



Independent Audit of the AEP Ohio 2014-2018 Energy Efficiency and Demand Reduction Programs

Submitted by Evergreen Economics to the
Public Utilities Commission of Ohio

FINAL Report

October 31, 2019



MichaelsEnergy

Dr. Phil Willems / PWP

Table of Contents

EXECUTIVE SUMMARY	1
1 INTRODUCTION.....	5
1.1 OHIO ENERGY EFFICIENCY REGULATORY BACKGROUND	6
2 AUDIT METHODS.....	9
3 PROGRAM CHARACTERIZATION	12
3.1 AEP OHIO PROGRAM SUMMARY.....	12
3.2 RESIDENTIAL PROGRAMS	14
3.3 NON-RESIDENTIAL PROGRAMS	16
3.4 AUDIT ASSESSMENT	18
4 SAVINGS REVIEW.....	21
5 CONCLUSIONS AND RECOMMENDATIONS.....	31
APPENDIX A: DETAILED ANNUAL SAVINGS AND COST TABLES	33
PROGRAM YEAR 2018	33
PROGRAM YEAR 2017	35
PROGRAM YEAR 2016	37
PROGRAM YEAR 2015	39
PROGRAM YEAR 2014	41

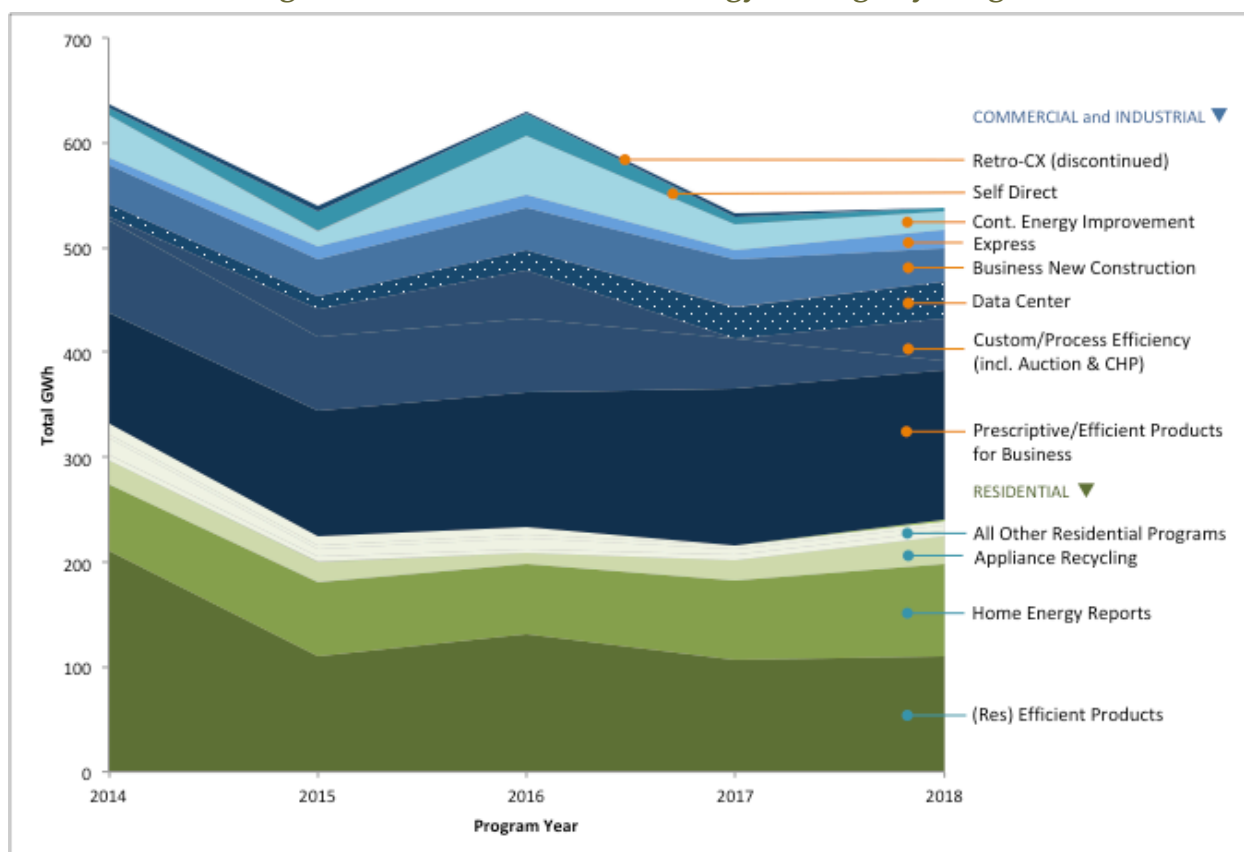
Executive Summary

In March 2019, the Public Utilities Commission of Ohio (PUCO) chose the Evergreen Economics team to conduct an independent audit of the Ohio electric utilities' energy efficiency and peak demand reduction programs. The audit team consists of staff from the following companies:

- Evergreen Economics
- Michaels Energy
- Dr. Philippus Willems / PWP

This report covers the audit review of all the energy efficiency and demand response programs for AEP Ohio over the 2014-2018 period. Figure 1 shows the annual energy savings claimed for each AEP Ohio program covered by this audit.

Figure 1: AEP Ohio Annual Energy Savings by Program



The primary objectives for the audit established by the PUCO were as follows:

1. Review the annual energy and demand impacts reported by each utility and make recommended adjustments to the savings estimates as needed;
2. Review the various PUCO rulings that are relevant to these programs and confirm that the utilities have adhered to these directives;
3. Characterize the utility programs in terms of utilization of channel partners, independent evaluators, program costs, and opt out and mercantile customers; and
4. Update the Ohio Technical Reference Manual (TRM) to reflect current market conditions, technologies, and evaluation best practices.

As part of the background review of the AEP Ohio programs, we conducted the following activities.

- ***Review of annual portfolio status reports.*** Each of the annual reports was reviewed for the 2014-2018 period. These annual reports were the primary source of the claimed energy savings and program cost information whenever possible.
- ***Review of annual evaluation reports.*** The evaluation reports were typically included as appendices to the annual portfolio status reports; these were reviewed in detail for each year.
- ***Review of additional filings related to the AEP Ohio programs.*** Related utility filings such as the Green Rules, comments by intervenors on AEP Ohio filings, and AEP Ohio program plans were also reviewed as needed.
- ***Analysis of program-related data from AEP Ohio.*** Additional data supplied by AEP Ohio included information on channel partners and third party contractors that implemented and evaluated the programs, information on mercantile customers and opt out customers, and program cost details that were not included in the portfolio status reports.
- ***Interviews of AEP Ohio program managers.*** Interviews of the AEP Ohio program managers were conducted to collect additional information on the programs that were not captured in the related documents.

The majority of the audit was spent reviewing the annual savings and program information for each of the AEP Ohio programs. All of the savings information from the evaluation reports was covered in an initial review, followed by a more in-depth review of selected programs and equipment types that accounted for the majority of program savings. The measures and programs selected for additional review were based on several criteria including the amount of total savings provided, the uncertainty surrounding the savings estimates, and whether or not the savings calculation methods had changed significantly during the audit period.

Based on our review of these materials, we identified measures for a more in-depth savings review based on several factors, including the total amount of savings and the potential uncertainty surrounding the savings estimates. Specific measures identified for the in-depth review included:

- Residential lighting (CFLs and LEDs)
- Commercial lighting (T8s, T5s, LED linear lighting)
- Home Energy Reports
- Custom projects
- Retrocommissioning
- Data centers

We estimate that these measures accounted for approximately 70 percent of the total savings that AEP Ohio claimed over the 2014-2018 period.

From the in-depth savings review, overall we found that the evaluation methods were sound and conformed to the regulatory requirements established for Ohio during the 2014-2018 period. While we have a few recommendations for changes to some savings values for future program years, the existing values are consistent with the rules that guide how energy savings are estimated in Ohio. In many cases, the savings calculations rely on algorithms that are recommended in the 2010 Ohio TRM. As a result, the audit team is not recommending any retroactive adjustments to AEP Ohio program savings over the 2014-2018 period.

For future program evaluations, we recommend the following:

1. **Future ‘as found’ baseline assumptions for residential LEDs should be adjusted to account for the high number of energy efficient bulbs distributed through the program.** Given that over 17,000,000 bulbs have been distributed to AEP Ohio customers through its programs, the average efficiency for installed lamps will be improving over time. The baseline efficiency used to estimate average savings in the future needs to be adjusted to account for the higher number of existing LEDs in these households.
2. **Update in-service rates to account for the high number of LEDs already purchased.** Given the high volume of LED sales, it is likely that more of the LEDs are being put in storage due to saturation of the market. Future evaluations should conduct a survey of residential customers to determine an updated in-service rate, as the current value of 0.97 is outdated and likely too high.
3. **Adjust savings from the Home Energy Reports program to account for upstream LED purchases (if needed).** In future evaluations, we recommend that a survey be conducted using a statistically representative sample of both participants and

control group customers. These surveys should ask about the type and number of LEDs purchased to determine if recipients of the home energy reports are purchasing more than the non-participant control group. If there is an increase in LED purchases among participants relative to the control group, then the savings from the Home Energy Report program should be adjusted to account for this difference, as the LED savings are already accounted for in the Residential Efficient Products program impacts.

