AEP OHIO
An AEP Company
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Legal Department

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May 15, 2018

Barcy F. McNeal
Docketing Division Chief
Public Utilities Commission of Ohio
180 East Broad Street
Columbus Ohio 43215-3793

Re: *In the Matter of the Annual Portfolio Status Report Under Rule 4901:1-39-05(C), Ohio Administrative Code, by Ohio Power Company,* Case No. 18-0835-EL-EEC.

Steven T. Nourse
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Dear Ms. McNeal:

Ohio Power Company ("OPCo," "the Company" or "AEP Ohio") submits the enclosed 2017 Portfolio Status Report, pursuant to Rule 4901:1-39-05(C), Ohio Administrative Code (OAC).

In Case Nos. 11-5568-EL-POR, et al., the Commission approved the Stipulation and Recommendation on March 21, 2012, and granted the requested waiver of Rule 4901:1-39-05(C), OAC, such that AEP Ohio may file its annual portfolio status report on May 15 instead of March 15 during each year of the EE/PDR Action Plan in order to provide sufficient time for adequate evaluation, measurement and verification of plan results.

Please note that the Report is broken into six volumes, due to the size of the supporting documentation. Volume I contains the narrative body of the Report; the supporting affidavit of Jon Williams (the compliance affidavit required by Rule 4901:1-39-05(C)(1)(c), OAC); and Report Appendices A and B. Volume II contains Report Appendices C through G. Volume III contains Report Appendices H and I. Volume IV contains Report Appendices J and K. Volume V contains Report Appendices L through N. And Volume VI contains Report Appendices O through Q.

Thank you for your attention to this matter.

Respectfully Submitted,

/s/ Steven T. Nourse

2017 Portfolio Status Report of the Energy Efficiency and Peak Demand Response Programs

VOLUME I

2017 PORTFOLIO STATUS REPORT

AFFIDAVIT OF JON WILLIAMS

APPENDICES A – B

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INTRODUCTION

In Docket No. 08-888-EL-UNC, the Public Utilities Commission of Ohio ("the Commission") approved Rules for Energy Efficiency and Peak Demand Reduction Programs of electric utilities ("the Green Rules"). These Green Rules first became effective December 10, 2009. In accordance with Amended Substitute Senate Bill 221 (S.B. 221), the Rules require that each electric utility in the Commission's jurisdiction implement energy efficiency and peak demand reduction programs and file an annual Portfolio Status Report, originally due March 15 of each year but extended to May 15 in the March 21, 2012 order in Docket Nos. 11-5568-EL-POR and 11-5569-EL-POR for AEP Ohio.

In 2012, the General Assembly enacted Senate Bill 315 (S.B. 315) which, among other items, classified combined heat and power projects as energy efficiency projects. In 2014, the General Assembly then enacted Senate Bill 310 (S.B. 310) which froze energy efficiency targets at the 2014 levels for two years. After the freeze expired, the targets have resumed and AEP Ohio is operating under an approved 2017-2020 four year plan.

Per Ohio Administrative Code (OAC) 4901:1-39-05(C), these Status Reports are required to address all approved energy efficiency and peak demand reduction (EE/PDR) programs' performance over the prior calendar year. The Ohio Power Company ("the Company" or "AEP Ohio") filed a Program Portfolio Plan for 2017-2020 under Docket No. 16-0574-EL-POR, which the Commission approved January 18th, 2017.

AEP Ohio submits this 2017 Portfolio Status Report in compliance with the above-cited Rules. In accordance with OAC 4901:1-39-05(C)(2)(b), AEP Ohio has contracted with Navigant Consulting, Inc. ("Navigant") to review the Company's programs; perform the impact and process evaluations; and provide evaluation, measurement, and verification reports.

This report is divided into three major sections: The first section covers how the Company has met all the requirements in the Green Rules in 2017 and achieved its S.B. 310 benchmark requirements. The second section reviews each of AEP Ohio's EE/PDR programs and how they have performed this past year. The third and final section contains Ohio Power Company's recommendations going forward for each of the programs.

Attached with this report are 17 appendices: Appendix A lists individual units incented and measures installed, at a detailed level, under each of Ohio Power Company's EE/PDR programs. Appendices B through P contain the Evaluation Reports of each program from Navigant. Appendix P covers transmission and distribution projects related to EE/PDR. Finally, Appendix Q contains the joint utility standardized reporting template that contains performance information at a program level.

DEMONSTRATION OF COMPLIANCE

BENCHMARK UPDATES

AEP Ohio filed its Initial Benchmark Report on February 8, 2010[2] and has made regular updates in its intervening Portfolio Status Reports for both energy usage and peak demand. The Company has adjusted both its gross energy sales and peak demand to include the impacts of mercantile[3] customers' energy efficiency resource commitments and economic development. These adjusted figures are shown in Figures 1 and 2 below.

The annual benchmark target is calculated as the average of the prior three years' adjusted load, multiplied by the yearly statutory benchmark requirements from S.B. 310. The amounts for 2017 are 1.0 percent incremental energy reduction and 7.00 percent cumulative demand reduction.

For purposes of this compliance filing, the 2017 benchmark adjustments include the following: Economic growth exclusions, the associated opt outs legislated under S.B. 310[4], and the load generated by the Combined Heat and Power projects that existed during the period are used to establish the baseline[5].Figure 1 shows the calculation of the adjusted 2017 benchmark for energy usage savings: 385.3 gigawatt-hours (GWh). Figure 2 shows the calculation for the adjusted 2017 benchmark for peak demand savings: 546.8 megawatts (MW).

[2] *In the Matter of the Initial Benchmark Report of Columbus Southern Power Company and Ohio Power Company*, Case No. 10-153-EL-EEC, February 8, 2010.

[3] "Mercantile customer" means a commercial or industrial customer if the electricity consumed is for nonresidential use and the customer consumes more than seven hundred thousand kilowatt hours per year or is part of a national account involving multiple facilities in one or more states. See Ohio Revised Code § 4928.01(A)(19).

[4] http://codes.ohio.gov/orc/4928.6611v1

[5] http://codes.ohio.gov/orc/4928.66v1 - See Ohio Revised Code §4928.66(A)(2)(c)

FIGURE 1: ADJUSTED ENERGY USAGE BASELINES

Year	Actual Retail Sales	Econ. Devel. Adj.*	S.B. 310 Opt Out[5]	Combined Heat and Power*	2011-16 Merc. Savings	2017 Merc. Savings	Adjusted Retail Sales
2014	43,700.4	-15.2	-4,797.1	0.0	66.6	3.0	38,957.6
2015	43,418.1	0.0	-5,310.2	44.7	69.4	5.9	38,227.9
2016	43,393.4	0.0	-5,162.1	95.7	69.4	6.5	38,403.0
						Three-Year Average:	**38,529.5**
						Benchmark Rate:	**1.00%**
						2017 Benchmark Target:	**385.3**

*All figures are in GWh - Docket 18-501-EL-FOR. *This baseline differs from the AEPS baseline filed in 18-0610-EL-ACP to reflect the above adjustments.

FIGURE 2: ADJUSTED PEAK DEMAND BASELINES

Year	Coincident Peak Demand	Econ. Devel. Adj.*	S.B. 310 Opt Out[5]	Combined Heat and Power*	2011-16 Merc. Savings	2017 Merc. Savings	Adjusted Peak Demand
2014	8,108.0	-0.9	-638.4	0.0	9.5	0.4	7,478.5
2015	8,485.0	0.0	-627.9	5.5	10.1	0.7	7,873.4
2016	8,685.0	0.0	-623.2	9.2	10.1	0.9	8,081.9
						Three-Year Average:	**7,811.3**
						Benchmark Rate:	**7.00%**
						2017 Benchmark Target:	**546.8**

*All figures are in MW - Docket 18-501-EL-FOR.

ACHIEVED SAVINGS

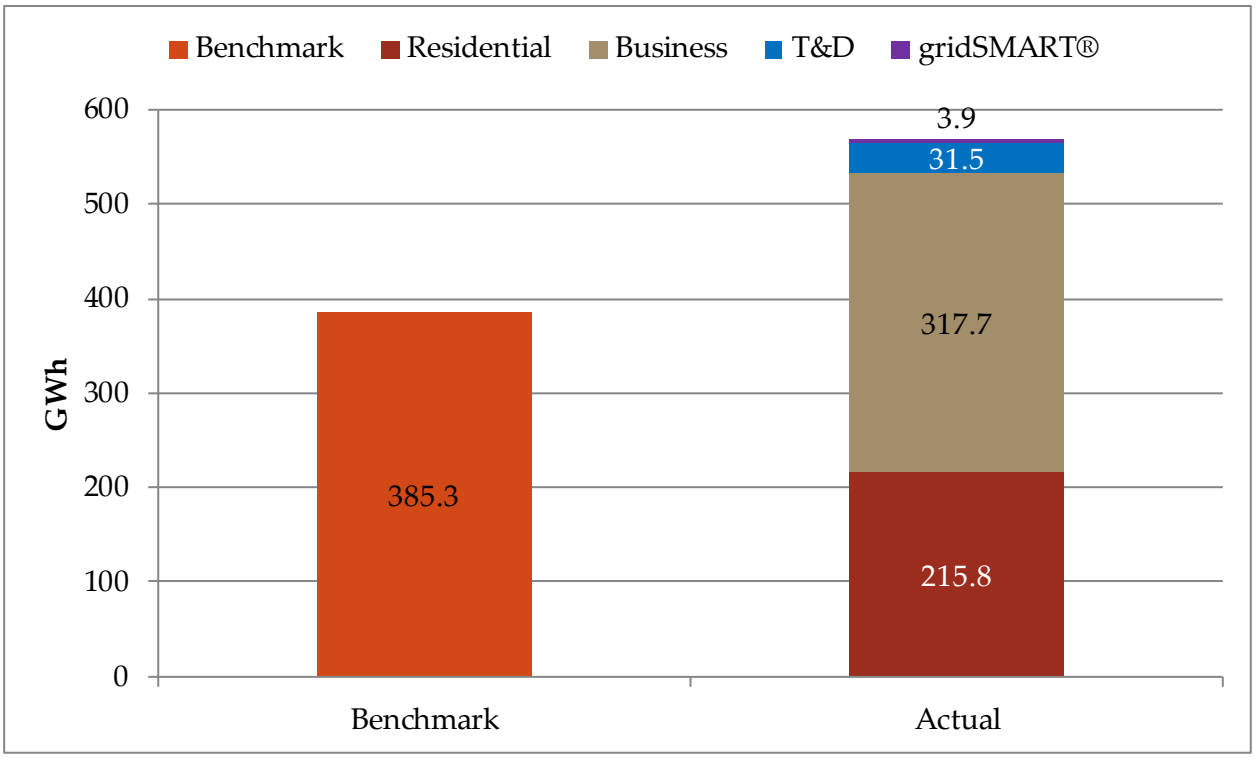
The Company has met all its EE/PDR benchmarks for both energy and demand savings for 2017, with all of Ohio Power's EE/PDR programs saving a combined 533.4 GWh of energy[6].

[5] Per the stipulation for docket 16-0574-EL-POR, AEP Ohio has included the load associated to the Opt Outs. Due to the various economic factors that have occurred during the life of the portfolio, AEP Ohio is not currently able to accurately quantify how the SB 310 Opt Outs affected the portfolio costs and shared savings.

[6] All achieved energy and demand savings figures in this report are *ex ante*.

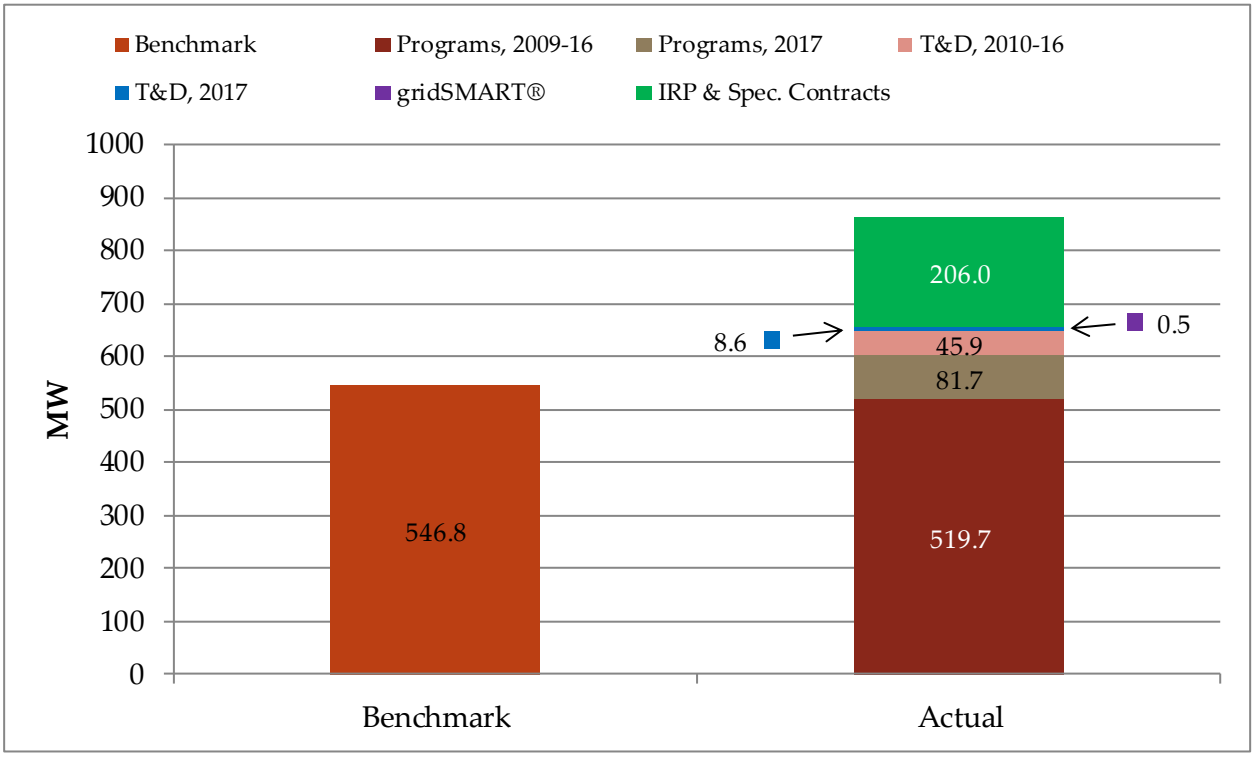
AEP Ohio is also permitted to add savings resulting from transmission and distribution (T&D) projects that reduce losses (see pages 34-35). In 2017, the Company saved 31.5 GWh of energy from T&D projects. Additionally, 2017 savings from Home Energy Reports for gridSMART® Phase 1 customers totaled 3.9 GWh. Together this yielded a grand total of 568.8 GWh, well above the benchmark target. Figure 3 illustrates the breakout of these savings between residential programs, business programs, T&D improvements, and gridSMART®. The majority of energy savings in 2017 came from business programs (55.8 percent). Residential programs, T&D projects, and gridSMART® accounted for 38.0 percent, 5.5 percent, and 0.7 percent of the total, respectively.

FIGURE 3: ACHIEVED ANNUAL ENERGY SAVINGS, BY SEGMENT, 2017



The Company's portfolio yielded 81.7 MW in permanent peak demand reductions in 2017, shown in Figure 4. The cumulative permanent peak demand reduction impact of programs from 2009 through 2016 was 519.7 MW. Combined with other sources of demand reduction, including past year T&D projects (45.9 MW), current year T&D projects (8.6 MW), special contracts and interruptible tariffs (206.0 MW), and gridSMART® Phase 1 (0.5 MW) AEP Ohio reduced peak demand by 862.4 MW in total.

FIGURE 4: ACHIEVED PEAK DEMAND SAVINGS, BY SOURCE, 2017



COST EFFECTIVENESS

The Company's portfolio of EE/PDR programs has been cost-effective. There are four common tests to determine cost effectiveness, differing in which costs and benefits are included and for whom:

- **Participant Test (PCT):** Participation is cost effective from this perspective if the reduced electric costs to the participating customer from the measure exceed the after-incentive cost of the measure to the customer.
- **Utility Cost Test (UCT):** Programs are cost effective from this perspective if the costs avoided by the program's energy and demand savings are greater than the utility's EE/PDR program costs to promote the program, including customer incentives.
- **Ratepayer Impact Measure (RIM) Test:** Programs are cost effective from this perspective if their avoided costs are greater than the sum of the EE/PDR program costs and the "lost revenues" caused by the program.
- **Total Resource Cost (TRC) Test:** Programs are cost effective from this perspective if their avoided costs are greater than the sum of the measures cost and the EE/PDR program administrative costs.

Figure 5 shows benefit-cost ratios for each of the cost effectiveness tests listed above. These ratios are based on *ex ante* savings. A ratio higher than one indicates that net benefits are greater

than net costs, and the portfolio is beneficial by the test's standards. Also included is the TRC levelized cost of energy.

FIGURE 5: PORTFOLIO EX ANTE BENEFIT-COST RATIOS AND TRC LEVELIZED COST, 2017

Test	Ratio or Cost
Total Resource Cost	1.8
Participant Cost	2.9
Ratepayer Impact	0.7
Utility Cost	4.4
TRC Levelized Cost per kWh (¢)	3.6

Total resource cost ratios and levelized energy costs for each individual program are shown in Figure 6. Again, a ratio greater than one indicates that the program's benefits exceed its costs. Note that the ratios presented in this table are based on *ex ante* savings and may differ from the *ex post* figures contained in Appendices B through P.

FIGURE 6: TOTAL RESOURCE COST RATIOS AND LEVELIZED COSTS, 2017

Program	Benefit-Cost Ratio	Levelized Cost per kWh (¢)
Efficient Products	4.5	1.7
Appliance Recycling	3.2	1.9
e^3 *smart*^{SM}	1.9	3.5
Community Assistance	0.7	10.7
EfficiencyCrafted^{SM} New Homes	1.7	7.4
Manu. New Homes	0.1	115.7
Home Energy Reports	2.2	1.8
Efficient Products for Bus.	1.3	4.7
Process Efficiency	1.3	5.3
Self Direct	0.8	7.7
Business New Construction	2.1	3.4
Express	1.4	4.7
Retro-Commissioning	0.7	5.2
Data Center	1.4	4.8
Continuous Energy Improvement	1.8	2.6

Banking of Energy Efficiency Achievements

In accordance with Senate Bill 310 Section 4928.662(G)[7], AEP Ohio presents its banking methodology. The Company reserves the right to bank all achievements exceeding the benchmark. At a minimum for 2017, Ohio Power is banking all achievement in excess of 115 percent of benchmark, shown in Figure 7.

FIGURE 7: BANKING OF ENERGY EFFICIENCY ACHIEVEMENTS

Year	GWh
2009	141.9
2010	103.3
2011	148.7
2012	252.6
2013	186.5
2014	182.2
2015	72.7
2016	152.2
2017	125.7
Total	**1,365.8**

Summary

In 2017, Ohio Power Company met its benchmark targets for both energy usage and peak demand. The Company's EE/PDR portfolio as a whole was cost-effective.

[7] http://codes.ohio.gov/orc/4928.662

PROGRAM ACTIVITY DESCRIPTIONS

This section of the report discusses program activity from January 1 through December 31, 2017. AEP Ohio operated seventeen programs this year, not counting T&D improvements:

Residential Programs:

- Efficient Products
- Appliance Recycling
- *e³smart*SM
- Intelligent Home & DR
- Community Assistance
- EfficiencyCrafted℠ New Homes
- New Energy Efficient Manufactured Home
- Home Energy Reports

Business Programs:

- Efficient Products for Business
- Process Efficiency
- Self Direct
- Business New Construction
- Express
- Retro-Commissioning
- Continuous Energy Improvement
- Data Center
- Combined Heat & Power

Figure 8 summarizes each program's direct and allocated department costs to AEP Ohio; the number of participants or units sold; and ex ante energy and demand savings. Descriptions of each program follow Figure 8. All figures seen below may not sum due to rounding.

FIGURE 8: SUMMARY OF DIRECT PROGRAM COSTS AND BENEFITS, 2017

Program	Customer Incentives	Third Party Costs	Utility Admin. Costs*	Total Costs	Number of Participants / Units	Coincident Peak MW Saved	Annual GWh Saved
Efficient Products	$7,359.6	$3,490.7	$1,045.0	$11,895.3	2,802,645	19.2	106.8
Appliance Recycling	994.4	931.5	186.5	2,112.4	12,880	2.9	18.4
*e*³ *smart* SM	551.1	288.6	73.7	913.4	25,000	0.4	3.0
Intelligent Home & DR	641.3	1,969.0	434.0	3,044.3	8,511	0.0	0.0
Community Assistance	4,906.4	888.0	485.8	6,280.1	4,397	0.9	6.0
Residential New Homes	991.7	975.0	246.2	2,212.8	1,762	2.8	5.3
Manu. New Homes	6.0	346.5	44.5	397.1	5	0.0	0.0
Home Energy Reports	0.0	1,177.8	178.1	1,355.8	550,209	9.9	76.2
Efficient Products for Bus.	9,617.3	3,524.5	1,509.2	14,651.1	2,141	23.9	150.1
Process Efficiency	1,558.3	1,569.6	633.2	3,761.2	62	4.9	46.5
Self Direct	302.5	448.0	56.7	807.2	63	0.9	6.5
Bus. New Construction	2,539.4	1,158.7	464.7	4,162.8	129	7.2	44.7
Express	1,789.5	81.2	271.6	2,142.3	422	1.2	9.3
Retro-Commissioning	457.1	233.0	100.9	791.0	19	0.0	4.7
Data Center	1,377.0	821.0	191.5	2,389.4	11	4.1	31.2
Demand Response	0.0	0.0	0.0	0.0	0	0.0	0.0
CEI	501.4	1,489.8	257.5	2,248.7	37	3.4	24.6
Combined Heat & Power	473.4	0.0	41.7	515.1	0.0	0.0	0.0
Total	**$34,066.4**	**$19,392.9**	**$6,220.9**	**$59,680.2**	**3,408,293**	**81.7**	**533.4**
Education and Media				2,989.8			
Pilot Programs, Research & Development				1,688.1			
Grand Total				**$64,358.1**			

*Programs' utility administrative costs include allocated departmental and evaluation costs.
All cost figures are in thousands of dollars. Columns may not total due to rounding.

RESIDENTIAL PROGRAMS

EFFICIENT PRODUCTS

This program provides incentives and marketing support through retailers to encourage purchases of ENERGY STAR®-approved lighting and appliances. The Efficient Products program contains multiple savings paths: The first is customer rebates at the point of sale. Over 200 participating retailers in the Company's service territory are equipped to offer instant rebates on certain ENERGY STAR®-approved lighting devices. Other retailers without the capability to offer electronic markdowns may also offer retailer-reimbursed rebates on these same approved lighting products. These products include various Light Emitting Diode (LED)

bulbs. In addition, the program offers customers the opportunity to mail-in rebate applications for refrigerators, smart thermostats, air purifiers, clothes washers, dehumidifiers, HVAC replacements, and heat pump water heaters. These applications are available from the retailer or on the AEP Ohio website. These rebates and incentives range from approximately one dollar each for 7-watt LEDs to $500 for heat pump water heaters.

As available technologies and ENERGY STAR® standards continue to evolve over time, AEP Ohio maintains and regularly updates the list of qualifying devices.

In addition, AEP Ohio offers marketing support to retailers. These services include in-store signage to promote efficient devices and training for sales associates to help them understand the benefits of energy-efficient lights and appliances.

In the 2017-2020 plan approved stipulation, AEP Ohio has combined the In Home program with the Efficient Products program. AEP Ohio offers the *Online Energy Checkups*, a free online tool available on AEP Ohio's website that customers may use to quickly identify their home energy costs, receive recommendations on how to save energy, and learn how to qualify for a kit of free energy-saving items. AEP Ohio provided 6,891 kits to Energy Checkup participants in 2017. Another option that is cost shared with Columbia Gas is the *In-Home Energy Assessments* for customers with dual fuel. This offering includes an in-home visit, visual inspection, prioritized suggestions for efficiency improvements, and installation of several energy-saving devices such as LEDs, programmable thermostats, or low-flow showerheads, at a subsidized price. In 2017, 1,712 customers had In-Home Assessments.

Additionally, program implementers work with property managers in multi-family housing complexes to schedule home assessments and installations with residents, as well as to identify potential savings in common areas. All individually metered residential multi-family housing in AEP Ohio's service territory is eligible to participate. This part of the program receives some marketing assistance from property manager associations around the state. In 2017, 57 properties had assessments.

Figure 9 below shows the number of products for which AEP Ohio provided incentives or distributed for free in 2017. Please see Appendix A for a detailed measure listing.

FIGURE 9: EFFICIENT PRODUCTS INCENTED OR PROVIDED, 2017

Product	Number	MWh	kW
Lighting	2,751,529	99,508,979	17,653.4
Appliances	12,854	2,138,446	333.5
Air Sealing & Insulation	16	4,435	0.1
HVAC	2,048	858,705	436.2
Hot Water	23,619	1,550,799	199.5
Smart Strips	4,355	447,623	40.1
Thermostats	8,224	2,273,986	570.9
Total	**2,802,645**	**106,782,973**	**19,233.7**

Energy and demand savings were calculated using the Draft Ohio Technical Resource Manual (TRM)[8] when calculations were presented. The Draft Ohio TRM does not provide energy savings for smart thermostats. The calculations for smart thermostats is taken from the Illinois TRM, page 152[9].

The Company's Action Plan goals for 2017 were 73.2 GWh of savings in energy consumption and 7.6 MW of savings from peak demand. Figure 10 below shows the Efficient Products program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 10: EFFICIENT PRODUCTS PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	106.8	73.2	145.9%
Demand Savings (MW)	19.2	7.6	252.6%
Program Costs ($M)	11.9	12.6	94.4%
First Year Cost per kWh Saved (¢)	11.1	17.2	64.7%

The Efficient Products program exceeded its goals for both energy and demand savings in 2017. The program saved 106.8 GWh of energy, 45.9 percent more than what was planned. The program also reduced peak demand by 19.2 MW, 152.6 percent more than planned. The program came in below budget at $11.9 million, yielding an average first year cost of 11.1 cents per kWh saved.

[8] In the Matter of the Protocols for the Measurement and Verification of Energy Efficiency and Peak Demand Reduction Measures, Case No. 09-512-GE-UNC, August 6, 2010.

[9] http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_5/Final/IL-TRM_Effective_060116_v5.0_Vol_3_Res_021116_Final.pdf

APPLIANCE RECYCLING

This program seeks to remove functioning but inefficient refrigerators and freezers from the power grid. Often, older appliances, especially refrigerators, remain in use as second or "backup" appliances—still plugged in and using an inordinate amount of energy. By removing these high-usage appliances from the grid, the Company reduces unnecessary load and usage. This program's primary focus is on these second refrigerators, but recycling for stand-alone freezers is also available. In return for recycling appliances, AEP Ohio paid the customer an incentive of $35 per unit in the first three quarters of 2017, and increased the incentive to $50 in the final quarter of 2017.

Customers enroll in the program either through the Company's website or over the phone, and schedule an at-home pickup. Figure 11 shows the number of appliances that were recycled through this program in 2017. Please see Appendix A for a detailed measure listing.

FIGURE 11: APPLIANCES RECYCLED, 2017

Appliances	Number	MWh	kW
Freezers	2,570	3,198,108	514.0
Refrigerators	11,038	15,189,944	2,428.4
Total	**13,608**	**18,388,052**	**2,942.4**

Energy and demand savings were calculated using the Draft Ohio TRM.

The Company's Action Plan goals for 2017 were 11.8 GWh of savings in energy consumption and 1.8 MW of savings from peak demand. Figure 12 shows the Appliance Recycling program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 12: APPLIANCE RECYCLING PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	18.4	11.8	155.9%
Demand Savings (MW)	2.9	1.8	161.1%
Program Costs ($M)	2.1	2.7	77.8%
First Year Cost per kWh Saved (¢)	11.4	22.9	49.9%

The Appliance Recycling program exceeded its goals for energy and demand savings for 2017. The program saved 18.4 GWh of energy, 55.9 percent above target. The program also reduced peak demand by 2.9 MW, 61.1 percent above goal. The program spent less than budgeted at $2.1 million, yielding an average first year cost of 11.4 cents per kWh saved.

*e³smart*SM

AEP Ohio offers an educational program covering energy efficiency for students in grades 4 through 12 in schools throughout the Company's service territory. It includes a curriculum designed to meet state and national science standards for these grades, teacher training, and supplies for classroom instruction. Students served by the program will learn about different forms of energy, their sources, and how electric power reaches their homes. Students are then given a box of energy-efficient devices—Light Emitting Diode (LED) bulbs, LED night lights, low-flow showerheads, faucet aerators, and weather-stripping—to install at home with their parents' or guardians' supervision. Kits also include tools students can use to measure energy use and efficiency losses.

In the 2016-2017 school year, there were 25,000 kits distributed to students in *e³smart*SM. (Of these, 19,648 students returned surveys.) Figure 13 shows how many of which items were included in their kits. Please see Appendix A for a detailed measure listing.

FIGURE 13: ITEMS INCLUDED IN *e³smart*SM KITS, 2017

Item	Number	MWh	kW
Faucet Aerators	6,027	449,740	56.1
Hot Water Temp. Setback	688	56,141	6.2
Lighting	37,614	1,108,946	173.0
Low-Flow Showerheads	3,739	886,180	113.4
Weather-Stripping	7,168	79,565	5.7
Allocated Kits*	5,352	392,195	32.2
Total	**60,588**	**2,972,766**	**386.5**

*These are kits for participants who had not returned surveys; AEP Ohio reduced the installation rates of these cases.
Note: Water heating measures in this table include measures that students installed in homes with gas water heating. No savings were claimed on these measures, and they are not tallied in Appendix A.

Energy and demand savings were calculated using the Draft Ohio TRM when calculations were available. The Draft Ohio TRM does not include calculations for LED night lights or weather-stripping.

The calculation for LED night lights is taken from the 2012 Portfolio Status Report, Navigant Program Evaluation ("2012 Navigant Evaluation").[10]

The formula for weather-stripping is shown below, where ΔE is energy savings in kWh; x_1 is maximum energy savings potential from weatherization measures; y_1 is average annual energy usage in all-electric residences; y_2 is average annual energy usage in non-all-electric residences; e is the percentage of homes that are all-electric; L_{shell} is the fraction of air leaks through

[10] *In the Matter of the Annual Portfolio Status Report Under Rule 4901:1-39-05(C), Ohio Administrative Code, by Ohio Power Company*, Case No. 13-1182-EL-EEC, May 15, 2013, Appendix E, page 22.

windows, doors, ceilings, walls, and floors; L_{HT} is the fraction of total heat transfer due to air leaks; Q is total inches of weather-stripping applied; L_{wid} is the average width of the leakage area in inches; and L_{area} is the average leakage area per house in inches.

$$\Delta E = x_1 \times \Big((y_1 \times e) + \big(y_2 \times (1 - e)\big) \Big) \times L_{\text{shell}} \times L_{\text{HT}} \times \frac{Q \times L_{\text{wid}}}{L_{\text{area}}}$$

AEP Ohio's Action Plan goals for 2017 were 6.8 GWh of savings in energy consumption and 0.5 MW of savings from peak demand. Figure 14 below shows the *e³smart*℠ program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 14: *e³smart*℠ PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	3.0	6.8	44.1%
Demand Savings (MW)	0.4	0.5	80.0%
Program Costs ($M)	0.9	1.2	75.0%
First Year Cost per kWh Saved (¢)	30.0	17.6	170.0%

The *e³smart*℠ program did not meet either its energy or demand goals for 2017. The program saved 3.0 GWh of energy, 55.9 percent below goal. The program also reduced peak demand by 0.4 MW, 20 percent below goal. The program came in slightly under budget at $0.9 million, yielding an average first year cost of 30.0 cents per kWh saved.

INTELLIGENT HOME & DR

AEP Ohio launched its Intelligent Home and DR program titled "It's Your Power" in 2017. This program offers a mobile smartphone app that customers may download for information to illustrate electricity consumption patterns, how their decisions and actions influence their usage, how that usage affects their energy bill, and actions they may take to manage and reduce their usage. Specifically targeting AMI customers, this app features includes a weather overlay, estimated billing based on usage, energy project and tip tracking. In addition, AEP Ohio offers a smart hub (energy bridge) that can communicate with the AMI meter and with the app to give customers near real-time, highly granular usage information, and through which customers may control various smart devices.

Coupled with the AEP Ohio "It's Your Power" app this offers customers control of electric space cooling and heating load using a thermostat with two-way communication capabilities. Load control is achieved through temperature set point adjustments on individual thermostats for both cooling and heating loads and/or through cycling of compressors. The app will enable customers to change heating and cooling settings remotely. AEP Ohio had an adoption of 8,511

AMI customers download the mobile app. From this participant segment, 6,583 customers requested an energy bridge. In the process of creating a control group, AEP Ohio could only approve 80% of requests for an energy bridge. This resulted in 5,195 customers being shipped an energy bridge.

With an energy bridge, a customer is then eligible for a communicating thermostat. This engagement resulted in 2,216 customers received a communicating thermostat. In 2017, Ohio Power spent $3.0 million to administer the program.

Several program adjustments were made throughout the year, because the program remained in startup mode, AEP Ohio did not count any energy or demand savings for It's Your Power in 2017, but the Company anticipates savings in 2018 and onward. The Company further plans to conduct a full program evaluation next year once savings are acquired.

Community Assistance

This program offers energy efficiency services to those AEP Ohio customers with limited income to assist them in reducing their electric energy use and making their utility bills more manageable. Residential customers with incomes up to 200 percent of the federal poverty level are eligible to participate.[11] The program offers services such as home assessments, efficient lighting, appliance replacement, HVAC replacement, water heating upgrades, health and safety repairs, and weatherization; at no cost to the customer.

In 2017, there were 4,397 jobs completed in the Community Assistance program. Figure 15 below shows which measures were installed. Please see Appendix A for a detailed measure listing.

[11] In 2017, this came to roughly $50,200 per year for a family of four. See U.S. Department of Health and Human Services, "2017 Poverty Guidelines," https://aspe.hhs.gov/computations-2017-annual-update-hhs-poverty-guidelines-48-contiguous-states-and-district-columbia.

FIGURE 15: MEASURES INSTALLED THROUGH COMMUNITY ASSISTANCE PROGRAM, 2017

Item	Number	MWh	kW
Appliance Retirement	7	9,236	1.5
Fridgers & Freezers	3,467	3,435,266	527.5
Health & Safety	8	0	0.0
HVAC	2,447	15,630	3.4
Hot Water	4,088	164,691	17.6
Lighting	54,332	1,946,448	327.8
Other	58	2,887	0.5
Smart Strips	1,668	136,940	0.0
Air Sealing & Insulation	284,618	338,513	7.5
Total	**350,693**	**6,049,612**	**885.8**

Energy and demand savings were calculated using the Draft Ohio TRM when calculations were available.

Ohio Power's Action Plan goals for 2017 were 8.4 GWh of savings in energy consumption and 0.8 MW of savings from peak demand. Figure 16 below shows the Community Assistance program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 16: COMMUNITY ASSISTANCE PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	6.0	8.4	71.4%
Demand Savings (MW)	0.9	0.8	112.5%
Program Costs ($M)	6.3	6.0	105.0%
First Year Cost per kWh Saved (¢)	105.0	71.4	147.0%

The Community Assistance program did not meet its energy savings goals, but the program met its demand savings goals in 2017. The program saved 6.0 GWh of energy and reduced peak demand by 0.9 MW. The program came in over budget at $6.3 million, yielding an average first year cost of 105.0 cents per kWh saved.

EFFICIENCYCRAFTED℠ NEW HOMES

EfficiencyCrafted℠ New Homes (formerly known as ENERGY STAR® New Homes) seeks to effect the construction of single-family residences that meet specific ENERGY STAR® or EnergyPath℠ standards. Such structures can use up to 50 percent less energy than residences built to the minimum code requirements. AEP Ohio will pay various incentives to participating

builders of single-family residences to help offset incremental construction costs. In addition, builders receive training, marketing, and financial support, including site signage, consumer brochures, model home displays, advertising, and other consumer education tools. All new single-family residential construction that meets standards is eligible.

AEP Ohio has agreed to share program costs with Columbia Gas for gas-heated homes in those areas served by both companies. In 2017, this program incented the construction of 1,762 efficient single-family homes.

Energy and demand savings were calculated as the difference between a baseline residence constructed at the applicable code and the as-built *REM/Rate* model. *REM/Rate* is software that analyzes energy usage in residential buildings.

The Company's Action Plan goals for 2017 were 4.7 GWh of savings in energy consumption and 1.0 MW of savings from peak demand. Figure 17 below shows the program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 17: EFFICIENCYCRAFTED℠ NEW HOMES PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	5.3	4.7	112.8%
Demand Savings (MW)	2.8	1.0	280.0%
Program Costs ($M)	2.2	2.0	110.0%
First Year Cost per kWh Saved (¢)	41.5	42.6	97.5%

The EfficiencyCrafted℠ New Homes program exceeded both its energy and demand savings goals in 2017. The program saved 5.3 GWh of energy. The program also reduced peak demand by 2.8 MW, nearly triple the annual goal. The program came in over budget at $2.2 million, yielding an average first year cost of 41.5 cents per kWh saved.

NEW ENERGY EFFICIENT MANUFACTURED HOME

The New Energy Efficient Manufactured Home Program will improve the energy performance of manufactured homes. AEP Ohio offered incentives to manufacturers to outfit new manufactured homes at the plant with high efficiency equipment, appliances, lighting and electronics for homes to be sited in AEP Ohio service territory. The original design was a combination of improved home design and construction practices, and increased demand for improved performance through manufacturer outreach. This implementation method was modified mid-year due to slow adoption by manufactures. AEP Ohio began utilizing the retail channel of manufactured homes by giving an incentive for the more efficient manufactured homes. Also, since the HVAC unit is installed after the manufactured home has been delivered,

HVAC dealers/contractors were incentivized to supply the home with an efficient heat pump instead of electric baseboard heating.

Due to the late modification, for 2017 this program only incented the construction of 5 efficient manufactured homes. Energy and demand savings were calculated as the difference between a baseline residence constructed at the applicable code and the as-built *REM/Rate* model. *REM/Rate* is software that analyzes energy usage in residential buildings. With the small number of participation and REM Models, the 2017 impact evaluation of this program was consolidated with EfficiencyCrafted℠ New Homes.

AEP Ohio's Action Plan goals for 2017 were 2.2 GWh of savings in energy consumption and 0.01 MW of savings from peak demand. Figure 18 below shows the New Energy Efficient Manufactured Home program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 18: NEW ENERGY EFFICIENT MANUFACTURED HOME, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	0.0	2.2	1.6%
Demand Savings (MW)	0.0	0.1	13.2%
Program Costs ($M)	0.4	0.7	56.7%
First Year Cost per kWh Saved (¢)	1,150.9	31.8	3617.2%

The New Energy Efficient Manufactured Home program missed both energy savings goals and demand savings goals. Due to the late modification and year end participants, the program only saved 0.03 GWh of energy, 98.4 percent below target. The program also reduced peak demand by 0.01 MW, this amount was 86.8 percent below the goal. The program came in below budget at $.4 million, yielding an average first year cost of 1,151 cents per kWh saved.

HOME ENERGY REPORTS

This program targets high-usage and/or low-income customers in the Company's service territory to receive a comparison mailing of how occupied homes of similar size and heating source use electricity. This is designed to spur these selected customers to save energy and use electricity more efficiently. Customers who wish to opt out of receiving these reports may call a toll-free number to do so. In 2017 there were 550,209 customers receiving reports.

Savings calculations for this program begin with the vendor using a proprietary model. Each year, AEP Ohio analysts compare participation in other residential EE/PDR programs between these two groups to determine whether savings in these other programs are being double-counted. This year, a significant difference was found (α=0.05), indicating report recipients participated in other programs at higher levels than the control group. Savings in both energy and demand were therefore adjusted downward by 543,445 kWh and 70.6 kW, respectively. AEP Ohio will continue to run cross participation tests to validate and remove double counted savings.

AEP Ohio's Action Plan goals for 2017 were 75.0 GWh of savings in energy consumption and 3.8 MW of savings from peak demand. Figure 19 below shows the Home Energy Report program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 19: HOME ENERGY REPORTS PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	76.2	75.0	101.6%
Demand Savings (MW)	9.9	3.8	264.0%
Program Costs ($M)	1.4	1.5	93.3%
First Year Cost per kWh Saved (¢)	1.8	2.0	91.9%

The Home Energy Report program exceeded both its energy and demand savings goals for 2017. The program saved 76.2 GWh of energy, 1.6 percent above goal. The program also reduced peak demand by 9.9 MW, 164 percent above goal. The program came in under budget at $1.4 million, yielding an average first year cost of 1.8 cents per kWh saved; however, unlike other residential programs, this program only has a one-year measure life.

BUSINESS PROGRAMS

EFFICIENT PRODUCTS FOR BUSINESS

This program offers fixed incentives for the installation and implementation of certain pre-approved types of energy efficient lighting; heating, ventilation, and air conditioning (HVAC) systems; variable frequency drives (VFDs); motors; controls; refrigeration equipment; and compressed air systems, among other commercial- and industrial-grade equipment. Incentive amounts offered to customers typically range between 10 and 50 percent of the incremental cost to purchase energy-efficient equipment. All non-residential customers in AEP Ohio's service territory are eligible to participate.

In 2017, there were 2,141 projects completed in the Efficient Products for Business program. Figure 20 shows which measures were installed through these projects. A single project may involve multiple measures. Please see Appendix A for a detailed measure listing.

FIGURE 20: MEASURES INSTALLED THROUGH THE EFFICIENT PRODUCTS FOR BUSINESS, 2017

Type	Number	MWh	kW
Compressed Air	11,627	2,948,744	408.8
Comm. Kitchen	57	127,591	7.8
HVAC	2,192,410	9,242,080	2,055.8
Controls	2,228,756	2,668,138	170.8
Advanced Lighting	1,102,138	6,009,001	951.7
Lighting	379,202	116,146,967	18,350.8
Other	1,134	69,992	16.0
Process/Motors	56	1,739,620	234.3
Refrigeration	24,814	11,188,865	1,677.5
Total	**5,940,194**	**150,140,998**	**23,873.4**

Energy and demand savings for prescriptive measures were calculated using the vendor-internal TRM which is filed with the Commission annually.

The Company's Action Plan goals for 2017 were 109.7 GWh of savings in energy consumption and 31.5 MW of savings from peak demand. Figure 21 shows the Efficient Products for Business program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 21: EFFICIENT PRODUCTS FOR BUSINESS PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	150.1	109.7	136.8%
Demand Savings (MW)	23.9	31.5	75.9%
Program Costs ($M)	14.7	12.8	114.8%
First Year Cost per kWh Saved (¢)	9.8	11.7	83.9%

The Efficient Products for Business program met its energy goals, but did not meet its demand goals for 2017. The program saved 150.1 GWh of energy, 36.8 percent above goal. The program also reduced peak demand by 23.9 MW, 24.1 percent below goal. The program came in above budget at $14.7 million, yielding an average first year cost of 9.8 cents per kWh saved.

