replace T-8 4ft 2L	58.7
LW HP T-8 4ft 4L replace T-8 4ft 4L	105.6
T8 2ft 2 lamp	140.7

Metric	Result
T8 4ft 2 lamp	76.2
T8 4ft 4 lamp	187.6
T8 8ft 2 lamp	82.1
Occupancy Sensors under 500 W	186.5
Occupancy Sensors over 500 W	467.0
VFD HVAC Fan	690.0
VFD HVAC Pump	1062.6
VFD Process Pump 1-50 HP	184.5
Net therms per unit	N/A
Measure Life	12yr (linear fluorescent) 10yr (occupancy sensor)

Lifecycle savings were estimated by applying the following EUL assumptions[17] to each measure.

Table 36. Effective Useful Life for Lighting Measures

Measure	EUL (years)
Linear Fluorescent	12
Occupancy Sensor	10
VFD	15

Applying the EUL estimates listed above to each measure, the lifecycle gross and net kWh savings are shown in Table 37.

[17] EUL data taken from Duke Energy workpapers prepared by Franklin Energy Systems.

Table 37. Gross and Net Lifecycle Savings

Metric	Result
Number of Program Participants from 1-1-2009 to 2-29-2012	2439 Projects
Gross lifecycle kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	2,299
HPT8 4ft 2 lamp, T8 to HPT8	869
Low Watt T8 lamps, 4ft	420
LW HPT8 4ft 2 lamp, replace T8	1,032
LW HPT8 4ft 4 lamp, replace T8	1,858
LW HP T-8 4ft 1L replace T-8 4ft 1L	722
LW HP T-8 4ft 2L replace T-8 4ft 2L	1,032
LW HP T-8 4ft 4L replace T-8 4ft 4L	1,858
T8 2ft 2 lamp	2,476
T8 4ft 2 lamp	1,342
T8 4ft 4 lamp	3,301
T8 8ft 2 lamp	1,445
Occupancy Sensors under 500 W	2,735
Occupancy Sensors over 500 W	6,848
VFD HVAC Fan	15,176
VFD HVAC Pump	23,370
VFD Process Pump 1-50 HP	4,060
Net lifecycle kWh per unit	kWh/unit
HPT8 4ft 2 lamp, T12 to HPT8	1,361
HPT8 4ft 2 lamp, T8 to HPT8	514
Low Watt T8 lamps, 4ft	249
LW HPT8 4ft 2 lamp, replace T8	611
LW HPT8 4ft 4 lamp, replace T8	1,100
LW HP T-8 4ft 1L replace T-8 4ft 1L	428
LW HP T-8 4ft 2L replace T-8 4ft 2L	611
LW HP T-8 4ft 4L replace T-8 4ft 4L	1,100
T8 2ft 2 lamp	1,466
T8 4ft 2 lamp	794
T8 4ft 4 lamp	1,954
T8 8ft 2 lamp	855
Occupancy Sensors under 500 W	1,619
Occupancy Sensors over 500 W	4,054

Metric	Result
VFD HVAC Fan	8,984
VFD HVAC Pump	13,835
VFD Process Pump 1-50 HP	2,403
Measure Life	12yr (linear fluorescent) 10yr (occupancy sensor) 15yr (VFD)

Conclusions and Recommendations for Program Changes

Significant Impact Evaluation Findings for Linear Fluorescent Measures

- Energy and coincident peak demand savings realization rates for kWh and coincident peak kW for linear fluorescent lighting were 1.89 (energy) and 1.61 (demand) respectively, indicating the program planning estimates were conservative estimates of linear fluorescent lighting savings.
- Measurement and verification (M&V) activities conducted for this study produced an estimate of 5,155 lighting equivalent full load hours (EFLH), compared to a program planning estimate of 4,144 EFLH.
- M&V activities estimated a coincidence factor (CF) of 0.80, compared to a program planning estimate of 0.77.
- Although there were some small differences between the quantity of fixtures recorded in the Duke Energy program tracking database versus the number of fixtures in the field, the overall installation verification rate was 1.00.
- Program planning and M&V estimates of baseline fixture wattage were within 1%. M&V estimates of efficient fixture watts were an average of about 7% lower than program planning estimates, indicating conservative values of fixture watts were used during program design.