I Introduction

In March 2019, the Public Utilities Commission of Ohio (PUCO) chose the Evergreen Economics team to serve as the Independent Evaluator to assist in the review and monitoring of the Ohio electric utilities' energy efficiency and peak demand reduction programs.¹ The Independent Evaluator team consists of staff from the following companies:

- Evergreen Economics
- Michaels Energy
- Dr. Philippus Willems / PWP

The programs reviewed are for the 2014-2018 period and include those of the following Ohio utilities:

- American Electric Power Ohio (AEP Ohio)²
- The Dayton Power and Light Company (DP&L)
- Duke Energy Ohio (Duke Energy)
- FirstEnergy³

As part of this process, the PUCO identified several primary objectives for the Independent Evaluator that can be summarized as follows:

1. Review the annual energy and demand impacts reported by each utility and make recommended adjustments to the savings estimates as needed;
2. Review the various PUCO rulings that are relevant to these programs and confirm that the utilities have adhered to these directives;

¹ Ohio utilities are required to propose energy efficiency plans and file annual status reports with the PUCO per the 2009 PUCO rules for implementing the Ohio law adopted in 2008 that established an Energy Efficiency Resource Standard with energy savings goals for electric utilities and that allows for cost recovery and decoupling. Each annual status report (called a Portfolio Status Report) must include a compliance demonstration and a program performance assessment (including a description of all transmission and distribution infrastructure improvements and an evaluation, measurement, and verification report, along with recommendations for the future of the programs).

² AEP Ohio had two operating companies in 2011: Columbus Southern Power Company (CSP) and Ohio Power Company (OPCo). As of December 31, 2011, CSP merged with OPCo, with OPCo as the surviving entity.

³ FirstEnergy has three Ohio operating companies: The Cleveland Electric Illuminating Company (CEI), Ohio Edison Company (Ohio Edison), and The Toledo Edison Company (Toledo Edison). In this report, these three are referred to collectively as FirstEnergy or Companies, where noted.

3. Characterize the utility programs in terms of utilization of channel partners, independent evaluators, program costs, and opt out and mercantile customers; and
4. Update the Ohio Technical Reference Manual (TRM) to reflect current market conditions, technologies, and evaluation best practices.

This report presents our review of the AEP Ohio programs from 2014-2018.

1.1 Ohio Energy Efficiency Regulatory Background

On April 23, 2008, the Ohio legislature adopted Amended Substitute Senate Bill No. 221 (SB 221),⁴ which went into effect on July 31, 2008. Among the provisions of SB 221 was the requirement in Section 4928.66, Revised Code,⁵ for the PUCO to take certain actions related to the implementation of energy efficiency and peak-demand reduction programs by the electric utilities. Section 4928.66(B), Revised Code, requires the PUCO to verify the annual levels of energy efficiency and peak-demand reduction achieved by each electric utility.

In order to assess the benefit of these activities, the PUCO must be in a position to be able to determine, with reasonable certainty, the energy savings and demand reductions attributable to the energy efficiency programs undertaken by the electric utilities and mercantile customers. Specifically, the PUCO needs the capability to: (a) verify each electric utility's achievement of energy and peak-demand reduction requirements, pursuant to Section 4928.66(B), Revised Code; (b) consider exempting mercantile customers from cost recovery mechanisms pursuant to Section 4928.66(A)(2)(c), Revised Code; and (c) review cost recovery mechanisms for energy efficiency and/or peak-demand reduction programs implemented by the electric utilities.

Other important information is contained in the Green Rules promulgated by the PUCO in Chapter 4901:1-39, Ohio Administrative Code (O.A.C.).⁶ As stated in Sec. 4928.662 of SB 310,⁷ for the purpose of measuring and determining compliance with the energy efficiency and peak demand reduction requirements, the public utilities commission shall count and recognize compliance as follows:

⁴ Am. Sub. SB221 (Schuler, May 1, 2008). Amended Substitute Senate Bill Number 221. 127th General Assembly. 2007-2008.

⁵ Ohio General Assembly, Ohio Revised Code. (Ohio, Amended by 129th General Assembly Effective Date September 10, 2012). Chapter 4928.66. <http://codes.ohio.gov/orc/4928.66>

⁶ Ohio General Assembly, Ohio Administrative Code. (Ohio, Effective Date December 10, 2009). Chapter 4901: 1-39. <http://codes.ohio.gov/oac/4901%3A1-39>.

⁷ SB 310 text taken from http://archives.legislature.state.oh.us/BillText130/130_SB_310_EN_N.pdf

(A) Energy efficiency savings and peak demand reduction achieved through actions taken by customers or through electric distribution utility programs that comply with federal standards for either or both energy efficiency and peak demand reduction requirements, including resources associated with such savings or reduction that are recognized as capacity resources by the regional transmission organization operating in Ohio in compliance with section 4928.12 of the Revised Code, shall count toward compliance with the energy efficiency and peak demand reduction requirements.

(B) Energy efficiency savings and peak demand reduction achieved on and after the effective date of SB 310 of the 130th general assembly shall be measured on the higher of an as found or deemed basis, except that, solely at the option of the electric distribution utility, such savings and reduction achieved since 2006 may also be measured using this method. For new construction, the energy efficiency savings and peak demand reduction shall be counted based on 2008 federal standards, provided that when new construction replaces an existing facility, the difference in energy consumed, energy intensity, and peak demand between the new and replaced facility shall be counted toward meeting the energy efficiency and peak demand reduction requirements.

(C) The commission shall count both the energy efficiency savings and peak demand reduction on an annualized basis.

(D) The commission shall count both the energy efficiency savings and peak demand reduction on a gross savings basis.

(E) The commission shall count energy efficiency savings and peak demand reductions associated with transmission and distribution infrastructure improvements that reduce line losses. No energy efficiency or peak demand reduction achieved under division (E) of this section shall qualify for shared savings.

(F) Energy efficiency savings and peak demand reduction amounts approved by the commission shall continue to be counted toward achieving the energy efficiency and peak demand reduction requirements as long as the requirements remain in effect.

(G) Any energy efficiency savings or peak demand reduction amount achieved in excess of the requirements may, at the discretion of the electric distribution utility, be banked and applied toward achieving the energy efficiency or peak demand reduction requirements in future years.

Finally, on July 23, 2019, the Ohio legislature passed House Bill 6 (HB 6) that gives the PUCO authority to end the requirement that utilities provide efficiency and demand response programs once the cumulative savings goal of 17.5 percent is achieved and no later than February 1, 2021. Despite this rule change, we have structured our report and the Ohio TRM update to be prospective in nature and are assuming (for the purposes of this report) that the programs will continue indefinitely (AEP Ohio has indicated in the press that it is planning to continue its programs).⁸ As a result, we have presented our recommendations and the Ohio TRM update for use in future program years.

⁸ See https://www.energycentral.com/news/american-electric-power-accelerates-carbon-dioxide-emissions-reduction-target?utm_medium=eNL&utm_campaign=DAILY_NEWS&utm_content=0&utm_source=2019_09_12

2 Audit Methods

The audit followed the same general process for each utility, beginning with a kickoff meeting held via webinar in April 2019. During this meeting, the Evergreen team discussed with AEP Ohio staff the specific tasks that would be completed as part of the audit review. Shortly after the kickoff meeting, a data request memo was sent to AEP Ohio that covered the program background information needed to complete the audit. Additional background material for each utility was also supplied by PUCO staff.

The various audit activities that followed the kickoff meeting are summarized below.

Program Characterization

Following the kickoff meeting, we reviewed as much background material as possible to familiarize ourselves with the AEP Ohio programs and to assess which programs and measure types should be subjected to a more thorough engineering review. As part of the background review, we conducted the following:

- ***Review of annual portfolio status reports.*** Each of the annual reports was reviewed for the 2014-2018 period. These annual reports were the primary source of the claimed energy savings and program cost information whenever possible.
- ***Review of annual evaluation reports.*** The evaluation reports were typically included as appendices to the annual portfolio status reports; these were reviewed in detail for each year.
- ***Review of additional filings related to the AEP Ohio programs.*** Related utility filings such as the Green Rules, comments by intervenors on AEP Ohio filings, and AEP Ohio program plans were also reviewed as needed.
- ***Analysis of program-related data from AEP Ohio.*** Additional data supplied by AEP Ohio included information on channel partners and third party contractors that implemented and evaluated the programs, information on mercantile customers and opt out customers, and program cost details that were not included in the portfolio status reports.
- ***Interviews of AEP Ohio program managers.*** Interviews of the AEP Ohio program managers were conducted to collect additional information on the programs that were not captured in the related documents.

The conclusion of this background research culminated in a “Program Characterization” memo that summarized the annual program accomplishments and identified measures for additional in-depth review. Most of the memo results are provided in the following *Program Characterization* chapter of this report and in Appendix A.

Savings Prioritization

The purpose of the program characterization was to review all of the programs and measures over the 2014-2018 program years, and then identify those measures and/or programs that would benefit from a more in-depth review of the savings calculations. To identify which measures would receive a more in-depth review, several criteria were used to prioritize measures. Questions that were asked as part of this prioritization included:

- Which programs and measures are accounting for the largest share of savings?
- Which measures have the most uncertainty around their estimated savings?
- What are the relative costs associated with improving savings estimates? Are there secondary data sources that can easily be applied to measures in Ohio?
- How much evaluation work has been done for each specific program/measure and how much additional work is needed?
- Which programs have the highest realization rates relative to the original *ex ante* savings values? Which have the lowest? Have the realization rates changed over time?

The final measures selected are discussed in the next chapter and cover the majority of the AEP Ohio savings over the 2014-2018 period.

In-depth Savings Review

As discussed in the next chapter, the AEP Ohio in-depth savings review focused primarily on several lighting measures that accounted for the majority of program savings. In most cases, the in-depth savings review was conducted by engineers from Michaels Energy, with additional review on sampling and statistics conducted as needed by Evergreen staff.

There were several elements relating to the Ohio regulatory requirements that influenced the in-depth savings review and what recommendations were made.