PROCESS EFFICIENCY

This program is for cost-effective energy efficiency improvements in existing buildings that reduce energy consumption or peak demand and have more complicated measures that are not included in the Efficient Products for Business program. All non-residential customers in the Company's service territory are eligible to participate. Customers work closely with their Ohio Power account managers and other employees to determine measure eligibility and verify energy savings. Customers receive an incentive customized to the specific results of the energy savings technologies implemented. Program management will assist commercial and industrial customers with the analysis and selection of high-efficiency equipment or processes.

There were 62 Process Efficiency projects completed in 2017. Figure 22 summarizes the measures installed in these projects. A single project may involve multiple measures. Please see Appendix A for a detailed measure listing.

FIGURE 22: MEASURES INSTALLED THROUGH THE PROCESS EFFICIENCY PROGRAM, 2017

Type	Number	MWh	kW
Compressed Air	2,221	5,911,561	710.5
HVAC	9	4,061,489	650.0
Lighting	2,596	559,866	81.7
Misc. Motors	7	2,729,795	289.8
Process	22	31,070,813	3,129.1
Refrigeration	367	2,129,977	73.0
Total	**5,222**	**46,463,501**	**4,934.1**

Energy and demand savings in the Process Efficiency program were individually computed for each measure in each project using methodologies consistent with the Draft Ohio TRM.

The Company's Action Plan goals for 2017 were 42.0 GWh of savings in energy consumption and 7.0 MW of savings from peak demand. Figure 23 below shows the Process Efficiency program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 23: PROCESS EFFICIENCY PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	46.5	42.0	110.7%
Demand Savings (MW)	4.9	7.0	70.0%
Program Costs ($M)	3.8	3.9	97.4%
First Year Cost per kWh Saved (¢)	8.2	9.3	88.0%

The Process Efficiency program met its energy savings goals for 2017, but missed its demand goal. The program saved 46.5 GWh of energy, 10.7 percent above goal. The program also reduced peak demand by 4.9 MW, 30.0 percent below goal. The program came in below budget in 2017 at $3.8 million, yielding an average first year cost of 8.2 cents per kWh saved.

SELF DIRECT

This program is designed for large customers able to internally administer their own energy management initiatives. Participants design their own energy efficiency programs and submit an application documenting their energy savings. Customers may apply for inclusion in the Self Direct program up to three years after implementing their energy efficiency measures. All applications are subject to approval by both Ohio Power and the Commission. If approved, participants may either receive a one-time payment, up to 75 percent of an equivalent incentive under the Efficient Products for Business or Process Efficiency programs, or an equivalent EE/PDR rider exemption. (The accounts may not participate in any other EE/PDR programs while under such an exemption.)

Participation in this program is limited to mercantile customers. In 2017, Ohio Power submitted 63 Self Direct applications to the Commission. Figure 24 below shows which measures were installed under these projects. A single project may involve multiple measures. For a detailed measure listing, see Appendix A.

FIGURE 24: MEASURES INCENTED THROUGH SELF DIRECT PROGRAM, 2017

Type	Number	MWh	kW
Compressed Air	8,751	220,314	30.5
Comm. Kitchen	13	35,976	5.3
HVAC	216	2,398,470	316.2
Controls	107,640	223,645	7.6
Lighting	99,143	2,628,072	349.9
Misc. Motors & Process	12	933,315	148.2
Refrigeration	62	93,702	8.7
Total	**215,837**	**6,533,494**	**866.5**

Energy and demand savings in the Self-Direct program are calculated using the same methods employed in the Efficient Products for Business and Process Efficiency programs.

AEP Ohio's Action Plan goals for 2017 were 13.2 GWh of savings in energy consumption and 1.9 MW of savings from peak demand. Figure 25 below shows the Self Direct program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 25: SELF DIRECT PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	6.5	13.2	49.2%
Demand Savings (MW)	0.9	1.9	47.4%
Program Costs ($M)	0.8	0.8	100.0%
First Year Cost per kWh Saved (¢)	12.3	6.1	203.1%

The Self Direct program did not meet either its energy or demand savings goals in 2017. The program saved 6.5 GWh of energy, 50.8 percent below goal. The program also reduced peak demand by 0.9 MW, which is 52.6 percent below the target level. The program came in at budget at $0.8 million, yielding an average first year cost of 12.3 cents per kWh saved.

BUSINESS NEW CONSTRUCTION

This program targets non-residential customers who are either building new facilities or making major renovations to existing sites, encouraging building owners, designers, and architects to exceed requirements in current construction practices and codes—specifically, measures that exceed the ASHRAE 90.1-2010 minimum requirements. Because of the lag time associated with new construction, any project certified before the ASHRAE 90.1 2010 code adoption were required to exceed the former ASHRAE 90.1 2007 requirements. The program includes incentives for the installation of high-efficiency lighting, HVAC systems, building envelopes, industrial refrigeration equipment, and other equipment and controls. The New Construction program offers three tracks: prescriptive and custom, similar to what is offered in those respective programs, plus a "whole building" approach based on building simulation modeling. All non-residential customers building new facilities are eligible to participate.

There were 129 New Construction projects completed in 2017. Figure 26 below shows which measures were installed under these construction projects. A single project may involve multiple measures. A detailed measure list is available in Appendix A.

FIGURE 26: MEASURES INSTALLED THROUGH BUSINESS NEW CONSTRUCTION PROGRAM, 2017

Type	Number	MWh	kW
Agriculture	263	503,681	128.4
Compressed Air	3	148,500	1.8
Comm. Kitchen	21	40,032	4.3
HVAC	538	1,725,843	410.1
Controls	158,073	182,074	67.0
Lighting	3,978,975	25,737,734	3,030.8
Other	162	790,614	105.3
Whole Building Models	20	11,800,340	2,973.4
Process	12	1,128,376	119.3
Refrigeration	72	2,468,270	330.7
Shell Upgrades	4	161,603	16.8
Total	**4,138,143**	**44,687,067**	**7,187.7**

Energy and demand savings were calculated using the same methods as employed in the Efficient Products for Business and Process Efficiency programs, the ENERGY STAR® website, or with simulation calculations in projects using whole building models.

The Company's Action Plan goals for 2017 were 27.6 GWh of savings in energy consumption and 6.2 MW of savings from peak demand. Figure 27 below shows the New Construction program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 27: BUSINESS NEW CONSTRUCTION PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	44.7	27.6	162.0%
Demand Savings (MW)	7.2	6.2	116.1%
Program Costs ($M)	4.2	5.9	71.2%
First Year Cost per kWh Saved (¢)	9.4	21.4	44.0%

The Business New Construction program exceeded both its energy and demand savings goals for 2017. The program saved 44.7 GWh of energy, 62 percent over goal. The program also reduced peak demand by 7.2 MW, which equates to 16.1 percent above goal. The program was under budget this year at $4.2 million, yielding an average first year cost of 9.4 cents per kWh saved.

EXPRESS

This program provides a streamlined, one-stop, turn-key energy efficiency service for small businesses. The program implementer first conducts a free on-site assessment to identify potential energy-saving opportunities. Based on recommendations from this assessment the implementer provides the participant with a proposal for installing energy efficiency measures. If the customer approves, the implementer then hires local contractors to perform the installation work. Once the work is completed, and after the customer has signed off on the work performed, the implementer bills the participant directly, after applying incentives from AEP Ohio. Incentive levels are generally higher in this program than in the Efficient Products for Business or Process Efficiency programs, up to 80 percent of project cost. This program is designed for small business customers with annual energy consumption levels no greater than 200 MWh or peak billing demands no higher than 100 kW.

Figure 28 below shows the number of measures installed through the Express program. Again, a single project may involve multiple measures. In total, there were 422 projects completed. See Appendix A for a complete listing of installed measures.

FIGURE 28: MEASURES INSTALLED THROUGH EXPRESS PROGRAM, 2017

Type	Number	MWh	kW
Delamping	88	47,809	7.3
LEDs	20,163	8,010,947	1,089.6
T5/T8	257	46,996	12.7
Exit Signs	394	117,741	11.2
Controls	263	39,840	0.0
Refrigeration	547	1,032,328	113.1
Total	**21,712**	**9,295,660**	**1,233.9**

Due to the granularity with respect to small business types, energy and demand savings are calculated using the New York TRM.[12]

The Company's Action Plan goals for 2017 were 14.4 GWh of savings in energy consumption and 3.7 MW of savings from peak demand. Figure 29 below shows the Express program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

[12] New York State Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Programs*, version 2, December 10, 2014.

FIGURE 29: EXPRESS PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	9.3	14.4	64.6%
Demand Savings (MW)	1.2	3.7	32.4%
Program Costs ($M)	2.1	3.6	58.3%
First Year Cost per kWh Saved (¢)	22.6	25.0	90.3%

The Express program fell short of its energy and demand savings goals for 2017. The program saved 9.3 GWh of energy, 35.4 percent below goal. The program also reduced peak demand by 1.2 MW, 67.6 percent below its goal. The program came in below budget at $2.1 million, yielding an average first year cost of 22.6 cents per kWh saved.

RETRO-COMMISSIONING

Differing from the capital-improvement-oriented programs above, Retro-Commissioning (RCx) seeks to reduce energy use through low-cost or no-cost operational changes and improve the efficiency of buildings' existing systems. It is a service-based incentive where the customer benefits from receiving a study that identifies inefficiencies in their building's operation. The program targets medium to large commercial business customers that have a building automation system.

The program offers two tracks for customers: *RCx Standard* or *RCx Lite.* The RCx Standard offering is available to eligible customers with at least 150,000 square feet and a peak demand of at least 500 kW. The customer receives a program-funded comprehensive RCx study of their facility in exchange for the customer to commit to spending a set amount towards implementing recommendations identified in the study. The RCx Lite offering is a more streamlined study made available to facilities between 50,000 and 150,000 square feet and peak demand of at least 125 kW. This study is also offered to the customer at no cost if the customer commits a certain amount to implementing recommendations from the study. Both tracks also provide verification results to the customer.

Figure 30 below shows which measures were implemented through the Retro-Commissioning program. A single project may involve multiple measures. In total, there were 19 projects completed in 2017. See Appendix A for a complete list of implemented measures.

FIGURE 30: MEASURES IMPLEMENTED THROUGH RETRO-COMMISSIONING PROGRAM, 2017

Type	Number	MWh	kW
HVAC Equip. Optimization	26	1,608,260	7.0
Other HVAC	56	2,804,782	7.0
Misc Equip Optimization	7	327,039	0.0
Total	**89**	**4,740,081**	**14.0**

Energy and demand savings were modeled individually for each project by the program implementer. Draft Ohio TRM calculations are unavailable.

AEP Ohio's Action Plan goals for 2017 were 8.6 GWh of savings in energy consumption and 0 MW of savings from peak demand. Figure 31 below shows the Retro-Commissioning program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 31: RETRO-COMMISSIONING PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	4.7	8.6	54.7%
Demand Savings (MW)	0.0	0.0	155.6%
Program Costs ($M)	0.8	1.0	80.0%
First Year Cost per kWh Saved (¢)	17.0	11.6	146.4%

The Retro-Commissioning program missed its energy savings goal but exceeded its demand goal in 2017. The program saved 4.7 GWh of energy, 45.3 percent below goal. The program reduced peak demand by .01 MW, 55.6 percent above goal. The program came in under budget at $0.8 million, yielding an average first year cost of 17.0 cents per kWh saved.

CONTINUOUS ENERGY IMPROVEMENT

The Continuous Energy Improvement program (CEI) is designed to target industrial customers using more than 3 GWh per year and institutional facilities. Like Retro-Commissioning, CEI focuses on low-cost or no-cost measures to reduce usage, primarily through system efficiency and process optimization. Participants join a targeted cohort of 10 to 20 companies, with care taken to avoid placing competitors in the same cohort, to protect participants' trade secrets. Each participant designates an internal team to act as *energy champions* and coordinate efforts within their companies to implement changes. Over a period of one year, energy champions attend workshops and work closely with program implementers to understand how their

facilities' loads change and identify opportunities for reducing energy usage. Program implementers, using information on electric consumption, weather, and participants' internal metrics (such as production levels), develop a predictive model of energy usage for each participant. Subsequent usage levels below model predictions are counted as savings. First-year energy savings pay an incentive of 2 cents per kWh.

At the close of 2017, there were 23 participating customers with a combined 37 accounts in two cohorts in the CEI program. Savings were estimated based on individual regression models for each participant and, in some cases, multiple premises.

The Company's Action Plan goals for 2017 were 19.8 GWh of savings in energy consumption and 0.4 MW of savings from peak demand. Figure 32 shows the CEI program's energy savings, demand savings, program costs, and average cost per first-year energy savings during calendar year 2017.

FIGURE 32: CONTINUOUS ENERGY IMPROVEMENT PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	24.6	19.8	124.2%
Demand Savings (MW)	3.4	0.4	850.0%
Program Costs ($M)	2.2	2.5	88.0%
First Year Cost per kWh Saved (¢)	8.9	12.6	70.8%

The CEI program met its energy and demand savings goals for 2017. The program saved 24.6 GWh of energy, 24.2 percent above the target level. The program saved 3.4 MW in energy demand. The program came in slightly below its budget at $2.2 million, yielding a first year cost of 8.9 cents per incremental kWh saved.

DATA CENTER

The Data Center program is a capital improvement program specially geared toward the unique needs of business IT operations and space. Such equipment can be highly energy-intensive, incorporate heavy HVAC loads, and have strict uptime requirements. Measures covered under this program may include ENERGY STAR® servers and telecommunications equipment; high-efficiency uninterruptable power supplies; high-efficiency power rectifiers; server virtualization; high-efficiency computer room air conditioner units; variable-speed drives on chilled water pumps; and airflow management and controls to optimize data center cooling. An additional track covers IT load growth when measured against an industry standard baseline.

Figure 33 below shows which measures were implemented through the Data Center program. A single project may involve multiple measures. In total, there were 11 projects completed. Please see Appendix A for a complete list of installed measures.

FIGURE 33: MEASURES INSTALLED THROUGH DATA CENTER PROGRAM, 2017

Type	Number	MWh	kW
HVAC	170	622,286	62.7
IT Equipment	269	3,210,010	366.4
Whole Building Model	3	27,159,675	3,304.5
Energy Mgt. System	2	188,304	367.6
Total	**444**	**31,180,275**	**4,101.2**

Energy and demand savings were modeled individually for each project by the program implementer.

The Company's Action Plan goals for 2017 were 16.6 GWh of savings in energy consumption and 1.5 MW of savings from peak demand. Figure 34 below shows the Data Center program's energy savings, demand savings, program costs, and average cost per first year energy savings during calendar year 2017.

FIGURE 34: DATA CENTER PROGRAM SUMMARY, 2017

	Actual	Goal	Percent of Goal
Energy Savings (GWh)	31.2	16.6	188.0%
Demand Savings (MW)	4.1	1.5	273.3%
Program Costs ($M)	2.4	2.3	104.3%
First Year Cost per kWh Saved (¢)	7.7	13.9	55.5%

The Data Center Program exceeded both its energy and demand savings goals for 2017. The program saved 31.2 GWh of energy, 88.0 percent above goal. The program also reduced peak demand by 4.1 MW, 173.3 percent above the goal. The program came in slightly over budget at $2.4 million, yielding an average first year cost of 7.7 cents per kWh saved.

CUSTOMER OUTREACH CHANNELS

ENERGY EFFICIENCY AUCTION

The Energy Efficiency Auction is a unique reverse auction in which pre-qualified non-residential customers and solution providers can submit bids to deliver energy savings at a price per annual kilowatt hour saved or watts reduced, either at a single site or spread out among multiple sites. The Energy Efficiency Auction is ideal for larger projects. Bidding processes are conducted online, with competing bids placed in real time and the winning bid being that with the lowest cost per kilowatt-hour. The participant or participants with the winning bid or bids are then eligible to receive incentive payments for their projects' completion

at the winning price. Auctions are typically conducted in the fall of the year for projects to be submitted through the Efficient Products for Business or Process Efficiency program during the following calendar year.

Because the projects are submitted to the Efficient Products for Business or Process Efficiency program using auction incentive pricing, the energy and demand savings from these projects were evaluated in those programs. The auction simply serves as a pricing vehicle for these larger projects. The energy efficiency auction follows the standard Efficient Products for Business and Process Efficiency policies and procedures therefore, AEP Ohio is not submitting a separate evaluation report for this pricing alternative.

Figure 35 below shows which measures utilized the Energy Efficiency Auction. A single project may involve multiple measures. In total, there were 78 projects completed. These savings are captured in the Efficient Products for Business and Process Efficiency programs. This figure is for informative purposes only.

FIGURE 35: MEASURES INSTALLED THROUGH ENERGY EFFICIENCY AUCTION, 2017

Type	Number	MWh	kW
Compressed Air	3	2,850,853	282.7
Comm. Kitchen	9	14,517	0.0
HVAC	242,259	3,568,793	637.0
Lighting Controls	87,488	87,652	7.0
Advanced Lighting	201,805	330,529	39.5
Lighting	64,400	15,979,081	2,373.9
Misc. Motors	16	2,404,493	241.6
Process	16	28,940,366	2,980.5
Refrigeration	1,298	1,756,393	155.7
Total	**597,294**	**55,932,676**	**6,718.0**

Energy and demand savings in the Energy Efficiency Auction are calculated using the same methods employed in the Efficient Products for Business and Process Efficiency programs.

AGRICULTURE

The main focus of the Agriculture Outreach is targeted outreach to the agricultural customers in AEP Ohio's service territory. The agricultural community is hard to reach, particularly residential farms, which may not be identified as such in AEP Ohio customer information. The agricultural market sector has not had strong historical participation with the EE/DR program, and will be approached through an outreach strategy that demonstrates understanding of the agricultural business and concerns.

Because the projects are submitted to the Efficient Products for Business, Process Efficiency, or New Construction program through the standardized application process, the energy and demand savings from these projects were evaluated in those programs. The Agriculture outreach follows the standard policies and procedures of the business programs, thus AEP Ohio is not submitting a separate evaluation report.

Figure 36 below shows which measures were utilized through the Agriculture outreach. A single project may involve multiple measures. In total, there were 11 projects completed. The savings for these measures are captured in the Efficient Products for Business, Process Efficiency, and Business New Construction programs. This figure is for informative purposes only.

FIGURE 36: MEASURES INSTALLED THROUGH AGRICULTURE OUTREACH, 2017

Type	Number	MWh	kW
Agriculture	128	123,146	29.5
Lighting Controls	11,000	6,510	0.4
Lighting	28,763	527,606	82.7
VFD	54	80,823	8.7
Process	1	17,968	0.0
Total	**39,946**	**756,053**	**121.4**

Energy and demand savings in the Agriculture outreach are calculated using the same methods employed in the Efficient Products for Business, Process Efficiency, and Business New Construction programs.

TRANSMISSION AND DISTRIBUTION PROJECTS

Inherent in the operation of any electric power system is the electrical resistance of its various elements, such as conductors, transformers, or regulators. The greater the distance the power must travel from generation to end use, the greater the amount of power lost in this transfer. The Ohio Revised Code allows a utility to include transmission and distribution infrastructure improvements to reduce line losses to meet benchmarks[13], and T&D projects are a major part of Ohio Power's plan for compliance. These projects include reconductoring, substation improvements, capacitor bank installation, and voltage regulator replacement.

[13] Ohio Revised Code § 4928.66(A)(2)(d).

- **Reconductoring** projects involve the replacement of existing wires with improved wires designed for lower losses at transmission or distribution voltages, lowering the system's resistance and the power lost over transmission to the end-user.
- **Substation improvements** typically include connecting previously unconnected T&D lines and the addition or upgrade of transformers and circuits, balancing loads between circuits, changing lines to multi-phase current, or the construction of altogether new substations. Such projects improve efficiency and reduce load losses by adding new transformation points closer to customers' loads. A greater portion of energy is carried in higher-voltage transmission lines than lower-voltage distribution lines.
- **Capacitor banks** reduce losses by improving system power factors closer to 100 percent.
- **Voltage regulators** assist in maintaining delivery voltage within the Commission's guidelines.

AEP Ohio had 13 distribution projects and 15 transmission projects completed in 2017 related to energy efficiency and peak demand reduction. These improvements prevented the loss of 31.5 GWh of energy and lowered peak demand by 8.6 MW. The report in Appendix Q contains a complete list of the Company's 2017 T&D projects and their estimated impacts.

Recommendations to the Commission

Residential Programs

Efficient Products

In 2017, AEP Ohio rebated various LED light bulbs via retailers and the online lighting store with strong energy savings results and high customer satisfaction. AEP Ohio will continue aggressive promotional tactics centered on LED awareness and education. ENERGY STAR® certified appliances such as clothes washers, freezers, dehumidifiers, refrigerators, HVAC and electric heat pump water heaters will continue to be rebated. High efficiency pool pumps have been added. In addition, the free online energy profile (home assessment) and direct install for multi-family units were rolled into this program because In-Home Energy program was discontinued. AEP Ohio recommends that the program continue as described in the Plan.

Appliance Recycling

A new vendor was selected for 2017-2020 and implementation has been completed and the program ran smoothly. AEP Ohio elected to increase the customer incentive from $35 to $50 and saw significant participation increase. AEP Ohio recommends the program continue as described in the Plan with the addition to add 4 LED bulbs to participants opting in to increase energy savings for efficient products, educate customers on LED's and meet customer expectations.

In-Home Energy

The 2016 results showed that the program was not a cost effective way to drive energy savings. AEP Ohio merged some components of In-Home Energy program with Efficient Products in 2017. AEP Ohio elected to sunset the program in 2017 to meet overall Plan budget cap requirements. AEP Ohio will look at ways to improve cost effectiveness and may re-establish the program if sufficient budget within the cap is available and cost effectiveness can be projected.

Community Assistance

This program, like previous years, provides low income customers energy saving measures to reduce energy costs and provide more comfort. Any customers who are enrolled in the Percentage of Income Payment Plan (PIPP), Home Weatherization Assistance Plan (HWAP) or Home Energy Assistance Program (HEAP) are eligible to participate in AEP Ohio's Community Assistance Program. In 2017, AEP Ohio returned to having a third party manage the program as described in the stipulation filed with the Plan. AEP Ohio recommends continuing this program as described in the Plan.

EFFICIENCYCRAFTED[SM] NEW HOMES

In 2017 the AEP Ohio EfficiencyCrafted[SM] Homes Program had a very successful year with more builders joining the program. AEP Ohio and Columbia Gas of Ohio no longer share the same vendor to manage the program; however both utilities work together to promote the program. Builders continue to have high satisfaction with the program and AEP Ohio recommends the program continue as described in the Plan.

HOME ENERGY REPORTS

In 2017, AEP Ohio provided home energy reports to over 500,000 customers. This program provides an opportunity to educate our customers on all of the residential energy efficiency programs they can participate in and change behavior to use energy wisely. AEP Ohio recommends the program continue as described in the Plan.

e³smart[SM]

This program continues to receive high satisfaction from teachers and students with over 350 teachers involved. AEP Ohio receives numerous letters from students thanking us for the program and educating them on energy efficiency. AEP Ohio recommends the program continue as described in the Plan.

BUSINESS PROGRAMS

EFFICIENT PRODUCTS FOR BUSINESS

The Efficient Products for Business program began June 1, 2009, focused in the first year on prescriptive lighting only. In addition and according to the Plan, AEP Ohio expanded the list of prescriptive measures in 2010 under this program beyond lighting, to include HVAC, motors, drives and other cost effective measures to simplify and market this program effectively. Over 200 prescriptive measures are currently offered. After a successful pilot, "Advanced Lighting Controls" were added to the program. In the 2017-2020 approved Plan, the Prescriptive Program was renamed the Efficient Products for Business Program to better characterize the nature of the program to AEP Ohio customers. AEP Ohio recommends that the program continue as described in the Plan.

PROCESS EFFICIENCY

The Process Efficiency program is designed to be a "kitchen sink" program to handle customer energy efficiency projects not addressed through other business programs. Target segments may also be explored to engage more non-participants in AEP Ohio programs. Each targeted

marketing effort will be monitored and listed as a subset of the Process Efficiency Program to track performance and participation. Since 2011, measures which show increased usage as technology develops, such as LED lighting, are moved to the Efficient Products for Business Program to remove barriers to participation. In the 2017-2020 approved Plan, the Process Efficiency Program was renamed to Process Efficiency to better characterize the nature of the program to AEP Ohio customers. AEP Ohio recommends that the program continue as described in the Plan.

Demand Response

The demand response program is used to supplement the peak demand reductions achieved from EE/PDR programs. AEP Ohio recommends that the program continue as described in the Plan.

Self Direct

This program has achieved significant impacts and participation since 2009. The Self Direct program has also helped drive participation in other programs through its unique allowance of previously completed projects and the option of either the payment of an energy efficiency credit or an exemption from the EE/PDR Rider. AEP Ohio recommends that the program continue as described in the Plan.

Business New Construction

The Business New Construction program started in 2011 with strong participation. In 2013 through 2017, participation continued to increase as customer recognition of the program increased. New construction continues to increase as the economy stabilizes and energy savings from new construction is a good opportunity for long-lived savings. AEP Ohio recommends that the program continue as described in the Plan.

Express

The Express program changed in 2012 from a program marketed by local contractors, to a program with dedicated program marketing staff that would present signed contracts and materials to local contractors for installation. Results from 2017 continue to be positive as customer knowledge of the program increases. AEP Ohio recommends that the program continue as described in the Plan.

Retro-Commissioning

The Retro-Commissioning program seeks to obtain energy savings through the identification and implementation of low-cost, operational adjustments that improve the efficiency of existing

buildings' operating systems by optimizing the systems to meet the building's requirements, with a focus on building controls and HVAC systems. Program enhancements in 2015 allow customers to better understand the costs and energy savings and has increased participation over 2013-2014. The 2016 results showed that the program was not very cost effective. AEP Ohio sunset the program in 2017. AEP Ohio will look at ways to improve cost effectiveness and re-establish the program.

Continuous Energy Improvement

The Continuous Energy Improvement program was a new program launched in early 2013. This program seeks to facilitate a comprehensive and enduring strategic approach to energy reduction at key customer facilities. Strong enlistment throughout 2013 indicated high acceptance of the program. In 2014, the first groups (cohorts) participated with exceptional no cost/low cost operational savings and very high satisfaction with the program. In 2015 through 2017, new groups of participants were enrolled yielding similar high satisfaction as the initial participants have experienced. Savings for this group of participants was strong when counted in 2016. AEP Ohio recommends that the program continue as described in the Plan.

Data Center

The Data Center program was a new program launched in early 2013. This program is designed to assist customers in addressing energy efficiency opportunities in both new and existing data centers (facilities used to house computer systems and associated components). Activity with data centers in 2013 indicated good acceptance of the program. In 2014, activity was expanded for medium size data rooms and smaller data closets. New enterprise size data centers expansion in 2015 through 2017 accounted for strong participation. AEP Ohio recommends that the program continue as described in the Plan.

New and Emerging Programs

New Energy Efficient Manufactured Home

This program was introduced in 2017 and did not meet year-end energy targets. This type of program takes time to generate and build manufacturer and retailer relationships to promote the program and its benefits to the buyers. Once this program gets established results will follow. AEP Ohio recommends that the program continue, with the modifications detailed in the Residential section.

Intelligent Home & DR

AEP Ohio launched its Intelligent Home and DR program titled "It's Your Power" in 2017, after initial piloting in 2016. The program offers real time measurement of AMI metered customers through an innovative mobile phone app and energy bridge in the customer's home. The app also disaggregates the various types of usage in the home and provides customers the opportunity to control usage through smart thermostats, switches, plugs and sensors for energy savings and convenience. The startup, roll out and complexity of this program has required AEP Ohio to move the program back to an R&D effort for at least a portion of 2018. It is expected that the program will move back to program status in 2018. AEP Ohio recommends the program continue as described in the Plan.

Combined Heat and Power/Waste Energy Recovery

A new program launched in 2017 after two successful CHP projects were filed in 2015 under the Custom Program following passage of SB 315. In 2017, several applications for CHP were received and projects started, however no projects operated beyond start-up to be able to quantify participation, savings, and incentives.

SUPPORTING AFFIDAVIT

AFFIDAVIT OF JON F. WILLIAMS

State of Ohio :
: ss
County of Franklin :

Jon F. Williams, being first duly cautioned and sworn, states as follows:

1. I am the Director of Distribution Technology & Innovation for AEP Ohio.

2. I am responsible for the design, development and implementation of customer programs relating to Energy Efficiency (EE) and Peak Demand Reduction (PDR) for AEP Ohio, including overseeing compliance with the EE/PDR mandates of Senate Bill 310 (S.B. 310) and the rules adopted by the Public Utilities Commission of Ohio (Commission) for inclusion in Ohio Administrative Code Chapter 4901:1-39 (Green Rules).

3. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio's energy baseline to be used for the 2017 reporting year is 38,529.5 GWh.

4. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio's 1.00% EE benchmark for the 2017 reporting year is 385.3 GWh.

5. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio complied with the EE benchmark for the 2017 reporting year.

6. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio's demand baseline to be used for the 2017 reporting year is 7,811.3 MW.

7. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio's 7.00% PDR benchmark for the 2017 reporting year is 546.8 MW. On that basis, AEP Ohio could achieve compliance for 2017 by either implementing programs (including programs offered through a tariff) designed to achieve a

cumulative peak demand reduction of 546.8 MW in 2017 or if peak demand is less than 7264.5 MW (*i.e.*, 7,811.3 MW less 546.8 MW).

8. Based on my understanding of S.B. 310 and the Commission's Green Rules, AEP Ohio complied with the PDR benchmark for the 2017 reporting year.

FURTHER AFFIANT SAYETH NAUGHT.

Jon F. Williams

Sworn to before me and subscribed in my presence this 11 day of May, 2018.

Notary Public

PAULA S. IGO
Attorney At Law
Notary Public, State of Ohio
My commission has no expiration date
Sec. 147.03 R.C.

TABLE OF APPENDICES

APPENDIX A

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2017**

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products[1]	Specialty LED 2 Watt	Light bulb	5	22.5	0.0040	112.4	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 3 Watt	Light bulb	2,680	21.5	0.0038	57,629.3	10.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 4 Watt	Light bulb	17,515	35.2	0.0063	616,308.7	109.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 5 Watt	Light bulb	58,448	34.2	0.0061	1,999,509.0	356.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 6 Watt	Light bulb	27,212	33.2	0.0059	904,326.1	161.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 7 Watt	Light bulb	19,388	32.3	0.0057	625,363.6	111.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 8 Watt	Light bulb	61,283	50.8	0.0091	3,114,791.8	555.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 9 Watt	Light bulb	31,937	49.8	0.0089	1,592,025.3	283.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 10 Watt	Light bulb	71,163	48.9	0.0087	3,477,842.6	619.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 11 Watt	Light bulb	122,721	62.6	0.0111	7,676,876.0	1368.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 12 Watt	Light bulb	77,219	61.6	0.0110	4,754,998.5	847.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 13 Watt	Light bulb	7,966	60.6	0.0108	482,744.9	86.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 14 Watt	Light bulb	17,684	59.6	0.0106	1,054,377.2	187.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 15 Watt	Light bulb	7,232	58.6	0.0105	424,126.4	75.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 16 Watt	Light bulb	14,812	82.1	0.0146	1,216,126.2	216.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 17 Watt	Light bulb	321	81.1	0.0145	26,041.7	4.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 18 Watt	Light bulb	2,010	80.1	0.0143	161,100.0	28.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 3.7 Watt	Light bulb	2	35.5	0.0063	71.0	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 3.8 Watt	Light bulb	10	35.4	0.0063	353.8	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4 Watt	Light bulb	7,513	24.4	0.0044	183,585.8	32.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4.2 Watt	Light bulb	4	35.0	0.0062	140.0	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4.5 Watt	Light bulb	1	34.7	0.0062	34.7	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4.7 Watt	Light bulb	6,857	23.7	0.0042	162,674.4	29.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 5 Watt	Light bulb	26,279	24.2	0.0043	635,051.9	113.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 5.5 Watt	Light bulb	7	23.0	0.0041	160.8	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 6 Watt	Light bulb	64,062	22.5	0.0040	1,440,192.3	256.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 7 Watt	Light bulb	59,121	21.5	0.0038	1,271,338.3	226.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 8 Watt	Light bulb	32,407	34.2	0.0061	1,108,438.9	197.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 9 Watt	Light bulb	1,589,538	33.0	0.0059	52,491,292.8	9355.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 9.5 Watt	Light bulb	24	32.7	0.0058	785.9	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 10 Watt	Light bulb	285,401	32.3	0.0057	9,204,181.7	1640.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 11 Watt	Light bulb	17,338	13.3	0.0024	231,451.5	41.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 11.5 Watt	Light bulb	1	62.1	0.0111	62.1	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 12 Watt	Light bulb	11,815	40.1	0.0071	473,481.8	84.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 13 Watt	Light bulb	3,525	39.1	0.0070	137,817.6	24.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 14 Watt	Light bulb	5,866	38.1	0.0068	223,610.6	39.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 15 Watt	Light bulb	55,727	37.1	0.0066	2,069,831.2	368.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 16 Watt	Light bulb	17,369	54.7	0.0098	950,327.8	169.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 17 Watt	Light bulb	2,443	53.7	0.0096	131,278.6	23.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 18 Watt	Light bulb	1,506	52.8	0.0094	79,488.5	14.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Room Air Purifiers	Air purifier	246	49.8	0.0074	12,242.3	1.8	NEEP Technical Reference Manual - page 234
	Clothes Washer Tier 1/2	Washer	5,039	202.0	0.0568	1,017,070.0	143.0	Draft Ohio 2010 Technical Reference Manual - Page 59
	Clothes Washer Tier 3	Washer	1,807	233.0	0.0327	420,332.0	59.1	Draft Ohio 2010 Technical Reference Manual - Page 59
	Dehumidifier > 25 to ≤35 Pints/Day	Dehumidifier	30	117.0	0.0270	3,510.0	0.8	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 54 to ≤ 75 Pints/Day	Dehumidifier	15	213.0	0.0480	3,195.0	0.7	Draft Ohio 2010 Technical Reference Manual - Page 64

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2017**

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products[1]	Dehumidifier > 35 to ≤45 Pints/Day	Dehumidifier	108	297.0	0.0680	32,076.0	7.3	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 45 to ≤ 54 Pints/Day	Dehumidifier	164	185.0	0.0420	30,340.0	6.9	Draft Ohio 2010 Technical Reference Manual - Page 64
	Refrigerator - Energy Star Bottom Freezer	Refrigerator	3,443	119.0	0.0210	409,598.0	72.3	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Energy Star Side-by-side	Refrigerator	489	142.0	0.0250	69,438.0	12.2	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Energy Star Top Freezer	Refrigerator	868	99.9	0.0180	86,700.0	15.6	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - CEE Tier 2 Bottom Freezer	Refrigerator	261	149.0	0.0260	38,889.0	6.8	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - CEE Tier 2 Side-by-side	Refrigerator	3	177.0	0.0310	531.0	0.1	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Energy Star	Refrigerator	335	38.5	0.0179	12,900.0	6.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Energy Star Compact	Refrigerator	46	35.3	0.0180	1,624.9	0.8	Draft Ohio 2010 Technical Reference Manual - Page 53
	Heat Pump Water Heater - Electric Heat	Heat pump	66	499.0	0.0701	32,934.0	4.5	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Heat Pump	Heat pump	140	1297.0	0.1800	181,580.0	25.2	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Gas Heat	Heat pump	194	2076.0	0.2669	402,744.0	50.7	Draft Ohio 2010 Technical Reference Manual - Page 86
	Smart Thermostat	Thermostat	8,224	276.5	0.0694	2,273,985.8	570.9	IL - Illinois Technical Reference Manual- - Page 152
	Air Conditioner	Air conditioner	1,609	285.0	0.2158	458,541.0	347.2	Draft Ohio 2010 Technical Reference Manual - Page 30
	Air Conditioner Early Replacement	Air conditioner	19	624.7	0.4431	11,869.4	8.4	Draft Ohio 2010 Technical Reference Manual - Page 78
	Air Sealing	Unit	7	299.2	0.0052	2,094.6	0.0	Draft Ohio 2010 Technical Reference Manual - Page 104
	Air Source Heat Pump	Heat pump	301	588.3	0.1768	177,088.4	53.2	Draft Ohio 2010 Technical Reference Manual - Page 33
	Air Source Heat Pump Early Replacement	Heat pump	16	1706.0	0.3909	27,296.4	6.3	Draft Ohio 2010 Technical Reference Manual - Page 33
	Attic Insulation	Unit	9	260.0	0.0050	2,340.0	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	CFL - Regular - 13w TCP Eco$ave Spiral	Light bulb	91	24.0	0.0029	2,186.5	0.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL - Regular - 23w TCP Eco$ave Spiral	Light bulb	22	42.7	0.0051	939.8	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL - Specialty - 16w TCP R30 Dimmable	Light bulb	34	28.9	0.0035	980.9	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL - Specialty - 9w TCP Globe Lamp 1G25	Light bulb	26	16.6	0.0020	432.5	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Ductless Mini-Split	Heat pump	80	1337.7	0.1378	107,012.0	11.0	Draft Ohio 2010 Technical Reference Manual - Page 33
	Ground Source Heat Pump	Heat pump	23	3343.4	0.4420	76,898.0	10.2	Draft Ohio 2010 Technical Reference Manual - Page 82
	Faucet Aerators	Faucet aerator	15,103	7.5	0.0009	112,698.4	14.1	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerheads	Low flow showerhead	8,116	101.1	0.0129	820,843.0	105.0	Draft Ohio 2010 Technical Reference Manual - Page 93
	LED Night Light	Night light	24,944	21.0	0.0005	524,488.1	12.5	Based on 2012 Navigant Evaluation Result
	7-Plug Smart Strip	Smart strip	4,355	102.8	0.0092	447,622.7	40.1	Draft Ohio 2010 Technical Reference Manual - Page 76
	TOTAL					**106,782,973**	**19,233.7**	
	[1]Energy and Demand savings for the inactive AEP Ohio customers are zeroed out							
Appliance Recycling	Freezer	Freezer	2,570	1,244.4	0.2000	3,198,108.0	514.0	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator	Refrigerator	11,038	1,376.2	0.2200	15,189,943.7	2,428.4	Draft Ohio 2010 Technical Reference Manual - Page 23
	TOTAL					**18,388,052**	**2,942.4**	
Efficiency Crafted New Homes	Energy Star Home	Energy Star home	1,762	3,007.2	1.5618	**5,298,604.0**	**2,751.9**	Residential Energy Modeling
New Manufactured Homes	New Manufactured Homes	Manufactured Home	5	6,900.0	2.6400	**34,500.0**	**13.2**	Residential Energy Modeling
E3Smart	HW Temp Setback	Temp setback	688	81.6	0.0090	56,140.8	6.2	Standard Engineering Calculation
	Bathroom Faucet Aerator	Faucet aerator	3,037	94.1	0.0117	285,675.3	35.6	Draft Ohio 2010 Technical Reference Manual - Page 89
	Kitchen Faucet Aerator	Faucet aerator	2,990	54.9	0.0068	164,065.0	20.5	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerhead	Low flow showerhead	3,739	237.0	0.0303	886,180.4	113.4	Draft Ohio 2010 Technical Reference Manual - Page 93
	11 Watt LED Replacing 13W CFL	Light bulb	716	2.2	0.0003	1,593.9	0.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED 23 Replacing 23W CFL	Light bulb	642	13.4	0.0016	8,575.1	1.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 40W	Light bulb	1,174	17.6	0.0031	20,655.1	3.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 60W	Light bulb	3,878	31.3	0.0056	121,295.2	21.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 75W	Light bulb	2,117	41.1	0.0073	86,907.2	15.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 100W	Light bulb	1,522	59.6	0.0106	90,746.6	16.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
E3Smart	9 Watt LED Replacing 13W CFL	Light bulb	1,794	4.5	0.0005	7,987.4	1.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 23W CFL	Light bulb	1,094	15.6	0.0019	17,047.7	2.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 40W	Light bulb	3,897	19.5	0.0035	76,180.9	13.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 60W	Light bulb	10,092	33.2	0.0059	335,383.6	59.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 75W	Light bulb	3,386	43.0	0.0077	145,621.4	26.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 100W	Light bulb	1,137	61.6	0.0110	70,014.3	12.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	LED Night Light	Light bulb	6,165	20.6	0.0000	126,937.4	-	Based on 2013 Navigant Evaluation Result
	Weather Stripping	Square foot	7,168	11.1	0.0008	79,564.8	5.7	Based on 2013 Navigant Evaluation Result
	Allocated Kits[2]	Kit	5,352	73.3	0.0060	392,194.6	32.2	Calculation based on Program Year data
	TOTAL					**2,972,766**	**386.46**	
	[2]These are kits that have not had returned surveys, so a reduced installation rate was assigned for these units							
Behavioral	Behavioral	Participant	550,209	140.0	0.0181	**76,771,950**	**9,980.0**	Proprietary Regression Model
	Cross Participation Reduction[3]	Participant	550,209	0.99	0.0001	(543,445)	(70.7)	Calculation based on Program Participation T-Tests
	TOTAL					**76,228,505**	**9,909.4**	
Low Income	Retirement of additional freezer	Freezer	3	1,244.0	0.2000	3,732.0	0.60	Draft Ohio 2010 Technical Reference Manual - Page 23
	Retirement of additional refrigerator	Refrigerator	4	1,376.0	0.2200	5,504.0	0.88	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 9-15 upright	Freezer	59	1,045.0	0.1750	61,655.0	10.33	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 16-18 upright	Freezer	280	1,045.0	0.1349	292,600.0	37.77	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 19-21 upright	Freezer	71	1,045.0	0.1349	74,195.0	9.58	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 5-10 Chest	Freezer	173	1,045.0	0.1349	180,785.0	23.34	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 11-15 Chest	Freezer	160	1,045.0	0.1349	167,200.0	21.58	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 16-20 Chest	Freezer	3	1,045.0	0.1349	3,135.0	0.41	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	RR05 Refrigerator replacement 14-16 TF	Refrigerator	377	976.0	0.1560	367,952.0	58.81	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	RR10 Refrigerator replacement 17-19 TF	Refrigerator	1,067	976.0	0.1560	1,041,392.0	166.45	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	RR15 Refrigerator replacement 20-22 TF	Refrigerator	501	976.0	0.1560	488,976.0	78.16	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	RR20 Refrigerator replacement 19-22 BF	Refrigerator	220	976.0	0.1560	214,720.0	34.32	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	RR25 Refrigerator replacement 20-23 SBS	Refrigerator	191	976.0	0.1560	186,416.0	29.80	
	RR30 Refrigerator replacement 24-26 SBS	Refrigerator	365	976.0	0.1560	356,240.0	56.94	Underlying Draft Ohio 2010 Technical Reference Manual - Page 23
	Miscellaneous approved items	Unit	8	-	0.0000	0.0	0.00	Health and Safety - No savings acquired
	Air Source Heat Pump	Heat pump	19	262.0	0.1138	4,977.3	2.16	Draft Ohio 2010 Technical Reference Manual - Page 33
	Central AC replacement	Air conditioner	7	164.2	0.0119	1,149.5	0.08	Draft Ohio 2010 Technical Reference Manual - Page 30
	DHW Temp Setback	Temp setback	17	146.0	0.0000	2,482.0	0.00	Based on 2012 Navigant Evaluation Result
	HVAC Tune Up	Unit	8	51.8	0.0000	414.6	0.00	Draft Ohio 2010 Technical Reference Manual - Page 26
	HW Tank Wrap	Unit	79	78.0	0.0089	6,162.0	0.70	Draft Ohio 2010 Technical Reference Manual - Page 131
	Install bathroom vent fan (Energy Star)	Fan	51	44.3	0.0101	2,259.3	0.52	NEEP TRM - Page 161
	Faucet Aerator	Faucet aerator	1,215	24.9	0.0031	30,282.0	3.79	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low flow showerhead	Low flow showerhead	892	53.3	0.0061	47,501.8	5.43	Draft Ohio 2010 Technical Reference Manual - Page 93
	Replace electric water heater	Water heater	84	571.7	0.0509	48,022.8	4.27	Draft Ohio 2010 Technical Reference Manual - Page 86
	Replace well pump	Well pump	1	157.0	0.0000	157.0	0.00	http://hes-documentation.lbl.gov
	Sump pump replacement	Sump pump	3	157.0	0.0000	471.0	0.00	http://hes-documentation.lbl.gov
	Smart Strips	Smart strip	1,668	82.1	0.0000	136,940.0	0.00	Draft Ohio 2010 Technical Reference Manual - Page 76
	CFL (60 watt replacement) outdoor	Light bulb	3	38.1	0.0000	114.2	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL (75 watt replacement) outdoor	Light bulb	(12)	(29.7)	0.0000	(89.1)	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL (100 watt replacement) indoor	Light bulb	26	33.4	0.0050	1,002.8	0.15	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL (3-way 150w max. replacement) indoor	Light bulb	(2)	(42.7)	(0.0070)	(85.4)	(0.01)	Based on Draft Ohio 2010 Technical Reference Manual - Page 11