Significant Impact Evaluation Findings for Occupancy Sensor Measures

- Energy and coincident peak demand savings realization rates for kWh and kW for occupancy sensor measures were 0.56 and 1.21 respectively, indicating the program planning estimates were conservative estimates of occupancy sensor coincident peak kW savings, but overestimated occupancy sensor kWh savings.
- M&V activities conducted for this study produced an estimate of 3,078 lighting equivalent full load hours (EFLH) before the installation of occupancy sensors, compared to a program planning estimate of 4,144 EFLH.
- M&V activities produced an estimate of connected lighting kW per occupancy sensor that was 31% lower than the program assumption. Many of the occupancy sensors in the study were controlling a single fixture, which contributed to the reduced connected watts per sensor.
- M&V activities estimated an average kWh savings of 54% of the uncontrolled consumption and an average kW savings of 46% of the uncontrolled demand, compared to the program estimate of 30% for both kWh and kW. Although the kW savings as a percentage of the baseline estimated from M&V was higher, the connected load per sensor was less, thus the overall demand savings per sensor from M&V was less than the program estimate.

Significant Impact Evaluation Findings for VFD Measures

VFD energy and coincident peak demand savings realization rates were lower than program planning estimates. On average, the realization rates for energy, non-coincident peak, and peak

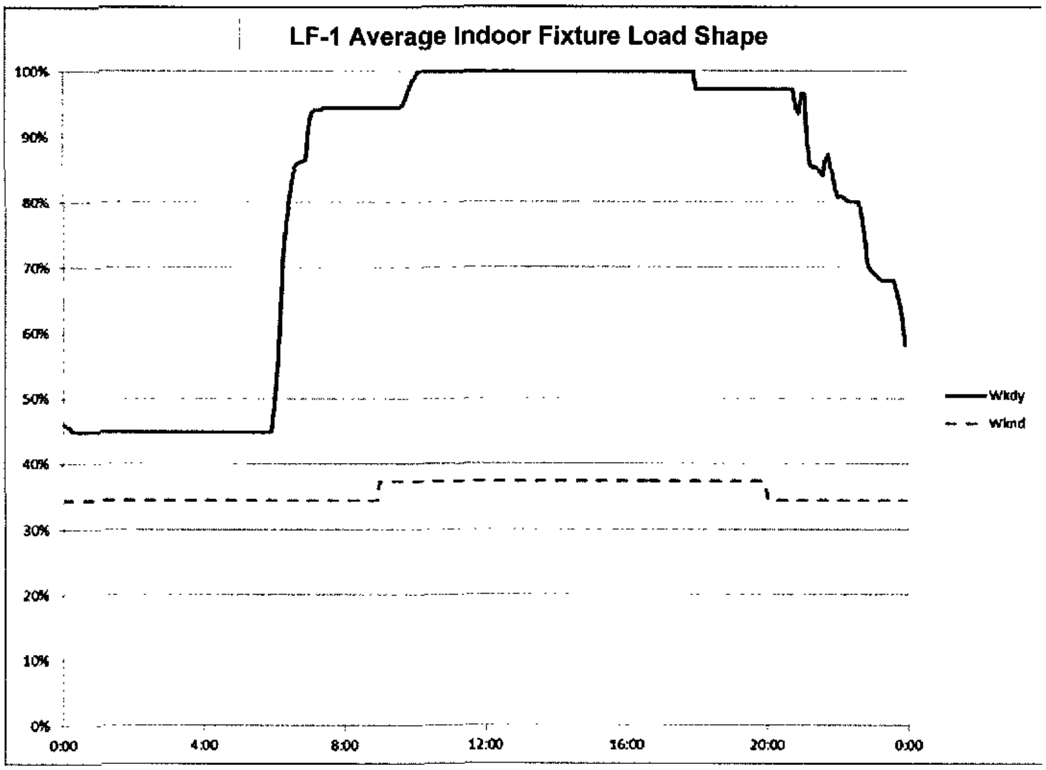
demand savings were about 62, 46, and 43% respectively. HVAC fans had the highest realization rates, and process pumping had the lowest realization rate
Based on the results of the impact evaluation, the TecMarket Works team has the following recommendations:

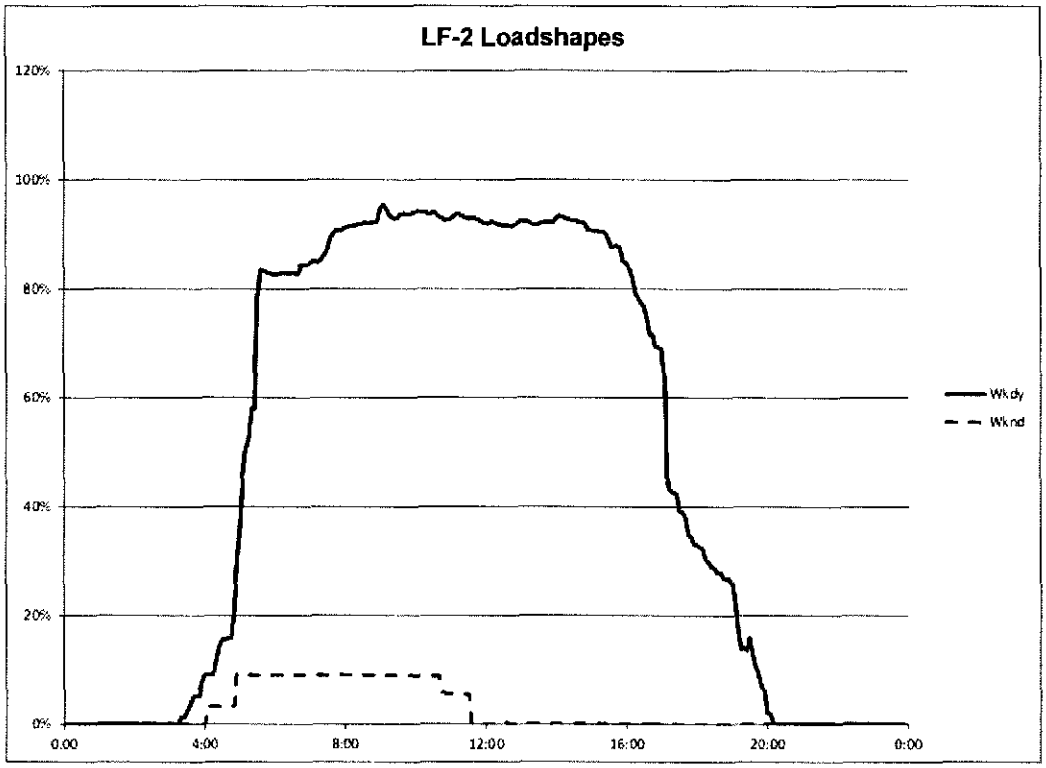
1. Conservative estimates of lighting EFLH should be updated with M&V results.
2. The weighted average self-reported operating hours were 4,944 EFLH, which represents a better estimate of lighting EFLH than the standard estimate of 4,144 EFLH. Consider including the self-reported operating hours in the ex-ante estimates of measure savings.
3. The measured coincidence factor of 0.80 was slightly higher than the program planning estimate of 0.77. Consider revising the coincidence factor assumption to 0.80 for future program planning activities.
4. The M&V savings for VFDs was significantly lower than program estimates, especially for HVAC pumps and process pumps. Consider reducing the annual savings estimates to the M&V results.