1. ***The Ohio TRM.*** The Ohio TRM is considered a “safe harbor,” meaning that if this source is used for the deemed savings values, the audit team did not attempt to make changes to the savings numbers. The Ohio TRM is outdated, however, with the current version updated in September 2013. In our in-depth savings review, we note if the Ohio TRM is used and make recommendations as needed for future savings values if the Ohio TRM source is outdated.
2. ***SB 310 and Ex Ante Savings.*** Ohio SB 310 states that savings “shall be measured on the higher of an as found or deemed basis” (Section 4928.662(B), Revised Code), which effectively allows the utilities to use either the *ex ante* savings values or the current evaluation savings estimates – whichever is higher. This system provides a disincentive for utilities to adopt the evaluation results if they are lower than the existing *ex ante* values, and in general, the utilities did not appear to regularly update their *ex ante* savings values with the evaluation results from the prior year.

This same section also states that “solely at the option of the electric distribution utility, such savings and reduction achieved since 2006 may also be measured using this method.” Based on this guidance, Duke Energy Ohio went back to prior years and re-estimated savings based on the new definition of how eligible savings can be defined.

3. ***SB 310 and Non-program Savings.*** One part of SB 310 states that eligible energy efficiency savings and peak demand reductions can be claimed from “actions taken by customers or through electric distribution utility programs that comply with federal standards” (Section 4928.662(A), Revised Code). This has been interpreted by FirstEnergy as allowing the utility to claim savings for equipment upgrades made by their customers without having to show that these purchases were at all influenced by FirstEnergy. This was approved by the PUCO for FirstEnergy but subsequently was not allowed for the other utilities.

With this regulatory context in mind, our in-depth savings review has resulted in two types of possible recommendations. The first is for *retroactive adjustments* to savings where we recommend that some or all of the savings be adjusted for the 2014-2018 programs. The retroactive adjustments are reserved for the most egregious calculations that clearly contain basic errors and/or are not adequately supported in the evaluation reports. The retroactive adjustments also take into account the considerable leeway that is provided by the three Ohio-specific issues described above.

The second type of adjustment is *prospective adjustments* that we are recommending for future program years. These are instances where the audit team has issues with how the savings are calculated, but the disagreement falls within the bounds of normal differences of interpretation that are commonly found between different evaluation teams. It also takes into account the information that was available to the evaluation team for each program year. In these cases, we recommend that savings values be modified for future program years. Where possible, our recommended savings values are also included in the update to the Ohio TRM that is being completed concurrently with these program reviews.

The results from each of these activities are presented in the following chapters.

3 Program Characterization

This chapter provides our characterization of the AEP Ohio energy efficiency and demand response programs, including a brief summary of the program achievements for this period and identification of specific energy efficient measures or programs that were identified to receive a more in-depth review as part of this audit.

The programs are summarized by year, followed by additional contextual information that we obtained through our interviews with the utility program staff. Tables summarizing additional information on annual program budgets and impacts are included as Appendix A at the end of this report.

The materials used for this program characterization include the following:

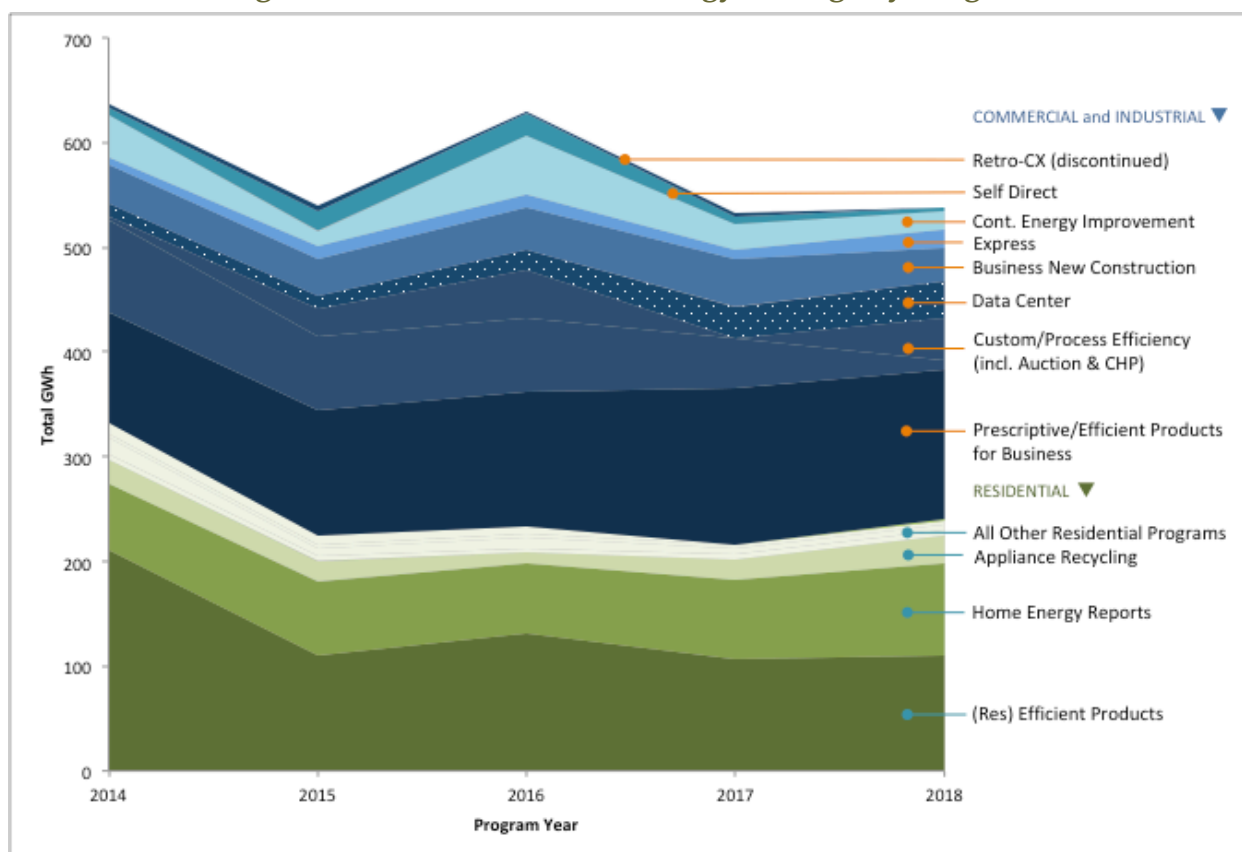
- AEP Ohio's Annual Reports
- AEP Ohio Evaluation Reports
- Additional filings and rulings available on the PUCO website
- Interviews with AEP Ohio staff involved with managing the programs

In total, we interviewed seven program managers that covered all of the AEP Ohio programs. These interviews typically lasted about 20 to 30 minutes, with one interview lasting longer that also covered more general portfolio and policy topics.

3.1 AEP Ohio Program Summary

AEP Ohio offers a range of energy efficiency programs targeting both the residential and commercial sectors. The program offerings and savings achievements have been relatively consistent throughout the 2014-2018 period, as shown in Figure 2.

Figure 2: AEP Ohio Annual Energy Savings by Program



In addition to the savings trends shown above, the number of mercantile projects and opt out customers for each year are summarized in Table 1, along with the program implementation and evaluation budgets.

Additional details on individual program costs for each year are included in Appendix A.

Table 1: AEP Ohio Mercantile Projects, Opt Out Customers, EM&V Budgets

Project Type	2014	2015	2016	2017	2018
Mercantile Projects	43	41	73	63	23
Opt Out Customers* (MWh)	-	-	-	5,089,794	5,564,759
Program Budgets	\$72,942,800	\$61,712,300	\$65,489,700	\$59,680,000	\$58,947,100
EM&V Budgets	\$2,553,000	\$2,102,000	\$1,828,000	\$2,124,000	\$1,825,000

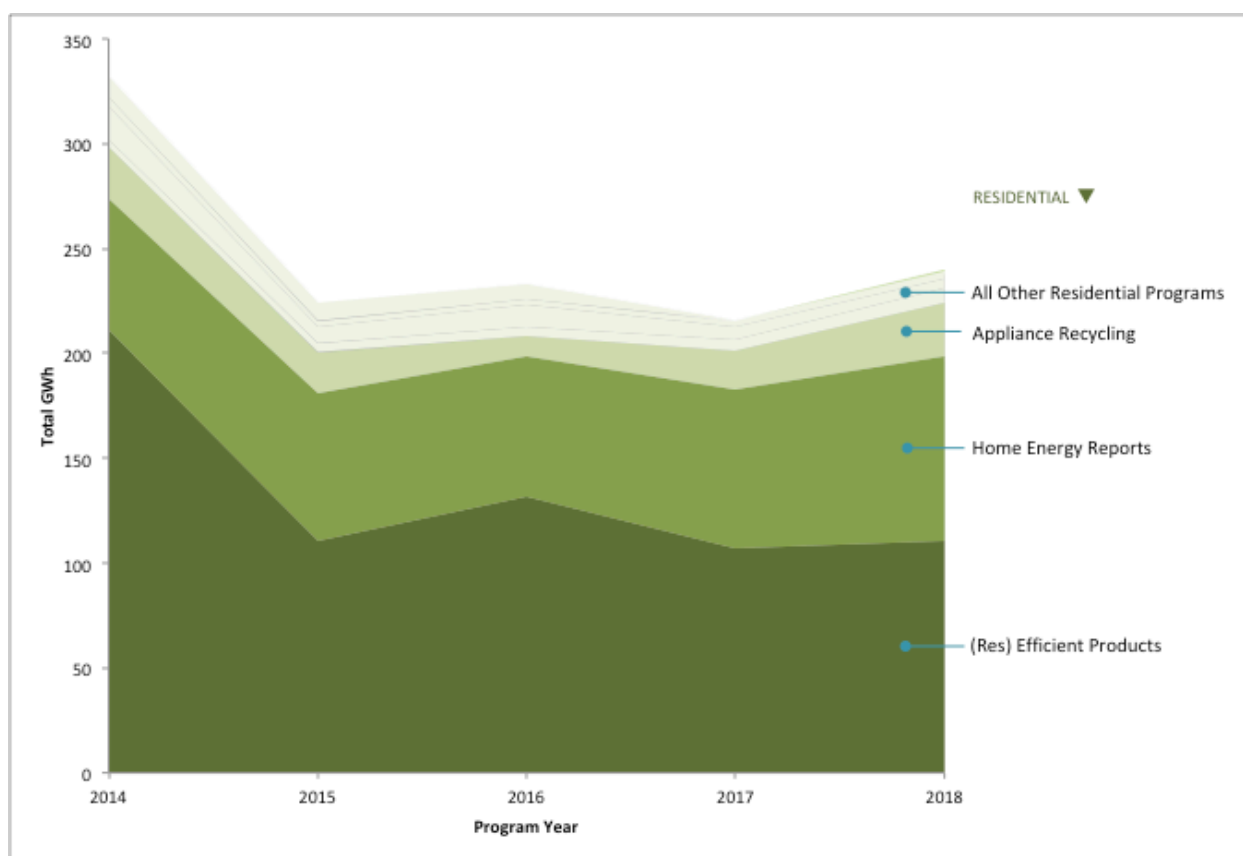
* There were 77 accounts that have opted out of AEP Ohio's energy efficiency programs. Of these, 46 met the criteria as described in OAC 4928.6610. The remaining 31 have met the criteria as described as 'adjacent' in OAC 4928.6611.