[3]Cross Participation savings reduced from the program savings

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Low Income	CFL (40w candelabra replacement) indoor	Light bulb	3	16.2	0.0028	48.7	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL (60 watt replacement) indoor	Light bulb	3	1.2	0.0001	114.2	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	CFL (75 watt replacement) indoor	Light bulb	(3)	3.4	0.0007	148.6	0.03	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	LED (60 w replacement) indoor	Light bulb	32,219	33.1	0.0059	1,070,721.1	190.83	Based on Draft Ohio 2010 Technical Reference Manual - Page 12
	LED (100 w replacement) indoor	Light bulb	7,598	54.7	0.0098	415,884.9	74.12	Based on Draft Ohio 2010 Technical Reference Manual - Page 13
	LED (40 w candelabra replacement) indoor	Light bulb	7,528	23.4	0.0042	176,594.1	31.48	Based on Draft Ohio 2010 Technical Reference Manual - Page 14
	LED (40 w globe replacement) indoor	Light bulb	2,684	23.3	0.0041	62,962.1	11.22	Based on Draft Ohio 2010 Technical Reference Manual - Page 15
	LED (60 w replacement) outdoor	Light bulb	638	33.2	0.0000	21,202.4	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 16
	LED (75 w floodlight replacement) outdoor	Light bulb	1,417	60.6	0.0000	85,871.2	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 17
	LED (75 w replacement) indoor	Light bulb	1,654	39.1	0.0070	64,666.8	11.53	Based on Draft Ohio 2010 Technical Reference Manual - Page 18
	LED (3-way replacement)indoor	Light bulb	576	82.1	0.0146	47,292.0	8.43	Based on Draft Ohio 2010 Technical Reference Manual - Page 19
	Closable Foundation Vents	Unit	14	-	0.0000	0.0	0.00	No direct savings
	Install 12x12 gable vent	Unit	8	-	0.0000	0.0	0.00	No direct savings
	Install 12x18 gable vent	Unit	23	-	0.0000	0.0	0.00	No direct savings
	Install 12x24 gable vent	Unit	2	-	0.0000	0.0	0.00	No direct savings
	Install 12` roof vent (average)	Unit	63	-	0.0000	0.0	0.00	No direct savings
	Install 12` roof vent (difficult)	Unit	13	-	0.0000	0.0	0.00	No direct savings
	Install 8` or 9` roof vent	Unit	5	-	0.0000	0.0	0.00	No direct savings
	Duct Sealing per CFM reduction - Central Air Conditioning	CFM reduced	10	0.4	0.0005	3.9	0.01	Draft Ohio 2010 Technical Reference Manual - Page 108
	Duct Sealing per CFM reduction - Electric Heat No AC	CFM reduced	1,039	3.8	0.0005	3,928.0	0.48	Draft Ohio 2010 Technical Reference Manual - Page 108
	Duct Sealing per CFM reduction - Electric Heat w/AC	CFM reduced	1,364	3.8	0.0005	5,156.7	0.64	Draft Ohio 2010 Technical Reference Manual - Page 108
	Shell Air Sealing per CFM reduction - Central Air Conditioning	CFM reduced	8,625	0.0	0.0000	237.9	0.22	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Heat Pump	CFM reduced	16,459	1.1	0.0000	18,087.6	0.20	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Electric Heat No AC	CFM reduced	33,588	1.8	0.0000	40,285.5	0.28	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Electric Heat w/AC	CFM reduced	12,067	1.8	0.0000	21,277.4	0.15	Draft Ohio 2010 Technical Reference Manual - Page 104
	Attic Insulation (R-11 -> R-38) - Central Air Conditioning	Square footage installed	17,966	0.0	0.0000	506.8	0.46	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Heat Pump	Square footage installed	4,846	2.2	0.0000	10,428.1	0.12	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat No AC	Square footage installed	5,658	1.9	0.0000	10,700.1	0.15	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat w/AC	Square footage installed	1,696	1.9	0.0000	3,207.4	0.04	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Central Air Conditioning	Square footage installed	22,332	0.0	0.0000	256.6	0.23	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Electric Heat w/AC	Square footage installed	2,984	0.6	0.0000	1,819.6	0.03	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Electric Heat No AC	Square footage installed	8,276	0.8	0.0000	6,376.3	0.09	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-28 -> R-38) - Central Air Conditioning	Square footage installed	1,868	-	0.0000	7.7	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-28 -> R-38) - Heat Pump	Square footage installed	1,296	0.2	0.0000	223.3	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-28 -> R-38) - Electric Heat No AC	Square footage installed	1,248	0.3	0.0000	343.4	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Central Air Conditioning	Square footage installed	15,139	0.1	0.0001	1,148.3	1.04	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Electric Heat No AC	Square footage installed	936	5.1	0.0001	4,759.6	0.06	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Electric Heat w/AC	Square footage installed	410	5.1	0.0001	2,084.9	0.03	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R44) - Central Air Conditioning	Square footage installed	2,632	0.1	0.0001	203.8	0.18	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R44) - sloped ceiling - Heat Pump	Square footage installed	3,616	2.2	0.0001	7,972.6	0.25	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace) - Central Air Conditioning	Square footage installed	1,935	0.1	0.0001	116.2	0.11	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace) - Heat Pump	Square footage installed	864	2.5	0.0000	2,177.4	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-11 Foundation wall insulation - Electric Heat w/AC	Square footage installed	512	4.0	0.0001	2,061.2	0.03	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Insulate band joist to R-11 - Central Air Conditioning	Square footage installed	226	0.1	0.0001	13.5	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Insulate band joist to R-11 - Heat Pump	Square footage installed	485	4.6	0.0001	2,205.8	0.03	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Insulate band joist to R-11 - Electric Heat w/AC	Square footage installed	150	4.0	0.0001	603.9	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 36

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Low Income	Install R-11 blown cellulose-sloped ceiling-Heat Pump w/Electric Heat	Square footage installed	540	0.2	0.0000	93.0	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-19 blown cellulose-sloped ceiling-Electric Heat No AC	Square footage installed	383	0.8	0.0000	295.1	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-19 blown cellulose-sloped ceiling-Heat Pump w/Electric Heat	Square footage installed	2,774	1.1	0.0000	3,059.3	0.03	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-27 blown cellulose-sloped ceiling-Heat Pump w/Electric Heat	Square footage installed	242	1.2	0.0000	286.5	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Mobile Home Belly Patch	Unit	13,516	-	0.0000	0.0	0.00	No direct savings
	Mobile Home Roof Coat	Unit	2,740	-	0.0000	0.0	0.00	No direct savings
	Mobile Home Underneath Vapor Retarder	Unit	35,186	-	0.0000	0.0	0.00	No direct savings
	R15 Mobile Home blown FG 4` - Central Air Conditioning	Square footage installed	740	0.1	0.0001	43.1	0.04	Draft Ohio 2010 Technical Reference Manual - Page 36
	R15 Mobile Home blown FG 4` - Electric Heat No AC	Square footage installed	1,404	3.9	0.0001	5,480.8	0.07	Draft Ohio 2010 Technical Reference Manual - Page 36
	R15 Mobile Home blown FG 4` - Electric Heat w/AC	Square footage installed	1,456	2.9	0.0001	4,282.3	0.08	Draft Ohio 2010 Technical Reference Manual - Page 36
	R23 Mobile Home blown FG 6` - Central Air Conditioning	Square footage installed	1,809	0.1	0.0001	123.7	0.11	Draft Ohio 2010 Technical Reference Manual - Page 36
	R23 Mobile Home blown FG 6` - Heat Pump w Electric Heat	Square footage installed	2,611	5.1	0.0001	13,426.7	0.16	Draft Ohio 2010 Technical Reference Manual - Page 36
	R23 Mobile Home blown FG 6` - Electric Heat No AC	Square footage installed	3,815	4.6	0.0001	17,482.6	0.24	Draft Ohio 2010 Technical Reference Manual - Page 36
	R23 Mobile Home blown FG 6` - Electric Heat w/AC	Square footage installed	11,509	4.1	0.0001	52,741.1	0.71	Draft Ohio 2010 Technical Reference Manual - Page 36
	R30 Mobile home blown FG 8` - Heat Pump	Square footage installed	1,707	3.1	0.0001	5,214.5	0.11	Draft Ohio 2010 Technical Reference Manual - Page 36
	R30 Mobile home blown FG 8` - Electric Heat No AC	Square footage installed	2,471	4.9	0.0001	12,057.5	0.16	Draft Ohio 2010 Technical Reference Manual - Page 36
	R30 Mobile home blown FG 8` - Electric Heat w/AC	Square footage installed	1,361	4.9	0.0001	6,641.2	0.09	Draft Ohio 2010 Technical Reference Manual - Page 36
	R38 Mobile Home blown FG 12` - Heat Pump	Square footage installed	1,484	3.2	0.0001	4,724.2	0.10	Draft Ohio 2010 Technical Reference Manual - Page 36
	R38 Mobile Home blown FG 12` - Electric Heat No AC	Square footage installed	2,134	5.1	0.0001	10,851.6	0.15	Draft Ohio 2010 Technical Reference Manual - Page 36
	R38 Mobile Home blown FG 12` - Electric Heat w /AC	Square footage installed	1,215	5.1	0.0001	6,178.4	0.08	Draft Ohio 2010 Technical Reference Manual - Page 36
	R45 Mobile home blown FG 12` - Heat Pump	Square footage installed	1,792	8.4	0.0001	15,027.2	0.13	Draft Ohio 2010 Technical Reference Manual - Page 36
	R45 Mobile home blown FG 12` - Electric Heat No AC	Square footage installed	2,078	5.2	0.0001	10,764.6	0.10	Draft Ohio 2010 Technical Reference Manual - Page 36
	R45 Mobile home blown FG 12` - Electric Heat w/AC	Square footage installed	2,897	5.2	0.0001	15,078.7	0.20	Draft Ohio 2010 Technical Reference Manual - Page 36
	Wall insulation- Framed siding(target R11) - Central Air Conditioning	Square footage installed	17,838	0.1	0.0000	1,071.0	0.97	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Framed siding(target R11) - Heat Pump	Square footage installed	3,520	2.9	0.0001	10,108.3	0.19	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Framed siding(target R11) - Electric Heat w/AC	Square footage installed	1,249	4.0	0.0001	5,028.1	0.07	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Brick Veneer(target R11) - Heat Pump	Square footage installed	208	6.5	0.0001	1,349.1	0.01	Draft Ohio 2010 Technical Reference Manual - Page 100
	Water Pipe Insulation	Square footage installed	1,801	16.2	0.0018	30,240.8	3.45	Draft Ohio 2010 Technical Reference Manual - Page 97
	TOTAL					**6,049,612**	**885.8**	
Process Efficiency	Adding compressed air master controls to existing system	Custom Measure	1	605,304.0	26.8400	605,304.0	26.8	
	Added (2) 350hp VFDs on process cooling blowers	Custom Measure	1	3,135,301.6	355.1600	3,135,301.6	355.2	
	Old refrigeration motors with QM Motor Pilot Project for 121 new motors	Custom Measure	1	15,372.1	1.7500	15,372.1	1.8	
	Process Chiller	Custom Measure	1	698,230.8	52.5170	698,230.8	52.5	
	Replaced (1) Freezer with Standard Compressor with (1) Efficient Freezer	Custom Measure	1	5,464.0	0.6200	5,464.0	0.6	
	Replaced (4) Freezer with Standard Compressor with (4) Efficient Freezer	Custom Measure	1	21,856.0	2.4900	21,856.0	2.5	
	Replacing 6 standard ultra low freezers with 6 stirling engine ultra low freezer	Custom Measure	2	59,200.0	6.7550	118,400.0	13.5	
	Scroll Compressors with no VFDs to Scroll Compressors with VFDs	Custom Measure	1	82,007.5	18.9810	82,007.5	19.0	
	1995 Farm Fans CF/SA-410 Continuous Flow Grain Dryer to 2017 Mathews Company MC-101160 Tower Grain Dryer	Custom Measure	1	17,967.7	0.0000	17,967.7	-	
	40HP Compressors running load no load with (1)40HP Atlas Copco with VSD	Custom Measure	1	123,424.8	14.6700	123,424.8	14.7	
	Bathroom ventilation running 24 X 7 toVentilation contolled b y HVAC system to run 12 x 5 and 6 hr x 2 on weekends.	Custom Measure	1	9,731.8	0.0000	9,731.8	-	
	Chiller Plant (chillers, towers,pumps) manually started and stopped. sequencing and setpoints adjusted manually - with- Software controlling optimization of chiller plant (chillers, towers, pumps) based on load demand, auto setpoint adjustment, total KW/ton efficiency.	Custom Measure	1	152,143.7	12.0420	152,143.7	12.0	
	Coal-Fired Boilers Conversion to Natural Gas Fired Boilers (BMACT Project Name)	Custom Measure	1	10,561,317.1	940.9050	10,561,317.1	940.9	

All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Process Efficiency	Dilute phase pneumatictransport system for pellets @ 75 KW - with - dense phase pneumatic phase transport system for pellets@ 45KW	Custom Measure	1	118,988.8	0.0000	118,988.8	-	
	Existing 4000V 500HP motor that is deemed to run, at best, at a 90% efficiency rating to New, energy efficient motor, with a 94.8% efficiency rating at operating conditions.	Custom Measure	1	58,043.0	16.7360	58,043.0	16.7	
	Existing fixed speed air compressor combination of 3 Sullair compressors and 2 Leroi compressors to A new compressor arrangement of 5 new Atlas Copco rotary screw compressors and one Atlas Copco variable speed compressor	Custom Measure	1	2,171,822.8	247.9200	2,171,822.8	247.9	
	Forced draft fan and induced draft fan of a furnace, which supply and exhaust air, are removed and the stack is re-designed to create natural draft	Custom Measure	1	2,916,617.1	338.5100	2,916,617.1	338.5	
	Increase plant capacity added: 1-100hp VFD and 1-100hp constant speed air compressor	Custom Measure	1	173,608.4	19.1000	173,608.4	19.1	
	Install additional GA110VSD compressor to a common feed with three constant speed compressors, change the sequence of operations	Custom Measure	1	312,976.7	31.0900	312,976.7	31.1	
	Mixers were running at full load throughout the mixing process. Run hours are the same. (No pre-trend data available) to Mixers incorporate VFD's which allow the drives to only use the required energy for the mixing needed with the tomato slurry consistency. Run hours	Custom Measure	1	191,356.1	25.1650	191,356.1	25.2	
	Operating Rooms set to run 24/7 at necessary CFM to maintain air changes to with added dampers and controls, Ors are now able to be set-back to reduce CFMs when Operating Rooms are in unoccupied mode.	Custom Measure	1	52,086.8	3.4840	52,086.8	3.5	
	OPT LAB and PRB ACH improvement	Custom Measure	1	1631711.52	267.1570	1,631,711.5	267.2	
	Piping modification for a process pump	Custom Measure	1	4,523.8	0.5400	4,523.8	0.5	
	Plant replaced two 150 hp centrifugal blowers with two 150 hp turbo blowers, added oxygen probes, and upgraded its control system.	Custom Measure	1	898,307.6	79.5000	898,307.6	79.5	
	Replace 100hp Load/Unload compressor w/ 150hp VSD compressor	Custom Measure	1	229,965.1	27.5900	229,965.1	27.6	
	Replace old hydraulic injection molding machines with new all electric	Custom Measure	1	472,352.0	65.6430	472,352.0	65.6	
	Replaced 1-2 000 hp combustion blower with a 800 hp motor with VFD control	Custom Measure	1	2,290,012.2	212.3060	2,290,012.2	212.3	
	Replaced 1-3000 hp combustion blower with a 800 hp motor with VFD control	Custom Measure	1	2,586,500.5	257.3280	2,586,500.5	257.3	
	Replaced 220hp load/unload compressor with 200 hp VSD compressor and added air receiver and controls	Custom Measure	1	267,194.3	200.8400	267,194.3	200.8	
	Replaced a 300 hp baghouse fan motor with a 600 hp motor	Custom Measure	1	224,798.5	25.6600	224,798.5	25.7	
	Replaced a 75hp L/Un compressor with a 100hp VSD compressor and upgraded the controls	Custom Measure	1	219,076.9	5.1700	219,076.9	5.2	
	Replaced a 75-hp screw compressor with 15-hp screw compressor with storage	Custom Measure	1	105,929.0	14.4000	105,929.0	14.4	
	Replaced an old dust collection system with new dust collection with VFDs	Custom Measure	1	196,312.5	26.0830	196,312.5	26.1	
	Replaced heatless dessicant dryer with demand controlled vacuum pumped heatless dryer	Custom Measure	1	142,110.9	16.7700	142,110.9	16.8	
	Replaced hydraulic injection molding machine with a hybrid injection molding machine	Custom Measure	1	966,332.7	40.9600	966,332.7	41.0	
	Replaced old 1402 ton chiller with new 1400 ton chiller and cooling tower	Custom Measure	1	1,530,736.2	169.6360	1,530,736.2	169.6	
	Replacing 1150 ton water cooled chiller plant with constant speed CT fans and pumps with 3x950 ton new chiller plant with VFDs on CT fans and loop pumps	Custom Measure	1	530,304.0	176.7450	530,304.0	176.7	
	Replacing 2 75 hp load/unload compressors with 1 100 hp VSD compressors and adding air	Custom Measure	1	166,255.3	0.0000	166,255.3	-	
	Replacing 2- fixed speed compressors w/ 1-VFD and 1- fixed speed compressor	Custom Measure	1	117,242.6	17.8520	117,242.6	17.9	
	Replacing 2-100hp constant speed air compressors w/ 2-200hp VFD air compressors	Custom Measure	1	95,474.5	0.0000	95,474.5	-	
	Replacing a 300 HP fixed speed compressor LNL control with Gardner Denver EnviroAire TVS132 compressor	Custom Measure	1	290,126.0	27.2930	290,126.0	27.3	
	Replacing load/unload compressors with new variable frequency drive compressors	Custom Measure	1	70,865.5	8.4900	70,865.5	8.5	
	Replacing one 100hp modulating compressor with one 150hp VSD compressor. Other 100hp modulating compressor will remain as a backup and adding 1060 gal air storage and an air dryer	Custom Measure	1	478,772.2	12.9000	478,772.2	12.9	
	Running a 4160V, 300 HP motor at 90% efficiency for 7,340 hrs/yr	Custom Measure	1	70,671.4	(27.9920)	70,671.4	(28.0)	
	System #1 floating head pressure optimization	Custom Measure	1	1,600,732.2	0.0000	1,600,732.2	-	
	The plant compressed air is currently cooled with 35 degree F glycol on a closed loop system using an after-cooler and is distributed to the plant at around 115 psig.	Custom Measure	1	98,721.0	11.7500	98,721.0	11.8	
	The plant compressed air is currently cooled with 35 degree F glycol on a closed loop system.	Custom Measure	1	200,258.4	21.9180	200,258.4	21.9	
	The project installed two (2) new 90-ton energy efficient electric injection molding machines.	Custom Measure	1	12,632.4	14.1660	12,632.4	14.2	
	Two 50 HP motors and old piping system.	Custom Measure	1	126,602.1	15.7300	126,602.1	15.7	
	Upgrading pizza line layout and converting hydraulic motors and to all electric motors	Custom Measure	3	408,638.1	32.8460	1,225,914.2	98.5	
	Using a Sullair compressor with a 700 HP driver to generate 456 tons of cooling. - with Installing a new Frick compressor with 750 HP driver to generate 550 tons of cooling.	Custom Measure	1	137,479.6	13.4060	137,479.6	13.4	
	Using compressed air as an air curtain with re-configuring ductwork to provide air from existing blowers	Custom Measure	1	97,414.7	3.7200	97,414.7	3.7	
	Using isolated risers which reduces the volume of the extra metal that is poured into the cast.	Custom Measure	1	6,548,671.5	816.9500	6,548,671.5	817.0	
	Cycling Air Dryer	SCFM	1,500	12.8	0.0020	19,219.5	2.7	Vendor Internal TRM - Compressed Air

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Process Efficiency	Low Pressure Drop Filter	SCFM	700	25.0	0.0030	17,472.0	2.4	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	3	1,913.6	0.2650	5,740.8	0.8	Vendor Internal TRM - Compressed Air
	Cooling Tower Fan	Unit	3	9,009.0	2.5110	27,027.0	7.5	Vendor Internal TRM - Cooling
	Interior Occupancy Sensor	Watt reduced	176	1.3	0.0000	221.3	0.0	Vendor Internal TRM - Lighting
	Exterior ES or DLC LED	Unit	153	1,194.6	0.0000	182,767.8	-	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	163	305.0	0.0000	49,710.3	-	Vendor Internal TRM - Lighting
	Exterior Screw-in LED	Unit	18	145.8	0.0000	2,623.6	-	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	1,864	163.2	0.0410	304,135.6	76.8	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	41	49.9	0.0150	2,044.1	0.6	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	181	101.5	0.0240	18,363.3	4.3	Vendor Internal TRM - Lighting
	Motors and Drives	Unit	2	178,795.8	29.6431	357,591.6	59.3	Vendor Internal TRM - Motors and Drives
	Other Non-HVAC Motor	Unit	2	7,208.4	0.7270	14,416.8	1.5	Vendor Internal TRM - Motors and Drives
	EC Motor for Reach-in Refrigerator cases and Freezer	Motor	87	625.0	0.0710	54,375.0	6.2	Vendor Internal TRM - Motors and Drives
	EC Motor for Walk-in Cooler and Freezer	Motor	102	1,250.0	0.1430	127,500.0	14.6	Vendor Internal TRM - Motors and Drives
	LED Refrigeration Case Lighting - With Doors	Unit	163	413.3	0.0670	67,438.2	10.9	Vendor Internal TRM - Refrigeration
	Replace fluorescent walking cooler lighting with LED lighting & occupancy sensor	Unit	2	4,629.1	0.4800	9,258.2	1.0	Vendor Internal TRM - Refrigeration
	Replace fluorescent walking freezer lighting with LED lighting & occupancy sensor	Unit	2	998.1	0.1030	1,996.1	0.2	Vendor Internal TRM - Refrigeration
	Walk-in coolers incandescent lighting retrofit with LED	Unit	2	2,572.2	0.3810	5,144.4	0.8	Vendor Internal TRM - Refrigeration
	Walk-in freezers incandescent lighting retrofit with LED	Unit	1	14,288.9	2.1190	14,288.9	2.1	Vendor Internal TRM - Refrigeration
	Walk-in freezers lighting occupancy sensors controls		1	6,144.2	-	6,144.2	-	Vendor Internal TRM - Refrigeration
	TOTAL					**46,463,501**	**4,934.1**	
New Construction	200-hp VFD compressor installation	Custom measure	1	137,822.6	0.0000	137,822.6	0.0	
	Project #5 Dock Door Design - Pit Design	Custom measure	1	44,401.7	16.8460	44,401.7	16.8	
	500 HP Pump to 500 HP Pump w/ VFD	Custom measure	1	197,499.5	28.1340	197,499.5	28.1	
	Project #3 Energy Mangement System Base line, without energy management system 6,2	Custom measure	1	452,570.6	59.4530	452,570.6	59.5	
	Project #2 Heated Glycol Electric heat elements to heat glycol and electric pumps	Custom measure	1	125,055.6	15.5530	125,055.6	15.6	
	300 ton chiller for process cooling to VFD 300 ton chiller for process cooling	Custom measure	1	94,913.3	13.5040	94,913.3	13.5	
	NC Refrigeration system for refrigerated warehouse	Custom measure	1	216,683.0	50.7190	216,683.0	50.7	
	Project #1 Single Stage Refrigeration Pumped Ammonia re-circulation system single	Custom measure	1	2,161,381.6	268.8010	2,161,381.6	268.8	
	Project #4 Enhanced Insulated Roof Panels and Roof Insulation	Custom measure	1	154,046.1	15.3020	154,046.1	15.3	
	New manufactured stone process equipment	Custom measure	1	32,156.1	0.0000	32,156.1	0.0	
	Prescriptive Whole Building	Unit	3	60,821.0	14.8941	182,463.0	44.7	Implementer Prescriptive Model
	Whole building - >30% (Owner)	Project	4	53,429.2	10.8433	6,411,507.0	1,301.2	Individually modeled by Implementer
	Whole building - e10 and <20% (Owner)	Project	5	17,328.8	11.8560	866,442.0	592.8	Individually modeled by Implementer
	Whole building - e20 and <30% (Owner)	Project	8	27,124.6	6.4669	4,339,928.0	1,034.7	Individually modeled by Implementer
	Cycling Air Dryer	Unit	2	5,338.7	0.8900	10,677.3	1.8	Vendor Internal TRM - Compressed Air
	Air Cooled, electrically operated, centrifugal chiller: <150 tons	Unit	3	3,521.2	4.9857	10,563.6	15.0	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	11	2,005.3	1.5811	22,058.2	17.4	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 20 - 63.2 tons	Unit	36	2,824.2	2.2268	101,672.7	80.2	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	19	951.9	0.7505	18,085.5	14.3	Vendor Internal TRM - Cooling
	Air Source Heat Pump <= 5.4 tons	Unit	9	365.2	0.2879	3,286.5	2.6	Vendor Internal TRM - Cooling
	Air-Side Economizer on RTU AHU DX or UV	Unit	201	2,574.8	0.0000	517,543.6	0.0	Vendor Internal TRM - Cooling

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
New Construction	Variable Refrigerant Flow AC - >= 20 tons	Unit	10	-	0.0000	0.0	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC - 11.25 - 19.9 tons	Unit	11	-	0.0000	0.0	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC - 5.4 - 11.24 tons	Unit	1	-	0.0000	0.0	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow - < 5.4 tons	Unit	28	-	0.0000	0.0	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC	Unit	6	737.0	0.0867	4,422.0	0.5	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 11.25 -19.9 tons	Unit	20	3,344.6	0.9215	66,892.7	18.4	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 20 -63.2 tons	Unit	22	8,762.8	3.7446	192,780.7	82.4	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 5.4 -11.24 tons	Unit	18	1,636.7	0.5700	29,460.8	10.3	Vendor Internal TRM - Cooling
	Cental Air Conditioner - < 5.4 tons	Unit	98	245.9	0.1863	24,099.5	18.3	Vendor Internal TRM - Cooling
	Cental Air Conditioner - > 63.3 tons	Unit	12	12,694.7	3.4199	152,336.5	41.0	Vendor Internal TRM - Cooling
	Guest Room High Efficiency Electric Hot Water Heat	Room	48	858.0	0.1890	41,184.0	9.1	Vendor Internal TRM - Cooling
	Ice Maker >1001 lbs/day	Icemaker	1	1,114.0	0.2090	1,114.0	0.2	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	6	581.0	0.1090	3,486.0	0.7	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	7	786.7	0.1307	5,507.0	0.9	Vendor Internal TRM - Food Service
	Hot Holding Cabinet	Cabinet	7	4,275.0	0.3614	29,925.0	2.5	Vendor Internal TRM - Food Service
	Exterior LPD	Watt reduced	363,615	4.2	0.0000	1,513,001.4	0.0	Vendor Internal TRM - Lighting
	Exterior New Construction - Lighting Power Density	Watt reduced	277,080	6.4	0.0000	1,766,045.0	5.4	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Unit	230	371.5	0.1781	85,436.2	41.0	Vendor Internal TRM - Lighting
	Network Lighting Controls	Watt controlled	157,843	0.6	0.0002	96,637.9	26.0	Vendor Internal TRM - Lighting
	Interior New Construction - Lighting Power Density	Watt reduced	1,596,574	4.8	0.0009	7,598,897.9	1,475.3	Vendor Internal TRM - Lighting
	Interior Lighting Power Density	Unit	3	51,423.6	12.1630	154,270.7	36.5	Vendor Internal TRM - Lighting
	Interior LPD	Watt reduced	1,741,703	8.4	0.0009	14,705,519.5	1,513.7	Vendor Internal TRM - Lighting
	ENERGY STAR Commercial Clothes Washer	Unit	1	587.0	0.2450	587.0	0.3	Vendor Internal TRM - Miscellaneous
	High Frequency Battery Charger 16-hour shift	Unit	14	2,287.0	0.2439	32,018.0	3.4	Vendor Internal TRM - Miscellaneous
	High Frequency Battery Charger 24-hour shift	Unit	10	3,094.0	0.8130	30,940.0	8.1	Vendor Internal TRM - Miscellaneous
	Energy Star Windows	Window	2	3,055.9	0.7280	6,111.7	1.5	Vendor Internal TRM - Miscellaneous
	Insulated Concrete Forms	Unit	1	1,445.5	0.0000	1,445.5	0.0	Vendor Internal TRM - Miscellaneous
	High Speed Fans 24" to 35"	Unit	3	90,849.5	17.8974	272,548.6	53.7	Vendor Internal TRM - Agriculture
	High Speed Fans 48" to 71"	Fan	260	889.0	0.2873	231,132.0	74.7	Vendor Internal TRM - Agriculture
	Air Compressor Motor	Unit	2	173,234.2	24.0140	346,468.5	48.0	Vendor Internal TRM - Motors and Drives
	ECM for HVAC - Heating Only	Motor	4	656.0	0.4630	2,624.0	1.9	Vendor Internal TRM - Motors and Drives
	Process Motor	Unit	8	52,960.0	3.8494	423,680.0	30.8	Vendor Internal TRM - Motors and Drives
	Chilled Water Pump	Unit	4	1,703.5	0.6251	6,814.0	2.5	Vendor Internal TRM - Motors and Drives
	Condenser Water Pump	Unit	2	2,205.0	1.9350	4,410.0	3.9	Vendor Internal TRM - Motors and Drives
	Hot Water Pump	Unit	11	2,873.5	0.0151	31,608.0	0.2	Vendor Internal TRM - Motors and Drives
	Other HVAC Motor	Unit	71	6,535.0	0.7245	463,982.7	51.4	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	9	16,257.2	4.0618	146,315.0	36.6	Vendor Internal TRM - Motors and Drives
	Motor 30 HP	Unit	12	1,511.1	0.2750	18,133.7	3.3	Vendor Internal TRM - Motors and Drives
	112.5 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	2	1,482.0	0.3639	2,964.0	0.7	Vendor Internal TRM - Miscellaneous
	45 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	2	1,024.9	0.2517	2,049.8	0.5	Vendor Internal TRM - Miscellaneous
	75 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	1	1,255.0	0.3081	1,255.0	0.3	Vendor Internal TRM - Miscellaneous
	Evaporator Fan Controls - Non EC Motor	Unit	18	1,351.0	0.1540	24,318.0	2.8	Vendor Internal TRM - Refrigeration

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
New Construction	ENERGY STAR Glass Door Freezer	Freezer	6	2,833.0	0.3233	16,998.0	1.9	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Refrigerator	Refrigerator	25	634.0	0.0723	15,850.0	1.8	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Freezer	5	1,307.0	0.1491	6,535.0	0.8	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Refrigerator	15	559.3	0.0634	8,390.0	1.0	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	1	18,114.8	2.9194	18,114.8	2.9	Vendor Internal TRM - Refrigeration
	TOTAL					**44,687,067**	**7,187.7**	
Efficient Products Busines	Advanced Lighting Controls: High Lumen Low Density Tier 3	Watt reduced	616,857	1.7	0.0003	1,063,492.9	173.3	Individually Modeled by Implementer
	Advanced Lighting Controls: High Lumen Low Density Tier 2	Watt reduced	296,000	4.6	0.0007	1,346,484.9	214.5	Individually Modeled by Implementer
	Advanced Lighting Controls: Low Lumen High Density Tier 3	Watt reduced	90,890	27.7	0.0034	2,514,399.8	309.1	Individually Modeled by Implementer
	Advanced Lighting Controls: Low Lumen High Density Tier 2	Watt reduced	98,391	11.0	0.0026	1,084,623.5	254.9	Individually Modeled by Implementer
	High Speed Fans 48" to 71"	Fan	7	1,122.0	0.3600	7,854.0	2.5	Vendor Internal TRM - Agriculture
	Engine Block Heater Timer	Unit	18	576.0	0.0000	10,368.0	0.0	Vendor Internal TRM - Agriculture
	Cycling Air Dryer	SCFM	8,013	12.8	0.0018	102,670.6	14.2	Vendor Internal TRM - Compressed Air
	Low Pressure Drop Filter	SCFM	2,000	25.0	0.0035	49,920.0	6.9	Vendor Internal TRM - Compressed Air
	New VFD Compressor	Horsepower	1,608	1,732.3	0.2401	2,784,672.3	386.0	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	6	1,913.6	0.2650	11,481.6	1.6	Vendor Internal TRM - Compressed Air
	Air Cooled Chiller <150 Tons	Unit	11	6,476.4	3.8395	71,240.1	42.2	Vendor Internal TRM - Cooling
	Air Cooled Chiller >= 150 Tons	Unit	9	45,128.1	25.0564	406,152.6	225.5	Vendor Internal TRM - Cooling
	Air Source Heat Pump < 5.4 tons	Unit	66	503.5	0.2435	33,230.3	16.1	Vendor Internal TRM - Cooling
	Air Source Heat Pump - >= 63.3 tons	Unit	3	16,349.8	9.7924	49,049.5	29.4	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	57	2,076.6	1.2275	118,367.6	70.0	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 20 - 63.2 tons	Unit	32	5,223.4	3.7778	167,149.7	120.9	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	77	1,290.7	0.7277	99,383.7	56.0	Vendor Internal TRM - Cooling
	Air-Side Economizer on RTU AHU DX or UV	Unit	4	20,199.3	0.0000	80,797.1	0.0	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Elec Heat)	Square foot	270,408	2.6	0.0000	694,006.7	0.0	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Non Elec Heat)	Square foot	1,921,303	1.3	0.0000	2,577,921.6	0.0	Vendor Internal TRM - Cooling
	Hotel Guest Room Occupancy Sensor (Electric Heat)	Room	70	692.7	0.0972	48,489.0	6.8	Vendor Internal TRM - Cooling
	ECMs for HVAC - Heating Only	Motor	2	462.0	0.4620	924.0	0.9	Vendor Internal TRM - Cooling
	ECMs for HVAC - Heating and Cooling	Motor	10	656.0	0.4620	6,560.0	4.6	Vendor Internal TRM - Cooling
	Occupancy Sensor Control for HVAC Systems	Unit	2	2,097.2	0.0000	4,194.3	0.0	Vendor Internal TRM - Cooling
	PTAC	Unit	1	383.5	0.2184	383.5	0.2	Vendor Internal TRM - Cooling
	Room AC Two Tons or Less	Unit	8	27.8	0.0158	222.4	0.1	Vendor Internal TRM - Cooling
	Suite WSHP to WSHP >= 17,000 Btu/h and < 135,000	Unit	27	0.0	0.0000	0.0	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pump >= 20 tons	Unit	1	9,154.2	7.3346	9,154.2	7.3	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps 11.25-19.9 tons	Unit	11	4,388.0	2.8362	48,268.1	31.2	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps 5.4 -11.24 tons	Unit	2	2,060.0	1.3772	4,120.0	2.8	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps < 5.4 tons	Unit	3	1,140.5	0.4329	3,421.6	1.3	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC >= 20 tons	Unit	2	7,254.1	8.5351	14,508.2	17.1	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - >= 600 Tons	Unit	3	99,808.8	58.7968	299,426.4	176.4	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - 300 to 599 Tons	Unit	3	91,357.8	35.9205	274,073.4	107.8	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - < 300 Tons	Unit	1	34,607.2	17.2519	34,607.2	17.3	Vendor Internal TRM - Cooling

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Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products Busines	Water cooled, electrically operated, positive displacement chiller - >= 300 Tons	Unit	2	79,792.5	50.3537	159,585.0	100.7	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, positive displacement chiller - 150 to 299 Tons	Unit	2	18,571.9	10.8672	37,143.9	21.7	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, positive displacement chiller - <75 Tons	Unit	3	3,719.4	2.5058	11,158.2	7.5	Vendor Internal TRM - Cooling
	Window Film	Square foot	1,096	2.7	0.0012	3,003.0	1.3	Vendor Internal TRM - Cooling
	Beverage Machine Controls	Machine	32	1,613.0	0.0000	51,616.0	0.0	Vendor Internal TRM - Miscellaneous
	Combination Oven	Oven	3	20,404.7	1.8790	61,214.2	5.6	Vendor Internal TRM - Food Service
	DCV for Kitchen Exhaust Hood - Retrofit	Unit	59	4,486.0	0.7600	264,674.0	44.8	Vendor Internal TRM - Food Service
	Ice Maker >1001 lbs/day	Icemaker	3	1,113.6	0.2090	3,340.8	0.6	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	8	846.8	0.1589	6,774.1	1.3	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	2	581.4	0.1091	1,162.7	0.2	Vendor Internal TRM - Food Service
	Snack Machine Controls	Machine	9	387.0	0.0000	3,483.0	0.0	Vendor Internal TRM - Miscellaneous
	Exterior Bi-Level Exterior or Garage Lighting Controls	Watts controlled	49,340	0.6	0.0000	30,795.6	0.0	Vendor Internal TRM - Lighting
	Exterior ES or DLC LED	Unit	18,202	1,290.8	0.0017	23,494,902.1	30.6	Vendor Internal TRM - Lighting
	Exterior Exit Sign	Sign	51	78.8	0.0090	4,020.8	0.5	Vendor Internal TRM - Lighting
	Exterior HID or IND	Unit	35	4,120.2	0.0000	144,206.5	0.0	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	3,923	759.9	0.0000	2,980,950.9	0.0	Vendor Internal TRM - Lighting
	Exterior Photocells	Watt controlled	74,314	0.3	0.0000	24,428.4	0.0	Vendor Internal TRM - Lighting
	Exterior Photocells + Timeclocks	Watt controlled	92,563	1.7	0.0000	160,967.1	0.0	Vendor Internal TRM - Lighting
	Exterior Screw-in LED	Unit / lamp	2,996	145.8	0.0000	436,680.4	0.0	Vendor Internal TRM - Lighting
	Exterior Time Clocks for Lighting	Watt controlled	18,918	0.2	0.0000	3,646.6	0.0	Vendor Internal TRM - Lighting
	Garage Bi-Level Exterior or Garage Lighting Control	Watts controlled	5,792	1.3	0.0002	7,610.7	0.9	Vendor Internal TRM - Lighting
	Garage ES or DLC LED	Unit	2,660	708.3	0.0806	1,884,092.3	214.4	Vendor Internal TRM - Lighting
	Garage Other LED	Unit	494	1,251.2	0.1428	618,096.8	70.6	Vendor Internal TRM - Lighting
	Garage Screw-in LED	Unit	585	306.9	0.0350	179,508.1	20.5	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Watt controlled	10,582	1.1	0.0006	11,324.0	6.3	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	250,473	267.8	0.0569	67,083,610.3	14,253.6	Vendor Internal TRM - Lighting
	Interior Exit Sign	Sign	1,016	96.3	0.0117	97,867.1	11.9	Vendor Internal TRM - Lighting
	Interior HID or IND	Unit	2	87.4	0.0243	174.8	0.1	Vendor Internal TRM - Lighting
	Interior HW CFL 30w to 60w	Unit	51	587.8	0.1201	29,975.3	6.1	Vendor Internal TRM - Lighting
	Interior Linear Fluorescent Retrofit	Lamp	327	16.2	0.0036	5,287.4	1.2	Vendor Internal TRM - Lighting
	Interior New T5 Fixture	Unit	644	2,130.4	0.3952	1,372,006.2	254.5	Vendor Internal TRM - Lighting
	Interior New T8 Fluorescent Fixtures	Unit	409	1,061.4	0.2063	434,112.1	84.4	Vendor Internal TRM - Lighting
	Interior Occupancy + Daylighting Sensor	Watt controlled	1,737	1.2	0.0004	2,118.6	0.7	Vendor Internal TRM - Lighting
	Interior Occupancy Sensor	Watt controlled	1,935,706	1.3	0.0001	2,411,801.0	162.8	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	30,712	346.6	0.0713	10,644,897.5	2,190.9	Vendor Internal TRM - Lighting
	Interior Other Lighting_CFL	Unit	39	239.2	0.0565	9,329.4	2.2	Vendor Internal TRM - Lighting
	Interior Other Lighting_Non-CFL	Unit	226	468.6	0.0967	105,907.0	21.9	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	37,176	149.9	0.0279	5,572,998.9	1,038.0	Vendor Internal TRM - Lighting
	Interior Time Clocks for Lighting	Watt controlled	39,804	0.4	0.0000	15,446.5	0.0	Vendor Internal TRM - Lighting
	LED Traffic Lights Green 12"	Unit	103	519.9	0.0593	53,544.1	6.1	Vendor Internal TRM - Lighting
	LED Traffic Lights Green 12" Arrow	Unit	3	76.4	0.0109	229.2	0.0	Vendor Internal TRM - Lighting
	LED Traffic Lights Red 12"	Unit	103	693.8	0.0792	71,460.6	8.2	Vendor Internal TRM - Lighting
	Suite ES or DLC LED	Unit	316	35.6	0.0052	11,253.5	1.7	Vendor Internal TRM - Lighting
	Suite Screw-in LED	Unit	28,656	31.8	0.0047	911,855.7	133.6	Vendor Internal TRM - Lighting