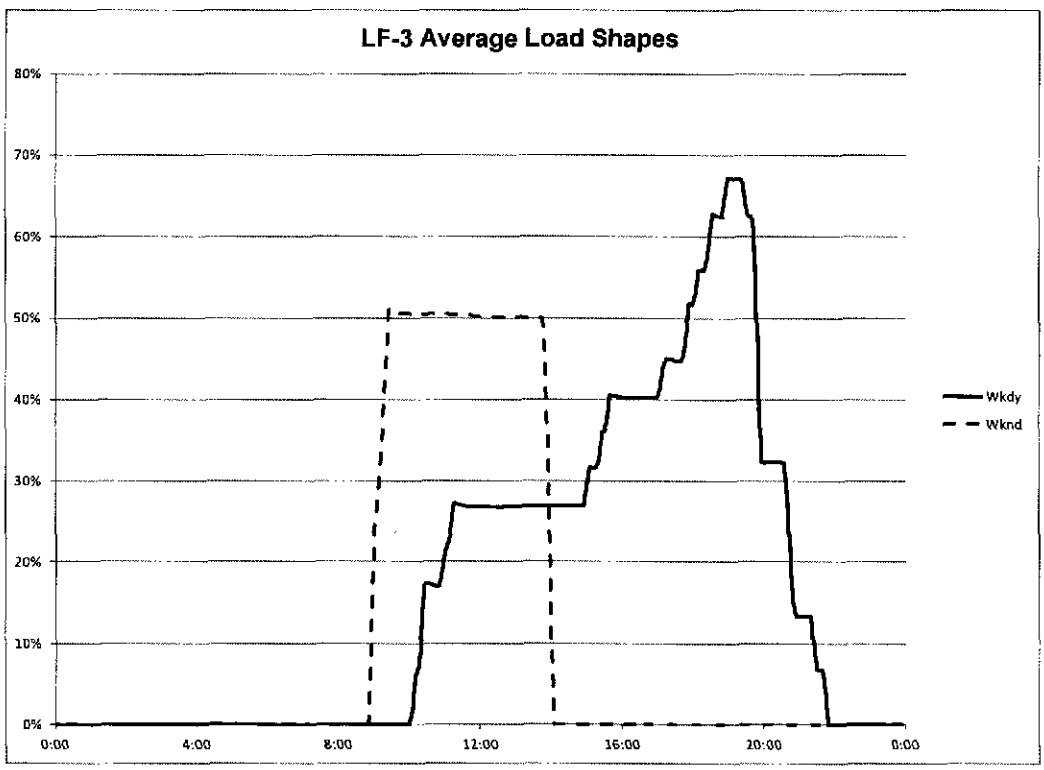
Appendix A: Load Shapes

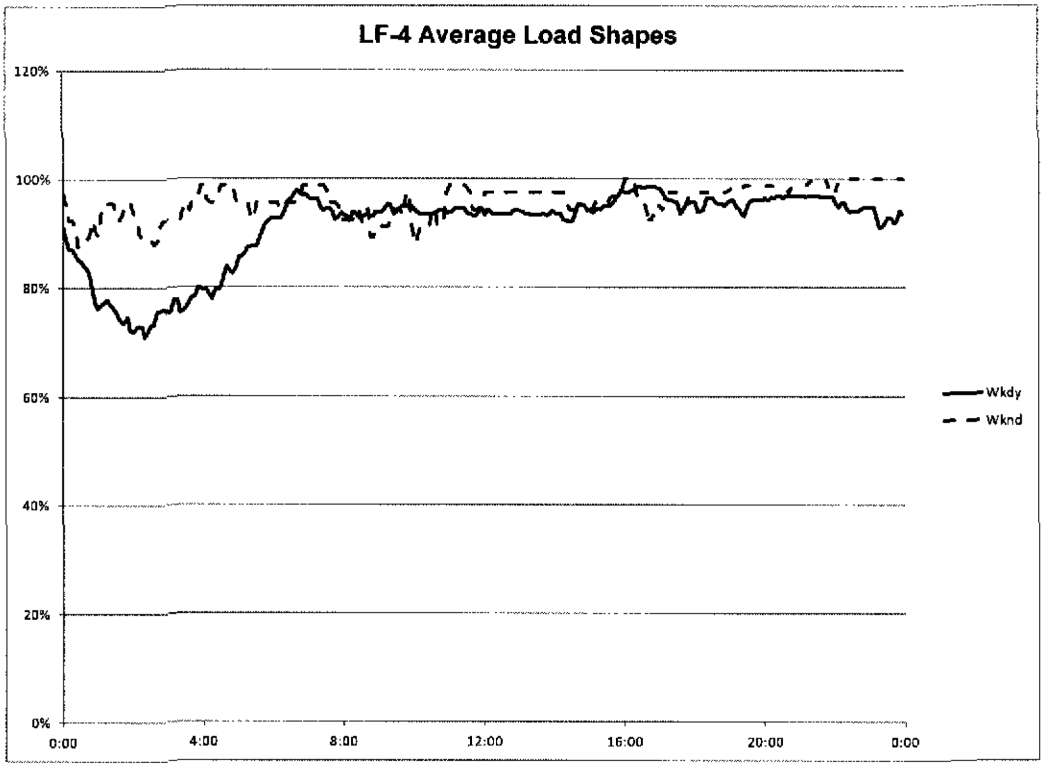
Average weekday and weekend/holiday load shapes from the logger data are shown for each site in the study.