Each of the AEP Ohio programs is described below, along with any significant changes or issues that occurred over the analysis period.

3.2 Residential Programs

Three programs accounted for over 90 percent of residential electricity savings, while six other programs provided the remaining savings. Residential program savings declined significantly from 2014 to 2015 and then rose in 2016 due to increases in both the Home Energy Reports and Efficient Products programs. Overall savings remained relatively stable for the remainder of the audit period.

Figure 3: AEP Ohio Residential Efficiency Programs (2014-2018)



AEP Ohio's residential programs for 2014-2018 are described below.

Efficient Products is an on-going rebate program for energy efficient consumer products. The program's emphasis is on upstream lighting rebates, but there are also some downstream consumer appliance rebates. CLEAResult implements the program for AEP Ohio. In 2018, this program accounted for 20 percent of AEP Ohio's total portfolio spending, 21 percent of energy savings, and 24 percent of demand savings.

Home Energy Reports is an on-going behavior-based program that sends feedback on household energy consumption to selected customers (usually higher using tiers). The reports compare the targeted household's consumption to peers and provide energy saving tips. Oracle implements the program for AEP Ohio.

Appliance Recycling is an on-going rebate program to remove functioning refrigerators and freezers from customers' homes with the intent of eliminating secondary appliances that are plugged in but not used much. AEP Ohio currently contracts with Recleim to operate this program. The program experienced an interruption due to turnover in implementation contractors when a prior provider, Jaco Environmental, went out of business and was temporarily replaced by ARCA, Inc., before the current contract with Recleim LLC began in 2017.

Residential New Homes (also referred to as EfficiencyCraftedSM New Homes in some program filings) is AEP Ohio's program for residential new construction. The program offers financial incentives and technical and marketing support for builders whose single-family homes meet ENERGY STAR® or EnergyPathSM requirements and are verified through a Home Energy Rating System (HERS) rating to ensure participating homes are built above code requirements. AEP Ohio and Columbia Gas collaborate on this program.

Community Assistance is a weatherization and energy efficiency program for low-income households. The program is managed by AEP Ohio and administered by a network of community action agencies that draw from various funding sources, including utility and federal funds, to provide energy efficiency upgrades to eligible households at no charge. AEP Ohio funds are used primarily for refrigerator, freezer, and lighting upgrades.

e3 SmartSM is AEP Ohio's energy education program for primary and secondary schools. The program provides energy curricula and kits with energy-saving products to teachers and children in grades 4 through 12 and their families. The bulk of the savings come from LED light bulbs and showerheads included in the kits. The Ohio Energy Project implements the e3 Smart program.

In-Home Energy was an informational and direct install program that offered three tiers of participation to residential and multifamily customers. Participants could conduct online energy check-ups, receive energy walk-throughs with direct installation of selected energy efficiency measures, or receive an energy audit. Lighting accounted for a majority of energy savings, followed by cooling and showerhead measures. The program struggled to meet goals, was not cost effective, and ceased operation after 2016 (with some measures transferred to the Efficient Products program beginning in 2017).

Intelligent Home & Demand Response is an app-based efficiency and demand response program that provides near real-time feedback on energy consumption, usage alerts, and thermostat controls for electric heating and cooling to participating residential customers

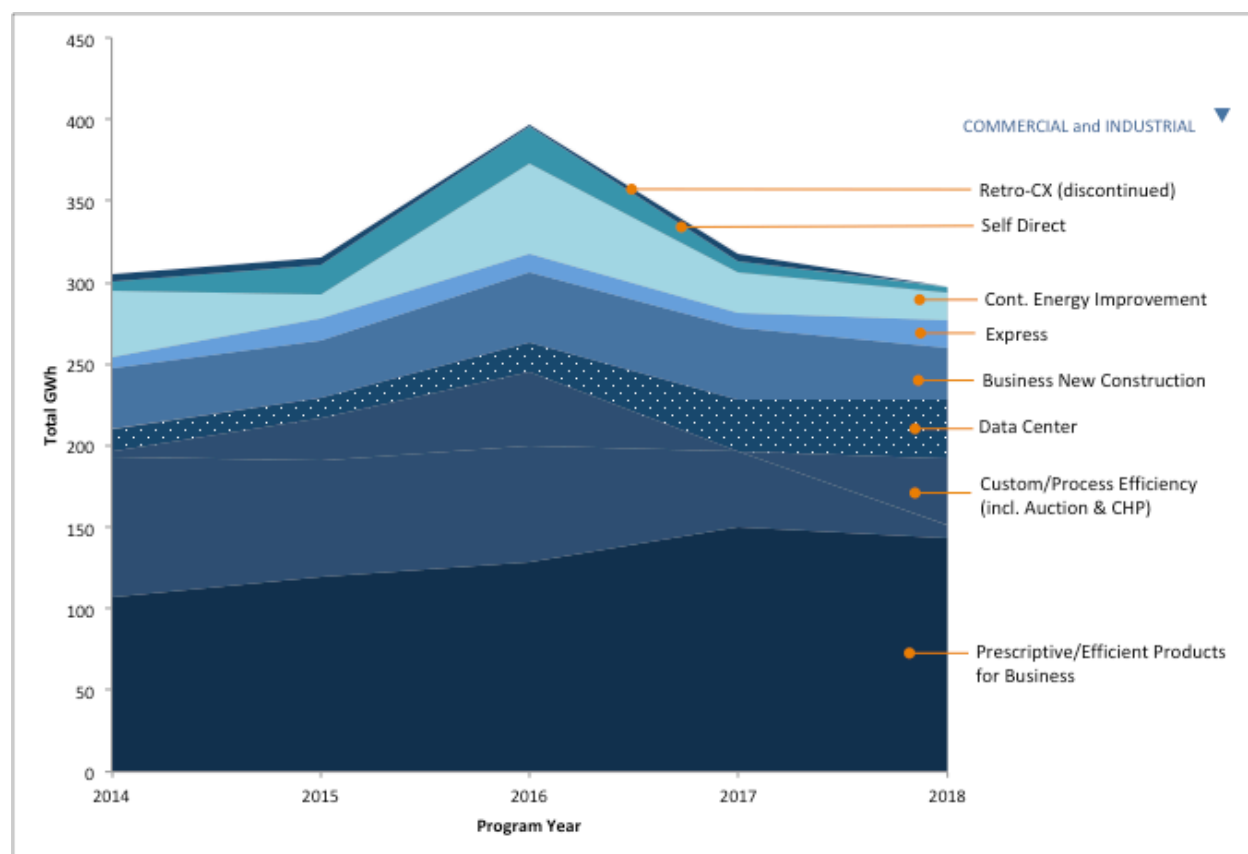
with smart meters. This program was developed in 2017 and first claimed savings in 2018, and is implemented by Powerley.

Manufactured New Homes provides midstream incentives for efficiently-constructed manufactured homes and contractor incentives for the installation of heat pumps rather than baseboard electric heating. This program was initially offered in 2017, but modified during rollout, thereby resulting in very low participation that year. The program has been active in its present form since 2018.

3.3 Non-Residential Programs

Three programs account for about 75 percent of non-residential electricity savings, while five other programs provide the remaining savings. Savings for the non-residential sector spiked in 2016 due to increases in multiple programs, followed by a gradual decline the following years.

Figure 4: AEP Ohio Non-Residential Efficiency Programs (2014-2018)



Prescriptive / Efficient Products for Business is AEP Ohio's on-going rebate program for energy-efficient equipment in non-residential buildings. The program focuses on lighting

improvements, which account for about 90 percent of claimed savings; HVAC, variable frequency drives, refrigeration, and compressed air account for the bulk of the remaining savings. The program changed its name from Prescriptive to Efficient Products for Business beginning with the 2017 program year. DNV GL implements this program for AEP Ohio. In 2018, this program accounted for 24 percent of AEP Ohio's total portfolio spending, 27 percent of energy savings, and 29 percent of demand savings.

Custom/Process Efficiency is an on-going program that addresses efficiency improvements for businesses (typically large industrial customers) that are not covered by the Efficient Products for Business program. It involves customized estimates of energy savings to be derived from site-specific efficiency improvements. The program was rebranded from Custom to Process Efficiency in 2017 and is implemented by DNV GL.