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2017**

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products Busines	High Frequency Battery Charger 24-hour shift	Unit	12	3,501.7	0.9251	42,020.6	11.1	Vendor Internal TRM - Miscellaneous
	High Efficiency Electric Hot Water Heater	Unit	1	6,746.2	1.0300	6,746.2	1.0	Vendor Internal TRM - Miscellaneous
	Chilled Water Pump	Unit	20	17,765.9	5.9683	355,317.5	119.4	Vendor Internal TRM - Motors and Drives
	Cooling Tower Fan	Unit	10	17,707.0	5.2304	177,070.0	52.3	Vendor Internal TRM - Motors and Drives
	Condenser Water Pump	Unit	12	24,684.1	5.7051	296,208.7	68.5	Vendor Internal TRM - Motors and Drives
	Green Motor Rewind	Motor	12	5,111.8	0.6241	61,341.0	7.5	Vendor Internal TRM - Motors and Drives
	Hot Water Pump	Unit	18	11,289.9	0.0408	203,217.6	0.7	Vendor Internal TRM - Motors and Drives
	Motor 100 HP	Unit	2	3,367.3	0.4676	6,734.6	0.9	Vendor Internal TRM - Motors and Drives
	Motor 50 HP	Unit	4	329.8	0.0720	1,319.0	0.3	Vendor Internal TRM - Motors and Drives
	Other HVAC Motor	Unit	3	3,123.9	0.7355	9,371.7	2.2	Vendor Internal TRM - Motors and Drives
	Other Non-HVAC Motor	Unit	5	25,950.2	2.6173	129,751.2	13.1	Vendor Internal TRM - Motors and Drives
	Process Motor	Unit	33	46,681.0	6.4387	1,540,474.0	212.5	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	165	16,258.7	4.2670	2,682,682.3	704.1	Vendor Internal TRM - Motors and Drives
	Anti-Sweat Heater Controls	Unit	9,023	528.0	0.0600	4,764,091.2	541.4	Vendor Internal TRM - Refrigeration
	EC Motor for Evaporator Fan Controls	Unit	73	1,351.0	0.1540	98,623.0	11.2	Vendor Internal TRM - Refrigeration
	EC Motor for Reach-in Refrigerator cases and Freezer cases	Unit	1,550	625.0	0.0710	968,750.0	110.1	Vendor Internal TRM - Refrigeration
	EC Motor for Walk-in Cooler and Freezer	Unit	107	1,250.0	0.1427	133,750.0	15.3	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Freezer	Unit	49	4,726.9	0.5392	231,618.1	26.4	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Unit	6	2,215.5	0.2527	13,293.0	1.5	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Refrigerator	Unit	59	795.4	0.0907	46,927.4	5.4	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	17	736.7	0.0840	12,524.2	1.4	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - Open Cases	Linear Foot	3,137	365.1	0.0625	1,145,310.7	196.2	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Linear Foot	8,157	413.3	0.0666	3,371,203.0	543.3	Vendor Internal TRM - Refrigeration
	Lighting Controls for Freezers and Coolers with Doors	Unit	504	77.3	0.0125	38,981.8	6.3	Vendor Internal TRM - Refrigeration
	Lighting Controls for Open Display Cases	Unit	60	68.3	0.0117	4,125.9	0.7	Vendor Internal TRM - Refrigeration
	New Doors on Medium Temp Open Refrigerated Case	Unit	403	395.6	0.0452	159,485.8	18.2	Vendor Internal TRM - Refrigeration
	Oversized Condenser for Refrigeration	Ton	1,668	120.0	0.1200	200,180.4	200.2	Vendor Internal TRM - Refrigeration
	TOTAL					**150,140,998**	**23,873.4**	
Self Direct	EOL Oven replaced with Zeph 200e convection Oven	Custom measure	1	843.9	0.0000	843.9	0.00	
	SOCC installed three (3) 85 kW Liebert Air Cooled CRAC units with economizers and three (3) Liebert 70 kW CRAC units with economizers on condenser water loop in 2013	Custom measure	1	296,037.0	16.6670	296,037.0	16.67	
	Added fluid cooler to provide free cooling when outdoor air temperature drops below 55 F	Custom measure	1	38,595.1	0.0000	38,595.1	0.00	
	Existing cooling tower with 4 constant speed fans. To Counter current cooling tower with 2 VFDs lowering the water temperature to the compression system.	Custom measure	1	1,483,666.4	0.0000	1,483,666.4	0.00	
	Motors and Drives	Custom measure	1	132,064.9	26.4000	132,064.9	26.40	
	40 HP 2 speed motor with Add VFD	Custom measure	1	11,837.9	2.1000	11,837.9	2.10	
	Replaced 500 ton hydraulic injection molding machine with 250 ton thermo server injection molding machine	Custom measure	1	235,897.7	58.5600	235,897.7	58.56	
	The project replaced four (4) hydraulic injection molding machines with four (4) new energy efficient electric injection molding machines	Custom measure	1	182,794.9	9.9600	182,794.9	9.96	
	Added fluid cooler to provide free cooling when outdoor air temperature is below 62.6 F	Custom measure	1	22,651.8	0.0000	22,651.8	0.00	
	Low Pressure Drop Filter	SCFM	8,750	25.0	0.0035	218,400.0	30.28	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	1	1,913.6	0.2650	1,913.6	0.27	Vendor Internal TRM - Compressed Air
	Air Source Heat Pump - <= 5.4 tons	Unit	14	581.5	0.1997	8,140.9	2.80	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	5	704.5	0.3961	3,522.7	1.98	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	1	1,251.2	0.7035	1,251.2	0.70	Vendor Internal TRM - Cooling

All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2017**

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Self Direct	Air Cooled, electrically operated, centrifugal chiller: <150 tons	Unit	2	1,169.7	0.5965	2,339.3	1.19	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller: >= 600 Tons	Unit	4	94,704.5	58.2049	378,817.9	232.82	Vendor Internal TRM - Cooling
	PTAC	Ton	174	182.5	0.1039	31,756.4	18.08	Vendor Internal TRM - Cooling
	Ice Maker >1001 lbs/day	Icemaker	5	1,113.6	0.2090	5,568.0	1.05	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	2	846.8	0.1589	1,693.5	0.32	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	4	581.4	0.1091	2,325.5	0.44	Vendor Internal TRM - Food Service
	Steam Cookers	Cooker	1	25,545.0	3.5261	25,545.0	3.53	Vendor Internal TRM - Food Service
	Interior Occupancy Sensor	Watt controlled	107,640	2.1	0.0001	223,645.4	7.62	Vendor Internal TRM - Lighting
	Exterior LPD	Watt reduced	47,625	4.2	0.0000	198,169.6	0.00	Vendor Internal TRM - Lighting
	Interior Exit Sign	Sign	6	98.2	0.0124	588.9	0.08	Vendor Internal TRM - Lighting
	Interior LPD	Watt reduced	44,566	3.7	0.0009	166,809.9	41.16	Vendor Internal TRM - Lighting
	Exterior ES or DLC LED	Unit	252	977.6	0.0000	246,364.5	0.00	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	38	1,030.4	0.0000	39,155.0	0.00	Vendor Internal TRM - Lighting
	Exterior Screw-in LED	Unit	12	145.8	0.0000	1,749.1	0.00	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	287	532.0	0.1058	152,694.2	30.35	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	61	889.7	0.1892	54,273.8	11.54	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	6,020	207.2	0.0317	1,247,456.6	190.63	Vendor Internal TRM - Lighting
	Interior New T5 Fixture	Unit	276	1,887.0	0.2759	520,810.6	76.14	Vendor Internal TRM - Lighting
	Cooling Tower Fan	Unit	7	20,513.4	5.4994	143,593.6	38.50	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	6	1,791.5	0.5819	10,749.1	3.49	Vendor Internal TRM - Motors and Drives
	Process Motor	Unit	8	46,340.0	6.3917	370,720.0	51.13	Vendor Internal TRM - Motors and Drives
	ENERGY STAR Glass Door Refrigerator	Unit	1	795.4	0.0907	795.4	0.09	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	8	736.7	0.0840	5,893.8	0.67	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Freezer	Unit	2	4,726.9	0.5392	9,453.8	1.08	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Unit	19	2,215.5	0.2527	42,094.5	4.80	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Linear foot	31	413.3	0.0666	12,812.3	2.07	Vendor Internal TRM - Refrigeration
	TOTAL					**6,533,494**	**866.47**	
Express	Occupancy Sensor	Unit	69	120.3	0.0000	8,298.0	0.0	New York State TRM - Lighting
	Photocells	Unit	194	162.6	0.0000	31,541.9	0.0	New York State TRM - Lighting
	Exterior LED	Unit	2,593	883.0	0.0000	2,289,726.3	0.0	New York State TRM - Lighting
	Exterior T8 Fluorescent	Unit	20	85.5	0.0000	1,709.3	0.0	New York State TRM - Lighting
	Garage LED	Unit	364	776.5	0.1644	282,645.3	59.8	New York State TRM - Lighting
	Garage T8 Fluorescent	Unit	9	292.0	0.1120	2,627.9	1.0	New York State TRM - Lighting
	Interior Exit Signs	Unit	394	298.8	0.0283	117,740.7	11.2	New York State TRM - Lighting
	Interior LED	Unit	17,206	316.1	0.0599	5,438,575.2	1,029.8	New York State TRM - Lighting
	Interior T8 Fluorescent	Unit	228	187.1	0.0512	42,658.7	11.7	New York State TRM - Lighting
	Interior Light - Disconnect Only	Unit	83	553.6	0.0884	45,949.7	7.3	New York State TRM - Lighting
	Exterior Light - Disconnect Only	Unit	5	372.0	0.0000	1,859.8	0.0	New York State TRM - Lighting
	Anti Sweat Heater Control	Unit	42	4,331.8	0.3693	181,934.7	15.5	New York State TRM - Refrigeration
	Control of Door Heater/Relay for Medium Temperature Door Heaters	Unit	9	6,149.9	0.5248	55,349.0	4.7	New York State TRM - Refrigeration
	Evaporator Fans	Unit	396	896.8	0.0773	355,147.1	30.6	New York State TRM - Refrigeration
	Compressor and Intelligent Fan Management	Unit	4	5,654.7	0.2026	22,618.9	0.8	New York State TRM - Refrigeration
	Refrigeration LED Case Lighting	Unit	96	4,346.6	0.6396	417,277.9	61.4	New York State TRM - Refrigeration
	TOTAL					**9,295,660**	**1,233.9**	

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2017**

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
RetroCommissioning	Demand Control Ventilation - AHU-4 Gymnasium	Unit	1	10,093.0	0.0000	10,093	0.0	Standard Engineering Calculation
	Fix Preheat Sequence and F&B Dampers for SCH AHU-1 and 3	Unit	1	61,000.0	0.0000	61,000	0.0	Standard Engineering Calculation
	Implement Suction Float for Rack A	Unit	1	86,279.0	0.0000	86,279	0.0	Standard Engineering Calculation
	Implement Suction Float for Rack B, C & D	Unit	1	122,535.0	0.0000	122,535	0.0	Standard Engineering Calculation
	Optimize Case Lighting Schedule	Unit	1	6,566.0	0.0000	6,566	0.0	Standard Engineering Calculation
	Optimize Floating Head Pressure Controls	Unit	1	29,080.0	0.0000	29,080	0.0	Standard Engineering Calculation
	Other - AHU-3 CHW Coil Pump	Unit	1	515.0	0.0000	515	0.0	Standard Engineering Calculation
	Other - WSHP Loop Temperature Optimization	Unit	1	21,064.0	0.0000	21,064	0.0	Standard Engineering Calculation
	Chiller / Chilled Water System - Chilled Water Temperature Reset	Unit	2	40,666	0.0000	81,333	0.0	Standard Engineering Calculation
	Pump Optimization	Unit	8	32,382.8	0.8750	259,062	7.0	Standard Engineering Calculation
	Economizer and Outdoor Air Control	Unit	11	110,988.3	0.0000	1,220,871	0.0	Standard Engineering Calculation
	Cooling Tower Optimization	Unit	3	12,696.7	0.0000	38,090	0.0	Standard Engineering Calculation
	Reduce Pump Differential Setpoint - CWS Pump Reset DP to Automati	Unit	1	3,735.0	0.0000	3,735.0	0.0	Standard Engineering Calculation
	Reduce Ventilation - AHU-1C 22qty for Classrooms	Unit	1	21,032.0	0.0000	21,032.0	0.0	Standard Engineering Calculation
	Reduce Ventilation - Schedul Change for Out of Session	Unit	1	30,849.0	0.0000	30,849.0	0.0	Standard Engineering Calculation
	Repair Economizer - Air Flow Measurment Station Recalibration	Unit	1	4,304.0	0.0000	4,304.0	0.0	Standard Engineering Calculation
	Fan Optimization	Unit	26	61,856.2	0.2692	1,608,260	7.0	Standard Engineering Calculation
	Equipment Scheduling	Unit	21	32,254.3	0.0000	677,341	0.0	Standard Engineering Calculation
	Schedule optimization: EF 7 Shut off	Unit	1	39,141.0	0.0000	39,141.0	0.0	Vendor Analysis
	Schedule optimization: Optimize Exterior Lighting Schedule	Unit	1	7,026.0	0.0000	7,026.0	0.0	Vendor Analysis
	Schedule optimization: Reset Discharge Air Temperature During Unoccuppied Cooling	Unit	1	46,451.3	0.0000	46,451.3	0.0	Vendor Analysis
	Schedule optimization: Schedule AHU for Space	Unit	2	182,187.5	0.0000	364,375.0	0.0	Vendor Analysis
	Schedule optimization: Schedule Pumps - Domestic Hot Water Circulation Pump Timeclock	Unit	1	1,078.0	0.0000	1,078.0	0.0	Vendor Analysis
	TOTAL					**4,740,081**	**14.0**	
Data Center	Computer Room Air Conditioner	Unit	4	127,375.8	12.4800	509,503.0	49.9	Standard Engineering Calculation
	Whole Building Model	Unit	3	9,053,225.0	1101.5000	27,159,675.0	3,304.5	Individually modeled by Implementer
	HVAC/equipment/motors	Unit	165	214.4	0.0200	35,370.0	4.0	Standard Engineering Calculation
	HVAC Equipment Optimization	Unit	1	77,413.0	8.8000	77,413.0	8.8	Standard Engineering Calculation
	IT/equipment/virtualization	Unit	269	11,933.1	1.3600	3,210,010.0	366.4	Standard Engineering Calculation
	Systemic/Equipment/Energy Management System	Unit	2	94,152.0	183.8000	188,304.0	367.6	Standard Engineering Calculation
	TOTAL					**31,180,275**	**4,101.2**	
Continuous Energy Improvement	Multivariate Linear Regression	Project	37	666,063.7	91.3054	**24,644,356**	**3,378.3**	Individually modeled by Implementer

APPENDIX B

NAVIGANT

Residential Efficient Products Program Evaluation

2017 Evaluation Report

Prepared for:

AEP Ohio

AEP OHIO®

A unit of American Electric Power

May 14, 2018

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EXECUTIVE SUMMARY

This report describes the results of the impact and process evaluation of the 2017 AEP Ohio Efficient Products Program. The Executive Summary provides a high-level description of the program, key impact and process evaluation findings, conclusions, and recommendations. Details regarding the methodologies used in this evaluation are described in the body of the report following the Executive Summary.

ES.1 Program Summary

The objective of the AEP Ohio Efficient Products Program is to produce long-term electric energy savings in the consumer sector by increasing the market share of ENERGY STAR® qualified lighting products and appliances. The program provides free equipment and financial incentives for energy-efficient lighting and appliances. Notable changes from 2016 include the integration of four program components formerly housed under the AEP Ohio Residential In-Home program: (1) rebates on select heating and cooling (HVAC) equipment, (2) free online assessment that a customer can choose to receive an energy efficiency kit, (3) free energy efficiency direct measure installations in select multi-family homes, and (4) free energy efficiency direct measure installations in select single-family homes through a partnership with Columbia Gas of Ohio. Section 1.1 describes the program in more detail.

ES.2 Key Impact Evaluation Findings

Table ES-1 shows the 2017 program goals, *ex ante* savings claimed by the program, and *ex post* savings. The *ex post* energy and demand savings for 2017 were 105,667 MWh and 19.05 MW, respectively. The realization rate (ratio of *ex ante* to *ex post* savings) for 2017 was 0.99 for energy and 0.99 for demand. The *ex post* energy and demand savings were 144 percent and 251 percent of the 2017 program goals, respectively.

Table ES-1. Summary of Program Savings and Realization Rates

	2017 Program Goals[1] (a)	*Ex ante* Savings (b)	*Ex post* Savings (c)	Realization Rate RR = (c) / (b)	Percent Of Goal = (c) / (a)
Program Energy Savings (MWh)	73,219	106,783	105,667	0.99	144%
Program Demand Savings (MW)	7.59	19.23	19.05	0.99	251%

[1] AEP Ohio combined the Efficient Products Program and In-Home program goals. The Efficient Products Program integrated cost-effective components from the discontinued In-Home program in 2017.
Source: Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, September 2, 2016, data for 2017.

Table ES-2 shows the breakdown of energy savings by product category. Downstream lighting made up 88 percent of energy savings, with 62 percent from standard LEDs and 26 percent from specialty LEDs.

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Table ES-2. Energy Savings and Realization Rates by Product Category

Product Category	*Ex Post* Savings (MWh)	Percent of Total Savings	Realization Rate
Standard LEDs	65,345	61.84%	1.00
Specialty LEDs	27,993	26.49%	0.99
Total Savings Downstream Lighting	**93,339**	**88.33%**	**1.00**
Smart Thermostats	2,035	1.93%	0.90
Clothes Washers	1,437	1.36%	1.00
Refrigerators	620	0.59%	1.00
Heat Pump Water Heaters	608	0.58%	0.98
Dehumidifiers	69	0.07%	1.00
Air Purifiers	12	0.01%	0.95
Total Savings Appliances	**4,781**	**4.52%**	**0.95**
Central Air Conditioners	470	0.45%	1.00
Air Source Heat Pump	216	0.20%	1.06
Ductless Heat Pumps	107	0.10%	1.00
Ground Source Heat Pumps	69	0.07%	0.90
Total Savings HVAC Appliances	**863**	**0.82%**	**1.00**
Energy Efficiency Kit LEDs	2,227	2.11%	0.93
Energy Efficiency Kit Nightlights	322	0.31%	0.84
Energy Efficiency Kit Showerheads	307	0.29%	0.84
Energy Efficiency Kit Faucet Aerators	80	0.08%	3.14
Total Savings Energy Efficiency Kits	**2,936**	**2.78%**	**0.93**
Multi-Family DI LEDs	2,210	2.09%	0.91
Multi-Family DI Nightlights	62	0.06%	0.57
Multi-Family DI Smart Power Strips	198	0.19%	0.64
Multi-Family DI Showerheads	321	0.30%	0.73
Multi-Family DI Faucet Aerators	62	0.06%	0.71
Total Savings Multi-Family Direct Installation	**2,853**	**2.70%**	**0.85**
Single-family DI LEDs	734	0.69%	1.12
Single-family DI Nightlights	26	0.02%	0.83
Single-family DI CFLs	5	< 0.01%	1.00
Single-family DI Smart Power Strips	114	0.11%	0.83
Single-family DI Showerheads	12	0.01%	0.76
Single-family DI Faucet Aerators	1	< 0.01%	0.88
Single-family DI Attic Insulation	2	< 0.01%	1.00
Single-family DI Air Sealing	2	< 0.01%	1.00
Total Savings Single-family Direct Installation	**896**	**0.85%**	**1.05**
Grand Total or Average Weighted Value	**105,667**	**100.00%**	**0.99**

Note. Totals may not sum due to rounding. DI = "Direct Installation"

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Table ES-3 shows the breakdown of demand savings by product category. Downstream lighting made up 87 percent of demand savings, with 61 percent from standard LEDs and 26 percent from specialty LEDs.

Table ES-3. Demand Savings and Realization Rates by Product Category

Product Category	*Ex Post* Savings (kW)	Percent of Total Savings	Realization Rate
Standard LEDs	11,646	61.13%	1.00
Specialty LEDs	4,989	26.19%	0.99
Total Savings Downstream Lighting	**16,635**	**87.31%**	**1.00**
Smart Thermostats	545	2.86%	0.96
Clothes Washers	202	1.06%	1.00
Refrigerators	113	0.59%	1.00
Heat Pump Water Heaters	83	0.43%	1.03
Dehumidifiers	16	0.08%	1.00
Air Purifiers	2	0.01%	0.95
Total Savings Appliances	**961**	**5.04%**	**0.98**
Central Air Conditioners	356	1.87%	1.00
Air Source Heat Pump	60	0.31%	1.00
Ductless Heat Pumps	11	0.06%	1.00
Ground Source Heat Pumps	10	0.05%	1.00
Total Savings HVAC Appliances	**437**	**2.29%**	**1.00**
Energy Efficiency Kit LEDs	397	2.08%	0.93
Energy Efficiency Kit Nightlights	0	0.00%	N/A
Energy Efficiency Kit Showerheads	39	0.21%	0.84
Energy Efficiency Kit Faucet Aerators	10	0.05%	3.14
Total Savings Energy Efficiency Kits	**446**	**2.34%**	**0.94**
Multi-Family DI LEDs	366	1.92%	0.85
Multi-Family DI Nightlights	0	0.00%	N/A
Multi-Family DI Smart Power Strips	22	0.12%	0.80
Multi-Family DI Showerheads	41	0.22%	0.73
Multi-Family DI Faucet Aerators	8	0.04%	0.71
Total Savings Multi-Family Direct Installation	**437**	**2.30%**	**0.81**
Single-family DI LEDs	122	0.64%	1.04
Single-family DI Nightlights	0	0.00%	N/A
Single-family DI CFLs	1	< 0.01%	1.00
Single-family DI Smart Power Strips	13	0.07%	1.04
Single-family DI Showerheads	2	0.01%	0.76
Single-family DI Faucet Aerators	0	< 0.01%	0.88
Single-family DI Attic Insulation	0	< 0.01%	1.00
Single-family DI Air Sealing	0	< 0.01%	1.00
Total Savings Single-family Direct Installation	**137**	**0.72%**	**1.03**
Grand Total or Average Weighted Value	**19,052**	**100.00%**	**0.99**

Note. Totals may not sum due to rounding. DI = "Direct Installation"

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ES.3 Findings and Recommendations for Program Improvements

The evaluation of the Efficient Products Program resulted in thirteen main conclusions and nine recommendations.

1. **The program surpassed its energy and demand savings goals.** The program achieved 105,667 MWh of energy savings, surpassing the goal of 73,219 MWh by 44 percent. The program also achieved 19.052 MW of demand savings, surpassing the goal of 7.59 MW by 151 percent.

2. **The program incented eight times as many smart thermostats in 2017 as it did in 2016.** The number of incented smart thermostats increased by 719 percent from 2016 to 2017 and represented a large portion of the appliance component *ex post* energy and demand savings (43% and 57%, respectively).

3. **Across all program components, standard LED lighting accounted for two-thirds of all energy and demand savings in 2017 (67% and 66%, respectively), while specialty LED lighting accounted for one-quarter of all energy and demand savings (26% for both).** The program incentivized or distributed 2,175,687 standard LED light bulbs through the downstream lighting component, the energy efficiency kit component, and both direct install components in 2017. In comparison, the program incentivized or distributed 550,725 specialty LEDs.[1]

    - **Recommendation 1: Increase the promotion of specialty LED lighting.** As prices decrease over time for specialty LED lighting products,[2] and as standard lighting sockets become saturated with LED bulbs,[3] there is an opportunity for specialty LED bulbs to play a more important role in the Efficient Products Program. This could be accomplished through either: increased incentives, increased marketing, the addition of bulb types, or the addition of bulb models. To ensure continued program savings growth, the evaluation team recommends an increased focus on specialty LEDs. Specialty LEDs made up about 20 percent of the total lighting products incentivized or distributed by the program in 2017, yet the per-unit energy savings value was higher than standard LEDs (55.34 kWh for specialty LEDs, compared to 34.39 kWh for standard LEDs). Including incentives for additional bulb types—such as candelabra or R bulb types—may increase specialty LED bulb sales.

4. **Downstream LED lighting accounted for 88 percent of all energy savings and 87 percent of all demand savings in 2017.** With the elimination of CFLs from the program in 2017, the program relied more heavily on downstream LED lighting savings than in 2016 (downstream

[1] In addition to downstream specialty LEDs, AEP Ohio distributed specialty LEDs through the single-family direct installation partnership with Columbia Gas of Ohio and through the multi-family direct installation component.
[2] A 2016 Massachusetts study interviewed LED suppliers, who estimated the average retail price of a specialty LED bulb would decrease by 19 percent from 2016 and 2018. The same study also ran a regression analysis on LED bulb sales data from the National Electrical Manufacturer Association sales data and estimated the average retail price of a specialty LED bulb would decrease by 36% from 2016 to 2018. http://ma-eeac.org/wordpress/wp-content/uploads/MA-Task-5b-LED-Incremental-Cost-Study_FINAL_01FEB2016.pdf
[3] In a 2017 Massachusetts and New York state study, researchers estimated 2017 overall LED saturation at 18% for MA and 10% for NY. Specialty LED saturation for 2017 was estimated at 8% for MA and 3% for NY. http://ma-eeac.org/wordpress/wp-content/uploads/Lighting-Market-Assessment-Consumer-Survey-and-On-Site-Saturation-Study.pdf

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LEDs accounted for 51 percent of all energy savings in 2016 and 60 percent of all demand savings).

5. **The evaluation relies on an in-service rate (ISR) value for LED lighting from research completed in 2014.** The ISR value of 0.97 is from the survey conducted for the 2014 Efficient Products Evaluation.

    - **Recommendation 2: Update the downstream LED lighting ISR value.** The evaluation team recommends AEP Ohio either apply ISR values from more recent studies completed in nearby jurisdictions, or conduct primary research in 2018 to update the downstream LED ISR value. Across the U.S., the penetration rate for standard LEDs has grown from 0.1 percent in 2010 to 13.5 percent in 2016.[4] As LEDs become more commonplace, ISR values have likely changed as well. In addition to determining an ISR for all LEDs, the program may want to consider determining individual downstream ISR values for standard LEDs and specialty LEDs.[5]

6. **The LED lighting ISR for multi-family direct installations was 0.91, which was greatly impacted by a single site audit where a large number of bulbs had been installed and subsequently removed.** Program implementers reported they do not cap the number of LED bulbs installed in a single home, as long as a light socket is in working order, has a standard base size, and has a non-LED bulb in the socket. On-site audits of multi-family direct installations revealed one tenant had 45 LED bulbs installed in the home and had removed all of these bulbs after being evicted from the unit. The results from this single unit (out of the 35 units audited) decreased the overall ISR by 0.05 (the ISR without this home was 0.96). Overall, less than one year after implementation staff installed measures, about one-quarter of audited units were vacant.

7. **Based on the multi-family direct installation audits, some LED bulbs are possibly being installed in lower-use sockets.** The multi-family direct installation audits found program bulbs installed in traditionally low-use sockets such as closets, hallways, and basements. It is unknown if the bulbs were initially installed in low-use sockets or if tenants relocated the bulbs after these were initially installed in more high-use sockets.

    - **Recommendation 3: Cap the number of total LED bulbs to 15 installed in a single unit and prioritize high-use sockets.** The evaluation team recommends placing a cap on the total number of bulbs installation staff may install in a single unit. Doing so would prevent situations where a tenant removing all bulbs has an outsized effect on the ISR. With a cap on the number of LEDs, installers could then prioritize installation in high-use sockets.

    - **Recommendation 4: Conduct a larger sample of multi-family direct installation audits to characterize vacant units and unit turnover.** The evaluation team recommends conducting a larger number of multi-family direct installation audits to capture a larger population of vacant units and units that are currently occupied by tenants who moved into the unit after measure installation (otherwise described as “unit turnover”). Due to the small sample of audits completed for this evaluation, the evaluation team was unable to quantify

[4] https://www.energy.gov/sites/prod/files/2017/08/f35/led-adoption-jul2017_0.pdf
[5] A 2016 report found that the first-year ISR for specialty LEDs is considerably higher than for standard LEDs (93% vs. 73%). http://ilsagfiles.org/SAG_files/Evaluation_Documents/Ameren/AIC_Eval_Reports_PY9/AIC-IPA_PY9_Residential_Lighting_Report_FINAL_2018-02-07.pdf

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the impact of unit turnover. By completing additional audits, the evaluation team would be able to explore the impact of unit turnover and help AEP Ohio narrow down appropriate next steps.

8. **The multi-family direct installation component currently replaces CFL bulbs in a working socket with an LED.** Program implementation staff reported CFLs may be replaced by LEDs during multi-family direct installations.

    - **Recommendation 5: End the practice of replacing CFL bulbs with LED bulbs during multi-family direct installations.** The evaluation team recommends only replacing halogen bulbs or incandescent bulbs with LEDs. Though currently LED lighting impact savings are not calculated using as-found conditions, in future years, methodologies may change. Savings would decrease using CFLs as baseline technology instead of the deemed baseline the program currently uses.

9. **The ISR for showerheads resulting from the energy efficiency kits survey was 0.43.** Less than half of energy efficiency kit survey respondents (43%) reported installing the showerhead they received from the program. To attempt to increase the ISR for showerheads in 2017, AEP Ohio began including a showerhead installation guide flyer in the energy efficiency kit in November. This guide illustrated the proper method for installing the showerhead included with the energy efficiency kit.

    - **Recommendation 6: In 2018, field the energy efficiency kit survey to gauge the effectiveness of the showerhead installation guide.** To measure the success of the installation guide, the evaluation team recommends fielding an energy efficiency kit survey for the 2018 program year. For the 2017 energy efficiency kit survey, the evaluation team used partial year data (with participants through the end of September) to develop the survey sample. Because the installation guide was not included in energy efficiency kits until November, the evaluation team was unable to survey customers receiving the guide. To estimate the effectiveness of the installation guide, the program should field a survey of energy efficiency kit participants in 2018. The program may then calculate the ISR value before and after the installation guide was included in the energy efficiency kit to determine the effectiveness of the guide.

    - **Recommendation 7: Allow customers to select the energy efficiency kit measures they would like to receive before a kit is mailed to them.** The evaluation team recommends that AEP Ohio customize energy efficiency kit request systems to allow customers to select which energy efficiency kit measures they would like to receive. Of customers who completed the online energy profile and did not install their showerhead, about 53 percent reported they did not install their showerhead because they like their current showerhead or they already have an efficient showerhead. These customers may not have ordered a showerhead with their energy efficiency kit if they were given the option. For customers who are interested in a receiving a showerhead, AEP Ohio may also consider providing several showerhead models to choose from for their energy efficiency kits. Options could include models differentiated by color (e.g., white, chrome, etc.) and unique features (e.g., multiple spray modes). Customers may be more engaged when involved in choosing the contents of their energy efficiency kits, and this increased engagement may translate to increased installation rates.

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10. **The realization rate for energy efficiency kit faucet aerator energy savings was 3.14.** AEP Ohio used the energy-efficient gallons-per-minute (GPM) value listed in the tracking data to calculate *ex ante* energy savings for all water-saving measures (2.0 GPM). This value differed from the description of the water-savings measures and the value listed for the model in specifications charts found through secondary research (1.5 GPM). *Ex post* savings were substantially higher than *ex ante* savings due to the GPM discrepancy.

    - **Recommendation 8: Update the gallon-per-minute value for all water-saving measures to reflect model specifications of the energy-efficient equipment.** The evaluation team recommends updating the gallons-per-minute value based on the description field in the tracking dataset.

11. **Overall, customers were satisfied with AEP Ohio and with the program components.** On average, respondents reported satisfaction with the energy efficiency kit component (Mean = 8.4, on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied), with the appliance rebate component (Mean = 8.4), and with AEP Ohio as an electric service provider (Mean = 8.2 for respondents of both the energy efficiency kits survey and the appliance rebate survey).

12. **Appliance rebate survey participants most often reported satisfaction with the contractor they used to install their equipment (Mean = 9.3) and least often reported satisfaction with interactions with program staff (Mean = 7.7).** Ninety three percent of appliance rebate survey respondents reported satisfaction (rated 8 or higher) with the contractor they used to install their equipment, while 67 percent of survey respondents reported satisfaction with their interactions with program staff.

13. **Energy efficiency kit participants most often reported satisfaction with the LED nightlight they received (Mean = 9.2) and least often reported satisfaction with the Home Energy Profile overall (Mean = 7.6).** Ninety-four percent of energy efficiency kit survey respondents reported satisfaction (rated 8 or higher on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied) with the LED nightlight they received in the energy efficiency kit, while 61 percent of survey respondents reported satisfaction with the Home Energy Profile overall. When asked to rate their agreement with a variety of statements regarding the Home Energy Profile, customers tended to agree that it was easy to complete, took a reasonable amount of time to complete, and was easy to understand. Customers were somewhat less likely to feel that they had learned information needed to take action or that they had learned about other sources of energy efficiency information through the Home Energy Profile.

    - **Recommendation 9: Conduct in-depth interviews with customers who have completed the Home Energy Profile to identify opportunities for improvement.** Participants indicated that there may be room to improve the information included in the Home Energy Profile report. To develop specific strategies for optimizing the report, the evaluation team recommends conducting in-depth interviews with customers who have recently completed the Home Energy Profile. These interviews could walk through the report with the customer, assessing the usefulness of various components of the report, how the components are perceived by customers, and ways in which the report could be improved. The interviews could also probe for additional information customers would like included in their Home Energy Profile report.

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1. INTRODUCTION

This chapter introduces the AEP Ohio Efficient Products Program, including the program description and differences in how the 2017 program was implemented compared to 2016. This chapter concludes with a list of evaluation objectives.

1.1 Program Description

This section describes the AEP Ohio Efficient Products Program including:

- Overall program description
- Program objectives and goals
- Role of the implementation contractor
- Downstream lighting component description
- Appliance rebate component description
- Energy efficiency kits component description
- Columbia Gas of Ohio single-family direct installation partnership component description
- Multi-family direct installation component description
- Program marketing efforts

1.1.1 Overall Program Description

The AEP Ohio Efficient Products Program provides financial incentives to customers and lighting retailers and manufacturers, and provides free energy-efficient measures directly to customers. Retailer and manufacturer incentives are passed directly to customers to encourage the purchase and installation of energy-efficient lighting, and customers are offered rebates for the installation of energy-efficient appliances in their homes, resulting in decreased energy usage and peak demand. Retail partners are recruited to promote rebated appliances by displaying marketing materials in their stores, and retail sales associates are provided training to help promote the program and inform customers of the incentives at the store. The program targets all residential customers.

In 2017, the AEP Ohio Efficient Products Program acquired components from the now discontinued In-Home program. AEP Ohio consolidated these programs to remove less cost-effective measures from the residential portfolio, to consolidate contracts, and to reduce portfolio costs. The Efficient Products Program now consists of six components: (1) downstream incentives on ENERGY STAR® qualified screw-in LEDs purchased at participating retail locations and the AEP Ohio online store, (2) rebates on select ENERGY STAR® qualified appliances, (3) rebates on select heating and cooling (HVAC) equipment, (4) free online assessment that a customer can choose to receive an energy efficiency kit, (5) free energy efficiency direct measure installations in select multi-family homes, and (6) free energy efficiency direct measure installations in select single-family homes through a partnership with Columbia Gas of Ohio.

1.1.2 Program Objectives and Goals

The objective of the AEP Ohio Residential Efficient Products Program is to produce long-term electric energy savings in the consumer sector by increasing the market share of ENERGY STAR® qualified lighting products and appliances, as well as water-saving measures and smart strips. As shown in Table 1-1, the savings goals for the program in 2017 were 73,219 MWh and 7,591 kW, accounting for 38 percent and 19 percent, respectively, of the expected (*ex ante*) savings impacts in the 2017 Consumer Sector Portfolio.

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Table 1-1. 2017 Efficient Products Program Savings Goals

Metric	Value[1]	Percent of Consumer Sector Portfolio
Estimated Energy Savings	73,219 MWh	38%
Estimated Demand Savings	7,591 kW	19%

[1] AEP Ohio combined the Efficient Products Program and In-Home Program goals as the Efficient Products Program integrated cost-effective components from the discontinued In-Home Program.
Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, September 2, 2016, combined data for 2017 Efficient Products Program and In-Home Energy Program.

1.1.3 Role of the Implementation Contractor

The program implementation contractor, CLEAResult, provides turnkey implementation services that includes: recruiting manufacturers and retailers to participate in the program, designing and placing marketing materials in participating store locations, conducting promotional activities, training participating retail sales associate staff at both independent and corporate retailers, recruiting potential multi-family sites, coordinating with Columbia Gas of Ohio for the single-family direct installation partnership component, distributing energy efficiency kits, and implementing the direct installation of multi-family measures.[6] The implementation contractor also conducts regular store visits to confirm that qualifying products are correctly labeled and that marketing materials are displayed. A subcontractor to the program implementation contractor handles the tracking of participation and sales data, payment of invoices to manufacturers and retailers for the downstream lighting component of the program, and payment of rebates to contractors and customers for the appliance component.

1.1.4 Downstream Lighting Component Description

In 2017, the downstream lighting component provided incentives to retailers and manufacturers for ENERGY STAR®-qualified LED light bulbs. Incentives are passed directly to the customer at participating retail locations, in the form of markdowns or instant coupons used at the point-of-purchase (POP). At the beginning of 2017, incentives were $1.50 for standard LEDs and ranged from $2.00 to $3.50 for specialty LEDs.[7] In March, incentives were reduced to $1.00 for standard LEDs and $1.50 to $3.50 for specialty LEDs to ensure the program would not exceed its budget by the end of the year. Then, to increase participation at the end of the year, incentives were then increased again to $1.50 for standard LEDs and ranged from $2.00 to $3.50 for specialty LEDs in August.

1.1.5 Appliance Rebate Component Description

Throughout 2017, AEP Ohio offered rebates for ENERGY STAR®-qualified clothes washers, refrigerators, electric heat pump water heaters, air purifiers, and smart thermostats. Dehumidifiers were removed from the program in January and air purifiers were removed in April. Dehumidifiers were removed due to specification changes that increased ENERGY STAR® standards.[8] AEP Ohio determined air purifiers to be not cost effective after new studies showed that savings from ENERGY STAR® air purifiers are low.[9] Rebates amounts are shown in Table 1-2.

[6] Several of these elements are subcontracted to Energy Federation Inc. (EFI), such as the processing of online rebate applications, though CLEAResult holds the primary contract for these services.
[7] The program provided larger incentives for 85 LED light bulbs sold through a special promotion in the online store.
[8] https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final.pdf
[9] 2016 PG&E Retail Products Platform (RPP) – Air Cleaner Hours of Use Research Results Memo and 2016 PG&E Retail Products Platform (RPP) Air Cleaner Lab Research Results Memo.

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Table 1-2. Appliance Rebate Amounts in 2017

Appliance Type	2017 Rebate Amounts
Clothes Washers	$50
Dehumidifiers	$25
Refrigerators	$50
Water Heater – Electric Heat Pump	$500
Air Purifiers	$50
Smart Thermostats – Gas Heated Homes	$75
Smart Thermostats – Electric Heated Homes	$100

HVAC appliance rebates were one of the components acquired in 2017 from the In-Home Program. To receive an HVAC appliance rebate, a contractor on the AEP Ohio participating contractor list must install the new equipment. An applicant must also submit an AHRI Certificate of Product Ratings for the installed equipment. Customers can either receive an "instant rebate" from their contractor (contractors are then reimbursed by AEP Ohio) or customers may receive a rebate directly from AEP Ohio through the mail. Incentives were increased for air source heat pumps and ductless mini-split heat pumps early in 2017 (from $200 to $300) to encourage participation. Rebate amounts are shown in Table 1-3.

Table 1-3. HVAC Appliance Rebate Amounts in 2017

Appliance Type	2017 Rebate Amounts
Central Air Conditioners	$150
Central Air Conditioner Early Replacement	$275
Air Source Heat Pumps	$200, $300
Air Source Heat Pump Early Replacement	$450
Ductless Mini-Split Heat Pumps	$200, $300
Ground Source Heat Pumps	$1,200

1.1.6 Energy Efficiency Kits Component Description

Previously part of the In-Home program, the energy efficiency kit component distributed free kits to AEP Ohio customers. Kits consisted of:

- 4 standard LED light bulbs
- 2 faucet aerators
- 1 low-flow showerhead
- 1 LED nightlight

Customers can request kits through two channels: 1) through the Home Energy Profile online tool, or 2) as an additionally requested item on their Appliance Rebate application. The Home Energy Profile online tool collects data on a customer's home and provides a customized report including a home energy efficiency score and energy savings suggestions.

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1.1.7 Columbia Gas of Ohio Single-family Direct Installation Partnership Component Description

Columbia Gas of Ohio conducts direct installation of energy efficiency measures to Columbia Gas of Ohio customer homes through its Home Energy Assessment and Home Energy Audit programs.[10] For customers who are both Columbia Gas of Ohio customers and AEP Ohio electric customers, AEP Ohio provides Columbia Gas of Ohio with energy efficiency measures and funding.[11] Columbia Gas of Ohio implementation staff install:

- LED lightbulbs
- Faucet aerators (for electric water heating customers)
- Low-flow showerheads (for electric water heating customers)
- Smart power strips
- LED nightlights
- Smart thermostats

1.1.8 Multi-Family Direct Installation Component Description

This component provides energy efficiency measures at select multi-family properties and was previously housed within the In-Home program. The implementer installs the following energy-efficient equipment in eligible units:

- LED lightbulbs
- Faucet aerators (for electric water heating customers)
- Low-flow showerheads (for electric water heating customers)
- Smart power strips
- LED nightlights

1.1.9 Program Marketing Efforts

Marketing efforts in 2017 included:

- In-store outreach
- Retail POP signage
- Bill inserts
- Email promotion (e-blasts)
- Social media posts (Facebook and Twitter)
- Contextual ads placed on home improvement, DIY, and green/sustainable living websites
- Google Adwords
- Direct mail postcards
- Outreach events at expos/festivals
- Bulb exchange events trading customers' working incandescent or halogen lamps for new LEDs

[10] Seven air sealing and attic insulation projects completed at the end of 2016 were also incentivized through the Efficient Products program in 2017. These units were reported with the single-family direct installation component.

[11] AEP Ohio provides Columbia Gas of Ohio with a fee of $25 for each treated housing unit.