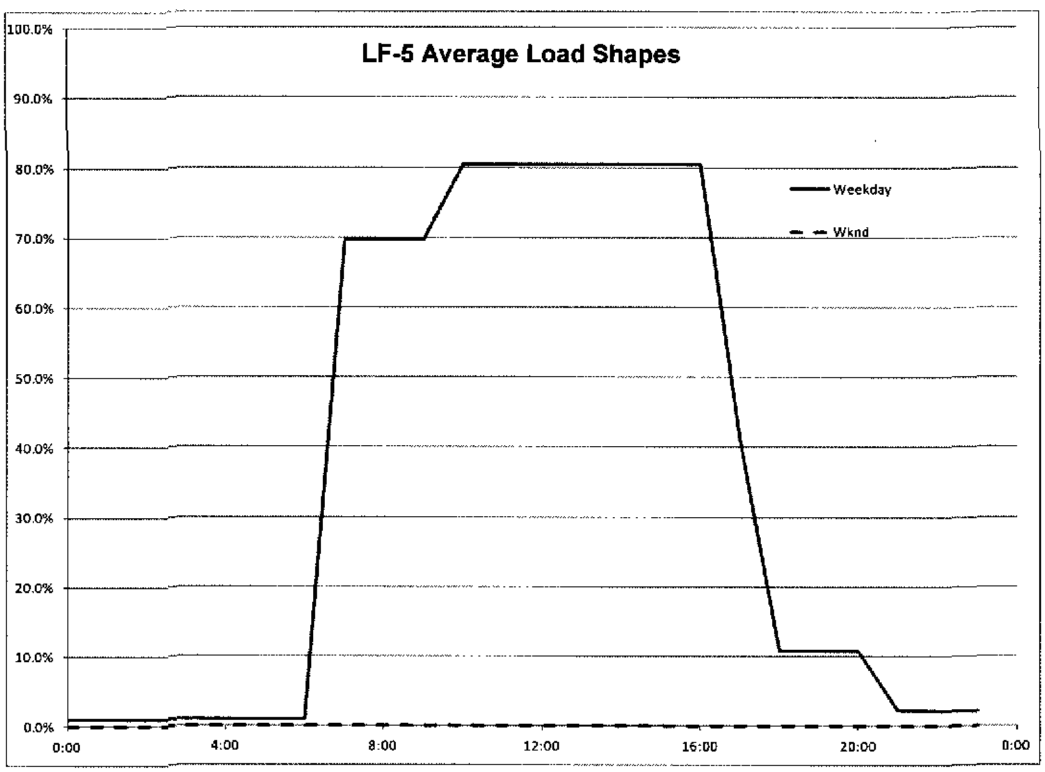
Linear Fluorescent Sites

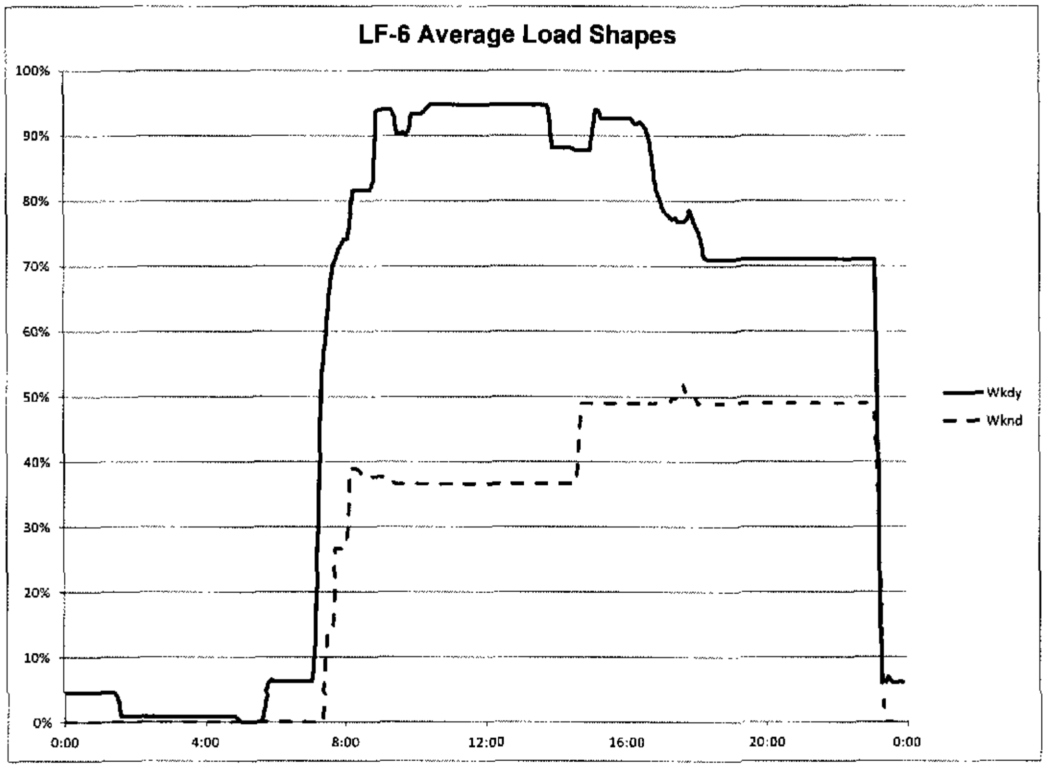