The Custom/Process Efficiency program provides a standard incentive level (7-8 cents per kilowatt-hour saved during the 2014-2018 period) for comparatively smaller projects and a bid or auction process for larger projects. The latter component is shown as "Bid" or "Auction" in program filings.

In addition, a small number of combined heat and power projects were included in filings for the Custom program in 2015 and 2016, but shown separately since then. For continuity sake, we have included combined heat and power projects in our description and summary values for the Custom/Process Efficiency program as well.

AEP Ohio reports that large customers were eligible to opt out of efficiency riders since 2017, which has affected the Custom/Process Efficiency program more than any other program in the company's portfolio. Approximately 20 percent of AEP Ohio's non-residential load (13 percent of total load) has opted out.

The **Data Center** program provides energy efficiency incentives to businesses with server rooms or data centers. The program provides assessments of energy saving opportunities to reduce cooling needs for servers and data centers. Incentives are based on a tiered rate per kWh saved (beginning with 7 cents for most measures and 6 cents for server virtualization). Wildan implements the program for AEP Ohio.

Business New Construction seeks to promote energy efficient designs and equipment installations in new commercial construction. The program offers design assistance and whole building modeling (and incentives associated with modeled savings) as well as referrals to custom and prescriptive incentives, where applicable. Savings come largely from lighting improvements, followed by motor-based efficiency improvements, which can offer high savings, but in only a small number of projects. KEMA implemented the program through 2014, and CLEAResult has been the program implementer since 2015.

Express For Small Business provides turnkey efficiency upgrades to small businesses based on a light audit, recommendations, and measure installation. The program provides

an incentive per kWh and kW saved to the implementation contractor, Lime Energy. Nearly all of the savings are lighting related, originating either from lighting replacements or controls.

Continuous Energy Improvement works with cohorts of industrial and large commercial customers to facilitate their own efforts to reduce energy intensity and use through low and no cost efforts (and to identify capital projects that can be implemented through the Custom/Process Efficiency or Prescriptive/Efficient Products for Business programs). Participating customers receive guidance in a series of workshops, a tool to track energy consumption and savings, and an incentive of 2 cents per kWh saved. This program results in savings from such customer-initiated approaches as production and staffing adjustments, turning equipment off when not in use, and leak reductions and improvements to compressed air systems. This program is based on the strategic energy management concept and is implemented by CLEAResult.

Self Direct is an on-going program that provides retroactive incentives to AEP Ohio's mercantile customers, which encompass both very large energy users (700 kW of demand or higher) and businesses with multi-state meters (i.e., franchises). The program pays a share of incentives for which the customer would have qualified for efficiency improvements conducted in the prior three years. The rebate is intended to help spur additional efficiency work for which capital funds may not be available. Lighting and HVAC upgrades account for the most common efficiency improvements rebated under the program. AEP Ohio works with DNV GL on this program.

Retro-Commissioning is a discontinued program that was phased out after 2016 and shows some minor wrap-up activity in 2017 and 2018. The program paid for retro-commissioning studies if customers agreed to complete any cost-effective improvements. It was ended because it was one of AEP Ohio's less cost-effective programs. CLEAResult and then Nexant implemented the program during the 2014-2018 audit period.

3.4 Audit Assessment

AEP Ohio's programs and evaluations have been generally stable and solid during the 2014 to 2018 period. Third-party evaluations, on the whole, seem reasonable for estimating and documenting energy savings associated with AEP Ohio's energy efficiency programs.

AEP Ohio staff interviewed for this audit discussed assorted trends and some challenges. A few themes and highlights that stood out from interviews of program staff include:

- Several programs (and the portfolio overall) are highly dependent on energy savings from lighting upgrades and controls. Lighting accounts for a large share of energy savings in many programs, including the large prescriptive programs for the residential and non-residential sectors, the Custom/Process Efficiency program,

and the Business New Construction program. The energy efficiency team has an interest in moving further beyond lighting to other end-uses.

- For some programs, changing codes and equipment standards presents challenges due to moving baselines. Uncertainty concerning the next round of increases in federal lighting standards presents particular challenges for planning and program designs for several programs that rely heavily on lighting savings.
- The loss of a meaningful share of customer load (13%) to opt-outs affects programs serving large industrial and commercial customers.
- Declining avoided costs of capacity have affected the cost effectiveness of demand response events, Intelligent Homes, and retro-commissioning, which has been phased out.
- Some programs are seeing a shift from smaller numbers of large efficiency upgrades to larger numbers of smaller upgrades, as the big known opportunities have been addressed.
- There is substantial cross-referral among programs, whereby participants in one program may also receive an incentive from a peer program. Non-residential new construction programs may access whole-building incentives, for example, or tap into incentives available from the Custom/Process Efficiency or Prescriptive/Efficient Products for Business programs. Programs appear to cooperate and coordinate in both the provision of services and the allocation of savings.
- Uncertainties concerning hours of operation for some measures (especially lighting) produce realization rates for some programs that fluctuate greatly from project to project or program year to program year. Obtaining reliable data on hours of use is a challenge.

Use of the TRM came up frequently during staff interviews and was evident in our review of third party evaluations. The programs and evaluators use the Ohio TRM when feasible for assessing energy savings from program measures, but there are numerous measures for which the Ohio TRM does not have savings values, is out-of-date, or does not provide the needed granularity.

Based on our program characterization and initial reviews of the evaluation reports, we have identified several topics for further review as part of this audit. We chose these measures based on several criteria, including:

- The contribution to overall savings;
- The uncertainty around the savings estimates; and
- Changes in savings estimation methods across years.

Table 2 summarizes the issues for which the audit team conducted a more in-depth review of the savings calculations.

Table 2: AEP Ohio Measures Selected for In-depth Audit Review

Program Name (year if applicable)	Topic / Issue	Comment
Overall	Systematic review of lighting savings claimed across programs.	Lighting savings account for a large share of total portfolio savings, and the TRM is outdated and does not include LEDs. While our initial review did not identify any specific areas of concern in how lighting savings were computed, we believe a more systematic review is justified given the amount of savings.
Retrocommissioning (2014-2016)	Review potential impact of program data challenges on past claimed savings before program was eliminated.	Evaluators noted problems with program data and recommended a reasonableness check of claimed savings to averages. (Note that this program accounts for a small amount of savings and has been discontinued.)
Data Center (2014-2018)	Review reasonableness of data savings calculations.	This is a new program, and the evaluators compiled a complex set of inputs and references for savings estimates. It also contributes a medium amount of savings and therefore justifies a second review.

4 Savings Review

The savings review is intended to verify that the evaluations and claimed program savings are consistent with industry standards and are compliant with the Ohio energy efficiency program rules. As discussed above, the audit team conducted an initial review of all the savings reported for all the AEP Ohio programs from 2014 through 2018. Following the initial review, selected measures were chosen for a more in-depth examination of the savings calculations.

Residential Lighting

Residential lighting measures, including CFLs and LEDs, have dominated the residential portfolio throughout the five program years reviewed. These measures have accounted for more than 90 percent of the Residential Efficient Products program and have also contributed to the e3 Smart program, In-Home Energy program, and the Community Assistance (low income) program. Due to the large level of savings and consistency across programs, the assessment of the residential programs focused on a review of these high-impact lighting measures, rather than on a review of the individual programs.

During the 2014 through 2016 program years, a significant (but steadily decreasing) portion of the lighting savings were from CFLs. In 2014, CFLs accounted for 83 percent of the Residential Efficient Products program, but by 2016, this had decreased to 45 percent. In 2017 and beyond, CFLs were essentially eliminated from the program, accounting for less than 1 percent of the Residential Efficient Products and a small percentage of the e3 Smart and Community Assistance programs.

The savings for CFL installations in the Residential Efficient Products program are calculated using the approach and formulae from the 2010 Ohio TRM:

$$\text{Annual kWh Savings} = \frac{(\text{ProgWatts} * \text{DeltaWattsMultiplier}) * \text{ISR} * \text{HOU} * 365 * \text{WHF}_E}{1000}$$

In the equation above, the installation rate (ISR) of 0.86, the hours of use (HOU) of 2.85 hours per day, and the energy waste heat factor (WHF_E) of 1.07 were all taken from the 2010 Ohio TRM. The installed CFL wattage (ProgWatts) was based on the wattage of the specific CFL lamps installed.

The delta watts multiplier was taken from the Ohio TRM, but did not exactly follow the procedure specified. Specifically, the Ohio TRM specifies that the delta watts multiplier changes over time, to account for the changes to available lamp types due to the effects of the federal Energy Independence and Security Act of 2007 (EISA), as shown in Table 3.

To calculate the savings, AEP Ohio used a delta watts multiplier of 3.25 instead of 2.05 for CFLs of 15W or less. This included the 13W and 14W CFLs, which alone accounted for 61 percent of the Residential Efficient Products program savings. This change resulted in the

savings for these bulbs increasing from 80,860,859 kWh to 128,194,044 kWh, an increase of 47,333,185 kWh or 58 percent. This was done because AEP Ohio assumed that lamps would be available in the marketplace for one year beyond the date specified for phase-out in the EISA legislation. Therefore, the 2014 savings values for general service bulbs are based on the 2013 CFL delta watts multiplier, rather than the 2014 value. For specialty CFLs, AEP Ohio retained the pre-EISA delta watts multiplier from 2009-2011, as these bulbs were unaffected by the EISA legislation.

Table 3: 2010 Ohio TRM-Specified Values for CFL Delta Watts Multiplier

CFL Wattage	2009-2011	2012	2013	2014 and Beyond
15W or less	3.25	3.25	3.25	2.05
16-20W	3.25	3.25	2.00	2.00
21W or greater	3.25	2.06	2.06	2.06

The Navigant evaluation found the use of a 3.25 delta watts multiplier to be reasonable, and completed shelf surveys to confirm that incandescent bulbs were available in the marketplace and that the pre-EISA 2013 delta watts multiplier was reasonable to use in 2014.