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1.2 Program Changes from 2016

This section describes changes to the program for 2017 compared to 2016.

1.2.1 Overall Changes to the Program

In comparison to 2016, changes to the program overall included:

- The addition of several components previously housed under the In-Home Program, including:
  - Multi-family direct install measures.
  - Rebates for ENERGY STAR® HVAC equipment.
  - Free energy efficiency kits mailed to AEP Ohio electric customers.
- The added components differed from the 2016 In-Home program in that:
  - The energy efficiency kit component only contains LEDS, it no longer includes CFLs.
  - The multi-family direct installation component only installs LEDs, the direct installation of CFL bulbs was ended.
  - Incentives increased for air source heat pumps and ductless mini splits ($200 to $300).
- A partnership with Columbia Gas of Ohio to distribute electric energy efficiency measures to single-family homes who receive AEP Ohio electric service and participate in Columbia Gas of Ohio's Home Energy Assessment and Home Energy Audit programs.
  - This single-family direct installation component began installing specialty LED bulbs and smart thermostats in 2017.
- In lieu of additional Bulb Exchange events, the program distributed LED light bulbs through the Appliance Recycling program. Customers who recycled their appliance in November and December received a lighting kit containing four standard LED light bulbs.

1.2.2 Changes to the Downstream Lighting Program

In comparison to 2016, changes to the downstream lighting component of the program included:

- The program discontinued rebates for CFL light bulbs, due to the ENERGY STAR® lighting specification change (v2.0).[12]
- Two new manufacturers were added to the program: Zoren Industries (sold exclusively through Lowe's) and Dangoo Electric (sold exclusively through Home Depot).
- Four manufacturers were dropped from the program: Satco/Nuvo, Lighting Science, Earthbulb, and Earthtronics.

1.2.3 Changes to the Appliance Rebate Program

In comparison to 2017, changes to the appliance rebate component of the program included:

- Dehumidifiers were removed at the end of 2016, though a few remaining dehumidifiers were incentivized through the program during January.
- Air purifiers were removed in April.
- Mail-in appliance rebate applications were discontinued in July. Customers and contractors may now only apply for rebates through the online application or over the telephone. Implementation staff reported that the updated rebate methods reduced the number of applications with errors.[13]
- Rebates on smart thermostats were increased from $50 to $75 for gas-heated homes and $100 for electric-heated homes.

[12] A few CFL bulbs were provided through the single-family direct install component in 2017.

[13] Implementation staff estimated that the overall rate of applications flagged as problematic (flaw rate) decreased from 33.9% to 20.7% since the program moved to the online form (correspondence on December 18, 2017).

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- The program implementer began mandatory collection of customer water heating type for every Efficient Products Program rebate in August 2017.

1.2.4 Changes in Marketing Strategy and Tactics

Notable changes from 2016 included:

- AEP Ohio rebranded early in 2017, and all marketing materials were updated with new branding.
- Marketing materials were cobranded with Columbia Gas of Ohio for the single-family direct installation component.
- Marketing focus shifted to increase program awareness and customer satisfaction, rather than solely focusing marketing on a specific equipment type.
- A flyer was included in energy efficiency kits describing equipment and providing a showerhead installation guide to help customers install their showerheads (began shipping with kits in November 2017).
- The frequency of program bill inserts was increased (5 in 2017 vs. 3 in 2016) and the number of direct customer emails increased (7 in 2017 vs. 3 in 2016).
- Upon completion of the Home Energy Profile web tool, the program implementer began including links to other AEP Ohio websites such as: smart thermostat rebates, appliance rebates, the AEP Ohio online energy savings store, and the It's Your Power App.
- POP marketing materials for sales of equipment in retail stores were updated.
- There were fewer bulb exchange events, as turnout to these events was lower than anticipated. Bulbs that were set aside for exchange were instead distributed to customers through the Appliance Recycling program.
- New lawn signs were displayed on participating properties promoting the multi-family direct installation component.

1.3 Evaluation Objectives

The objectives of the evaluation were to: (1) quantify the energy and peak demand savings impacts, (2) determine key process-related program strengths and weaknesses, (3) provide recommendations to improve the program, and (4) determine program cost-effectiveness. The evaluation sought to meet these objectives by answering the following research questions.

1.3.1 Impact Questions

1. What are the annual energy (kWh) and summer peak demand (kW) impacts resulting from the program? Did the program meet its energy and demand savings goals?
2. What are the energy (kWh) and peak demand (kW) savings per-unit, for each of the program products?
3. How many LEDs discounted through this program were sold, by category (e.g., wattage, specialty lamp types)? How many appliances were rebated through the program, by type? How many Home Energy Profiles were completed, and how many energy efficiency kits were shipped? How many multi-family direct installations were completed?
4. What are the realization rates for the program? (Defined as evaluation-verified (*ex post*) savings divided by program-reported (*ex ante*) savings).
5. What is the cost-effectiveness of this program?

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1.3.2 Process Questions

Marketing and Participation

1. How do participants become aware of the program?
2. Does the marketing effort appropriately meet current and future program participation goals?
3. Does the program outreach effectively increase awareness of program opportunities?
4. How often does program outreach occur?
5. Are the messages included within program outreach clear and actionable?
6. What are the key interests and motivations for potential and actual participants beyond the financial incentive offered?
7. What are the key barriers to participation in the program?

Program Effectiveness and Satisfaction

8. What improvements could be made to create a more effective program and to help increase energy and demand impacts?
9. What is the status of implementing recommendations/issues identified in previous evaluations?
10. How do the findings in the current year's evaluation compare to previous evaluations?
11. Are participants and providers satisfied with the programs?
12. Are participants satisfied with various aspects of the program? If not, why not? Is program satisfaction related to satisfaction with AEP Ohio?
13. Have implementation changes effectively increased satisfaction and/or participation?

Administration and Delivery

14. Is program administration functioning effectively?
15. Has the program, as implemented, changed from the original plan? If so, how, why, and was this an advantageous change?
16. Are there any problems with program delivery?
17. Are program tracking systems adequate? Are program tracking systems consistently maintained? Do program tracking systems contain all data required to support AEP Ohio supervision, program tracking, and evaluation?
18. Are program procedures documented and followed?
19. Are verification procedures implemented in a manner consistent with program design?
20. Is the implementation contractor meeting key performance indicators?
21. What are the current program challenges and how are these being addressed?
22. What are the opportunities for program improvement?
23. What processes and procedures have program staff developed for conducting direct installations of measures in multi-family homes? How do AEP Ohio staff ensure adherence to these guidelines? Do direct installation implementation staff systematically comply with guidelines? How might processes and procedures be improved?

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2. METHODOLOGY

This chapter describes the methodologies used to complete the process and impact evaluations. Table 2-1 shows the various activities and methods undertaken by the evaluation team, which are described in further detail in the following sub-sections. This chapter ends with a review of impact evaluation methods.

Table 2-1. Summary of Evaluation Activities

Evaluation Activity	Targeted Population	Supported Evaluation Activities
Tracking data review	All program participants	Impact evaluation
Program documentation review	Any new program documentation	Process evaluation
In-depth staff interviews	Program staff and implementers	Process evaluation
Appliance rebate participant web survey	All program participants who submitted rebates for HVAC measures or smart thermostats	Impact and process evaluation
Energy efficiency kits participant web survey	All program participants who received an Energy Efficiency Kit	Impact and process evaluation
Multi-family direct installation onsite audits	Multi-family direct installation component participants	Impact and process evaluation

2.1 Tracking Data Review

AEP Ohio provided the tracking data for the evaluation team to review. First, the evaluation team determined key data fields essential for consideration in the impact and process evaluations. Next, the team examined frequency distributions for each of the key fields, identifying missing, incomplete, or inconsistent data. Finally, the team resolved any inconsistencies with AEP Ohio.

The evaluation team assessed key characteristics of rebated measures. The team also analyzed process dates and service account IDs to determine duplicate entries and the number of customers that participated more than once in the program. The assessment of the tracking data and program activity is discussed in Section 3.1.

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2.2 Program Documentation Review

To better understand the details of the program and to inform customer surveys, the evaluation team conducted a program documentation review, including the:

- 2017 Efficient Products marketing plan and marketing materials
- AEP Ohio Efficient Products Program website

2.3 In-depth Staff Interviews

The evaluation team conducted a series of in-depth interviews, as summarized in Table 2-2, to understand changes in program implementation, collect feedback on research priorities, and answer key process evaluation research questions.

Table 2-2. Summary of In-depth Interviews

Targeted Population	Sample Frame	Sample Target	Sample Size	Timing
AEP Ohio Program Staff	Contacts from AEP Ohio	Program Manager	1	October 2017
Implementation Contractor Program Staff	Contacts from AEP Ohio	Residential Portfolio Manager Program Manager Marketing Account Manager Program Director	3	October 2017, December 2017, February 2018

2.4 Appliance Rebate Participant Web Survey

The evaluation team conducted a web survey (fielded between January 29 and February 7, 2018) of Appliance Rebate Program participants who received rebates for either smart thermostats, central air conditioners, air source heat pumps, ductless mini-split heat pumps, and ground source heat pumps. The survey focused on both impact- and process-related questions. Key impact questions were related to the equipment installation rates. Process-related questions quantified as: how satisfied customers were with the program, how satisfied customers were with the application process, and how customers learned about the program.

The evaluation team designed the sample for the survey to attain 90% confidence and +/- 10% precision at the component-level. For appliance rebates, the evaluation team used a stratified sample with a target of 129 completes over all five equipment categories. Table 2-3 shows the number of surveys completed, broken down by equipment type, and it provides confidence and precision in total. The evaluation team achieved an overall response rate of 15.3 percent for the appliance rebate survey.

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Table 2-3. Summary of Appliance Rebate Survey Results

Equipment Type	2017 Population Size	Survey Target Competes	Survey Completes [1]	Sampling Error
Smart Thermostat	8,224	70	94	8.4%
Central Air Conditioner	1,628	45	52	11.2%
Air Source Heat Pump	317	9	10	N/A
Ductless Mini-Split Heat Pump	80	4	5	N/A
Ground Source Heat Pump	23	1	1	N/A
Total	**10,272**	**129**	**162**	**6.4%**

[1] Because the air source heat pump, ductless mini-split, and ground source heat pump strata had so few sample points, several partial survey respondents (6 in total) were included in the survey as they had valid responses for the impact-related questions and had important information to share about their experiences with the program.

2.5 Energy Efficiency Kits Participant Web Survey

The evaluation team conducted a web survey (fielded between January 12 and January 22, 2018) of energy efficiency kit recipients to answer central impact- and process-related questions. Key impact questions were related to installation rates for kit measures. Process-related questions covered topics including: knowledge retention, satisfaction (with the energy efficiency kit component, equipment, communication with AEP Ohio, energy savings, and AEP Ohio as an energy provider), awareness, other program participation, and demographic information.

The evaluation team designed the sample for the survey to attain 90% confidence and +/- 10% precision at the component-level. The evaluation team used a stratified sample with a target of 44 and 36 completes for electric and gas water heater owners, respectively. Table 2-4 shows the number of surveys completed and confidence and precision in total and by water heater type. The evaluation team achieved an overall response rate of 24.3 percent for the energy efficiency kits survey.

Table 2-4. Summary of Energy Efficiency Kits Survey Results

Water Heater Type	2017 Population Size	Survey Target Completes	Survey Completes	Sampling Error
Electric Water Heater	3,012	44	49	11.6%
Non-Electric or Unknown Water Heater Type	15,201	36	65	10.1%
Total or *Weighted Average Value*	**18,213**	**80**	**114**	***7.7%***

2.6 Multi-Family Direct Installation On-Site Audits

The evaluation team managed a subcontractor to conduct audits (fielded between February 1 and February 22, 2018) of units receiving measures through the multi-family direct installation program. The audit verified the installation of measures and asked process-related questions of tenants present during the audit. It is worth noting that, qualitatively, occupied units had higher ISRs for all measures compared to vacant units, though sample sizes were too small to detect significant differences. Process-related questions included:

- Whether tenants were present during the installation of program equipment.

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- Whether tenants received equipment that was not directly installed.
- Whether tenants uninstalled equipment.
- What types of light bulbs the program LEDs replaced.

The evaluation team performed a census attempt of all multi-family direct installation participants and performed 35 audits to attain 90 percent confidence and +/- 10 percent precision at the component level. Table 2-5 shows the number of audits completed and confidence and precision in total.

Table 2-5. Summary of Completed Multi-Family Direct Installation Audits

	2017 Population Size	Survey Target Competes	Survey Completes	Sampling Error
Multi-Family Direct Installation Participants	5,176	35	35	8.4% [1]

[1] *Sampling error of key impact response questions with a 90% response distribution.*

2.7 Impact Evaluation

The evaluation team analyzed program tracking data from all equipment invoiced during 2017 to evaluate demand and energy savings achieved through the program. In general, the evaluation team applied the following review steps to each product category as part of the impact evaluation:

- Reviewed program tracking data for inconsistencies and errors and resolved issues with AEP Ohio
- Assessed which calculation methods and parameters were used by AEP Ohio to determine *ex ante* energy and demand savings
- Summed up the *ex ante* savings per invoice or line item in the tracking data to determine total *ex ante* savings at the product and program level
- Used the Draft 2010 Ohio Technical Reference Manual (TRM) methods, or independently-determined methods where measures were not included in the TRM, to calculate *ex post* energy and demand savings at the product and program level
- Calculated a realization rate for energy and demand at the product and program levels

For products covered in the Draft Ohio TRM, which includes CFLs, smart power strips, faucet aerators, showerheads, clothes washers, dehumidifiers, refrigerators, and heat pump water heaters, *ex post* savings were calculated using TRM methods and parameters. For products not covered by the TRM, including LEDs, LED nightlights, air purifiers, and smart thermostats, *ex post* savings were calculated using independent, research-based savings approaches.

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3. DETAILED EVALUATION FINDINGS

This chapter presents the impact and process evaluation findings in the following sections:

- Program Activity
- Combined Impacts of the Efficient Products Program
- Process Evaluation Findings
- Cost-Effectiveness Review

3.1 Program Activity

This section presents a summary of program activity, including the number of overall units incentivized in 2017, followed by specific values for each program component.

3.1.1 Number of Downstream Lighting Component Units Incentivized

The evaluation team examined program data for all downstream lighting products invoiced during 2017 to characterize this component of the program, including lighting products discounted through the markdown and coupon delivery mechanisms.

Due to the removal of CFLs from the Efficient Products Program, the program discounted 30 percent fewer total downstream lighting products in 2017 than in 2016. The number of LEDs discounted increased by 51 percent. Of the total 2,561,683 lighting products invoiced in 2017, standard LEDs accounted for 79 percent of all downstream lighting products and specialty LEDs accounted for 21 percent, as shown in Table 3-1.

Table 3-1. Downstream Lighting Component 2017 Units for Standard and Specialty LEDs

Product	Total Units in 2017	Percent
Standard LED	2,022,057	78.9%
Specialty LED	539,626	21.1%
Total	**2,561,683**	**100.0%**

Figure 3-1 shows the distribution of 2017 downstream lighting component standard LEDs and specialty LEDs by month. Since point-of-sale data was not available, the data populating this figure is based on invoice dates. The program rebated the most standard and specialty LEDs in November with an additional peak in sales occurring in March.

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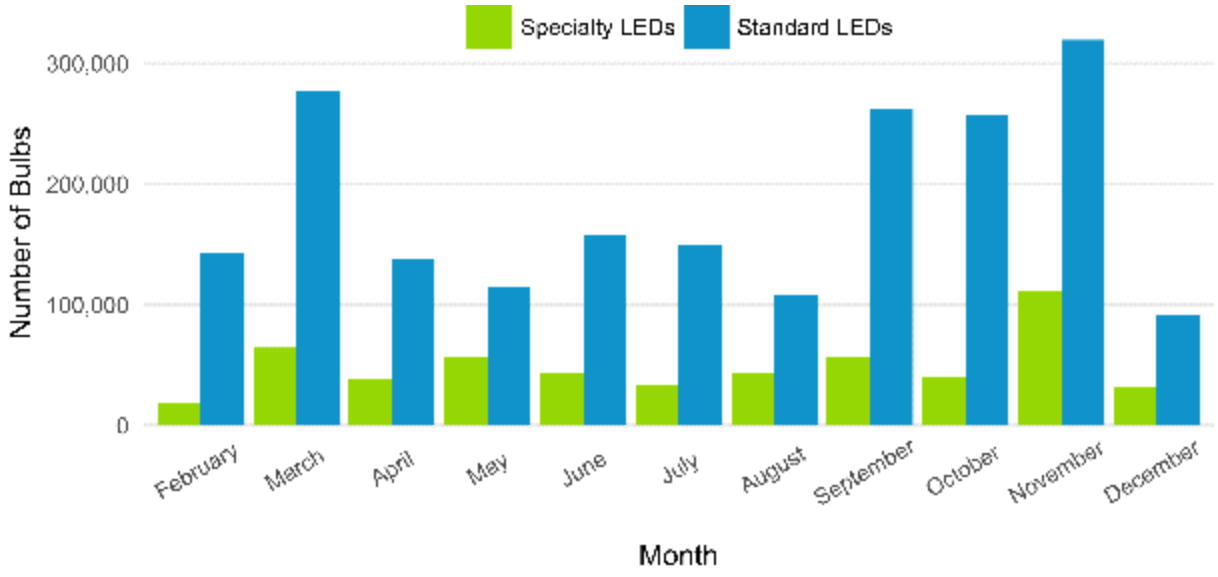
Figure 3-1. Downstream Lighting Products Discounted by Month Invoiced



3.1.2 Number of Appliance Units Incentivized

The evaluation team examined data for all appliance products invoiced during 2017 to characterize this component of the program. The range in the number of appliances incented varied from a low of 246 units for air purifiers to 8,224 units for smart thermostats, as shown in Table 3-2. The number of smart thermostats incented by the program increased by 719 percent from 2016 (from 1,004 in 2016 to 8,224 in 2017), while the number of appliances incented decreased for all other appliance types.[14]

Table 3-2. Appliance Component 2017 Units

Product	Total Units in 2017	Percentage of Units
Smart Thermostats	8,224	38.3%
Clothes Washers	6,846	31.9%
Refrigerators	5,445	25.4%
Heat Pump Water Heaters	400	1.9%
Dehumidifiers	317	1.5%
Air Purifiers	246	1.1%
Appliance Total	**21,478**	**100.0%**

[14] A portion of smart thermostats were provided through the HVAC appliance rebate portion of the program (about 2 percent, or 138 thermostats) and through the single-family direct installation component (about 9 percent, or 759 thermostats). These units were included in this section to simplify reporting.

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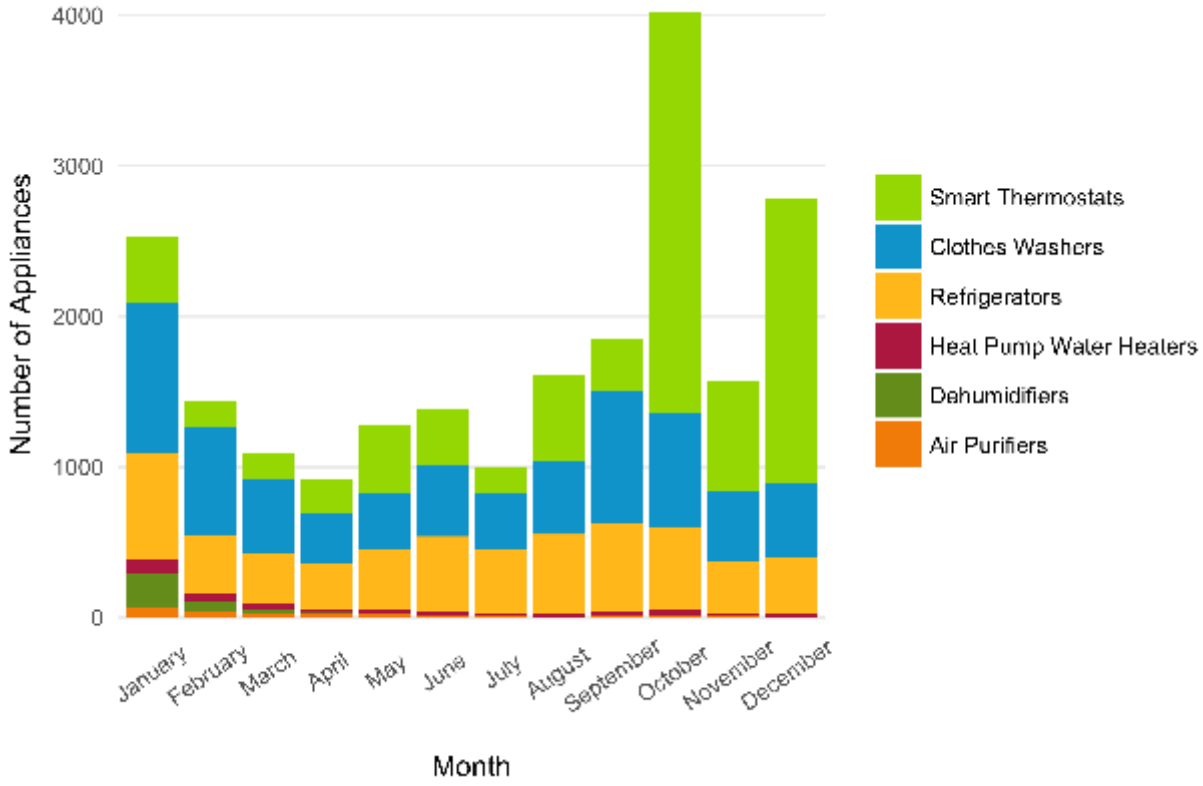
Appliance rebates by month are shown in Figure 3-2. The program witnessed increased smart thermostat sales in the last three months of the year, likely driven by the addition of the "Nest E" smart thermostat in September.[15]

Figure 3-2. Appliance Rebates by Month



3.1.3 Number of HVAC Appliance Units Incentivized

The evaluation team examined data for all HVAC appliance products invoiced during 2017 to characterize this component of the program. The number of incented HVAC appliances decreased by 20 percent from the 2016 In-Home Program.[16]

[15] "Nest E" smart thermostats were provided through the single-family direct installation component in November and December.

[16] Compared to the same measures incented by the 2016 In-Home Program. The 2016 In-Home program incented 2,095 central air conditioners, 371 air source heat pumps, and 96 ground source/ductless mini-split heat pumps.

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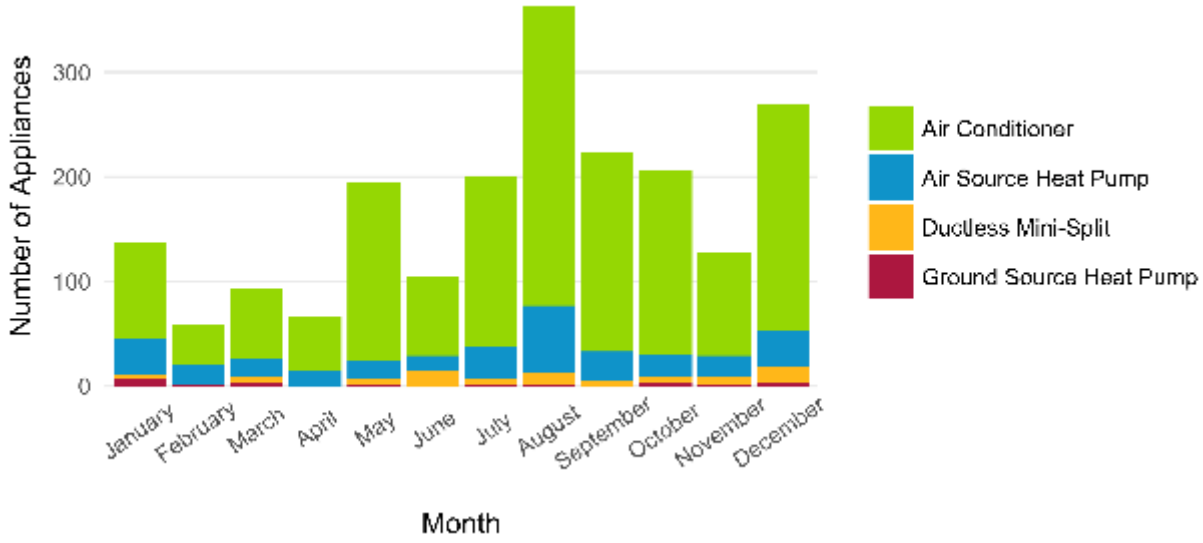
Table 3-3. HVAC Appliance Component 2017 Units

Product	Total Units in 2017	Percentage of Units
Air Conditioners	1,628	79.5%
Air Source Heat Pumps	317	15.5%
Ductless Mini-Split Heat Pumps	80	3.9%
Ground Source Heat Pumps	23	1.1%
HVAC Appliance Total	**2,048**	**100.0%**

HVAC appliance rebates by month are shown in Figure 3-3. Reflecting seasonal trends, the program rebated the most central air conditioners and air source heat pumps in August. The strongest month for ductless mini-splits was December, and January for ground source heat pumps.

Figure 3-3. HVAC Appliance Rebates by Month



3.1.4 Number of Energy Efficiency Kits Distributed

The evaluation team examined data for all energy efficiency kits distributed during 2017 to characterize this component of the program. The number of energy efficiency kits distributed by the program increased by 540 percent from the 2016 In-Home Program. The component distributed more LEDs than any other measure as each energy efficiency kit contained four LED bulbs. LEDs constituted two-thirds of all distributed units (Table 3-4).

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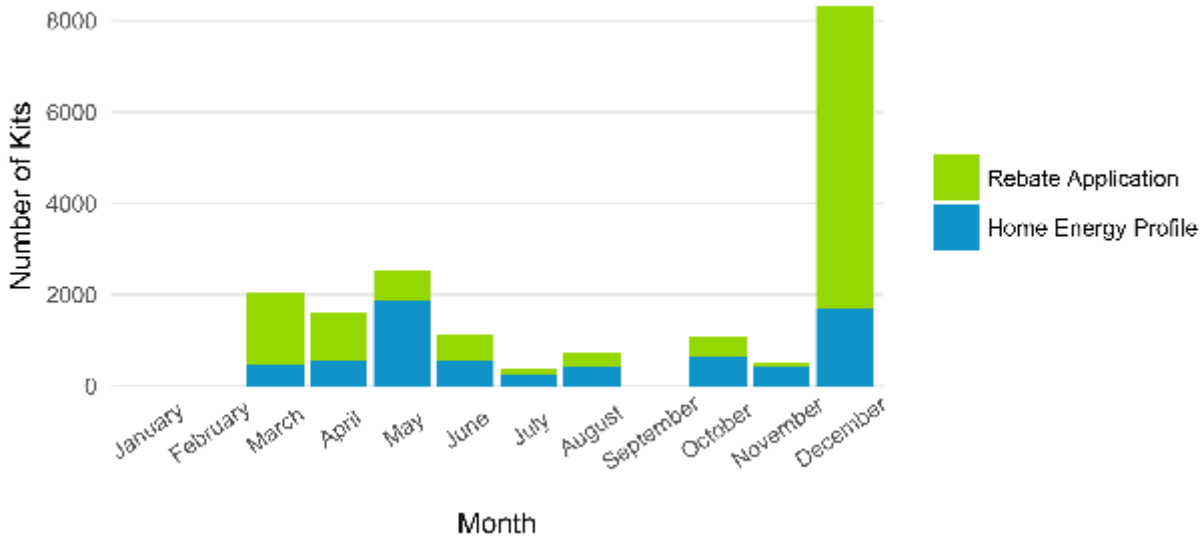
Table 3-4. Energy Efficiency Kits Component 2017 Units

Product	Total Units in 2017	Percentage of Units
LEDs	73,080	66.7%
Nightlights	18,270	16.7%
Showerheads	6,081	5.5%
Faucet Aerators	12,162	11.1%
Energy Efficiency Kits Total	**109,593**	**100.0%**

Energy efficiency kits distributed by channel and by month are shown in Figure 3-4. Customers most often applied for energy efficiency kits through the rebate application form in December, while customers most often applied through the Home Energy Profile in May, 2017.

Figure 3-4. Energy Efficiency Kits by Channel and Month



3.1.5 Number of Multi-Family Measures Installed

The evaluation team examined all 2017 multi-family direct installation data to characterize this component of the program. AEP Ohio ended the direct installation of CFL lighting in at the beginning of 2017. AEP Ohio also installed LED lighting throughout 2017, as opposed to 2016, for which AEP Ohio installed LED lighting for only part the year.[17] In 2017, LED lighting constituted more than 85 percent of all multi-family component units, as seen in Table 3-4.

[17] Lighting measures discussed were incented by the 2016 In-Home program.

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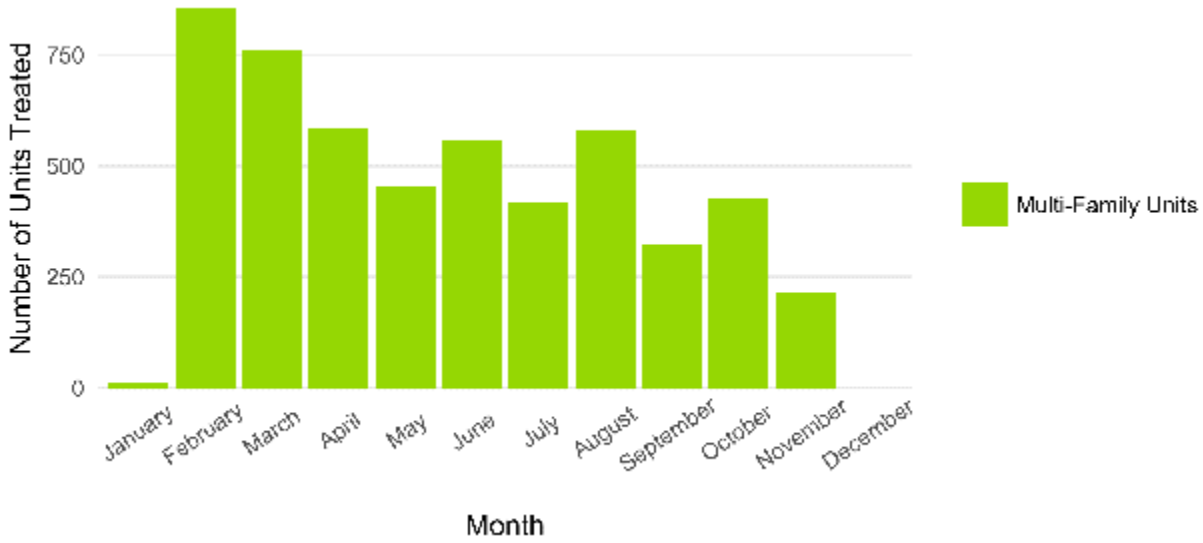
Table 3-5. Multi-Family Component 2017 Units

Product	Total Units in 2017	Percentage of Units
LEDs	74,169	85.1%
Nightlights	5,173	5.9%
Smart Strips	3,014	3.5%
Showerheads	1,919	2.2%
Faucet Aerators	2,868	3.3%
Multi-Family Direct Installation Total	**87,143**	**100.0%**

Multi-family units treated by month are shown in Figure 3-5. The component treated very few units in January, had a dramatic rise in the number of treated units in February, and saw a gradual decline in participation over the rest of the year.

Figure 3-5. Multi-Family Units Treated by Month



3.1.6 Number of Single-family Measures Installed

The evaluation team examined all 2017 single-family direct installation data to characterize this component of the program. During 2017, the component delivery model transitioned from an AEP Ohio-administered single-family direct installation component to a partnership with Columbia Gas of Ohio. While most of the component measures were installed through the partnership, a few measures remained in the tracking database in 2017 from the previous delivery method (namely, attic insulation and air sealing). The vast majority of measures installed through the single-family direct installation partnership were LEDs (84.4%, as seen in Table 3-6).

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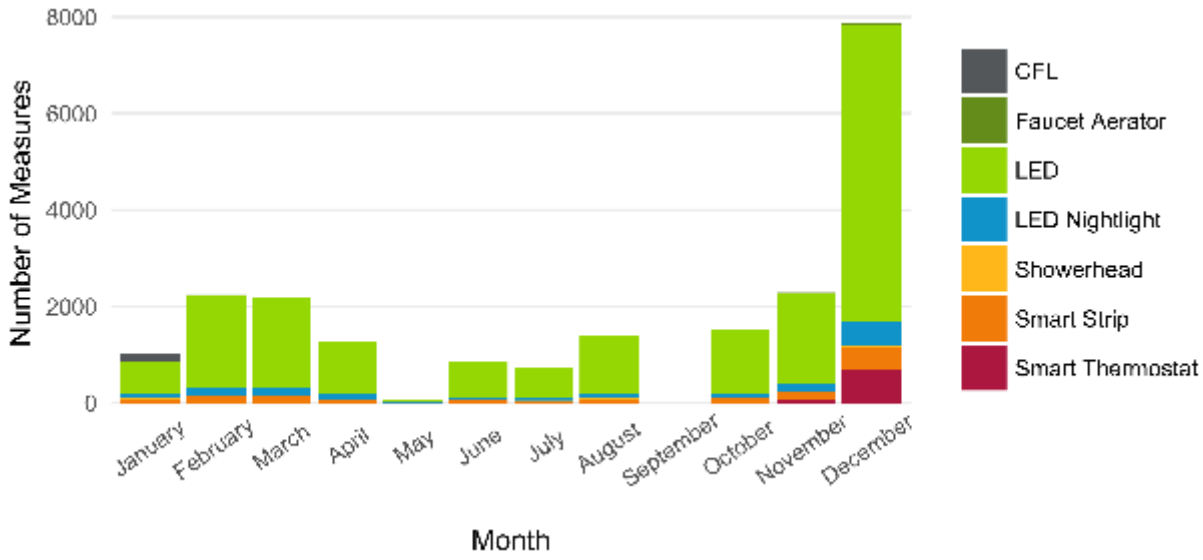
Table 3-6. Single-family Component 2017 Units

Product	Total Units in 2017	Percentage of Units
LEDs	17,480	84.4%
Nightlights	1,501	7.3%
CFLs	173	0.8%
Smart Strips	1,341	6.5%
Showerheads	116	0.6%
Faucet Aerators	73	0.4%
Attic Insulation	9	< 0.1%
Air Sealing	7	< 0.1%
Single-family Direct Installation Total	**20,700**	**100.0%**

The number of single-family measures installed by month are shown in Figure 3-6. More than one-third (37%) of all family direct installation measures were installed in December.

Figure 3-6. Single-family Measures Installed by Month



3.2 Combined Impacts of the Efficient Products Program

This section presents the savings and realization rates for the 2017 Efficient Products Program. The results are reported first for the overall program and then for each program component. The parameters and methods used to determine these values are also described in this section.

3.2.1 Overall Program Savings and Realization Rates

The 2017 AEP Ohio Efficient Products Program had a total *ex post* energy savings of 105,667 MWh and demand savings of 19.1 MW. Downstream lighting products accounted for 88 percent of energy savings and 87 percent of demand savings. Total realization rates are 0.99 for both energy and demand savings. Total savings and realization rates are summarized in Table 3-7 and Table 3-8.

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Table 3-7. Combined Program Energy Savings and Realization Rates

Product	Number of Units	Average *Ex Post* Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
Downstream Lighting	2,561,683	42.92	93,500	93,339	88.3%	1.00
Appliance	21,478	222.60	5,030	4,781	4.5%	0.95
HVAC Appliance	2,048	421.15	859	863	0.8%	1.00
Energy Efficiency Kits	109,593	26.28	3,171	2,936	2.8%	0.93
Multi-Family Direct Installation	87,143	59.29	3,372	2,853	2.7%	0.85
Single-family Direct Installation	20,700	214.33	852	896	0.8%	1.05
Total or Average *Weighted Value*	**2,802,645**	**N/A**	**106,783**	**105,667**	**100.0%**	***0.99***

Note. Totals may not sum due to rounding.

Table 3-8. Combined Program Demand Savings and Realization Rates

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex post* Demand Savings	Realization Rate
Downstream Lighting	2,561,683	7.65	16,664	16,635	87.3%	1.00
Appliances	21,478	44.74	985	961	5.0%	0.98
HVAC Appliances	2,048	213.14	436	437	2.3%	1.00
Energy Efficiency Kits	109,593	3.18	477	446	2.3%	0.94
Multi-Family Direct Installation	87,143	7.28	540	437	2.3%	0.81
Single-family Direct Installation	20,700	5.23	132	137	0.7%	1.03
Total or *Weighted Average Value*	**2,802,645**	**N/A**	**19,234**	**19,052**	**100.0%**	***0.99***

Note. Totals may not sum due to rounding.

3.2.2 Downstream Lighting Savings and Realization Rates

Ex post energy savings for the downstream lighting component of the program were 93,339 MWh and *ex post* demand savings were 16.6 MW, as seen in Table 3-9 and Table 3-10. Because AEP Ohio ended incentives for CFLs at the end of 2016, the number of incented downstream LEDs increased by 74 percent from 2016 to 2017. In 2017, standard LEDs accounted for the majority of downstream lighting

savings, with 70 percent of downstream lighting energy savings and 70 percent of downstream lighting demand savings attributable to standard LEDs. The number of specialty LEDs incented remained about the same from 2016 to 2017. In 2017, specialty LEDs accounted for a little less than one-third of downstream lighting energy savings and demand savings (30%).

The overall downstream lighting realization rates were 1.00 for energy and 1.00 for demand. The slight differences in *ex ante* and *ex post* savings are due to slightly different baseline wattage values and a different ISR value used by the evaluation team. The differences in *ex ante* savings and *ex post* savings results are explained in detail in Appendix A.

Table 3-9. Downstream Lighting Energy Savings – 2017

Product	Number of Units	Average Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
Standard LEDs	2,022,057	34.39	65,315	65,345	70%	1.00
Specialty LEDs	539,626	55.34	28,185	27,993	30%	0.99
Total or *Average Weighted Value*	**2,561,683**	**42.92**	**93,500**	**93,339**	**100%**	***1.00***

Note. Totals may not sum due to rounding.

Table 3-10. Downstream Lighting Demand Savings – 2017

Product	Number of Units	Average Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
Standard LEDs	2,022,057	6.13	11,641	11,646	70%	1.00
Specialty LEDs	539,626	9.86	5,023	4,989	30%	0.99
Total or *Average Weighted Value*	**2,561,683**	**7.65**	**16,664**	**16,635**	**100%**	***1.00***

Note. Totals may not sum due to rounding.

3.2.3 Appliance Savings and Realization Rates

Ex post energy savings for the appliance component were 4,781 MWh and *ex post* demand savings were 0.96 MW. Table 3-11 and Table 3-12 present the overall appliance impact findings for energy and demand savings, respectively. Smart thermostats and clothes washers contributed most to both energy savings (43% and 30%) and demand savings (57% and 21%).

The number of incented smart thermostats increased by 719% from 2016 to 2017. Smart thermostats also had the second largest per-unit energy savings (247 kWh) and demand savings (66.3 W) in 2017. The average *ex post* per-unit savings were the largest for heat pump water heaters, at 1,520 kWh per unit for energy and 207 W per unit for demand.

The overall appliance realization rates were 0.95 for energy and 0.98 for demand. The differences in *ex ante* savings and *ex post* savings result are due to an updated ISR value for smart thermostats, an

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updated heat reduction value for the smart thermostat energy savings calculation, a correction to the air purifier energy savings equation, and additional model information for air purifiers. The differences in *ex ante* savings and *ex post* savings results are explained in detailed in Appendix A.

Table 3-11. Appliance Energy Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
Smart Thermostats	8,224	247	2,274	2,035	42.6%	0.90
Clothes Washers	6,846	210	1,437	1,437	30.1%	1.00
Refrigerators	5,445	114	620	620	13.0%	1.00
Heat Pump Water Heaters	400	1,520	617	608	12.7%	0.98
Dehumidifiers	317	218	69	69	1.4%	1.00
Air Purifiers	246	47	12	12	0.2%	0.95
Total or *Average Weighted Value*	**21,478**	**223**	**5,030**	**4,781**	**100.0%**	***0.95***

Note. Totals may not sum due to rounding.

Table 3-12. Appliance Demand Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
Smart Thermostats	8,224	66.3	571	545	56.7%	0.96
Clothes Washers	6,846	29.5	202	202	21.0%	1.00
Refrigerators	5,445	20.8	114	113	11.8%	1.00
Heat Pump Water Heaters	400	206.9	80	83	8.6%	1.03
Dehumidifiers	317	49.7	16	16	1.6%	1.00
Air Purifiers	246	7.0	2	2	0.2%	0.95
Total or *Average Weighted Value*	**21,478**	**44.7**	**985**	**961**	**100.0%**	***0.98***

Note. Totals may not sum due to rounding.

3.2.4 HVAC Appliance Savings and Realization Rates

Ex post energy savings for the HVAC appliance component were 863 MWh and *ex post* demand savings were 0.44 MW. Table 3-13 and Table 3-14 present the overall HVAC appliance component impact findings for energy and demand savings, respectively. Central air conditioners contributed to more than half of energy savings (55%) and more than four-fifths of demand savings (82%).

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The number of incented central air conditioners decreased by about 22 percent from the 2016 In-Home program while air source heat pumps, ductless mini-splits, and ground source heat pumps remained roughly the same. The average *ex post* per unit savings were the largest for ground source heat pumps, at 3,000 kWh for energy savings and 442 W for demand savings.

The overall HVAC appliance realization rates were 1.00 for energy and 1.00 for demand. Central air conditioners and ductless mini-splits had realization rates of 1.00, whereas air source heat pumps and ground source heat pumps differed from 1.00. The differences were driven by differences in the heating season performance factor for a few air source heat pumps and differences in heating fuel type for a few ground source heat pumps. The differences in *ex ante* savings and *ex post* savings results are explained in detail in Appendix A.

Table 3-13. HVAC Appliance Energy Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
Central Air Conditioners	1,628	289	470	470	54.5%	1.00
Air Source Heat Pumps	317	682	204	216	25.0%	1.06
Ductless Mini-Splits	80	1,338	107	107	12.4%	1.00
Ground Source Heat Pumps	23	3,000	77	69	8.0%	0.90
Total or *Average Weighted Value*	**2,048**	**421**	**859**	**863**	**100.0%**	***1.00***

Note. Totals may not sum due to rounding.

Table 3-14. HVAC Appliance Demand Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
Central Air Conditioners	1,628	218.4	356	356	81.5%	1.00
Air Source Heat Pumps	317	188.5	59	60	13.7%	1.00
Ductless Mini-Splits	80	137.8	11	11	2.5%	1.00
Ground Source Heat Pumps	23	442.0	10	10	2.3%	1.00
Total or *Average Weighted Value*	**2,048**	**213.1**	**436**	**437**	**100.0%**	***1.00***

Note. Totals may not sum due to rounding.

3.2.5 Energy Efficiency Kits Savings and Realization Rates

Ex post energy savings for the energy efficiency kit component were 2,936 MWh and *ex post* demand savings were 0.45 MW. Table 3-15 and Table 3-16 present the overall energy efficiency kit component impact findings for energy and demand savings, respectively. LED savings contributed to three-quarters (75.8%) of energy savings and the vast majority (89.0%) of demand savings.