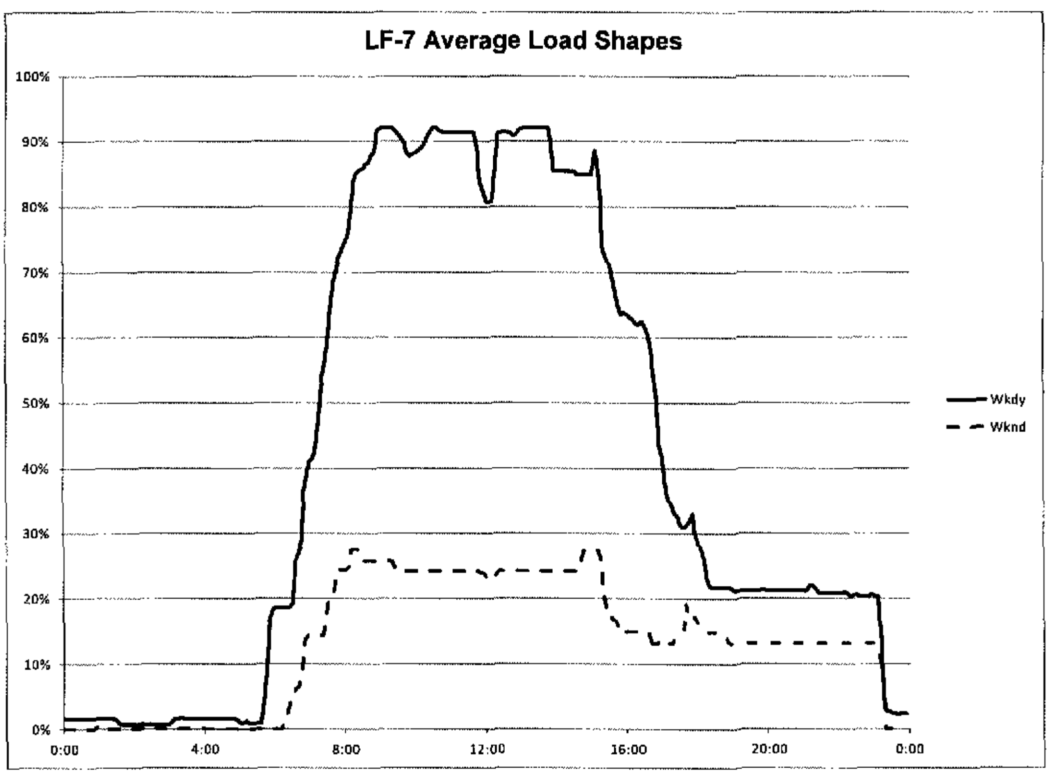

LF-2 Loadshapes
120%
100%
80%
60%
40%
20%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd

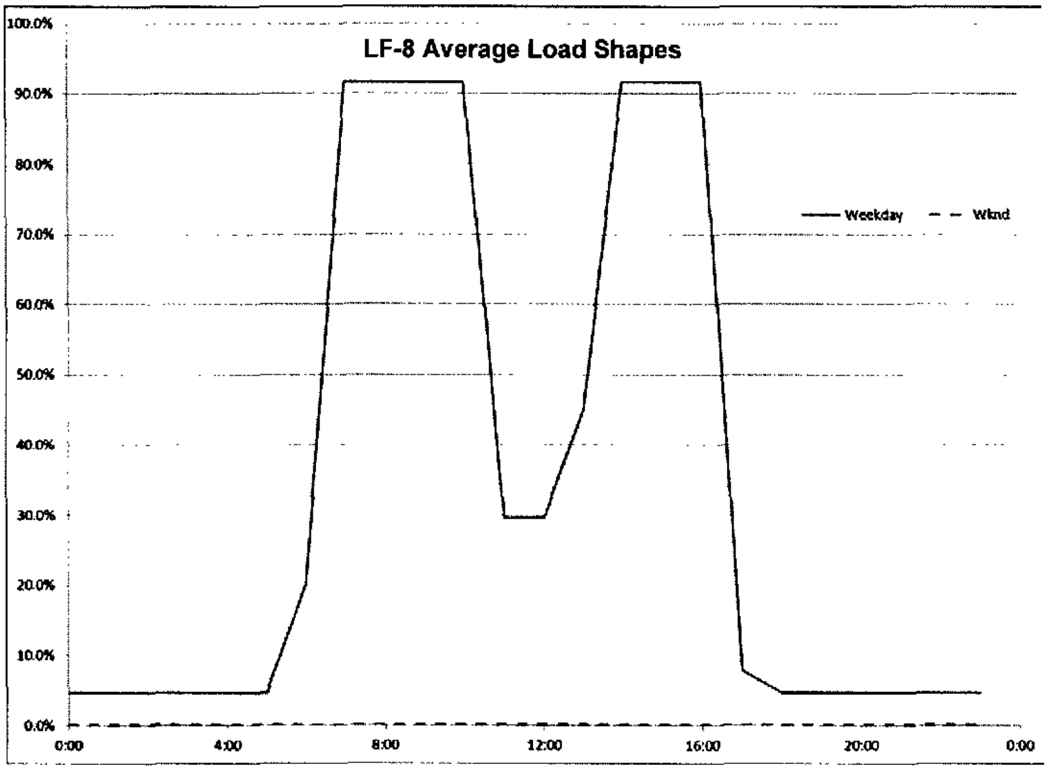

LF-3 Average Load Shapes
80%
70%
60%
50%
40%
30%
20%
10%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd

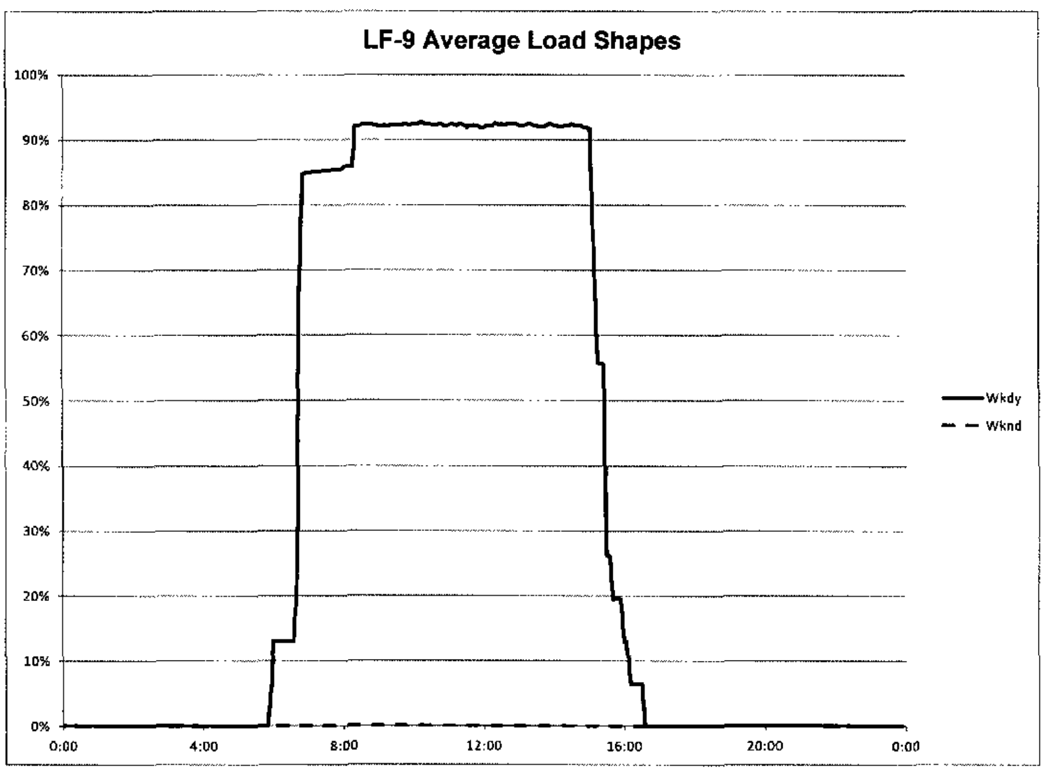

LF-4 Average Load Shapes
120%
100%
80%
60%
40%
20%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd


LF-5 Average Load Shapes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Weekday
Wknd


LF-6 Average Load Shapes
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd


LF-7 Average Load Shapes
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd


LF-8 Average Load Shapes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Weekday
Wknd


LF-9 Average Load Shapes
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Wkdy
Wknd