The savings for CFLs installed through the e3 Smart program were calculated using a different approach than the CFLs installed through the Residential Efficient Products program (described above). Specifically, survey data of participants were used to determine the “as-found” condition by identifying the actual wattage of the bulbs replaced. The savings for these bulbs were then calculated:

$$\text{Annual kWh Savings} = \frac{(\text{PreWatts} - \text{ProgWatts}) * \text{HOU} * 365 * \text{WHF}_E}{1000}$$

For CFLs without an identified replaced lamp wattage, due to the survey not being returned, the savings were calculated consistent with the approach used for the Nonresidential Efficient Products program. However, the installation rate (ISR) was adjusted to be consistent with the installation rate identified from the participant survey responses.

The Navigant evaluation followed a similar approach. However, due to slightly different weights assigned to the survey data, the savings per CFL was increased slightly (less than 1 percent).

Overall, the savings estimation approaches are reasonable and comply with Ohio requirements, which allow use of either a deemed approach from the TRM or the use of as-found conditions. Therefore, the audit team is not recommending any changes to the CFL measure savings.

LEDs

Residential LED lighting comprised a significant and increasing portion of the AEP Ohio portfolio savings. In 2014, LEDs accounted for 14 percent of the Residential Efficient Products program. By 2018, this had grown to 91 percent of this program's savings. In addition to the Residential Efficient Products program, LEDs also contributed significant portions of the savings for the e3 Smart and Community Assistance programs.

LEDs were not included in the 2010 Ohio TRM; consequently, Navigant used a variation of the algorithm included for other lighting measures. In this case, Navigant assumed that the ProgWatts was the difference between the new LED wattage and an assumed baseline bulb wattage:

$$\text{Annual kWh Savings} = \frac{(\text{PreWatts} - \text{ProgWatts}) * \text{ISR} * \text{HOU} * 365 * \text{WHF}_E}{1000}$$

In 2014, AEP Ohio assumed that LEDs would have an installation rate (ISR) of 1.0. It was assumed that the higher cost relative to CFLs would result in a higher installation rate. The hours of use (HOU) of 2.85 hours per day and the energy waste heat factor (WHF_E) of 1.07 were all taken from the 2010 Ohio TRM CFL measure assumptions. In the evaluation, Navigant slightly reduced the installation rate from 1.0 to 0.973, based on a survey of program participants. Additionally, Navigant slightly increased the hours of operation from 1,040 hours per year to 1,051 hours per year, based on metered data collected through a lighting study.

The program watts (ProgWatts) is the wattage of the installed LED and was used by both AEP Ohio and the Navigant evaluation. However, the baseline wattage differed between the two analyses. Specifically, AEP Ohio assumed a baseline incandescent or halogen wattage for each LED installed. Specialty bulbs assumed an incandescent baseline.

Navigant found that baseline halogen and incandescent wattage levels were overestimated. Specifically, Navigant found that the breaks between the nominal incandescent wattage categories corresponded to higher LED wattages than originally claimed. The *ex ante* and *ex post* wattage breakdowns are shown in Table 4.

Navigant also adjusted the baseline wattage by month for the 40W and 60W equivalent bulb categories to account for decreasing availability of incandescent standard fixtures and the progression to EISA-compliant halogens. The monthly breakdown of baseline wattages for these lamps is given in Table 5. For specialty LEDs, AEP Ohio retained the "pre-EISA" incandescent baseline wattage, as these bulbs were unaffected by the EISA legislation.

Table 4: 2014 *Ex Ante* and *Ex Post* Baseline LED Wattage

LED Wattage	<i>Ex Ante</i> Baseline Wattage	<i>Ex Post</i> (Evaluation) Baseline Wattage
2-3	25W	25W
4	40W	25W
5	40W	40W (specialty) Standard adjusted by month
6-7	60W	40W (specialty) Standard adjusted by month
8	60W	60W (specialty) Standard adjusted by month
9-11	75W (specialty) 53W (standard)	60W (specialty) Standard adjusted by month
12	100W (specialty) 72W (standard)	60W (specialty) Standard adjusted by month
13-14	100W (specialty) 72W (standard)	75W (specialty) 53W (standard)
15-20	100W (specialty) 72W (standard)	100W (specialty) 72W (standard)
23+	150W	100W (specialty) 72W (standard)

Table 5: 2014 Adjusted Baseline Wattages by Month and by Incandescent Wattage

Month	Under 310 Lumens (25W)	310-749 Lumen Range (40W)	750-1049 Lumen Range (60W)	1050-1489 Lumen Range (75W)	1490-2600 Lumen Range (100W)
January	25.0W	40.0W	60.0W	53.0W	72.0W
February	25.0W	38.9W	58.7W	53.0W	72.0W
March	25.0W	37.8W	54.4W	53.0W	72.0W
April	25.0W	36.8W	56.1W	53.0W	72.0W
May	25.0W	35.7W	54.8W	53.0W	72.0W
June	25.0W	34.6W	53.5W	53.0W	72.0W
July	25.0W	33.5W	52.2W	53.0W	72.0W
August	25.0W	33.0W	51.7W	53.0W	72.0W
September	25.0W	32.6W	51.2W	53.0W	72.0W
October	25.0W	32.1W	50.6W	53.0W	72.0W
November	25.0W	31.7W	50.1W	53.0W	72.0W
December	25.0W	31.2W	49.6W	53.0W	72.0W

In 2015 and beyond, a similar approach was used. However, the baseline was not adjusted by month. Instead, the baseline for standard LEDs was simply assumed to be an EISA-compliant lamp.

Starting in 2016, LEDs were also installed through the e3 Smart program. The savings for these LEDs were calculated using a slightly different approach than the CFLs installed through the Residential Efficient Products program (described above). Specifically, survey data of participants were used to determine the as-found condition and the actual wattage of the bulbs replaced, rather than the assumed baseline wattage described above.

Based on the review of the evaluation reports, the *ex post* savings approaches and values are reasonable and comply with Ohio requirements, which allow use of either a deemed approach or the use of as found conditions. Therefore, no retroactive changes are recommended to the LED measure savings.

Prospectively, we recommend that the in-service rates and baseline wattage assumptions be updated in future years to account for the large amount of efficient lightbulbs already

distributed through these programs. Through the 2018 program year, Navigant used an assumed installation rate of 0.97 for LED bulbs based on a survey completed in 2014. However, between 2014 and 2018, over 17,000,000 CFL and LED bulbs were incented through the AEP Ohio programs, which represents about 12 bulbs (and possibly as many as 30 bulbs) per household, on average. It is likely that socket saturation may result, given the high volume of bulbs sold, resulting in some LEDs being put in storage. The baseline wattages of existing lamps will also decrease over time as more LEDs get installed. Future evaluations should update the ISR by conducting a new customer survey similar to the one completed in 2014. The baseline wattage assumptions should also be revisited by the evaluation to account for the higher efficiency levels.

Home Energy Report

The Home Energy Report program represents between 10 and 15 percent of the total AEP Ohio portfolio energy savings, and typically accounted for savings of approximately 100 kWh per participating household across the various program years. The Home Energy Report program savings were calculated using industry standard billed data regression to compare participant and non-participant groups. The analysis attempted to account for “uplift” – or energy savings that are attributable, and claimed, through other programs. The uplift analysis used program tracking data to assess how many program measures had been installed in the participant and non-participant cohorts. This a common approach used when evaluating similar home energy report programs.

One related issue that should be addressed in future evaluations is determining how much of the Home Energy Report program savings is due to purchases of LEDs. Approximately 40 percent of the AEP Ohio residential portfolio savings were derived from upstream lighting programs. Since this is an upstream program, however, there is no participant tracking data and therefore, residential lighting measures could not be accounted for in the uplift analysis. If the estimated savings from the Home Energy Report program is the result of participants purchasing more energy efficient lightbulbs than customers in the non-participant control group, then the savings will be double counted. Given the large number of LEDs sold in AEP Ohio's service territory, it seems likely that at least some of the savings estimated for the Home Energy Report program is already being captured in the savings numbers for the upstream lighting program (Residential Efficient Products program).

Future evaluations should address this issue and determine if the Home Energy Report participants are purchasing energy efficient lightbulbs at a faster rate than non-participants. This could be accomplished with surveys of both participants and customers in the non-participant control group using a representative sample from each.

Efficient Products for Business/Lighting

Similar to residential, the largest portion of the savings for the commercial and industrial programs is due to lighting. The majority of the savings are from the installation of T8, T5, or linear LED lighting with the Commercial Efficient Products program.

The savings for the lighting measures completed through the Commercial Efficient Products for Business program were calculated by AEP Ohio using a prescriptive approach, using the formula:

$$\text{Annual kWh Savings} = \frac{\Delta \text{Watts} * \text{HOU} * \text{WHF}_E}{1000}$$

This equation assumes a deemed baseline and a 100 percent ISR. The Δ Watts value is the total lighting watts reduced due to the installation of the efficient lighting and is calculated based on the quantity of installed and removed fixtures, and the wattage and type of each fixture for each project. The hours of operation were set based on the building type.

The Navigant evaluation team used a similar algorithm, and evaluated these measures by (1) verifying the total watts reduced and (2) updating the hours of operation. This was accomplished through a combination of customer interviews, site visits, and metered lighting operation. However, it should be noted that in 2014, the evaluation focused on non-lighting measures, as the lighting measures had historically resulted in minimal savings adjustments. Screw-in CFLs and LEDs were also included in the Business Lighting program, but accounted for a much smaller portion of the savings. The savings for these fixtures were calculated similar to the residential screw-in CFLs and LEDs, described previously.