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The number of LED nightlights increased by 540 percent from the 2016 In-Home program and the number of LED lights also increased dramatically (1,816%). The average *ex post* per unit savings were the largest for showerheads, at 50 kWh for energy savings and 6.5 W for demand savings.

The overall energy efficiency kit realization rates were 0.93 for energy and 0.94 for demand. The differences were largely driven by differences in ISRs for all measures and assumed efficient GPM in water measures. The differences in *ex ante* and *ex post* savings are explained in detail in Appendix A.

Table 3-15. Energy Efficiency Kit Energy Savings – 2017

Product	Number of Units	Average Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
LED	73,080	30	2,394	2,227	75.8%	0.93
LED Nightlight	18,270	18	384	322	11.0%	0.84
Showerhead	6,081	50	367	307	10.4%	0.84
Faucet Aerator	12,162	7	25	80	2.7%	3.14
Total or *Average Weighted Value*	**109,593**	**26**	**3,171**	**2,936**	**100.0%**	***0.93***

Table 3-16. Energy Efficiency Kit Demand Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
LED	73,080	5.4	427	397	89.0%	0.93
LED Nightlight	18,270	0.0	0	0	0.0%	N/A
Showerhead	6,081	6.5	47	39	8.8%	0.84
Faucet Aerator	12,162	0.8	3	10	2.2%	3.14
Total or *Average Weighted Value*	**109,593**	**3.2**	**477**	**446**	**100.0%**	***0.94***

3.2.6 Multi-Family Direct Install Savings and Realization Rates

Ex post energy savings for the multi-family direct installation component were 3,032 MWh and *ex post* demand savings were 0.46 MW. Table 3-17 and Table 3-18 present the overall multi-family direct installation component impact findings for energy and demand savings, respectively. LED savings contributed to more than three-quarters (78.5%) of energy savings and more than three-quarters (86.7%) of demand savings.

The number of multi-family direct installation LEDs increased dramatically from the 2016 In-Home program (778%). For the other component measures, the number of installed measures decreased from 2016 (by 25% for nightlights/smart strips, 22% for showerheads, and by 7% for faucet aerators). The

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average *ex post* per unit savings were the largest for showerheads, at 167 kWh for energy savings and 21.4 W for demand savings.

The overall Multi-Family Direct Installation component realization rates were 0.85 for energy and 0.81 for demand. The differences were largely driven by differences in ISRs for all measures and assumed efficient GPM in water measures. The differences in *ex ante* and *ex post* savings are explained in detail in Appendix A.

Table 3-17. Multi-Family Direct Installation Energy Savings – 2017

Product	Number of Units	Average Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
LEDs	74,169	30	2,428	2,210	77.5%	0.91
LED Nightlights	5,173	12	109	62	2.2%	0.57
Smart Power Strips	3,014	66	310	198	6.9%	0.64
Showerheads	1,919	167	438	321	11.3%	0.73
Faucet Aerators	2,868	22	87	62	2.2%	0.71
Total or *Average Weighted Value*	**87,143**	**59**	**3,372**	**2,853**	**100.0%**	***0.85***

Table 3-18. Multi-Family Direct Installation Demand Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
LEDs	74,169	4.9	433	366	83.8%	0.85
LED Nightlights	5,173	0.0	12	0	0.0%	N/A
Smart Power Strips	3,014	7.3	28	22	5.1%	0.80
Showerheads	1,919	21.4	56	41	9.4%	0.73
Faucet Aerators	2,868	2.7	11	8	1.8%	0.71
Total or *Average Weighted Value*	**87,143**	**7.3**	**540**	**437**	**100.0%**	***0.81***

3.2.7 Single-family Direct Installation Savings and Realization Rates

Ex post energy savings for the single-family direct installation component were 896 MWh and *ex post* demand savings were 0.14 MW. Table 3-19 and Table 3-20 present the overall single-family direct installation component impact findings for energy and demand savings, respectively. LED savings contributed to most (81.9%) of the energy savings and most (89.0%) of the demand savings.

The number of LEDs installed through the single-family direct installation component greatly increased from 2016 (293%). For the other component measures, the number of installed measures decreased

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from 2016 (by 85% for faucet aerators, 82% for showerheads, 33% for nightlights, and by 30% for smart strips). A few remaining CFL bulbs appear in the tracking data as they were installed at the end of the 2016 and invoiced at the beginning of 2017. The average *ex post* per unit savings were the largest for air sealing, at 299 kWh for energy savings, and showerheads at 13.1 W for demand savings.

The overall single-family realization rates were 1.05 for energy and 1.03 for demand. The differences were largely driven by differences in ISRs for all measures and assumed efficient GPM in water saving measures. The differences in *ex ante* and *ex post* savings are explained in detail in Appendix A.

Table 3-19. Single-family Direct Installation Energy Savings – 2017

Product	Number of Units	Average Per-Unit Energy Savings (kWh)	Total *Ex Ante* Energy Savings (MWh)	Total *Ex Post* Energy Savings (MWh)	Percent of *Ex Post* Energy Savings	Realization Rate
LEDs	17,480	42	657	734	81.9%	1.12
LED Nightlights	1,501	17	32	26	2.9%	0.83
CFLs	173	26	5	5	0.5%	1.00
Smart Strips	1,341	85	138	114	12.8%	0.83
Showerheads	116	103	16	12	1.3%	0.76
Faucet Aerators	73	7	1	1	0.1%	0.88
Attic Insulation	9	260	2	2	0.3%	1.00
Air Sealing	7	299	2	2	0.2%	1.00
Total *or Average Weighted Value*	**20,700**	**214**	**852**	**896**	**100.0%**	***1.05***

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Table 3-20. Single-family Direct Installation Demand Savings – 2017

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
LEDs	17,480	7.0	117	122	89.0%	1.04
LED Nightlights	1,501	0.0	0	0	0.0%	N/A
CFLs	173	3.1	1	1	0.4%	1.00
Smart Strips	1,341	9.5	12	13	9.4%	1.04
Showerheads	116	13.1	2	2	1.1%	0.76
Faucet Aerators	73	0.9	0	0	0.0%	0.88
Attic Insulation	9	5.0	0	0	< 0.1%	1.00
Air Sealing	7	5.2	0	0	< 0.1%	1.00
Total *or Average Weighted Value*	**20,700**	**5.2**	**132**	**137**	**100.0%**	***1.03***

3.3 Process Evaluation Findings

The process evaluation of the Efficient Products Program focused on assessing sources of program awareness, measuring satisfaction with various aspects of the appliance rebate and HVAC appliance rebate components, describing vacancy rates found during the multi-family direct installation site audits, and detailing implementer processes for the multi-family direct installation component. Data for the process evaluation were collected through the energy efficiency kits survey, the appliance rebate survey,[18] through staff interviews, and the multi-family direct installation audits. There was no survey with downstream lighting or single-family direct install participants in 2017; thus, the process evaluation for these portions of the program was limited.

Overall, both the appliance rebate component and the energy efficiency kit component ran smoothly in 2017. More than three-quarters of survey respondents reported satisfaction with either the appliance rebate component or the energy efficiency kits component (79% and 78%, respectively, rated 8 or higher on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied).[19]

This chapter contains the following sections:

- Satisfaction with Efficient Products Program and Individual Program Components
- Sources of Program Awareness
- Multi-Family Direct Installation Process Findings
- Implementer Processes for the Multi-Family Direct Installation Component

[18] The evaluation team only surveyed appliance rebate participants who purchased smart thermostats, central air conditioners, air source heat pumps, ductless mini-splits, and ground source heat pumps. Thus, the combined results from the appliance rebate survey may not be representative of the entire population of appliance rebate participants.

[19] As the satisfaction rating scales changed from 2016 to 2017, we cannot draw direct comparisons between the satisfaction results from 2016 and the satisfaction results from 2017.

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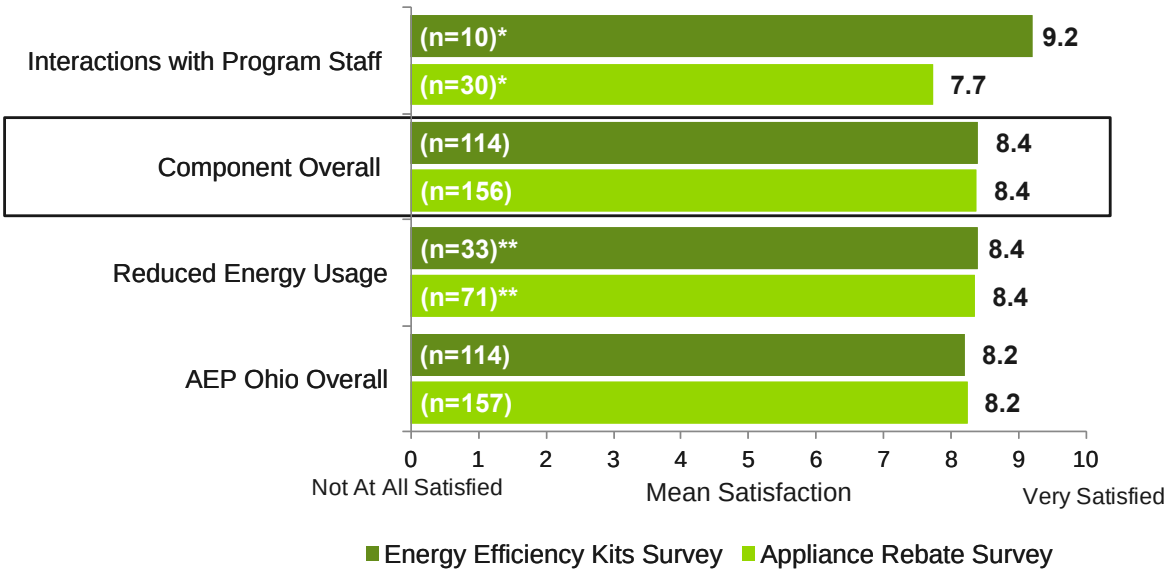
3.3.1 Satisfaction with Efficient Products Program and Individual Program Components

Comparing the two surveyed program components (energy efficiency kits and appliance rebates), respondents similarly rated their satisfaction for all items except their interactions with program staff. Survey respondents were, on average, satisfied with the program component overall (Mean = 8.4), reduced energy usage resulting from installed equipment (Mean = 8.4), and AEP Ohio as their electric service provider (Mean = 8.2), as seen in Figure 3-7. Nineteen percent of appliance rebate survey respondents and 9 percent of energy efficiency kit respondents contacted program staff after participating in the program component. Energy efficiency kit respondents reported satisfaction with the interactions with program staff (Mean = 9.2), while appliance rebate participants, on average, provided lower satisfaction ratings on their interactions with program staff (Mean = 7.7).

Figure 3-7. Overview of Satisfaction Results



** Question only asked of respondents who had contacted program staff during their participation in the program.*
*** Question only asked of respondents who had noticed a reduction in energy usage on their bill.*
Note: appliance rebate survey response totals vary (from the overall total of 162) as six respondents partially completed the survey.

3.3.2 Sources of Program Awareness

This section summarizes sources of program awareness among participating customers. Survey respondents for both the appliance rebate component and the energy efficiency kits component were asked how they became aware of the related component.

Customers can request kits through two channels: 1) through the Home Energy Profile online tool, or 2) as an additionally requested item on their appliance rebate application. The Home Energy Profile online tool collects data on a customer's home and provides a customized report including a home energy efficiency score and energy savings suggestions. As shown in Figure 3-8, energy efficiency kit survey respondents most frequently cited the AEP Ohio website (27%) and AEP Ohio emails (24%) as the source of awareness of the Home Energy Profile. Few (1%) respondents indicated hearing about the Home Energy Profile via Facebook or Twitter, or a contractor. Respondents who listed more than one source of awareness (*n* = 16) indicated that emails from AEP Ohio (31%), program information on bills

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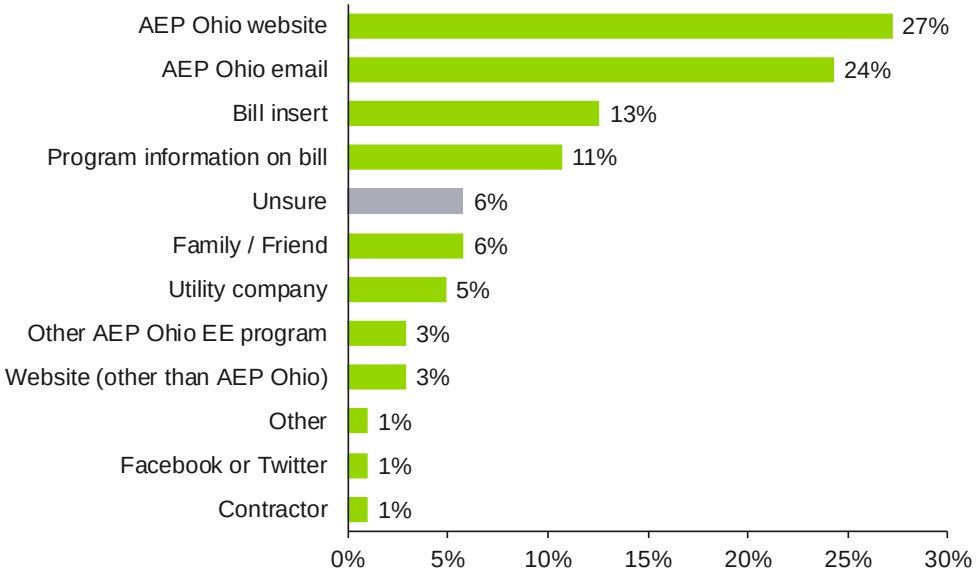
(19%), and the AEP Ohio website (19%) were the most influential materials in terms of their decision to participate.[20]

Figure 3-8. Sources of Awareness: Home Energy Profile (n = 103)



Note: Question only asked of those respondents who completed the Home Energy Profile.

Appliance rebate survey respondents also most frequently cited the AEP Ohio website as a source of awareness (13% as the primary source and 22% as the secondary source of awareness, Figure 3-1). In contrast to the energy efficiency kit respondents, appliance rebate respondents often cited contractors (22% as the primary source and 7% as the secondary source) and utility bill inserts (10% as the primary source and 23% as the secondary source) as a source of awareness.

[20] Other sources listed as most influential by respondents who mentioned more than one source of awareness were: bill inserts (*n* = 2, 13%), websites (other than AEP Ohio) (*n* = 1, 6.3%), utility companies (general) (*n* = 1, 6.3%), and family and friends (*n* = 1, 6.3%).

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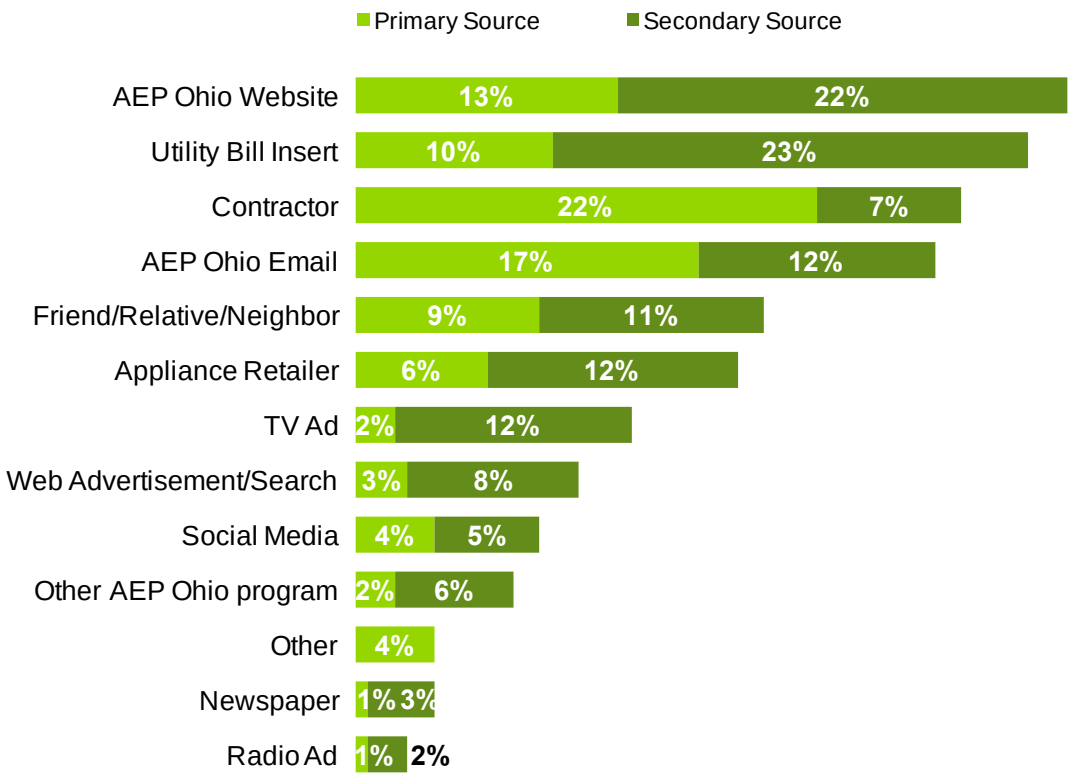
Figure 3-9. Sources of Awareness: Appliance Rebate (n=156)



3.3.3 Multi-Family Direct Installation Process Findings

This sub-section presents process findings for the multi-family direct installation component.

Audits - Unit Occupancy and Tenant Turn-Over

Program staff expressed interest in the vacancy rate for multifamily direct installation units, the "turn-over" of units, and the relationship between these rates and ISR. The evaluation team found less than one year after implementation staff installed measures, about one-quarter of audited units were vacant (26%, as seen in Figure 3-10).

The evaluation team also observed multi-family unit "turn-over" during site visits, though the sample sizes were too small to detect significance and auditors were unable to determine "turn-over" on units for which the tenant was not present during the audit. At least 11 percent of units were currently occupied by a different tenant than when measure installation occurred. For another 11 percent of units, the tenant was not present for the audit, and thus, auditors were unable to determine the "turn-over" for these units.

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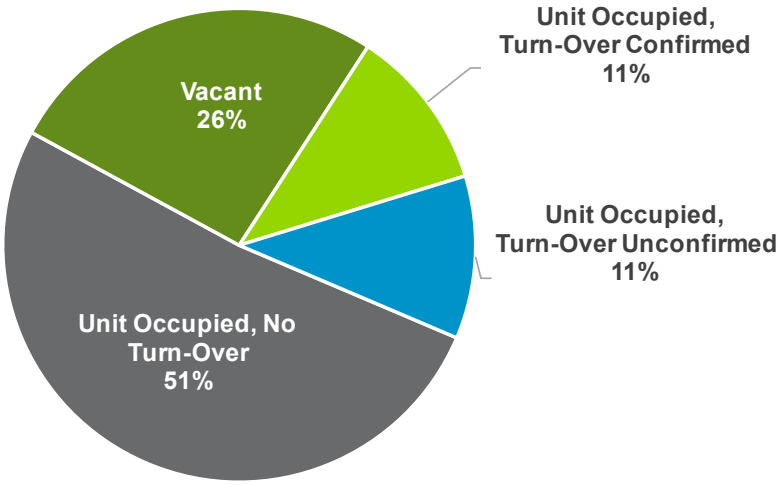
Figure 3-10. Multi-Family Direct Installation Audits: Unit Vacancy and Tenant Presence (n = 35)



Note: Totals may not sum to 100% due to rounding

Audits - Installation and Removal of Multi-Family Direct Installation Measures

Audits suggest that most measures (LEDs, faucet aerators, and showerheads) were installed by implementation staff rather than occupants (as reported by tenants present for the audit). One multi-family direct installation measure was reported as removed after installation: one individual reported removing a showerhead after installation (no reason was provided for removal).[21]

3.3.4 Implementer Processes for the Multi-Family Direct Installation Component

The evaluation team conducted two interviews with program implementation staff regarding the multi-family direct installation component procedures and processes. Discussions with implementation staff revealed the implementer:

- Researches potential multi-family direct installation sites through web searches and direct outreach.
- Before the initial assessment, ensures units are individually metered through either web searches for property information or on-site inspection of equipment.
- Conducts an initial assessment, recorded on paper, of the facility grounds and enters units to count the number of measures that will be installed. This data is transferred to an electronic system upon return to the office.
- Provides facility management with door hangers to give tenants a 24-hour notice before entry.

After this initial assessment is completed, installation staff make a second site visit. At the beginning of the year, installation staff use a paper “tally sheet” to track installed measures at the facility. This system switched to a tablet-based recording system towards the end of the year, with the “tally sheet” used as a back-up recording tool. During the actual installation of program measures, installation staff adhere to the following procedures:

[21] As previously noted, the audits also revealed one unit where the tenant had been evicted and subsequently removed all 45 program LEDs, one nightlight, and one faucet aerator upon moving out.

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- Only install equipment in units that are occupied, however, tenants do not need to be present at the time of the installation.
- Only install lighting in operable sockets (socket is functioning when lighting is installed and there are no exposed wires).
- Replace all non-LED bulbs in standard-sized screw-based sockets with program LED bulbs.
- Check equipment functionality before leaving the unit (turn on faucet, showerhead, or light switch).

If a tenant is present during the installation of measures, installation staff may give the tenant a smart power strip. Staff then train the tenant on the use of the smart power strip. If a tenant explicitly requests additional LED light bulbs from staff, they may be given up to two additional LED light bulbs. Currently there is no maximum number of LED bulbs that can be installed in a single unit and LED bulbs may replace CFL bulbs in the home.

3.4 Cost-Effectiveness Review

This section addresses the cost-effectiveness of the Efficient Products Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test. Table 3-21 summarizes the unique inputs used in the TRC test. Based on these inputs, the TRC ratio is 4.4 as shown in Table 3-22. Therefore, the program passes the TRC test.

Table 3-21. Inputs to Cost-Effectiveness Model for Efficient Products Program

Input	Value
Average Measure Life	17
Units	2,802,645
Annual Energy Savings (kWh)	105,667,000
Coincident Peak Savings (kW)	19,052
Third Party Implementation Costs	$3,490,711
Utility Administration Costs	$1,045,019
Utility Incentive Costs	$7,359,585
Participant Contribution to Incremental Measure Costs	$12,938,996

Table 3-22 summarizes the results of the cost-effectiveness tests. Results are presented for the Total Resource Cost test, the Participant test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

Table 3-22. Cost-Effectiveness Results for the Efficient Products Program

Benefit-Cost Test Results for Efficient Products Program	Ratio
Total Resource Cost	4.4
Participant Cost Test	7.2
Ratepayer Impact Measure	0.6
Utility Cost Test	6.5

At this time, additional benefits related to reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC. These additional benefits would increase the given TRC benefit/cost ratio.

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4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions and Recommendations for Program Improvements

The evaluation of the Efficient Products Program resulted in thirteen main conclusions and nine recommendations.

1. **The program surpassed its energy and demand savings goals.** The program achieved 105,667 MWh of energy savings, surpassing the goal of 73,219 MWh by 44 percent. The program also achieved 19.052 MW of demand savings, surpassing the goal of 7.59 MW by 151 percent.

2. **The program incented eight times as many smart thermostats in 2017 as it did in 2016.** The number of incented smart thermostats increased by 719 percent from 2016 to 2017 and represented a large portion of the appliance component *ex post* energy and demand savings (43% and 57%, respectively).

3. **Across all program components, standard LED lighting accounted for two-thirds of all energy and demand savings in 2017 (67% and 66%, respectively), while specialty LED lighting accounted for one-quarter of all energy and demand savings (26% for both).** The program incentivized or distributed 2,175,687 standard LED light bulbs through the downstream lighting component, the energy efficiency kit component, and both direct install components in 2017. In comparison, the program incentivized or distributed 550,725 specialty LEDs.[22]

    - **Recommendation 1: Increase the promotion of specialty LED lighting.** As prices decrease over time for specialty LED lighting products,[23] and as standard lighting sockets become saturated with LED bulbs,[24] there is an opportunity for specialty LED bulbs to play a more important role in the Efficient Products Program. This could be accomplished through either: increased incentives, increased marketing, the addition of bulb types, or the addition of bulb models. To ensure continued program savings growth, the evaluation team recommends an increased focus on specialty LEDs. Specialty LEDs made up about 20 percent of the total lighting products incentivized or distributed by the program in 2017, yet the per-unit energy savings value was higher than standard LEDs (55.34 kWh for specialty LEDs, compared to 34.39 kWh for standard LEDs). Including incentives for additional bulb types—such as candelabra or R bulb types—may increase specialty LED bulb sales.

4. **Downstream LED lighting accounted for 88 percent of all energy savings and 87 percent of all demand savings in 2017.** With the elimination of CFLs from the program in 2017, the

[22] In addition to downstream specialty LEDs, AEP Ohio distributed specialty LEDs through the single-family direct installation partnership with Columbia Gas of Ohio and through the multi-family direct installation component.
[23] A 2016 Massachusetts study interviewed LED suppliers, who estimated the average retail price of a specialty LED bulb would decrease by 19 percent from 2016 and 2018. The same study also ran a regression analysis on LED bulb sales data from the National Electrical Manufacturer Association sales data and estimated the average retail price of a specialty LED bulb would decrease by 36% from 2016 to 2018. http://ma-eeac.org/wordpress/wp-content/uploads/MA-Task-5b-LED-Incremental-Cost-Study_FINAL_01FEB2016.pdf
[24] In a 2017 Massachusetts and New York state study, researchers estimated 2017 overall LED saturation at 18% for MA and 10% for NY. Specialty LED saturation for 2017 was estimated at 8% for MA and 3% for NY. http://ma-eeac.org/wordpress/wp-content/uploads/Lighting-Market-Assessment-Consumer-Survey-and-On-Site-Saturation-Study.pdf

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program relied more heavily on downstream LED lighting savings than in 2016 (downstream LEDs accounted for 51 percent of all energy savings in 2016 and 60 percent of all demand savings).

5. **The evaluation relies on an in-service rate (ISR) value for LED lighting from research completed in 2014.** The ISR value of 0.97 is from the survey conducted for the 2014 Efficient Products Evaluation.

    - **Recommendation 2: Update the downstream LED lighting ISR value.** The evaluation team recommends AEP Ohio either apply ISR values from more recent studies completed in nearby jurisdictions, or conduct primary research in 2018 to update the downstream LED ISR value. Across the U.S., the penetration rate for standard LEDs has grown from 0.1 percent in 2010 to 13.5 percent in 2016.[25] As LEDs become more commonplace, ISR values have likely changed as well. In addition to determining an ISR for all LEDs, the program may want to consider determining individual downstream ISR values for standard LEDs and specialty LEDs.[26]

6. **The LED lighting ISR for multi-family direct installations was 0.91, which was greatly impacted by a single site audit where a large number of bulbs had been installed and subsequently removed.** Program implementers reported they do not cap the number of LED bulbs installed in a single home, as long as a light socket is in working order, has a standard base size, and has a non-LED bulb in the socket. On-site audits of multi-family direct installations revealed one tenant had 45 LED bulbs installed in the home and had removed all of these bulbs after being evicted from the unit. The results from this single unit (out of the 35 units audited) decreased the overall ISR by 0.05 (the ISR without this home was 0.96). Overall, less than one year after implementation staff installed measures, about one-quarter of audited units were vacant.

7. **Based on the multi-family direct installation audits, some LED bulbs are possibly being installed in lower-use sockets.** The multi-family direct installation audits found program bulbs installed in traditionally low-use sockets such as closets, hallways, and basements. It is unknown if the bulbs were initially installed in low-use sockets or if tenants relocated the bulbs after these were initially installed in more high-use sockets.

    - **Recommendation 3: Cap the number of total LED bulbs to 15 installed in a single unit and prioritize high-use sockets.** The evaluation team recommends placing a cap on the total number of bulbs installation staff may install in a single unit. Doing so would prevent situations where a tenant removing all bulbs has an outsized effect on the ISR. With a cap on the number of LEDs, installers could then prioritize installation in high-use sockets.

    - **Recommendation 4: Conduct a larger sample of multi-family direct installation audits to characterize vacant units and unit turnover.** The evaluation team recommends conducting a larger number of multi-family direct installation audits to capture a larger population of vacant units and units that are currently occupied by tenants who moved into the unit after measure installation (otherwise described as “unit turnover”). Due to the small

[25] https://www.energy.gov/sites/prod/files/2017/08/f35/led-adoption-jul2017_0.pdf
[26] A 2016 report found that the first-year ISR for specialty LEDs is considerably higher than for standard LEDs (93% vs. 73%). http://ilsagfiles.org/SAG_files/Evaluation_Documents/Ameren/AIC_Eval_Reports_PY9/AIC-IPA_PY9_Residential_Lighting_Report_FINAL_2018-02-07.pdf

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sample of audits completed for this evaluation, the evaluation team was unable to quantify the impact of unit turnover. By completing additional audits, the evaluation team would be able to explore the impact of unit turnover and help AEP Ohio narrow down appropriate next steps.

8. **The multi-family direct installation component currently replaces CFL bulbs in a working socket with an LED.** Program implementation staff reported CFLs may be replaced by LEDs during multi-family direct installations.

    - **Recommendation 5: End the practice of replacing CFL bulbs with LED bulbs during multi-family direct installations.** The evaluation team recommends only replacing halogen bulbs or incandescent bulbs with LEDs. Though currently LED lighting impact savings are not calculated using as-found conditions, in future years, methodologies may change. Savings would decrease using CFLs as baseline technology instead of the deemed baseline the program currently uses.

9. **The ISR for showerheads resulting from the energy efficiency kits survey was 0.43.** Less than half of energy efficiency kit survey respondents (43%) reported installing the showerhead they received from the program. To attempt to increase the ISR for showerheads in 2017, AEP Ohio began including a showerhead installation guide flyer in the energy efficiency kit in November. This guide illustrated the proper method for installing the showerhead included with the energy efficiency kit.

    - **Recommendation 6: In 2018, field the energy efficiency kit survey to gauge the effectiveness of the showerhead installation guide.** To measure the success of the installation guide, the evaluation team recommends fielding an energy efficiency kit survey for the 2018 program year. For the 2017 energy efficiency kit survey, the evaluation team used partial year data (with participants through the end of September) to develop the survey sample. Because the installation guide was not included in energy efficiency kits until November, the evaluation team was unable to survey customers receiving the guide. To estimate the effectiveness of the installation guide, the program should field a survey of energy efficiency kit participants in 2018. The program may then calculate the ISR value before and after the installation guide was included in the energy efficiency kit to determine the effectiveness of the guide.

    - **Recommendation 7: Allow customers to select the energy efficiency kit measures they would like to receive before a kit is mailed to them.** The evaluation team recommends that AEP Ohio customize energy efficiency kit request systems to allow customers to select which energy efficiency kit measures they would like to receive. Of customers who completed the online energy profile and did not install their showerhead, about 53 percent reported they did not install their showerhead because they like their current showerhead or they already have an efficient showerhead. These customers may not have ordered a showerhead with their energy efficiency kit if they were given the option. For customers who are interested in a receiving a showerhead, AEP Ohio may also consider providing several showerhead models to choose from for their energy efficiency kits. Options could include models differentiated by color (e.g., white, chrome, etc.) and unique features (e.g., multiple spray modes). Customers may be more engaged when involved in choosing the contents of their energy efficiency kits, and this increased engagement may translate to increased installation rates.

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10. **The realization rate for energy efficiency kit faucet aerator energy savings was 3.14.** AEP Ohio used the energy-efficient gallons-per-minute (GPM) value listed in the tracking data to calculate *ex ante* energy savings for all water-saving measures (2.0 GPM). This value differed from the description of the water-savings measures and the value listed for the model in specifications charts found through secondary research (1.5 GPM). *Ex post* savings were substantially higher than *ex ante* savings due to the GPM discrepancy.

    - **Recommendation 8: Update the gallon-per-minute value for all water-saving measures to reflect model specifications of the energy-efficient equipment.** The evaluation team recommends updating the gallons-per-minute value based on the description field in the tracking dataset.

11. **Overall, customers were satisfied with AEP Ohio and with the program components.** On average, respondents reported satisfaction with the energy efficiency kit component (Mean = 8.4, on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied), with the appliance rebate component (Mean = 8.4), and with AEP Ohio as an electric service provider (Mean = 8.2 for respondents of both the energy efficiency kits survey and the appliance rebate survey).

12. **Appliance rebate survey participants most often reported satisfaction with the contractor they used to install their equipment (Mean = 9.3) and least often reported satisfaction with interactions with program staff (Mean = 7.7).** Ninety three percent of appliance rebate survey respondents reported satisfaction (rated 8 or higher) with the contractor they used to install their equipment, while 67 percent of survey respondents reported satisfaction with their interactions with program staff.

13. **Energy efficiency kit participants most often reported satisfaction with the LED nightlight they received (Mean = 9.2) and least often reported satisfaction with the Home Energy Profile overall (Mean = 7.6).** Ninety-four percent of energy efficiency kit survey respondents reported satisfaction (rated 8 or higher on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied) with the LED nightlight they received in the energy efficiency kit, while 61 percent of survey respondents reported satisfaction with the Home Energy Profile overall. When asked to rate their agreement with a variety of statements regarding the Home Energy Profile, customers tended to agree that it was easy to complete, took a reasonable amount of time to complete, and was easy to understand. Customers were somewhat less likely to feel that they had learned information needed to take action or that they had learned about other sources of energy efficiency information through the Home Energy Profile.

    - **Recommendation 9: Conduct in-depth interviews with customers who have completed the Home Energy Profile to identify opportunities for improvement.** Energy efficiency kit participants indicated that there may be room to improve the information included in the Home Energy Profile report. To develop specific strategies for optimizing the report, the evaluation team recommends conducting in-depth interviews with customers who have recently completed the Home Energy Profile. These interviews could walk through the report with the customer, assessing the usefulness of various components of the report, how the components are perceived by customers, and ways in which the report could be improved. The interviews could also probe for additional information customers would like included in their Home Energy Profile report.

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APPENDIX A. DETAILED EVALUATION RESULTS

This Appendix describes additional details on the methods and findings for the impact evaluation and process evaluation of the 2017 Efficient Products Program.

Appendix A includes the following sections:

A.1 Tracking Data Review

Because the program tracking data is critical for determining program impacts, the evaluation team completed a thorough review of the tracking data, which included five separate databases. Two databases were for downstream lighting, including one for lighting products discounted through markdowns and another contained products discounted through coupons. Another database included several single-family measures, including: single-family direct installation measures, energy efficiency kit measures, and HVAC appliance rebate measures. The remaining two databases contained appliance rebate measures and multi-family direct installation measures.

The evaluation team ran frequencies on each key variable to identify any missing data or inconsistencies. The evaluation team discovered some tracking data errors and inconsistencies; some were resolved through discussion with AEP Ohio.

Issues not resolved were corrected in the *ex post* savings calculations. This caused minor changes in the *ex post* savings values, including in some products that are in the TRM.

The evaluation team did not address whether the tracking system is adequate for regulatory prudency reviews or corporate requirements.

A.2 Impact Evaluation Analysis Details

This section provides detailed descriptions of the methods, assumptions, and parameters from the impact evaluation.

LED Savings Analysis Details

This sub-section describes the analysis methods applied to LEDs.

LED *Ex Ante* Savings

As LEDs are not included in the TRM, AEP Ohio modified the methods and parameters used for CFLs to account for differences in the two technologies. Instead of delta Watt multipliers, AEP Ohio calculated the difference between program LED wattages and equivalent baseline wattages. The following equations (Equation A-1 and Equation A-2) were used for *ex ante* energy and demand savings.

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Equation A-1. *Ex Ante* Energy Savings for LEDs

$$\textit{Annual kWh Savings} = (\text{BaselineWatts} - \text{LEDWatts}) * ISR_{LED} * HOU_{LED} * 365 * WHF_{E,\,LED} / 1{,}000$$

Equation A-2. *Ex Ante* Demand Savings for LEDs

$$\textit{Summer Coincident Peak kW Savings} = (\text{BaselineWatts} - \text{LEDWatts}) * ISR_{LED} * CF_{LED} * WHF_{D,\,LED} / 1{,}000$$

For LED *ex ante* savings, AEP Ohio applied the following parameters:

- ISR equal to 1.00 (assumes that because of the higher cost of LEDs, customers will install them right away)
- HOU value of 1,051 hours per year [27]
- CF of 0.13 [28]
- WHF_E of 0.93 and 1.34 for WHF_D [29]

Table A-1 presents the baseline wattages used by AEP Ohio to calculate *ex ante* savings for each program wattage range. AEP Ohio applied baseline wattage equivalencies used to calculate *ex post* savings values in 2016.

Table A-1: *Ex Ante* LED Baseline Wattage, by Program Measure Wattage

Program LED Measure Wattage	*Ex Ante* Baseline Wattage for Standard Bulbs	*Ex Ante* Baseline Wattage for Specialty Bulbs	Count
2 – 3	-	25	2,697
4 – 7	29	40	286,407
8 – 10	43	60	2,071,753
11 – 15	53	75	327,094
16 – 22	72	100	38,461
Total	**-**	**-**	**2,726,412**

Note. From AEP Ohio program tracking data.
There were no standard 2-3 W LED bulbs incented in 2017.

LED *Ex Post* Savings

For LED *ex post* savings, the evaluation team followed an approach similar to AEP Ohio's method for calculating *ex ante* savings. For ISR, the value varied by program type, as shown in Table A-2. The multi-family direct installation *ex post* ISR found through survey research for the 2016 In-Home program matched the *ex post* ISR the evaluation team found in 2017.

[27] Residential Lighting Metering Study (Final Report), March 25, 2015.
[28] Residential Lighting Metering Study (Final Report), March 25, 2015.
[29] AEP Ohio Residential Lighting Interactive Effects Modeling Results memo, January 2016.

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Table A-2. *Ex Post* LED ISR by Program Type

Component	ISR
Downstream Lighting (Markdown and Coupon)	0.97 [1]
Energy Efficiency Kits	0.93 [2]
Multi-Family Direct Installation	0.91 [3]
Single-family Direct Installation	1.00 [4]

[1] Based on a 2014 LED survey of 101 AEP Ohio customers.
[2] Based on 2017 Energy Efficiency Kits Survey.
[3] Based on 2017 Multi-Family Direct Installation audits.
[4] Based on AEP Ohio assumption of direct installation rate as reported in the 2016 In-Home evaluation report.

The evaluation team applied baseline wattages corresponding to each bulb model listed in the ENERGY STAR® Qualified Products List (QPL). For bulb models not listed in the ENERGY STAR® QPL, the evaluation team took the average baseline bulb wattage from other bulb models of the same type and energy-efficient wattage.

Table A-3 and Table A-4 detail the baseline equivalent wattages used to calculate *ex post* savings for standard LEDs and specialty LEDs, respectively.

Table A-3. *Ex Post* Standard LED Baseline Wattage, by Program Measure Wattage

Program LED Measure Wattage	*Ex Post* Baseline Wattage for Standard Bulbs	Count
4 – 6	29	96,114
7 – 10	43	1,963,984
11 – 14	53	38,544
15+	72	77,045
Total	**-**	**2,175,687**

Source: ENERGY STAR® Certified Light Bulbs, downloaded Mar. 3, 2017.
http://www.energystar.gov/productfinder/download/certified-light-bulbs/

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Table A-4. *Ex Post* Specialty LED Baseline Wattage, by Program Measure Wattage

Program LED Measure Wattage	*Ex Post* Baseline Wattage for Specialty Bulbs	Count
2 – 3	25	2,697
4 – 5	40	84,570
6 – 7	50	46,605
8 – 12	65	366,828
13 – 14	100	25,650
15 – 18	120	24,375
Total	**-**	**550,725**

Source: ENERGY STAR® Certified Light Bulbs, downloaded Mar. 3, 2017.
http://www.energystar.gov/productfinder/download/certified-light-bulbs/

Table A-5 summarizes the differences in savings parameters for *ex ante* and *ex post* savings.

Table A-5. Key *Ex Ante* and *Ex Post* Parameters for LEDs

Parameter Description	Parameter	*Ex Ante* Value	*Ex Post* Value	*Ex Post* Source
Average Program Wattage (W)	LEDWatts	9.3	9.3	Tracking Data
Average Standard Wattage (W)	BaselineWatts	46.7	47.7	Evaluation based on 2017 ENERGY STAR® product list, Tracking Data
Hours of Use (hours/year)	HOU_{LED}	1,051	1,051	Lighting Metering Study[1]
Coincidence Factor	CF_{LED}	0.13	0.13	
Waste Heat Factor for Energy	$WHF_{E, LED}$	0.93	0.93	Interactive Effects Modeling Study[2]
Waste Heat Factor for Demand	$WHF_{D, LED}$	1.34	1.34	

[1] Residential Lighting Metering Study (Final Report), March 25, 2015.
[2] AEP Ohio Residential Lighting Interactive Effects Modeling Results" memo, January 2016.

Smart Thermostat Savings Analysis Details

This sub-section describes the analysis methods applied to smart thermostats.

Smart Thermostat *Ex Ante* Savings

As smart thermostats are not included in the TRM, AEP Ohio chose to use the Illinois Technical Reference Manual (IL TRM) approach for advanced thermostats as well as parameters developed for the 2016 evaluation, as seen in Equation A-3 and Equation A-4.

Equation A-3. *Ex Ante* Energy Savings for Smart Thermostats

$$Annual\ kWh\ Savings = Annual\ kWh\ Heating\ Savings + Annual\ kWh\ Cooling\ Savings$$

$$Annual\ kWh\ Heating\ Savings = \%ElectricHeat * ElecHeatingConsumption * HeatingReduction * HF * ISR + (GasHeatFlag * F_e)$$

*Annual kWh Cooling Savings = %AC * ((FLH * Btu / hr * 1 / SEER) / 1000) * CoolingReduction * ISR*

Equation A-4. *Ex Ante* Demand Savings for Smart Thermostats

*Summer Coincident Peak kW Savings = (CoolingReduction * Btu / hr * (1 / EER)) / 1000 * ISR * CF*

In 2017, AEP Ohio began to collect data on the baseline home cooling equipment (%AC). For homes without baseline home cooling equipment data, AEP Ohio assumed customers did not have cooling equipment.

AEP Ohio applied the heating reduction value used in the 2016 *ex post* impact calculations. This value was calculated based on the baseline thermostat technology reported in the 2016 appliance rebate survey and using the IL TRM formula, as shown in Equation A-5. 2016 survey results were used to estimate the percentage of homes with manual thermostats and percentage of homes with programmable thermostats.

Equation A-5. *Ex Ante* Heating Reduction Formula

*HeatingReduction = 0.088 * %ManualThermostats + 0.056 * %ProgrammableThermostats*

Where:

%ManualThermostats = The percentage of homes replacing manual thermostats (78% in the 2016 appliance rebate survey)
%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (23% in the 2016 appliance rebate survey)

Smart Thermostat *Ex Post* Savings

To calculate *ex post* impacts, the evaluation team mirrored AEP Ohio's approach. Unlike AEP Ohio, the evaluation team updated the heat reduction parameter and the ISR based on responses to the 2017 appliance rebate survey.