The Navigant evaluation approach was reasonable and appropriate, and resulted in only minor changes to the lighting savings. Therefore, no retroactive or prospective changes are recommended.

Data Centers

AEP Ohio added a data center program to its portfolio starting in 2013; this is a highly focused program that only serves customers that operate data centers. The program has few participants per year, but due to the high energy usage of large data center facilities, the overall program savings and average savings per project are very large. In the 2017-2018 program years, the savings per project for the Data Center program was increased significantly due to the inclusion of large data center new construction projects. During these years, the Data Center program had the greatest savings per participant of any AEP Ohio program.

Table 6 shows the savings for the major technologies in the Data Center program.⁹ In 2014-2015, the savings for the Data Center program were split approximately equally between HVAC and IT-related measures. HVAC measures included hot-isle containment, HVAC variable frequency drives (VFDs), efficient computer room air conditioning/computer room air handler (CRAC/CRAH) units, or HVAC control measures. IT-related measures included server virtualization, server/storage refresh, or efficient uninterruptible power supplies (UPS). No comprehensive new construction projects were completed in either the 2014 or 2015 program years.

Table 6: Breakdown of Savings by Technology

Savings Area	2014	2015	2016	2017	2018
HVAC	37%	61%	38%	2%	7%
IT-Related	63%	39%	5%	11%	1%
New Construction	0%	0%	57%	87%	93%
Total Savings (kWh)	13,571,522	12,182,714	18,990,284	31,180,275	34,233,494

The HVAC and IT-related measures involved the installation of specific equipment or controls for specific pieces of equipment. The savings for these projects were calculated by comparing the operation of the installed efficient equipment to a similar, less efficient baseline piece of equipment. Projects involving the replacement of existing equipment used the existing equipment as the baseline. Projects involving the installation of new equipment (not replacing other similar equipment) or projects replacing existing failed or end-of-life equipment used baseline specifications from ASHRAE 90.1, ASHRAE 90.4, or the California Energy Efficiency Baselines for Data Centers guidance document. This approach is reasonable and appropriate for these projects.

In the 2016-2018 program years, the amount of savings achieved through the equipment-specific HVAC and IT-related measures decreased. During these years, the majority of the program savings were due to comprehensive new construction projects. These new construction projects accounted for 83 percent of the total cumulative savings over the 2016-2018 period.

It is important to note that these new construction projects differed from the other projects in that they were completed in phases, spanning multiple program years. Although three projects were completed in each of the 2016, 2017, and 2018 program years, these are not

⁹ The small amount of savings due to EMS are excluded from the table.

all unique customer locations. Instead, these represent three sites, which each undertook three implementation phases, all for one corporate entity. All of the comprehensive new construction project savings claimed in these years occurred at the three sites for this single customer. Although this phased approach is unique, it is reasonable and consistent with the approach used in other jurisdictions¹⁰ for data center programs.

The new construction projects also used a more comprehensive approach than the HVAC and IT-related measures. The HVAC and IT-related measures calculated the savings relative to similar baseline-efficiency equipment. The new construction project calculated savings using a whole-building approach. For these projects, the savings are the difference in expected energy use for the as-built data center compared to a less efficient baseline data center design. The baseline data center design was based on the California Energy Efficiency Baseline for Data Centers guidance document with HVAC equipment efficiencies being taken from ASHRAE 90.1.

The evaluation recalculated the savings for a sample of projects from each program year using a consistent approach. The analysis for each project was updated based on a review of the project documentation as well as through additional information collected through onsite inspections. While this resulted in adjustments to individual projects, no systemic reasons for adjustment were identified. Both the original program approach and the evaluation approach are reasonable, and no changes are recommended.

It should be noted that the evaluated savings for this program might be slightly conservative. Per SB 310, existing equipment is a valid baseline even when near the end of useful life. The evaluation adjusted the baseline for several projects to new, minimum code-compliant HVAC equipment. This resulted in a reduction in savings for these projects. However, these adjustments were minor compared to other changes, such as correction calculation errors. Additionally, these HVAC projects accounted for a very small portion of the overall program savings. Therefore, no retroactive changes are recommended.

For the years reviewed, the new construction projects were sampled into a dedicated “certainty” strata with no additional projects included in that strata. However, it appears that this is simply due to the size of the individual projects and not by design. Due to the unique nature of these projects (with individual projects being completed in phases over multiple program years), a change in savings in one year can result in a corresponding change to the next program year, even in cases where the project savings “as a whole” are

¹⁰ See *ComEd Data Centers Efficiency Program Evaluation Report*, prepared by Navigant for Commonwealth Edison Company, 2016.

http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY8_Evaluation_Reports_Final/ComEd_Data_Centers_PY8_Evaluation_Report_2016-12-08_final.pdf

unchanged. Therefore, care should be taken to ensure that these projects are sampled separately from the single-year HVAC and IT-related projects to avoid any bias.

Custom/Process Efficiency Program

Throughout the 2014-2018 period, AEP Ohio offered a custom projects program that allows projects that require customized savings calculations beyond what can be provided by the Ohio TRM or other sources for prescriptive savings values. This includes the main Custom program (renamed the Process Efficiency program in 2017) in addition to separate programs for retrocommissioning and data centers that also require customized savings calculations.

The typical evaluation approach for each type of these custom projects is the same. For each program, a sample of project applications is selected for additional review by the evaluation team. This typically involves (at a minimum) having the evaluation team conduct a desk review of the project application and recalculating the savings numbers if necessary. This review process is sometimes supplemented with an interview with the customer to obtain additional detail on the project, such as the efficiency of the replaced equipment, operating hours, and other factors that might affect the savings calculations. For some projects, a site visit is done that may include short term metering. It is generally preferred that the savings calculations utilize as much site-specific information as possible so that the savings numbers take into account the characteristics of the individual projects and customers.

In our review of Navigant's custom project evaluations, we found that their approach is consistent with industry best practice. We have no recommendations for adjustments to the Custom program savings.

5 Conclusions and Recommendations

For this audit, Evergreen Economics and Michaels Energy reviewed the AEP Ohio energy efficiency and demand response programs covering the 2014-2018 period. The audit process involved a thorough review of the annual reports and associated program evaluation reports that AEP Ohio filed each year. AEP Ohio provided additional program cost information as part of a data request made by the audit team. The audit team also interviewed AEP Ohio staff members to obtain additional contextual details about these programs.

Based on our review of these materials, we identified measures for a more in-depth savings review based on several factors, including the total amount of savings and the potential uncertainty surrounding the savings estimates. Specific measures identified for the in-depth review included:

- Residential lighting (CFLs and LEDs)
- Commercial lighting (T8s, T5s, LED linear lighting)
- Home Energy Reports
- Custom projects
- Retrocommissioning
- Data centers

We estimate that these measures accounted for approximately 70 percent of the total savings that AEP Ohio claimed over the 2014-2018 period.

From the in-depth savings review, overall we found that the evaluation methods were sound and conformed to the regulatory requirements established for Ohio during the 2014-2018 period. While we have a few recommendations for changes to some savings values for future program years, the existing values are consistent with the rules that guide how energy savings are estimated in Ohio. In many cases, the savings calculations rely on algorithms that are recommended in the 2010 Ohio TRM.

Retroactive Savings Adjustments

None.

Prospective Savings Adjustments

We recommend that future evaluations adopt the following:

1. **Future ‘as found’ baseline assumptions for residential LEDs should be adjusted to account for the high number of energy efficient bulbs distributed through the program.** Given that over 17,000,000 bulbs have been distributed to AEP Ohio

customers through its programs, the average efficiency for installed lamps will be improving over time. The baseline efficiency used to estimate average savings in the future needs to be adjusted to account for the higher number of existing LEDs in these households.

2. **Update in-service rates to account for the high number of LEDs already purchased.** Given the high volume of LED sales, it is likely that more of the LEDs are being put in storage due to saturation of the market. Future evaluations should conduct a survey of residential customers to determine an updated in-service rate, as the current value of 0.97 is outdated and likely too high.
3. **Adjust savings from the Home Energy Reports program to account for upstream LED purchases (if needed).** In future evaluations, we recommend that a survey be conducted using a statistically representative sample of both participants and control group customers. These surveys should ask about the type and number of LEDs purchased to determine if recipients of the home energy reports are purchasing more than the non-participant control group. If there is an increase in LED purchases among participants, then the savings from the Home Energy Report program should be adjusted to account for this difference, as the LED savings are already accounted for in the Residential Efficient Products program impacts.

Appendix A: Detailed Annual Savings and Cost Tables

The following tables show the program costs and claimed savings by year for each AEP Ohio program. All of the information for these tables was taken directly from the AEP Ohio Annual Reports, or else supplied by AEP Ohio in response to the data request made as part of this audit.

Program Year 2018

Table 7: AEP Ohio Energy Efficiency Programs (2018)

Program Name	Expenditures	kWh Savings	Share of Total Savings
Appliance Recycling	\$3,148,300	25,500,000	5%
Community Assistance	\$5,755,600	4,600,000	1%
e3 Smart SM	\$902,400	3,300,000	1%
Residential New Homes	\$2,462,800	6,300,000	1%
Efficient Products	\$11,708,100	110,400,000	21%
Home Energy Reports	\$1,370,200	88,600,000	16%
Intelligent Home & DR	\$2,282,800	800,000	<1%
Manu. New Homes	\$334,000	400,000	<1%
Business New Construction	\$4,188,600	31,500,000	6%
Continuous Energy Improvement	\$1,851,700	17,000,000	3%
Combined Heat & Power	\$2,397,300	40,700,000	8%
Process Efficiency	\$1,309,200	8,200,000	2%
Data Center	\$2,493,400	36,100,000	7%
Express for Small Business	\$4,082,500	17,200,000	3%
Efficient Products for Business	\$14,294,900	143,100,000	27%
Retro-Commissioning	\$7,500	0	0%
Self Direct	\$357,800	3,700,000	1%
Total	\$58,947,100	537,400,000	

Note: Totals may not match filed numbers due to rounding.

Table 8: AEP Ohio Demand Reduction Programs (2018)

Program Name	kW Savings	Share of Total Savings
Appliance Recycling	4,100	5%
Community Assistance	700	1%
e3 Smart SM	500	1%
Residential New Homes	3,000	3%
Efficient Products	20,300	24%
Home Energy Reports	11,500	13%
Intelligent Home & DR	1,400	2%
Manu. New Homes	200	0%
Business New Construction	5,300	6%
Continuous Energy Improvement	1,300	2%
Combined Heat & Power	4,600	5%
Process Efficiency	1,200	1%
Data Center	4,200	5%
Express for Small Business	2,400	3%
Efficient Products for Business	24,700	29%
Retro-Commissioning	-	0%
Self Direct	600	1%
Total	86,000	

Note: Totals may not match filed numbers due to rounding.

Evaluation Contractor: Navigant

Program Year 2017

Table 9: AEP Ohio Energy Efficiency Programs (2017)

Program Name	Expenditures	kWh Savings	Share of Total Savings
Appliance Recycling	\$2,112,400	18,400,000	3%
Community Assistance	\$6,280,100	6,000,000	1%
e3 Smart SM	\$913,400	3,000,000	1%
Residential New Homes	\$2,212,800	5,300,000	1%
Efficient Products	\$11,895,300	106,800,000	20%
Home Energy Reports	\$1,355,800	76,200,000	14%
Intelligent Home & DR	\$3,044,300	-	0%
Manu. New Homes	\$397,100	-	0%
Business New Construction	\$4,162,800	44,700,000	8%
Continuous Energy Improvement	\$2,248,700	24,600,000	5%
Combined Heat & Power	\$515,100	-	0%
Process Efficiency	\$3,761,200	46,500,000	9%
Data Center	\$2,389,400	31,200,000	6%
Express for Small Business	\$2,142,300	9,300,000	2%
Efficient Products for Business	\$14,651,100	150,100,000	28%
Retro-Commissioning	\$791,000	4,700,000	1%
Self Direct	\$807,200	6,500,000	1%
Total	\$59,680,000	533,300,000	

Note: Totals may not match filed numbers due to rounding.

Table 10: AEP Ohio Demand Reduction Programs (2017)

Program Name	kW Savings	Share of Total Savings
Appliance Recycling	2,900	4%
Community Assistance	900	1%
e3 Smart SM	400	0%
Residential New Homes	2,800	3%
Efficient Products	19,200	24%
Home Energy Reports	9,900	12%
Intelligent Home & DR	-	0%
Manu. New Homes	-	0%
Business New Construction	7,200	9%
Continuous Energy Improvement	3,400	4%
Combined Heat & Power	-	0%
Process Efficiency	4,900	6%
Data Center	4,100	5%
Express for Small Business	1,200	1%
Efficient Products for Business	23,900	29%
Retro-Commissioning	-	0%
Self Direct	900	1%
Total	81,700	

Note: Totals may not match filed numbers due to rounding.

Evaluation Contractor: Navigant

Program Year 2016

Table 11: AEP Ohio Energy Efficiency Programs (2016)

Program Name	Expenditures	kWh Savings	Share of Total Savings
Appliance Recycling	\$1,435,400	9,900,000	2%
Community Assistance	\$9,213,300	10,100,000	2%
e 3 smart SM	\$727,500	3,400,000	1%
Residential New Homes	\$1,862,000	4,100,000	1%
Efficient Products	\$9,992,300	131,500,000	21%
Home Energy Reports	\$816,200	67,300,000	11%
In-Home Energy	\$4,020,500	6,800,000	1%
Business New Construction	\$5,550,800	42,000,000	7%
Continuous Energy Improvement	\$4,367,000	55,900,000	9%
Custom	\$1,779,400	70,400,000	11%
Energy Efficiency Auction	\$3,102,700	45,300,000	7%
Data Center	\$1,940,100	19,000,000	3%
Express	\$3,186,600	11,400,000	2%
Prescriptive	\$14,839,600	129,100,000	20%
Retro-Commissioning	\$1,156,700	1,600,000	<1%
Self Direct	\$1,499,600	22,500,000	4%
Total	\$65,489,700	630,300,000	

Note: Totals may not match filed numbers due to rounding.

Table 12: AEP Ohio Demand Reduction Programs (2016)

Program Name	kW Savings	Share of Total Savings
Appliance Recycling	1,600	2%
Community Assistance	1,000	1%
e3 Smart SM	400	1%
Residential New Homes	2,500	3%
Efficient Products	16,000	21%
Home Energy Reports	8,700	11%
In-Home Energy	600	1%
Business New Construction	8,400	11%
Continuous Energy Improvement	1,700	2%
Custom	5,800	8%
Energy Efficiency Auction	4,400	6%
Data Center	2,400	3%
Express for Small Business	1,500	2%
Prescriptive	18,900	25%
Retro-Commissioning	-	0%
Self Direct	3,000	4%
Total	76,900	

Note: Totals may not match filed numbers due to rounding.

Evaluation Contractor: Navigant

Program Year 2015

Table 13: AEP Ohio Energy Efficiency Programs (2015)

Program Name	Expenditures	kWh Savings	Share of Total Savings
Appliance Recycling	\$2,166,600	19,700,000	4%
Community Assistance	\$6,651,500	7,400,000	1%
e3 Smart SM	\$953,000	3,400,000	1%
Residential New Homes	\$1,757,700	4,200,000	1%
Efficient Products	\$10,344,900	110,400,000	20%
Home Energy Reports	\$707,700	70,600,000	13%
In-Home Energy	\$4,663,700	8,100,000	2%
Business New Construction	\$3,873,800	35,200,000	7%
Continuous Energy Improvement	\$2,664,100	14,700,000	3%
Custom	\$3,902,900	71,100,000	13%
Energy Efficiency Auction	\$1,091,200	26,300,000	5%
Data Center	\$1,663,600	12,300,000	2%
Express for Small Business	\$3,122,600	12,700,000	2%
Prescriptive	\$16,162,100	119,900,000	22%
Retro-Commissioning	\$1,037,000	4,700,000	1%
Self Direct	\$949,900	18,500,000	3%
Total	\$61,712,300	539,200,000	

Note: Totals may not match filed numbers due to rounding.

Table 14: AEP Ohio Demand Reduction Programs (2015)

Program Name	kW Savings	Share of Total Savings
Appliance Recycling	3,200	5%
Community Assistance	600	1%
e3 Smart SM	400	1%
Residential New Homes	1,000	1%
Efficient Products	13,400	20%
Home Energy Reports	9,200	14%
In-Home Energy	2,000	3%
Business New Construction	7,200	11%
Continuous Energy Improvement	-	0%
Custom	7,900	12%
Energy Efficiency Auction	400	1%
Data Center	1,300	2%
Express for Small Business	2,000	3%
Prescriptive	16,700	25%
Retro-Commissioning	200	<1%
Self Direct	2,200	3%
Total	67,700	

Note: Totals may not match filed numbers due to rounding.

Evaluation Contractor: Navigant

Program Year 2014

Table 15: AEP Ohio Energy Efficiency Programs (2014)

Program Name	Expenditures	kWh Savings	Share of Total Savings
Appliance Recycling	\$3,262,500	24,000,000	4%
Community Assistance	\$11,709,100	15,900,000	2%
e3 Smart SM	\$968,700	4,300,000	1%
Efficiency Crafted SM New Homes	\$1,473,400	3,800,000	1%
Efficient Products	\$15,175,600	210,500,000	33%
Home Energy Reports	\$1,564,100	63,200,000	10%
In-Home Energy	\$5,064,300	10,000,000	2%
Business New Construction	\$4,075,100	36,700,000	6%
Continuous Energy Improvement	\$4,348,600	40,200,000	6%
Bid to Win	\$653,900	3,400,000	1%
Custom	\$5,932,800	86,600,000	14%
Data Center	\$1,995,600	13,600,000	2%
Express for Small Business	\$1,955,900	7,200,000	1%
Prescriptive	\$13,295,000	106,800,000	17%
Retro-Commissioning	\$742,100	4,500,000	1%
Self Direct	\$726,100	6,200,000	1%
Total	\$72,942,800	636,900,000	

Note: Totals may not match filed numbers due to rounding.

Table 16: AEP Ohio Demand Reduction Programs (2014)

Program Name	kW Savings	Share of Total Savings
Appliance Recycling	3,800	5%
Community Assistance	1,400	2%
e3 Smart SM	500	1%
Efficiency Crafted SM New Homes	1,000	1%
Efficient Products	25,600	32%
Home Energy Reports	8,200	10%
In-Home Energy	1,500	2%
Business New Construction	6,500	8%
Continuous Energy Improvement	1,700	2%
Bid to Win	400	1%
Custom	7,400	9%
Data Center	1,600	2%
Express for Small Business	1,800	2%
Prescriptive	16,700	21%
Retro-Commissioning	300	<1%
Self Direct	800	1%
Total	79,200	

Note: Totals may not match filed numbers due to rounding.

Evaluation Contractor: Navigant

This foregoing document was electronically filed with the Public Utilities

Commission of Ohio Docketing Information System on

11/29/2019 3:25:21 PM

in

Case No(s). 19-0002-EL-UNC

Summary: Report Independent Audit of AEP Ohio 2014-2018 Energy Efficiency and Demand Reduction Programs electronically filed by Kristin DuPree on behalf of PUCO Staff