Table A-6 presents the differences in key parameter values for *ex ante* and *ex post* calculations. Parameters not described in Table A-6 were as-found values pulled from the tracking database.

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Table A-6. Key *Ex Ante* and *Ex Post* Parameters for Smart Thermostats

Parameter Description	*Ex ante* Value	*Ex post* Value	*Ex post* Source
Electric Heating Consumption – Electric Forced Air	17,789 kWh/year	17,789 kWh/year	IL TRM
Electric Heating Consumption – Heat Pump	10,464 kWh/year	10,464 kWh/year	IL TRM
Heating Reduction	0.080	0.066	IL TRM and 2017 Appliance Rebate Survey
Household Factor – Multi-Family	0.65	0.65	IL TRM
Household Factor – Single-family	1	1	IL TRM
Cooling Full Load Hours	552	552	OH TRM
Cooling System Efficiency (SEER)	9.734	9.734	Calculated by AEP Ohio using In-home Energy program data
Cooling System Size (BTU/hr)	33,600	33,600	IL TRM
ISR	1.00	0.95	2016 Appliance Rebate Survey and 2017 Appliance Rebate Survey

The *ex post* heating reduction values were calculated based on the baseline thermostat technology reported in the 2017 appliance rebate survey. In 2017, survey respondents reported a larger portion of programmable thermostats than in 2016 (61% in 2017 compared to 23% in 2016), and two respondents reported replacing smart thermostats with the program-rebated smart thermostats (2% receiving no heating reduction at all).

Equation A-6. *Ex Post* Heating Reduction Formula

$$HeatingReduction = 0.088 * \%ManualThermostats + 0.056 * \%ProgrammableThermostats + 0 * \%SmartThermostats$$

Where:

%ManualThermostats = The percentage of homes replacing manual thermostats (36% in the 2017 appliance rebate survey)
%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (61% in the 2017 appliance rebate survey)
%ProgrammableThermostats = The percentage of homes replacing smart thermostats (2% in the 2017 appliance rebate survey)

The evaluation team found one record that had a negative quantity that AEP Ohio did not deduct from their total quantities. This record appeared to be a returned unit. The evaluation team deducted the savings from this negative quantity unit.

Clothes Washer Savings Analysis Details

This sub-section describes the analysis methods applied to clothes washers.

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Clothes Washer *Ex Ante* Savings

To determine *ex ante* savings for clothes washers, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the deemed savings values specified in the TRM. According to the TRM, savings for clothes washers are deemed for two levels of efficiency (ENERGY STAR® and CEE Tier 3) using the per-unit savings shown in Table A-7.

Table A-7. Draft 2010 Ohio TRM Per-Unit Savings Values for Clothes Washers

Efficiency Level	Per-Unit Energy Savings (kWh)	Per-Unit Peak Demand Savings (kW)
ENERGY STAR® (CEE Tier 1 and 2)	202	0.028
CEE Tier 3	233	0.033

Source: Clothes Washer – ENERGY STAR® and CEE TIER 3 (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 59.

Total clothes washer savings were calculated by summing the per-unit savings for each program unit in the program tracking data. Most of the savings were from CEE Tier 1 and 2 (ENERGY STAR®) washers as shown in Table A-8. Three units did not have a CEE tier listed in the data and AEP Ohio did not claim savings for these units.

Table A-8. Percent of Program Clothes Washers by Draft 2010 Ohio TRM Efficiency Level

Efficiency Level	Units	Percent of Units	Percent of Savings
ENERGY STAR® (CEE Tier 1 & 2)	5,036	73.6%	71%
CEE Tier 3	1,807	26.4%	29%
Tier is "N/A" in tracking data	3	< 0.1%	0%
Total	**6,846**	**100.0%**	**100%**

Clothes Washer *Ex Post* Savings

The clothes washer *ex post* savings methodology also followed the TRM. The evaluation team calculated the *ex post* savings using the same parameters and equations as previously described. Therefore, the *ex post* savings are equal to the *ex ante* savings.

Refrigerator Savings Analysis Details

This sub-section describes the analysis methods applied to refrigerators.

Refrigerator *Ex Ante* Savings

To determine *ex ante* savings for refrigerators, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the TRM-specified deemed savings values for those refrigerator configurations described in the TRM. For refrigerators, the TRM deemed savings values are based on whether the appliance meets ENERGY STAR® or CEE Tier 2 specifications. Savings are based on the specification and the unit configuration as shown in Table A-9.

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For compact refrigerators, AEP Ohio used deemed savings values found in the ENERGY STAR® refrigerator QPL.[30]

Table A-9. Draft 2010 Ohio TRM Per-Unit Savings Values for Refrigerators

Efficiency Level	Refrigerator Configuration	Per-Unit Energy Savings (kWh)	Per-Unit Demand Savings (kW)
ENERGY STAR®	Bottom Freezer	119	0.021
	Top Freezer	100	0.018
	Side by Side	142	0.025
CEE Tier 2	Bottom Freezer	149	0.026
	Top Freezer	124	0.022
	Side by Side	177	0.031

Source: Efficient Refrigerator – ENERGY STAR® and CEE TIER 2 (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 53.

Table A-10 shows the distribution of program units by configuration and ENERGY STAR®/CEE Tier level in the program tracking data. The evaluation team notes the TRM does not include savings estimates for Tier 3 units, therefore, Tier 3 units are included within the Tier 2 category. This approach likely underestimates savings for Tier 3 units, which are more efficient than Tier 2 units. AEP Ohio was unable to identify the CEE Tier of several refrigerator models. For these units, as well as for compact refrigerator units, AEP Ohio applied the most conservative savings estimates established by the TRM (100 kWh per unit and 0.018 kW per unit).

[30] Compared AEP Ohio's deemed savings values to those found in the following source: ENERGY STAR® Certified Residential Refrigerators, downloaded Jan. 23, 2017. http://www.energystar.gov/productfinder/download/certified-residential-refrigerators/

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Table A-10. Percent of Program Refrigerators by Efficiency and Configuration

Efficiency Level	Refrigerator Configuration	Count	Percent of Units	Percent of *Ex Ante* Savings (kWh)
ENERGY STAR®	Bottom Freezer	3,717	68.3%	67.6%
	Top Freezer[1]	868	15.9%	14.0%
	Side by Side	514	9.4%	11.3%
	Compact[3]	42	0.8%	0.2%
	Freezer-less Refrigerator	12	0.2%	0.1%
CEE Tier 2 & 3[2]	Bottom Freezer	261	4.8%	6.3%
	Side by Side	3	0.1%	0.1%
	Compact[3]	4	0.1%	0.1%
Unknown[4]	Unknown	24	0.4%	0.4%
Total[5]		**5,445**	**100%**	**100%**

[1] Refrigerators with single door configurations were binned with ENERGY STAR® top freezers by AEP Ohio as this provided the most conservative estimate for *ex ante* unit energy and demand savings.
[2]The Draft 2010 Ohio TRM does not include savings estimates for Tier 3 units, so Tier 3 units are included within the Tier 2 category.
[3] The Draft 2010 Ohio TRM does not include estimates for compact units, so AEP Ohio used the ENERGY STAR® QPL to determine the deemed energy and demand usage.
[4] AEP Ohio estimated the *ex ante* energy and demand savings for refrigerators with unknown configurations as the deemed savings for ENERGY STAR® top freezers as this provided the most conservative estimate.
[5]Totals may not sum to 100% due to rounding.

Refrigerator *Ex Post* Savings

The evaluation team verified that AEP Ohio correctly applied the TRM methods and therefore the total *ex post* savings are equal to the *ex ante* savings. Although the evaluation team attempted to locate savings estimates for unknown configurations, the team did not discover any savings information and therefore applied the same assumptions as AEP Ohio.

Heat Pump Water Heater Savings Analysis Details

This sub-section describes the analysis methods applied to heat pump water heaters.

Heat Pump Water Heater *Ex Ante* Savings

To determine *ex ante* savings for heat pump water heaters, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied TRM-specified deemed savings values with the modifications suggested by the evaluation team in the 2016 evaluation. For heat pump water heaters, TRM-specified deemed savings values depend on the type of home heating system where the new equipment is installed. Table A-11 presents the per-unit savings values.

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Table A-11. Draft 2010 Ohio TRM Per-Unit Savings Values for Heat Pump Water Heaters

Home Heating System	Per-Unit Energy Savings (kWh)	Per-Unit Demand Savings (kW)
Fossil Fuel	2,076	0.280
Heat Pump	1,297	0.180
Electric Resistance Heat	499	0.068

Source: Heat Pump Water Heaters (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 86.

For heating system types marked as "other" in the tracking data, AEP Ohio applied the methods suggested in the 2016 evaluation. AEP Ohio used the "Revn_Clas_Cd" field to determine whether these units were installed in homes with electric or gas heat. A value of 10 in this field means the home likely (based on AEP Ohio modeling) uses gas for heating, while a value of 20 means the home likely uses electricity for heating. For homes with some type of electric heating system (it is unknown if the system is electric resistance or heat pump), AEP Ohio computed average per-unit energy and demand savings values using data from the 2013 AEP Ohio Residential Appliance Saturation Survey (RASS) survey, which indicated 31 percent of electric heating came from heat pumps and 69 percent came from electric resistance heaters. The weighted average energy savings value for electrically heated homes with unknown system types was 746 kWh/unit, and the demand savings value was 0.102 kW/unit. Except for these homes, AEP Ohio used deemed savings values from the TRM. Based on these assumptions, customers with fossil fuel heating made up about half of *ex ante* heat pump water heater energy savings (48%), as described in Table A-12.

Table A-12. *Ex Ante* Percent of Program Heat Pump Water Heaters by Home Heating Type

Home Heating Type	Number of Units	Percent of Units	Percent of *Ex Ante* Energy Savings
Fossil Fuel	194	49%	65%
Heat Pump	140	35%	30%
Electric Resistance Heat	47	12%	4%
Electric, Unknown System Type	19	5%	1%

Heat Pump Water Heater *Ex Post* Savings

The evaluation team verified that AEP Ohio correctly applied the TRM methods and the modifications suggested in the 2016 evaluation. These methods were correctly applied. However, the evaluation team found three records that had negative quantities that AEP Ohio did not deduct from their total quantities. These records appeared to be returned units. The evaluation team deducted the savings from these negative quantity units, and therefore, the total *ex post* savings are not equal to the *ex ante* savings.

Dehumidifier Savings Analysis Details

This sub-section describes the analysis methods applied to dehumidifiers.

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Dehumidifier *Ex Ante* Savings

To determine *ex ante* savings for dehumidifiers, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the TRM-specified deemed savings values. According to the TRM, savings for dehumidifiers are deemed based on the capacity of the dehumidifier using the ranges shown in Table A-13.

Table A-13. Draft 2010 Ohio TRM Per-Unit Savings Values for Dehumidifiers

Capacity (pints/day)	Per-Unit Energy Savings (kWh)	Per-Unit Demand Savings (kW)
≤ 25	54	0.012
> 25 to ≤ 35	117	0.027
> 35 to ≤ 45	213	0.048
> 45 to ≤ 54	297	0.068
> 54 to ≤ 75	185	0.042
> 75 to ≤ 185	374	0.085

Source: ENERGY STAR® Dehumidifier (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 64.

Customers purchasing the large dehumidifiers (45 to 75 pints/day) constituted 90 percent of all dehumidifier *ex ante* energy savings, as seen in Table A-14.

Table A-14. Percent of Program Dehumidifiers by Capacity

Capacity (pints/day)	Number of Units	Percent of Units	Percent of *Ex Ante* Energy Savings
> 25 to ≤ 35	30	9%	5%
> 35 to ≤ 45	15	5%	5%
> 45 to ≤ 54	108	34%	46%
> 54 to ≤ 75	164	52%	44%

Dehumidifier *Ex Post* Savings

The dehumidifier *ex post* savings methodology also followed the TRM. The evaluation team calculated the *ex post* savings using the same parameters and equations as previously described. Therefore, the *ex post* savings are equal to the *ex ante* savings.

Air Purifier Savings Analysis Details

This sub-section describes the analysis methods applied to air purifiers.

Air Purifier *Ex Ante* Savings

As air purifiers are not included in the TRM, AEP Ohio estimated air purifier energy savings by modifying the equation developed for the 2016 evaluation, as shown in Equation A-7.

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Equation A-7. *Ex Ante* Energy Savings for Air Purifiers

$$Annual\ kWh\ Savings = (ActiveWattsBaseline - ActiveWattsEfficient) * HOU_{Active} / 1{,}000 + (StandbyWattsBaseline - StandbyWattsEfficient) * (HOU_{Standby} - HOU_{Active}) / 1{,}000$$

AEP Ohio estimated air purifier demand savings using the equation developed for the 2016 evaluation, as seen in Equation A-8.

Equation A-8. *Ex Post* Demand Savings for Air Purifiers

$$Summer\ Coincident\ Peak\ kW\ Savings = (ActiveWattsBaseline - ActiveWattsEfficient) * CF / 1{,}000 + (StandbyWattsBaseline - StandbyWattsEfficient) * (1 - CF) / 1{,}000$$

AEP Ohio determined each program model's active power (ActiveWattsEfficient), standby power (StandbyWattsEfficient), and CADR by matching model numbers from the program tracking data with the ENERGY STAR® air purifier QPL. For model numbers not found in the ENERGY STAR® air purifier QPL, AEP Ohio used the average active power value and standby power value from the tracking dataset. AEP Ohio relied on air purifier research recently conducted for Pacific Gas and Electric Company (PG&E) for the other parameters in Equation A-7 (ActiveWattsBaseline, HOU_{Active}, StandbyWattBaseline, and $HOU_{Standby}$). The following assumptions were used to calculate energy savings for each incented unit:

- baseline active power draw (ActiveWattsBaseline) equal to the CADR (from program tracking data) divided by an efficiency of 2.2 CADR/Watt[31]
- baseline standby power (StandbyWattsBaseline) of 0.7 Watt[32]
- active hours of use (HOU_{Active}) value of 3,641[33,34]
- standby hours of use ($HOU_{Standby}$) value of 3,787[35]

Total air purifier *ex ante* energy savings were calculated by summing the per-unit savings for each program unit in the program tracking data. To calculate the *ex post* demand savings, AEP Ohio used Equation A-8 and a CF of 0.54.[36]

Air Purifier *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and used the same methods to calculate demand savings. For energy savings, the evaluation team applied calculations to match the methods developed during the 2016 evaluation. This resulted in a slightly different equation from that used by AEP Ohio, namely by removing the subtraction of the HOU_{Active} value from the $HOU_{Standby}$ value.

Equation A-9. *Ex Post* Energy Savings for Air Purifiers

$$Annual\ kWh\ Savings = (ActiveWattsBaseline - ActiveWattsEfficient) * HOU_{Active} / 1{,}000 + (StandbyWattsBaseline - StandbyWattsEfficient) * HOU_{Standby} / 1{,}000$$

[31] Results from PG&E Retail Products Platform (RPP) Air Cleaner Lab Research Results Memo.
[32] Ibid.
[33] Results from PG&E Retail Products Platform (RPP) Air Cleaner Lab Research Results Memo.
[34] Note using the 2015 Appliance Rebate Survey results, the evaluation team calculated an average HOU of 3,377 hours with a 90% confidence interval ranging from 2,529 to 4,225 hours. While this finding does not satisfy 90/10 confidence and precision, it does generally agree with the PG&E finding that HOU are lower than the assumed 5,840 from the ENERGY STAR® Appliance Savings Calculator. The PG&E finding has a relative precision of +/- 6.2% at a 90% level of confidence.
[35] Results from PG&E Retail Products Platform (RPP) Air Cleaner Lab Research Results Memo.
[36] Based on results from the 2015 Appliance Rebate Survey.

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The evaluation team used the same parameters as AEP Ohio to calculate program savings, however, the evaluation team was able to find the active power, standby power, and CADR for all program tracking data model numbers using the ENERGY STAR® air purifier QPL. The evaluation team was able to identify all air purifier models in the ENERGY STAR® QPL by using the "Additional Model Information" field which contains additional model numbers for the specified equipment. Using this field, the evaluation team was able to extract parameters to calculate *ex post* energy and demand savings for all air purifiers. The parameters used for *ex ante* and *ex post* air purifier savings are summarized in Table A-15.

Table A-15. Key *Ex Ante* and *Ex Post* Parameters for Air Purifiers

Parameter Description	Average *Ex Ante* Value	Average *Ex Post* Value	*Ex Post* Source
Baseline Active Power	77.9 Watts	80.1 Watts	Program Tracking Data Matched to ENERGY STAR® QPL[1]
Efficient Unit Active Power	64.1 Watts	67.3 Watts	Program Tracking Data Matched to ENERGY STAR® QPL[1]
Efficient Unit Standby Power	0.64 Watts	0.53 Watts	Program Tracking Data Matched to ENERGY STAR® QPL[1]

[1] ENERGY STAR® Certified Room Air Cleaners, downloaded Jan. 23, 2018. http://www.energystar.gov/productfinder/product/certified-room-air-cleaners

Central Air Conditioners Savings Analysis Details

This sub-section describes the analysis methods applied to central air conditioners.

Central Air Conditioner *Ex Ante* Savings

To determine *ex ante* savings for central air conditioners, the evaluation team first assessed the methodologies used by AEP Ohio. AEP Ohio rebated both air conditioner purchases at the time of sale and the early replacement of central air conditioners. The evaluation team confirmed AEP Ohio applied the TRM-specified equations for central air conditioners rebated at the time of sale, as detailed in Equation A-10 and Equation A-11.

Equation A-10. *Ex Ante* Energy Savings for Central Air Conditioners

$$Annual\ kWh\ Savings = (FLH_{cool} * BtuH * (1/ SEER_{base} - 1 / SEER_{ee})) / 1000$$

Equation A-11. *Ex Ante* Demand Savings for Central Air Conditioners

$$Summer\ Coincident\ Peak\ kW\ Savings = (BtuH * (1 / EER_{base} - 1 / EER_{ee})) / 1000 * CF$$

For the early replacement of central air conditioners, AEP Ohio applied the TRM savings calculation methods for early replacement air conditioners, however, AEP Ohio modified the equation to only calculate current-year savings (shown in Equation A-12 and Equation A-13).[37]

[37] The TRM equation for central air conditioner early replacement savings sets out two equations: one for savings over the remaining useful life of the removed unit (deemed as five years), and the other for the savings over baseline equipment for the effective useful life of the energy-efficient equipment. As AEP Ohio claims current year savings for all program measures, program staff modified the equation to reflect just savings over the first year the equipment is installed.

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Equation A-12. *Ex Ante* Energy Savings for Central Air Conditioner Early Replacement

$$Annual\ kWh\ Savings = ((FLH_{cool} * BtuH_{exist} * (1 / SEER_{exist})) / 1000) - ((FLH_{cool} * BtuH_{ee} * 1 / SEER_{ee})) / 1000)$$

Equation A-13. *Ex Ante* Demand Savings for Central Air Conditioner Early Replacement

$$Summer\ Coincident\ Peak\ kW\ Savings = (BtuH_{exist} * (1 / EER_{exist}) / 1000 * CF) - (BtuH_{ee} * (1 / EER_{ee}) /1000 * CF)$$

AEP Ohio applied the TRM deemed parameter values for full load cooling hours (FLH_{cool}), SEER baseline efficiency ($SEER_{base}$), EER baseline efficiency (EER_{base}), and coincidence factor (CF). For the remaining variables, AEP Ohio used values from the tracking data.

Central Air Conditioner *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and mirrored their methodology to calculate *ex post* savings, and therefore, the *ex post* savings are equal to the *ex ante* savings.

Air Source Heat Pumps Savings Analysis Details

This sub-section describes the analysis methods applied to air source heat pumps.

Air Source Heat Pump *Ex Ante* Savings

To determine *ex ante* savings for air source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team verified that AEP Ohio correctly applied the TRM calculations detailed in Equation A-14 and Equation A-15. AEP Ohio applied most parameters as described in the TRM, however, they updated the SEER baseline value (14) and heating season performance factor (HSPF) baseline value (8.2) based on updated Federal Regional Standards for cooling equipment that went it to effect on Jan 1, 2015.[38] For the few records (4) missing baseline measure size information ($SEER_{base}$ and EER_{base}), AEP Ohio estimated savings as the average per-unit savings.

Equation A-14. *Ex Ante* Energy Savings for Air Source Heat Pumps

$$Annual\ kWh\ Savings = (FLHcool * BtuH * (1/SEERbase - 1/SEERee))/1000 + (FLHheat * BtuH * (1/HSPFbase – 1/HSPFee))/1000$$

Equation A-15. *Ex Ante* Demand Savings for Air Source Heat Pumps

$$Summer\ Coincident\ Peak\ kW\ Savings = BtuH * (1/EERbase - 1/EERee))/1000 * CF$$

Air Source Heat Pump *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and applied the same parameters except for the HSPF. For this parameter, the evaluation team found that more than a quarter (26%) of air source heat pumps had HSPF values below the new federal standard (8.0 instead of the 8.2

[38] http://www.sgtorrice.com/files/Pages/News/2015-Regional-Standards-Cooling-Heating%20Products-rev1.pdf

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standard). The evaluation team took a sample of impacted model numbers, searched for model specifications on several retail websites, and found that the specified HSPF for those models was higher than the HSPF listed in the database for those models.[39] Based on this limited analysis, the evaluation team adjusted the HSPF to 8.2 for the impacted records. The evaluation team assumed that the tracking data presented a rounded HSPF value and that all incented air source heat pumps met the federal standard. Due to this adjustment, *ex post* energy savings were slightly higher than *ex ante* values.

Ductless Mini-Split Savings Analysis Details

This sub-section describes the analysis methods applied to ductless mini-split systems.

Ductless Mini-Split *Ex Ante* Savings

To determine *ex ante* savings for air source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. As ductless mini-split systems are not included specifically in the TRM, AEP Ohio applied the air source heat pump savings algorithms as seen in Equation A-14 and Equation A-15. AEP Ohio applied all of the air source heat pump parameter assumptions found the in the TRM.

Ductless Mini-Split *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate *ex post* savings, and therefore, the *ex post* savings are equal to the *ex ante* savings.

Ground Source Heat Pumps Savings Analysis Details

This sub-section describes the analysis methods applied to ground source heat pumps.

Ground Source Heat Pump *Ex Ante* Savings

To determine *ex ante* savings for ground source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. AEP Ohio applied the TRM calculations detailed in Equation A-16 and Equation A-17.

Equation A-16. *Ex Ante* Energy Savings for Ground Source Heat Pumps

$$\textit{Annual kWh Savings} = (FLHcool * BtuH * (1/SEERbase - (1/(EERee * 1.02))/1000 + (FLHheat * BtuH * (1/HSPFbase - (1/COPee * 3.412))/1000$$

Equation A-17. *Ex Ante* Demand Savings for Ground Source Heat Pumps

$$\textit{Summer Coincident Peak kW Savings} = BtuH * (1/EERbase - 1/(((EERee * 1.02) * 0.37) + 6.43))/1000 * CF$$

Ground Source Heat Pump *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and discovered that AEP Ohio assumed the incorrect heating fuel type two records. The evaluation team corrected the heating fuel type for both records.

Nightlights Savings Analysis Details

[39] Searched for model specifications of five air source heat pumps on the websites of Lowes, Home Depot, Trane, and Rheem.

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This subsection describes the analysis methods applied to nightlights.

Nightlight *Ex Ante* Savings

Methodologies for determining savings achieved from nightlights are not present in the TRM, thus AEP Ohio used the ex-post savings results of the 2012 In-Home Energy Program evaluation report (per-unit value of 21.07 kWh). No savings values were claimed for demand kW savings.

Nightlight *Ex Post* Savings

The evaluation team applied the same methodologies as AEP Ohio to calculate *ex post* savings. The evaluation team determined that the deemed savings value used by AEP Ohio was reasonable and was more conservative than savings estimations used by another U.S. utility.[40] In addition, the evaluation team applied ISR values that varied by component, as seen in Table A-16.

Table A-16. *Ex Post* ISR Adjustments - Nightlights

Sub-Program	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.84	Energy Efficiency Kits survey
Single-family Direct Installation	0.83	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.57	Multi-Family onsite audits

Showerheads Savings Analysis Details

Showerheads *Ex Ante* Savings

The evaluation team verified that AEP Ohio calculated *ex ante* savings for showerheads using an adapted version of the methodology detailed in the Draft 2010 Ohio TRM.[41] Equation A-18 and Equation A-19 show the TRM equations used by AEP Ohio for showerheads energy and demand savings.

Equation A-18. Draft 2010 Ohio TRM-Specified Energy Savings for Showerheads

$$\Delta kWh = ISR * (GPMbase - GPMlow) * kWh/GPMreduced$$

Equation A-19. Draft 2010 Ohio TRM-Specified Demand Savings for Showerheads

$$\Delta kW = \Delta kWh / Hours * CF$$

The following parameters were used by AEP Ohio:

- ISR = 0.81 (Customer self-install) / ISR = 1.00 (Direct install)

[40] Idaho Power estimated a per-unit savings of 26.54 kWh for LED night lights included in their residential energy savings kit. Source: https://docs.idahopower.com/pdfs/EnergyEfficiency/Reports/Supplement2_evaluation.pdf

[41] *Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).*

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- GPMbase = 2.87 (Gallons per minute of baseline showerhead)
- GPMlow = 2.0 (Gallons per minute of low flow showerhead)
- kWh / GPMreduced = 173 (Assumed kWh savings per GPM reduction)[42]
- Hours = Gal/person * #people * days / y) / SH/home / GPM / 60 (Average number of hours per year spent using showerhead)
    - gals/day = 11.6 (Average gallons per day used for showering)
    - # people = 2.46 (Average number of people per household)
    - days/y = 365 (Days shower used per year)
    - SH/home = 2.1 (Average number of showers in the home)
- CF = 0.0037 ([11.6 * 2.46 * 365] / 2.1 / 2.87 / 60 = 29 hours = Summer peak coincidence factor for measure)

Showerheads *Ex Post* Savings

The evaluation team adjusted the gallons-per-minute of energy-efficient equipment (GPMlow) to reflect the information listed in the model description (1.5 GPM). The evaluation team also applied ISR values that varied by component, as seen in Table A-17.

Table A-17. *Ex Post* ISR Adjustments - Showerheads

Sub-Program	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.43	Energy Efficiency Kits survey
Single-family Direct Installation	0.76	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.73	Multi-Family onsite audits

Faucet Aerators Savings Analysis Details

Faucet Aerators *Ex Ante* Savings

The evaluation team verified that AEP Ohio calculated *ex ante* savings for faucet aerators based on modified calculations from the Draft 2010 Ohio TRM, as described in Equation A-20 and Equation A-21.[43]

Equation A-20. Draft 2010 Ohio TRM-Specified Energy Savings for Faucet Aerators

$$\Delta kWh = ISR * ((GPMbase - GPMlow / GPMbase) * 97.02^{44}$$

[42] AEP Ohio adjusted this value from 179 to 173 based on VEIC comments.
[43] Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).
[44] AEP Ohio adjusted this value from 77.0 to 97.02 based on VEIC comments.

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Equation A-21. Draft 2010 Ohio TRM-Specified Demand Savings for Faucet Aerators

$$\Delta kW = \Delta kWh * 0.000125$$

The evaluation team verified the following parameters were used by AEP Ohio:

- ISR = 0.48 (Customer self-install)
- GPMbase = 2.2 (Gallons per minute of baseline faucet)
- GPMlow = 2.0 (Gallons per minute of low flow aerator)

Faucet Aerators *Ex Post* Savings

The evaluation team adjusted the gallons-per-minute of energy-efficient equipment (GPMlow) to reflect the information listed in the model description (1.5 GPM). The evaluation team also applied ISR values that varied by component, as seen in Table A-18.

Table A-18. *Ex Post* ISR Adjustments - Faucet Aerators

Sub-Program	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.43	Energy Efficiency Kits survey
Single-family Direct Installation	0.88	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.71	Multi-Family onsite audits

Smart Power Strips Savings Analysis Details

Smart Power Strips *Ex Ante* Savings

Equation A-22 and Equation A-23 shown are the TRM equations used by AEP Ohio for smart power strips energy and demand savings:[43]

Equation A-22. Draft 2010 Ohio TRM-Specified Energy Savings for Smart Power Strips

$$\text{Deemed kWh Savings } (\Delta kWh_{7\text{-}Plug}) = 103.139 \text{ kWh}$$

Equation A-23. Draft 2010 Ohio TRM-Specified Demand Savings for Smart Power Strips

$$\text{Summer Coincident Peak Demand Savings}(\Delta kW) = \Delta kWh / Hours * CF$$

The evaluation team verified the following parameters were used by AEP Ohio:

- Hours = Annual number of hours during which the controlled standby loads are turned off by the smart strip = 7,152.5[45]
- CF = Summer peak coincidence factor for measure = 0.8

[45] The hours of use value was adjusted from 7,129 to 7,152.3 based on a suggestion in the VEIC response document.
Source: Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).

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Smart Power Strips *Ex Post* Savings

The evaluation team applied the same methodologies as AEP Ohio to calculate *ex post* savings. In addition, the evaluation team applied ISR values that varied by component, as seen in Table A-19.

Table A-19. *Ex Post* ISR Adjustments - Smart Power Strips

Sub-Program	ISR Adjustment	Source of ISR Adjustment
Single-family Direct Installation	0.83	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.64	Multi-Family Direct Installation onsite audits

CFL Savings Analysis Details

This sub-section describes the analysis methods applied to CFLs.

CFL *Ex Ante* Savings

To determine *ex ante* savings for CFLs, the evaluation team first assessed which methodologies were used by AEP Ohio. The evaluation team verified AEP Ohio applied methods specified in the TRM. Equation A-24 and Equation A-25 are the TRM equations used by AEP Ohio for CFL energy and demand savings:

Equation A-24. Draft 2010 Ohio TRM-Specified Energy Savings for CFLs

$$Annual\ kWh\ Savings = (ProgWatts * DeltaWattsMultiplier) * ISR * HOU * WHF_E / 1{,}000$$

Equation A-25. Draft 2010 Ohio TRM-Specified Demand Savings for CFLs

$$Summer\ Coincident\ Peak\ kW\ Savings = (ProgWatts * DeltaWattsMultiplier) * ISR * CF * WHF_D / 1{,}000$$

AEP Ohio applied the following values from the Draft Ohio TRM:

- ISR = 0.81
- HOU = 1,040.25 hours per year
- WHF_E equivalent to 1.07 and 1.21 for WHF_D to account for the interactive effect that the reduced heat emitted by CFL lighting (compared to the baseline technology) has on the heating and cooling system
- CF = 0.11

For delta Watt multipliers (DeltaWattsMultiplier), the evaluation team verified AEP Ohio used the values in the table on page 17 of the TRM for "2014 and Beyond", which are shown in Table A-20. Delta Watt multipliers, which represent the ratio of savings to the program bulb wattage (ProgWatts), are specified in the TRM as changing over time to account for shifting baselines resulting from the federal Energy Independence and Security Act of 2007 (EISA), a federally-mandated phase out of incandescent bulbs. For specialty CFLs, the evaluation team confirmed AEP Ohio used the Delta Watts Multiplier in the table on page 17 of the TRM for "2009 - 2011", because EISA (implemented in 2011) did not affect the baseline for specialty CFLs.

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Table A-20. Draft 2010 Ohio TRM-Specified Values for CFLs Delta Watts Multiplier

CFL Wattage	Delta Watts Multiplier			
	2009 to 2011	2012	2013	2014 and Beyond
15 or less	3.25	3.25	3.25	2.05
16 – 20	3.25	3.25	2.00	2.00
21 or greater	3.25	2.06	2.06	2.06

Source: Residential ENERGY STAR® Compact Fluorescent Lamp (CFL) (Time of Sale). Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 13.

The evaluation team verified the total energy and demand *ex ante* savings for CFLs by summing the savings for each invoice in the program tracking data.

CFL *Ex Post* Savings

The evaluation team applied the same methodologies as AEP Ohio to calculate *ex post* savings.

Attic Insulation and Air Sealing Savings Analysis Details

Attic Insulation and Air Sealing *Ex Ante* Savings

To determine *ex ante* savings for attic insulation and air sealing measures, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the TRM-specified deemed savings values.

Attic Insulation and Air Sealing *Ex Ante* Savings

The evaluation team also applied the TRM methodology from the TRM to estimate *ex post* savings for attic insulation and air sealing measures, and therefore, the *ex post* savings are equal to the *ex ante* savings.

A.3 Distribution of LED Wattages

A key impact parameter for program light bulbs is the bulb's wattage. Figure A-1 shows the distribution of 2017 program standard and specialty LED wattages. The most common wattages were 9 Watts for standard LEDs and 11 Watts for specialty LEDs.

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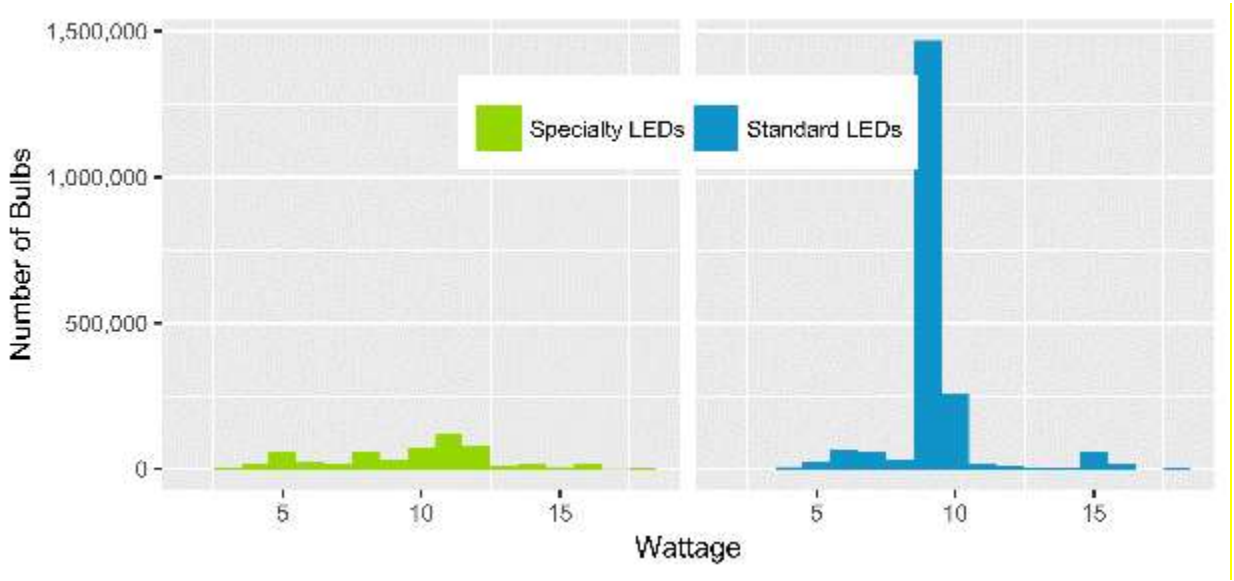
Figure A-1. Distribution of Program Standard LED and Specialty LED Wattage



A.4 Additional Process Evaluation Findings

This section contains additional findings from the process evaluation related to the energy efficiency kits survey, the appliance rebate survey, and the multi-family direct installation audits. It includes the following sub-sections:

- Energy Efficiency Kit Survey:
  - Demographics
  - Satisfaction
  - Report Use and Usefulness
  - Attitudes
  - Knowledge Gains and Retention and Additional Equipment
  - AEP Ohio Contact and Communication
  - Perceptions of and Satisfaction with Energy Savings
  - Additional Program Participation
- Appliance Rebate Survey:
  - Completes by Appliance Type
  - Demographics
  - Satisfaction
  - Installation of Appliances
  - Motivation for Appliance Purchase
  - Recall of Rebate
  - Contractors
  - Retail Stores
  - Contact with AEP Ohio
  - Reduced Energy Usage on Bill and Energy Efficiency Kits
- Multi-Family Direct Installation Audits:
  - LED Installations by Room Type

Energy Efficiency Kit Survey: Demographics

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This subsection displays demographics for energy efficiency kit survey respondents.

Table A-21 shows the distribution of residence types reported by survey respondents.

Table A-21. Residence Types - Energy Efficiency Kits Survey

Residence Type	Percent of Total (n=114)
Single-family home, detached construction	79%
Condo	7%
Two or three family attached residences	5%
Single-family home, factor manufactured / modular	3%
Single-family home, mobile home	3%
Apartment	2%
Other	2%

Note: Responses not required for demographic questions.

Table A-22 shows the distribution of tenure (renter versus owner) by energy efficiency kit respondents. The majority (86.8%) of respondents reported owning their residence. Of the 15 respondents who reported renting, 14 reported paying their own electric bill (1 reported the bill was included in the rent). Of the respondents who rent their homes, only one respondent reported that their electric bill is included in their rent.

Table A-22. Tenure - Energy Efficiency Kits Survey

Tenure	Percent of Total (n=114)
Own	87%
Rent	13%

Note: Responses not required for demographic questions.

Table A-23 shows the residence year of construction reported by energy efficiency kit survey respondents.

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Table A-23. Years of Residence Construction - Energy Efficiency Kits Survey

Year of Residence Construction	Percent of Total (n=114)
Before 1960	35%
1960 - 1969	8%
1970 - 1979	18%
1980 - 1989	9%
1990 - 1999	12%
2000 - 2005	6%
2006 or later	9%
Unsure	4%

Note: Responses not required for demographic questions.

Table A-24 shows the estimated below and above ground living space square footage reported by energy efficiency kit survey respondents.

Table A-24. Above and Below Ground Living Space - Energy Efficiency Kits Survey

	Above Ground	Below Ground
Year of Residence Construction	Percent of Total (n=114)	Percent of Total (n=114)
< 1,000 sq. ft.	63%	18%
1,001 - 2,000 sq. ft.	21%	46%
2,001 - 3,000 sq. ft.	3%	25%
3,001 - 4,000 sq. ft.	1%	4%
4,001 - 5,000 sq. ft.	0%	2%
Other	4%	0%
Unsure	9%	5%

Note: "Other" responses included: "crawl" and "slab construction" - 2 respondents did not provide additional information.
Responses not required for demographic questions.

Table A-25 shows the annual incomes reported by energy efficiency kit survey respondents.

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Table A-25. Annual Household Income - Energy Efficiency Kits Survey

Amount	Percent of Total (n=114)
< $15,000	7%
$15,001 - $30,000	17%
$30,001 - $50,000	13%
$50,001 - $75,000	23%
$75,001 - $100,000	18%
> $100,000	22%

Note: Responses not required for demographic questions.

Energy Efficiency Kit Survey: ISR

Energy efficiency kit survey respondents reported installing almost all of the LEDs received in their energy efficiency kits (93%), however, less than half reported installing their showerhead or faucet aerator (43% for each measure). Of respondents who completed the online energy profile and did not install their showerhead (*n* = 19), 53 percent reported they did not install it either because they already had an efficient showerhead installed or they liked their current showerhead.

Table A-26. ISR by Measure Type – Energy Efficiency Kits Survey

Equipment Type	Percent of All Measures Installed
LED (n = 114)	93%
Showerhead (n = 49)	43%
Faucet Aerator (n = 49)	43%
LED Nightlight (n = 114)	**84%**

Energy Efficiency Kit Survey: Satisfaction

This section presents results related to participant satisfaction with the: overall Home Energy Profile program component, the Home Energy Profile itself, energy efficiency kits, and kit contents (LEDs, LED nightlights, showerheads, and faucet aerators).

Participants were generally satisfied with all elements of the program, including the Home Energy Profile and the energy efficiency kits. As shown in Figure A-2, the energy efficiency kit was rated highest among program components, followed by the program overall, and finally the Home Energy Profile. Ninety-eight percent (98%) of respondents rated their satisfaction with the energy efficiency kits as an eight or higher on the 11-point (Not at all satisfied to Very satisfied) scale. The majority of respondents were highly satisfied with the Home Energy Profile (63%) and the program overall (78%), as indicated by an 8 or higher on the 11-point scale.

Figure A-2 also displays survey respondents' satisfaction with the energy efficiency kit contents. LED nightlights received the highest average satisfaction rating (Mean = 9.2). However, respondents

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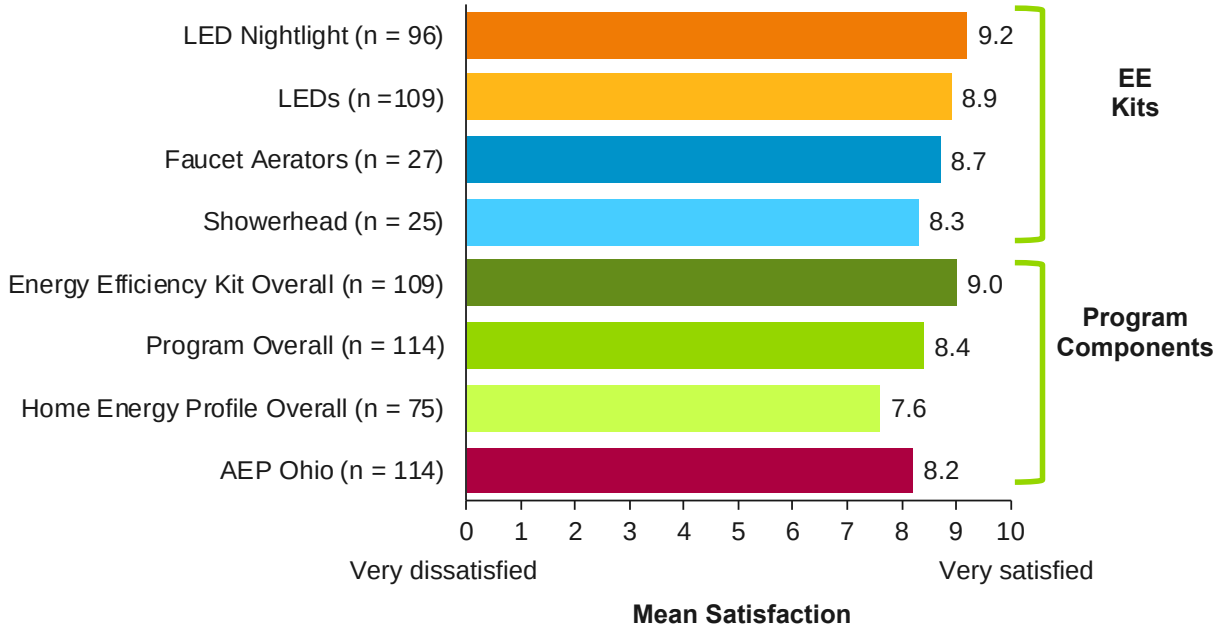
indicated being highly satisfied with all of the equipment in the energy efficiency kits, on the 11-point scale satisfaction scale:

- 96% of respondents rated faucet aerators an 8 or higher.
- 91% rated LEDs an 8 or higher.
- 76% rated showerheads and 8 or higher.

Overall, respondents rated their satisfaction with AEP Ohio an average of 8.2 on the 0-to-10 scale.

Figure A-2. Satisfaction with Energy Efficiency Kits Elements, Program Overall, and AEP Ohio



Respondents' ratings of the Home Energy Profile program component and their ratings of AEP Ohio significantly varied depending on how they had applied for the energy efficiency kit. Those who had applied via an appliance rebate form were significantly more satisfied with the program (Mean = 9.3) compared to those who had applied online (Mean = 8.2). Similarly, those who had applied via an appliance rebate form were significantly more satisfied with AEP Ohio (Mean = 9.2), compared to those who had applied online (Mean = 8.1).

Customers were asked an open-ended question to clarify why they rated the Efficient Products energy efficiency kit component as they did. Most customers provided positive feedback; the most common comments included appreciating:

- The energy saving tips (*n* = 16)
- The contents of the energy efficiency kit (*n* = 15)
- The LEDs in the energy efficiency kits (*n* = 12)
- The simplicity of participating the program and that participation and the kit was free (*n* = 9)

Customers were also asked an open-ended question to clarify why they rated AEP Ohio as they did. The majority of customers provided positive feedback, customers mentioned the following regarding their satisfaction with AEP Ohio:

- Reliable service (few outages or quick restoration of power after outages) (*n* = 34)
- Rebates and energy efficiency programs or tips (*n* = 8)

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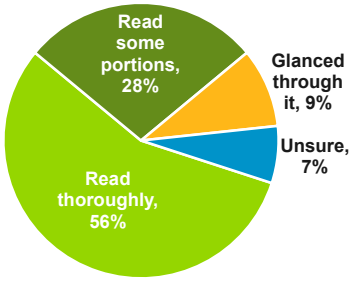
- Low or fair pricing / cost of service (*n* = 5)
- Good customer service (*n* = 2)

Energy Efficiency Kit Survey: Report Use and Usefulness

Home Energy Profile survey respondents were asked to indicate what they did with their Home Energy Report. Figure A-3 shows that more than three-quarters (84%) of respondents either read the report thoroughly (56%) or read some portions (28%). No respondents reported they "did not read the report at all". Respondents were also asked to indicate the extent to which they found the recommendations in the report useful on a 0 (Not at all useful) to 10 (Extremely useful) scale. Results show that respondents found the report to be useful, as indicated by the observed mean of 7.5 (n = 70); differences in ratings between respondents who read the report to different extents (e.g., "glanced through it" vs. "read thoroughly) were not statistically significant (χ^2 [2, n = 70] = 1.14, ns).

Figure A-3. Extent to Which Respondents Reviewed HEP Report



Energy Efficiency Kit Survey: Attitudes

Home Energy Profile participants who completed the survey were asked to rate their agreement with a number of statements regarding their opinions of the Home Energy Profile. As shown in Figure A-4, respondents generally saw the Home Energy Profile as easy to complete, taking a reasonable amount of time to complete, and easy to understand. Customers were somewhat less likely to agree that they had learned information needed to take action, or that they had learned about other sources of energy efficiency information.

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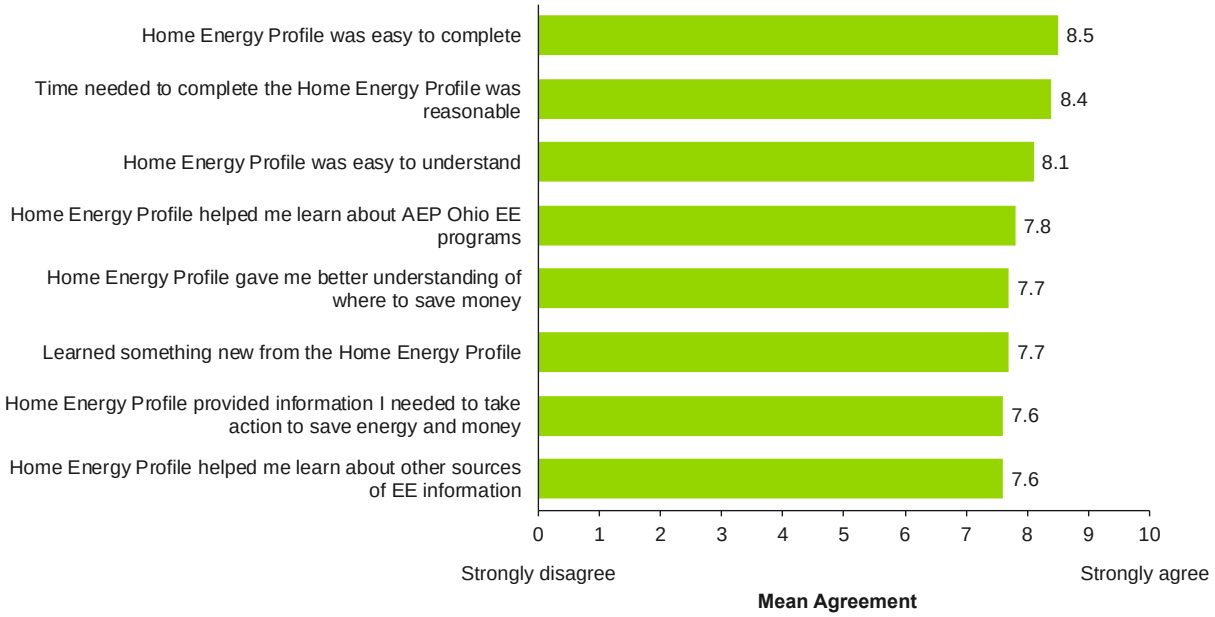
Figure A-4. Attitudes Toward the Home Energy Profile (n = 75)

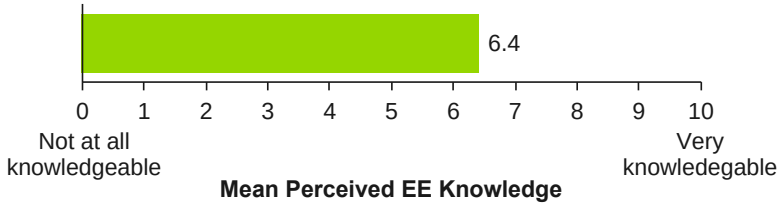


Energy Efficiency Kit Survey: Knowledge Gains, Retention, and Additional Equipment

This section details findings related to the knowledge gained and retained from program participation and participants' purchase of additional energy-efficient equipment due to program influence.

Survey respondents were asked to rate their energy efficiency knowledge prior to participating in the Home Energy Profile. As shown in Figure A-5, respondents reported having a moderate amount of energy efficiency knowledge prior to program participation, as indicated by the mean score of 6.4 on the 0 (Not at all knowledgeable) to 10 (Very knowledgeable) rating scale.

Figure A-5. Mean Perceived Energy Efficiency Knowledge Prior to Participation (n = 75)



In addition to being asked about energy efficiency knowledge prior to participation, respondents were asked to indicate how much they learned from the Home Energy Profile. As shown in Figure A-6, nearly all (93%) of participants reported learning either Some (73%) or A lot (20%).

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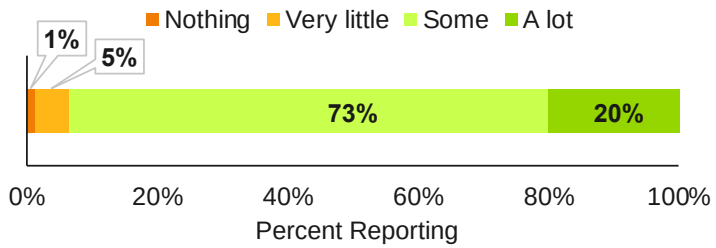
Figure A-6. Extent to Which Learned about Energy Efficiency from Home Energy Profile (n = 75)

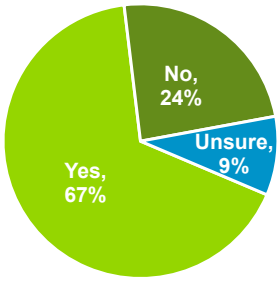


Respondents were asked to respond to an open-ended question asking about specific aspects of the Home Energy Profile that they found helpful. Respondents primarily reported the following regarding the particular features of the program they found helpful:

- LED lighting information in general (*n* = 12)
- Energy savings / energy efficiency recommendations (*n* = 10)
- LED information regarding savings attained from changing lightbulbs (*n* = 7)
- Information regarding thermostat settings / thermostat tips (*n* = 4)
- Savings achieved from efficient showerheads (*n* = 4)

Respondents were also asked to indicate if participation in the Home Energy Profile resulted in the purchase of additional energy-efficient equipment. As Shown in Figure A-7, the majority (67%) of respondents who completed the Home Energy Profile indicated that it influenced them to purchase additional energy-efficient equipment.

Figure A-7. Home Energy Profile Influence on Purchase of Additional EE Equipment (n = 75)



Those respondents who reported an influence of the Home Energy Profile on their decision to purchase additional energy-efficient equipment were asked to indicate the equipment they purchased. Figure A-8 shows that the most commonly purchased (additional) equipment was LED light bulbs. The remaining equipment types purchased were very similar in their frequency.

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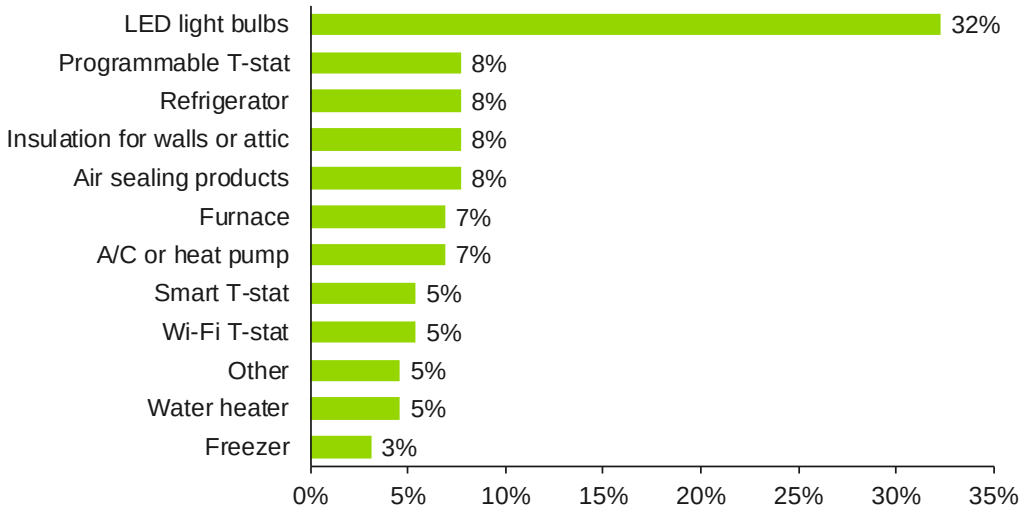
Figure A-8. Additional Equipment Purchased Due to Home Energy Profile (n = 50)

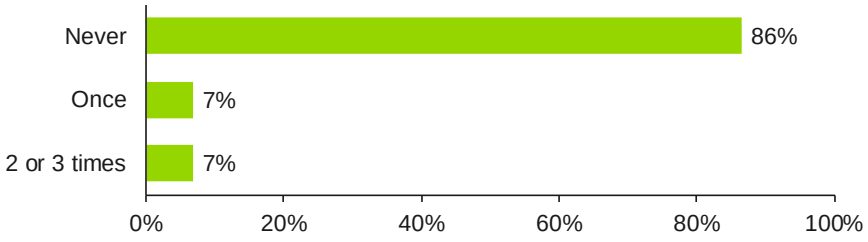


Respondents who reported that they had not purchased any additional equipment (recommended via the Online Energy Profile) were asked to provide their main reason for not doing so. Most (38%) of respondents indicated that they believed the cost of the equipment was too high; other common responses included the perception that the improvements would not "save enough energy" (24%) and "haven't got around to it" (24%).

Energy Efficiency Kit Survey: AEP Ohio Contact and Communication

As shown in Figure A-9, less than a quarter (14%) of survey respondents indicated contacting AEP Ohio during the course of participating in the Home Energy Profile: among those reporting contact, frequency of contact was evenly split between "once" (7%) and "2 or 3 times" (7%). Nearly all (90%) respondents who indicated contacting AEP Ohio reported contacting them via phone.

Figure A-9. Respondents Contact of AEP Ohio During Participation (n = 74)



Note: One respondent who responded "unsure" was removed from the calculation above.

Respondents who reported contacting AEP Ohio during the Home Energy Profile were asked to rate the extent to which they were satisfied with their communication with AEP Ohio staff. Figure A-10 shows that those who contacted AEP Ohio were highly satisfied with their experience.

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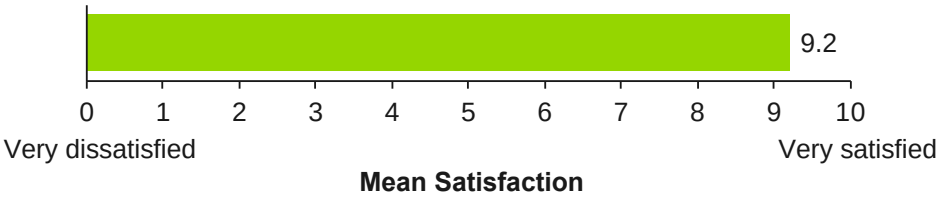
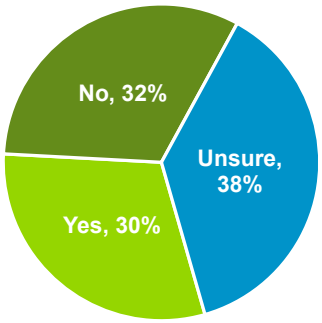
Figure A-10. Satisfaction with AEP Ohio Communication (n = 10)



Energy Efficiency Kit Survey: Perceptions of and Satisfaction with Energy Savings

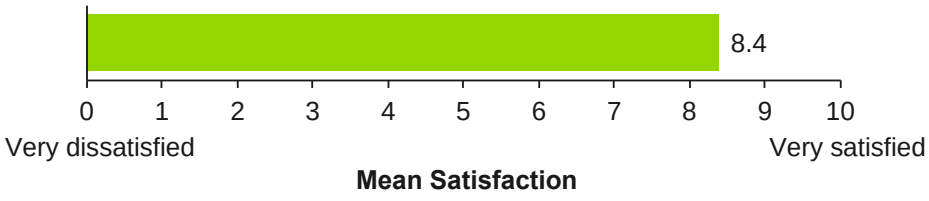
Survey respondents were asked to indicate whether they had noticed energy savings since installing items they received in their kits. As shown in Figure A-11, perceptions of energy savings were mixed: responses were nearly evenly split between noticing energy savings (30%), not noticing energy savings (32%), and being unsure (38%).

Figure A-11. Perceptions of Energy Savings from EE Equipment (n = 109)



Respondents who reported noticing energy savings were asked to indicate the extent to which they were satisfied with the savings they noticed. Figure A-12 shows that respondents who noticed energy savings (*n* = 33) were highly satisfied with the savings.

Figure A-12. Satisfaction with Energy Savings (n = 33)



Energy Efficiency Kit Survey: Additional Program Participation

Survey respondents who received energy efficiency kits were asked whether they had participated in any other AEP Ohio energy efficiency programs. As shown in Figure A-13, the majority (76%) of respondents indicated that they had not participated in other energy efficiency programs offered by AEP Ohio.

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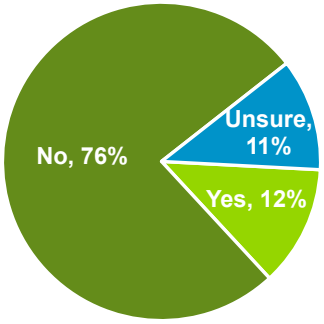
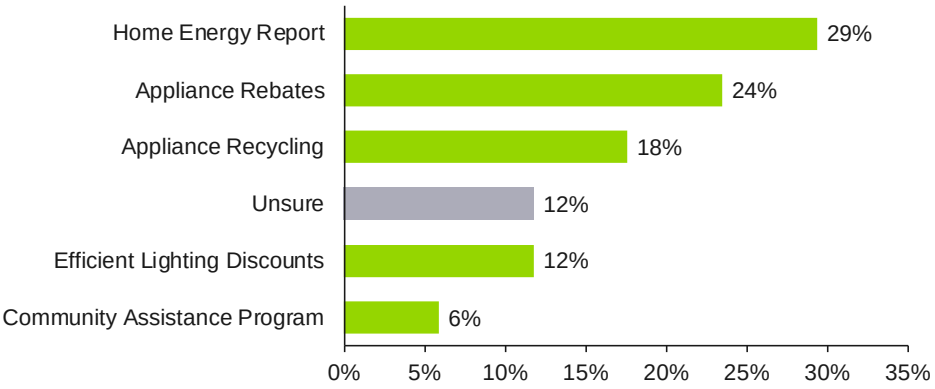
Figure A-13. Additional AEP Ohio Program Participation (n = 114)



Those participants who indicated they had participated in other AEP Ohio energy efficiency programs were asked what other programs they had participated in. Figure A-14 shows that most respondents who had participated in other programs had participated in the Home Energy Report (29%) or the Appliance Rebates (24%) component of the Efficient Products Program. In addition to asking what other programs respondents had participated in, respondents were asked to indicate when they had participated (in relation to receiving their energy efficiency kits). Respondents most commonly reported participating before receiving their energy efficiency kits (42.9%); two (14.3%) respondents indicated participating both before and after receiving their kits.

Figure A-14. Other Programs Participated In (n = 14)



The next sections provide detailed results for the appliance rebate survey.

Appliance Rebate Survey: Completes by Appliance Type

The number of respondents by equipment type closely aligned to the target number of completes based on the sample frame, as seen in Table A-27. Most survey respondents purchased or received smart thermostats (58%) and a third of survey respondents received rebates on central air conditioners (32%). The sample frame contained very few customers who purchased air source heat pumps, ductless heat pumps and ground source heat pumps and therefore few survey respondents from these strata completed the survey. Because the air source heat pump, ductless mini-split, and ground source heat pump strata had so few sample points, several partial survey respondents (6 in total) were included in the survey as they had valid responses for the impact-related questions and they had important information to share about their experiences with the program.

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Table A-27. Appliance Rebate Survey Completes by Equipment Type

Equipment Type	Sample Frame	Number of Survey Completes	Percent of Total Survey Completes
Smart Thermostat	3,630	94	58%
Central Air Conditioner	369	52	32%
Air Source Heat Pump	68	10	6%
Ductless Heat Pump	31	5	3%
Ground Source Heat Pump	6	1	1%
Total	**129**	**162**	**100%**

Note: totals may not sum to 100% due to rounding.

Appliance Rebate Survey: Demographics

Table A-28 shows the residence types reported by Appliance Rebate participants who completed the survey.

Table A-28. Residence Types – Appliance Rebate Survey

Residence Type	Percent of Total (n=156)
Single-family home, detached construction	87%
Condo	6%
Two or three family attached residences	3%
Single-family home, factor manufactured / modular	1%
Apartment	1%
Other	1%

Note: Responses not required for demographic questions.

Table A-29 shows the distribution of tenure (renter versus owner) by appliance rebate survey respondents. All respondents who rent their homes also reported paying their own utility bills.

Table A-29. Tenure - Appliance Rebate Survey

Tenure	Percent of Total (n=156)
Own	97%
Rent	3%

Note: Responses not required for demographic questions.

Table A-30 shows the year of residence construction reported by Appliance Rebate survey respondents.

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Table A-30. Years of Residence Construction – Appliance Rebate Survey

Year of Residence Construction	Percent of Total (n=157)
Before 1960	22%
1960 - 1969	9%
1970 - 1979	11%
1980 - 1989	12%
1990 - 1999	20%
2000 - 2005	12%
2006 or later	12%

Note: Responses not required for demographic questions.

Table A-31 shows the estimated below and above ground living space square footage reported by Appliance Rebate survey respondents.

Table A-31. Above and Below Ground Living Space – Appliance Rebate Survey

	Total Area	Above Ground
Year of Residence Construction	Percent of Total (n=157)	Percent of Total (n=157)
< 1,000 sq. ft.	5%	8%
1,001 - 2,000 sq. ft.	48%	52%
2,001 - 3,000 sq. ft.	35%	29%
3,001 - 4,000 sq. ft.	8%	6%
4,001 - 5,000 sq. ft.	1%	1%
Other	0%	0%
Unsure	1%	3%

Note: "Other" responses included: "crawl" and "slab construction" - 2 respondents did not provide additional information
Responses not required for demographic questions.

Table A-32 shows the heating fuel reported by Appliance Rebate survey respondents.

Table A-32. Heating Fuel – Appliance Rebate Survey

Fuel Type	Percent of Total (n=157)
Natural Gas	84%
Electric	18%
Propane	6%
Wood	3%
Geothermal	1%

Note: Responses not required for demographic questions.

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Table A-33 shows the electric heating equipment reported by appliance rebate survey respondents. The majority of participants reported owning central forced air furnaces (59%) or air source heat pumps.

Table A-33. Electric Heating Equipment – Appliance Rebate Survey

Electric Heating Equipment	Percent of Total (n=29)
Central Forced Air Furnace	59%
Air Source Heat Pump	52%
Other	10%
Baseboard or Resistance Heat	7%

Note: Responses not required for demographic questions. Multiple responses were allowed for this question.

Table A-34 shows the electric cooling equipment reported by appliance rebate survey respondents. The majority (91%) of respondents reporting having central forced air conditioning.

Table A-34. Electric Cooling Equipment – Appliance Rebate Survey

Electric Cooling Equipment	Percent of Total (n=155)
Central Forced AC	91%
Electric Fans	14%
Air Source Heat Pump	11%
Window AC Units	1%
No Electric Cooling	1%
Other	1%

Note: Responses not required for demographic questions. Multiple responses were allowed for this question.

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Table A-35 shows the annual income for appliance rebate survey respondents.

Table A-35. Annual Household Income – Appliance Rebate Survey

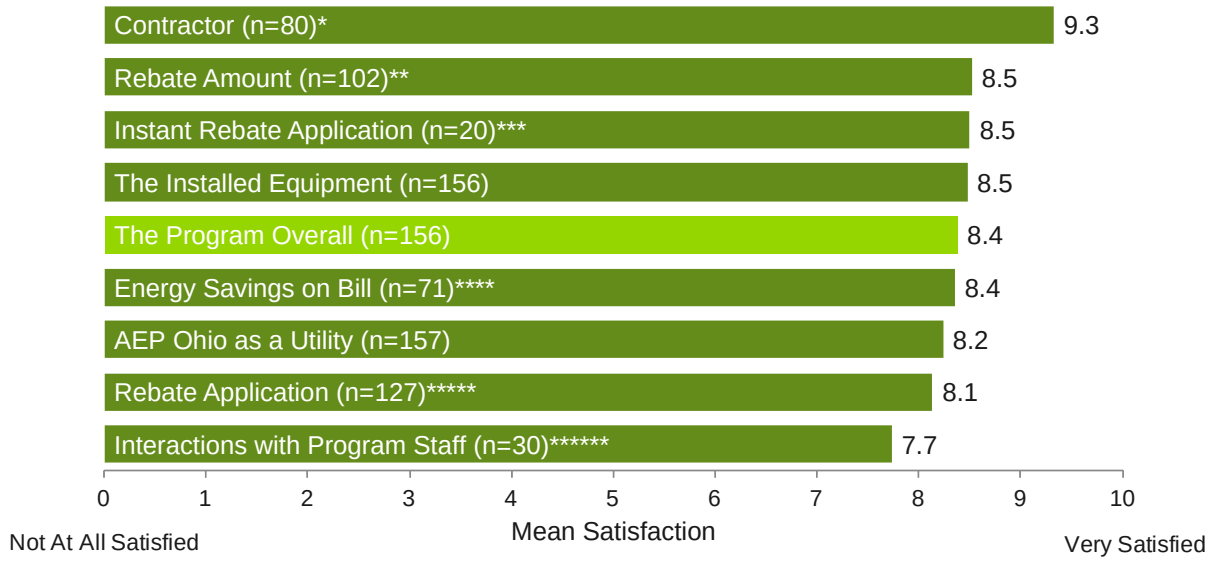
Amount	Percent of Total (n=141)
< $15,000	1%
$15,001 - $30,000	6%
$30,001 - $50,000	10%
$50,001 - $75,000	21%
$75,001 - $100,000	23%
> $100,000	38%

Note: Responses not required for demographic questions.

Appliance Rebate Survey: Satisfaction

Figure A-15 shows appliance rebate participants' satisfaction with the elements of the program. Respondents were highly satisfied with all aspects of the program, but were particularly satisfied with contractors (Mean = 9.3). Respondents on average gave the lowest rating to their interactions with program staff (Mean = 7.7), yet only 7 percent (2 respondents) were dissatisfied with their interactions with program staff (rated 4 or less on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied).

Figure A-15. Satisfaction with Appliance Rebate Elements



** Only asked of respondents who used a contractor to install their equipment.*
*** Only asked of respondents who recalled the amount of their rebate.*
**** Only asked of respondents who received an instant rebate.*
***** Only asked of respondents who noticed a reduction in energy usage on their bill.*
****** Only asked of respondents who received a standard rebate.*
******* Only asked of customers who contacted program staff during their participation in the program.*

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Respondents who were dissatisfied with the program (rated lower than 5) were asked a follow-up open-ended question to better understand why they were dissatisfied. Respondents primarily reported the following reasons for their dissatisfaction:

- Rebate application was too time-consuming (*n* = 10)
- Energy bill is too high (*n* = 5)
- Customer support was not courteous (*n* = 2)

Respondents were also given an opportunity to give feedback to AEP Ohio about the Appliance Rebate component. Respondents offered the following suggestions for the Appliance Rebate program:

- Process rebates more quickly given the online application process (*n* = 3)
- The program could offer a status report email to inform customers where their application is in the process (*n* = 2)

Appliance Rebate Survey: Installation of Appliances

The appliance rebate program contained three distribution channels for smart thermostats: the HVAC appliance rebate application, the standard appliance rebate application, and the single-family direct installation Columbia Gas of Ohio partnership. Most smart thermostat survey respondents (79%) received their rebate through the standard appliance rebate application. About 20 percent of survey respondents received their smart thermostat through the partnership program with Columbia Gas of Ohio. Only one smart thermostat survey respondent received their rebate through the HVAC appliance rebate application channel, as seen in Table A-36.

Table A-36. Smart Thermostat Survey Completes by Channel

Channel	Number of Survey Completes	Percent of Total Survey Completes
Standard Appliance Rebate Application	74	79%
Columbia Gas of Ohio	19	20%
HVAC Appliance Rebate Application	1	1%
Total	**94**	**100%**

All respondents recalled purchasing their appliance and all reported that AEP Ohio provides service at their home. Five smart thermostat respondents reported that the smart thermostat was not currently installed in their home, as described in Table A-37. Two respondents who received their smart thermostats from Columbia Gas of Ohio reported that their thermostats are not installed. One of these customers reported that the smart thermostat was “not installed [because they] could not make it work”. Two of these customers implied they would install the smart thermostat at some point in the future and another stated that they had not received the smart thermostat unit. This respondent ordered their unit from an online retailer in August.

Almost all central air conditioner respondents installed the central air conditioner at their home (98%). One respondent reported that the central air conditioning unit was installed at a family member’s home and that they did not know if the home received electric service from AEP Ohio. If the appliance rebate survey respondent was unsure about the equipment installation location’s electric service provider, the evaluation team assumed the location was serviced by AEP Ohio when calculating ISR. All ground

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source heat pumps and ductless mini-split respondents reported that their HVAC equipment was installed at their home.

Table A-37. Appliance Installed in Customer's Home

Equipment	Smart Thermostat (n=94)	Central Air Conditioner (n=52)	Air Source Heat Pump (n=10)	Ductless Mini-Splits (n=5)
Installed in Home	95%	98%	90%	100%
Installed at Other Location, Unknown Electric Service Provider	0%	2%	10%	0%
Not Installed	5%	0%	0%	0%

Customers most often reported that smart thermostats replaced programmable thermostats (59%, Table A-38). Very few customers indicated that new smart thermostats replaced another smart thermostat (2%) or replaced Wi-Fi programmable thermostats (1%).

Table A-38. Devices Smart Thermostats Replaced

Device Replaced	Percent of Respondents (n=88) [1]
Programmable Thermostat	59%
Manual Thermostat	38%
Smart Thermostat	2%
Wi-Fi Programmable Thermostat	1%

[1] One customer reported that the location did not have a thermostat to begin with and five customers reported that their smart thermostat was not installed.

Appliance Rebate Survey: Motivation for Appliance Purchase

Respondents purchasing smart thermostats most often reported reducing energy costs as a motivation for purchasing their equipment (79%), respondents purchasing central air conditioners and air source heat pumps less often reported energy costs as a motivation (48% and 50%, respectively).

Smart thermostat respondents also reported the rebate from AEP Ohio (66%) was a motivation to purchase their equipment significantly more often than central air conditioner or air source heat pump respondents, as seen in Figure A-16. Respondents purchasing central air conditioners and air source heat pumps most often reported making general improvements to their home as a motivation (56% and 70%, respectively).

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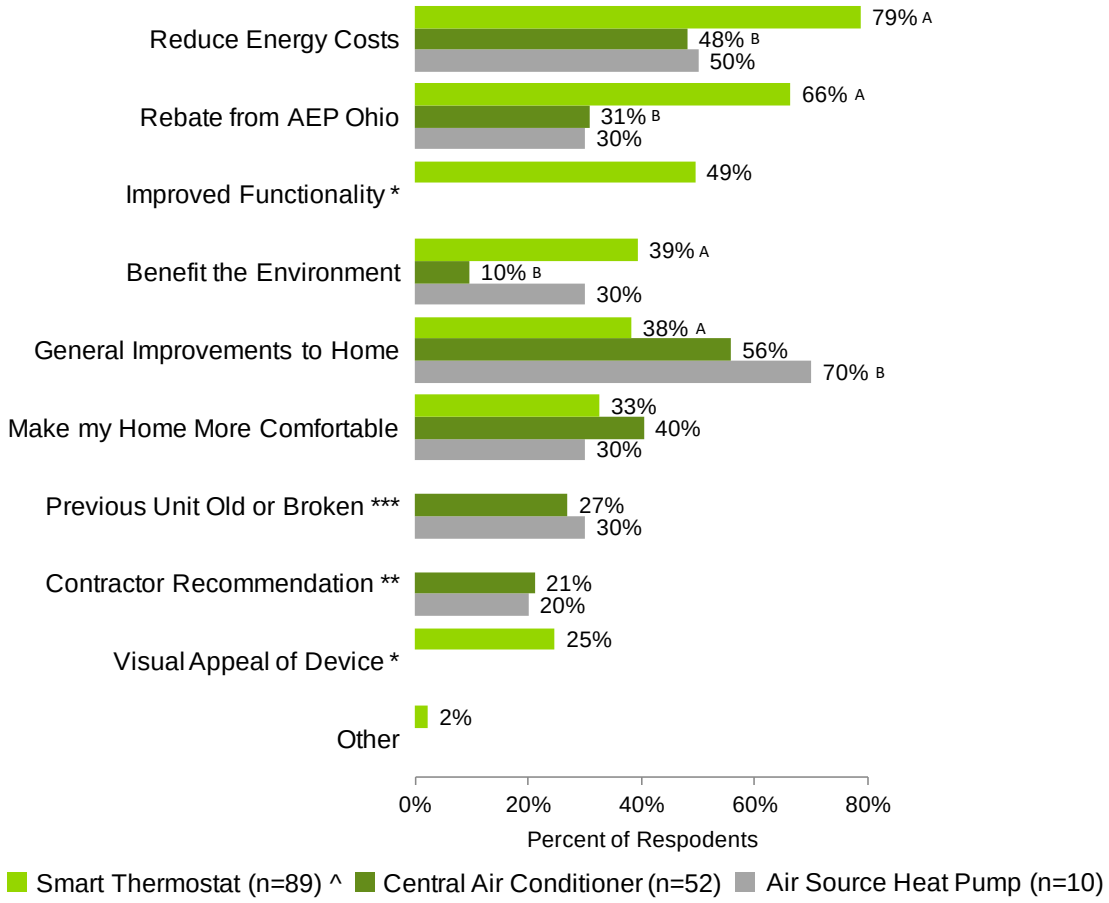
Figure A-16. Motivation to Purchase Equipment by Appliance Type



A - significant difference from central air conditioner respondents,
B - significant difference from smart thermostat respondents.
** - question only asked of smart thermostat respondents.*
*** - question only asked of central air conditioner and air source heat pump respondents.*
**** - category aggregated from open-end responses.*
^ - Five customers terminated the survey before completing this question.

Appliance Rebate Survey: Recall of Rebate

Based on the program tracking data, about 13 percent of survey respondents received an instant rebate through their contractor. Of those who received an instant rebate from their contractor, 95 percent recalled receiving a rebate. Of those who received a standard rebate, 89 percent recalled receiving a rebate, as seen in Table A-39. For both respondent groups, a portion of respondents misremembered their rebate type (10% of instant rebate respondents thought they had received a standard rebate and 19% of standard rebate respondents thought they had received an instant rebate through their contractor). The majority of respondents who accurately recalled receiving an instant rebate through their contractor were aware that the instant rebate was provided by AEP Ohio (83%).

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Table A-39. Recall of Rebate

	Received Instant Rebate through Contractor (n=21)	Received Standard Rebate in the Mail (n=141)
Recalled Receiving Rebate with Accurate Categorization	85%	71%
Recalled Receiving Rebate with Inaccurate Categorization	10%	18%
Total Recalled Receiving Rebate	**95%**	**89%**

Of the customers who accurately recalled receiving an instant rebate, 61 percent were unsure of the rebate amount and 22 percent inaccurately recalled the instant rebate amount (Table A-40). In contrast, of the customers who accurately recalled receiving a rebate in the mail, 70 percent accurately recalled the rebate amount.

Table A-40. Recall of Rebate Amount

	Accurately Recalled Receiving Instant Rebate (n=18)	Accurately Recalled Receiving Standard Rebate (n=99)*
Unsure of the Rebate Amount	61%	18%
Accurately Recalled Rebate Amount	22%	70%
Inaccurately Recalled Rebate Amount	17%	12%

** One respondent did not receive this question as they terminated before receiving the question.*

For respondents who accurately recalled receiving a standard rebate, most applied for their rebate through the online application (62%), followed by mailed applications (18%). About 12 percent of respondents were unsure which application method they used. Almost half of respondents who accurately recalled receiving a standard rebate received their rebate less than six weeks after they submitted their application (44%). One-quarter of these respondents were unsure how long it took to receive their rebate (26%). Only two respondents were dissatisfied with the length of time it took to receive their rebates (a rating of less than 5) and one respondent attributed their dissatisfaction to the contractor submitting late paperwork.

Appliance Rebate Survey: Contractors

Almost all respondents who purchased central air conditioners, air source heat pumps, ground source heat pumps, and ductless mini-splits reported using a contractor to install their equipment (98%). Of those respondents who purchased smart thermostats, only 18 percent reported using a contractor to install their equipment. Respondents most often found their contractor through a referral from a friend (22%) or the respondent already had a long-term relationship with a contractor previous to the installation of their equipment (22%), as seen in Table A-41.

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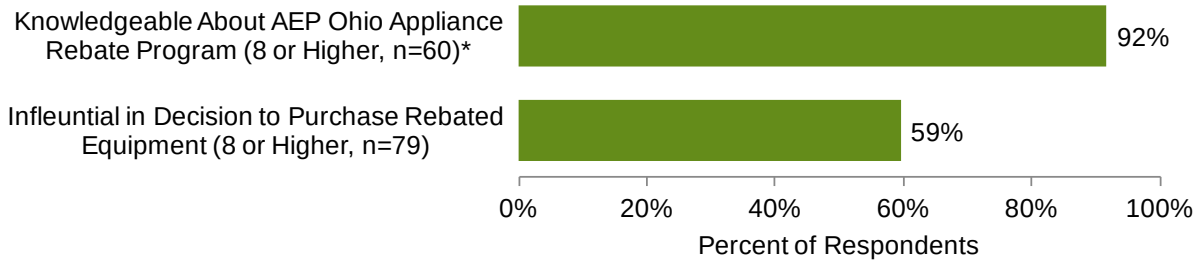
Table A-41. Contractor Source

Source	Percent of Respondents Using Contractor to Install Equipment (n=79)*
Long-term Relationship with Company	22%
Friend	22%
Internet Search	6%
AEP Ohio's Approved Contractor List	5%
Don't Know	5%
Personal Referral	4%
Retailer	4%
Angie's List	4%
Other	29%

** three respondents terminated the survey before answering this question.*

Three-quarters of respondents who used a contractor reported that the contractor mentioned either the AEP Ohio Appliance Rebate program or mentioned the rebate itself (75%). As seen in Figure A-17, respondents overwhelmingly reported that their contractor was knowledgeable (92% rated 8 or higher on a scale from 0 to 10, where 0 was not at all knowledgeable and 10 was very knowledgeable) and most respondents reported their contractor was influential in their decision to purchase the rebated equipment (59% rated 8 or higher on a scale from 0 to 10, where 0 was not at all influential and 10 was very influential).

Figure A-17. Contractor Knowledge and Influence



** Only asked of respondents who reported discussing the appliance rebate program or the appliance rebate itself with their contractor.*

Appliance Rebate Survey: Retail Stores

A little more than one quarter of smart thermostat respondents reported purchasing their device at a retail store (27%, or 25 respondents). Of those, only ten respondents saw AEP Ohio promotional materials or informational displays in the retail store and only four felt the in-store promotional materials were influential in their decision to purchase the rebated product (rated 8 or higher on a scale from 0 to 10). Only one respondent reported that they talked to a sales associate at the retail store about the rebate available through AEP Ohio and that respondent did not feel the associate was influential in their

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decision to purchase the rebated product (rated 5 on a scale from 0 to 10, where 0 was not at all influential and 10 was very influential).

Appliance Rebate Survey: Contact with AEP Ohio

The majority of survey respondents reported they did not contact AEP Ohio staff with questions during the course of their participation in the Appliance Rebate program (80%). For the few respondents who did contact AEP Ohio, most contacted AEP Ohio only once (12%). Most respondents contacted AEP Ohio program staff over the phone (70%) or by email (23%), as seen in Table A-42.

Table A-42. How Customer Contacted AEP Ohio

Method	Percent of Respondents Who Contacted AEP Ohio Staff (n=30)
Phone	70%
Email	23%
Through Website	13%
In Person	3%

Note: Totals may not sum to 100% due to rounding.

Appliance Rebate Survey: Reduced Energy Usage on Bill and Energy Efficiency Kits

Almost half of respondents (45%) noticed reduced energy usage on their electric bill since installing their rebated equipment. About 70 percent of those respondents were satisfied with the savings they noticed on their electric bill (rated 8 or higher on a scale from 0 to 10, where 0 was not at all satisfied and 10 was very satisfied), as highlighted in the body of the report and in Figure 3-7.

AEP Ohio also offered to mail appliance rebate participants a free energy efficiency kit. Rebate participants simply needed to check off a box indicating their interest on their appliance rebate application. Almost all the survey respondents who indicated they would like a free energy efficiency kit reported receiving their energy efficiency kit (23 out of 25). AEP Ohio invoiced the energy efficiency kit in October for the respondent who reported they did not receive a kit and for the respondent who did not recall receiving their kit.

The next section contains details regarding the locations of LED installation verified during the multi-family audits.

Multi-Family Direct Installation Audits: LED Installations by Room Type

Table A-43 shows the room types for which auditors verified installs of program bulbs, the total number of bulbs verified, the percentage of all bulbs verified, and the average number of bulbs verified per room type. Results show that bathrooms (28% of bulbs) and bedrooms (21% of bulbs) were the rooms containing the most program bulbs in audited apartments. Dining rooms (3.9), bathrooms (3.8), and basements (3.8) showed the highest number of average bulbs per room. The average number of bulbs per household was 16.1.

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Table A-43. Multi-Family Direct Installation Audit: Program Bulbs by Room Type

Room Type	Total Bulbs Verified	Percentage of Bulbs Verified	Average Bulbs Installed per Room
Bathroom	156	27.8%	3.8
Bedroom	120	21.4%	2.0
Kitchen	87	15.5%	2.3
Hallway	46	8.2%	2.3
Living Room	46	8.2%	2.0
Basement	34	6.0%	3.8
Dining	31	5.5%	3.9
Closet	19	3.4%	2.5
Other Room	25	4.1%	2.5
Total	**562**	**100%**	**2.6**

Note: Data entry errors in verified bulb counts were noted in the audit data: these errors were adjusted at the household-level (rather than the room-level).
Note: "Other Room" contains entries listed as: "Exterior", "Garage", "Laundry", and "Whole House".

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APPENDIX B. APPLIANCE REBATE PARTICIPANT SURVEY INSTRUMENT

Section A: Introduction

INTRO. We are conducting a study to evaluate AEP Ohio's Appliance Rebate Program and would like to include your opinions. This survey will take about 15 minutes.

A0. According to our records, you purchased **[SHOW IF COUNT=1:** a <MEASURE> in 2017.**]** **[SHOW IF COUNT>1:** more than one <MEASURE> in 2017. We would like to discuss your experience with just one of the <MEASURE>s you purchased that is associated with your address at <ADDRESS>.**]**

Do you remember purchasing this product?
1. Yes
2. No **[TERMINATE]**

A1. Does your home receive electric service from AEP Ohio?
1. Yes
2. No

Section B: Impact Evaluation

Smart Thermostat Battery

[ASK SMART THERMOSTAT BATTERY IF THERMOSTATFLAG = 1]

ST0. The next several questions concern the smart thermostat you purchased.

ST2. Is the smart thermostat installed **in your home**?
1. Yes
2. No

[ASK IF ST2=2]
ST2a. Where is the smart thermostat installed? [**RANDOMIZE, ANCHOR 0 LAST]**
1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF ST2=2]
ST2b. Does the location where the smart thermostat is installed receive electric service from AEP Ohio?
1. Yes
2. No
98. Unsure

ST3. Did the smart thermostat replace an existing thermostat?
1. Yes
2. No – This location did not have a thermostat to begin with
98. Unsure

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[ASK IF ST3 = 1]

ST4. What did the smart thermostat replace?

1. Manual thermostat **[ROLLOVER TEXT: A manual thermostat only allows for basic temperature adjustments and cannot be programmed to raise temperatures automatically during particular days or times.]**
2. A programmable thermostat **[ROLLOVER TEXT: A programmable thermostat is a thermostat which is designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day.]**
3. A Wi-Fi programmable thermostat featuring remote thermostat control through a cell phone application **[ROLLOVER TEXT: A Wi-Fi programmable thermostat is a thermostat which is designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day and also features remote thermostat control through either a smart phone application or computer.]**
4. A smart thermostat featuring either occupancy detection or optimized heating/cooling based on customer behavior patterns **and also** remote thermostat control through a phone application

98. Unsure

[ASK IF ST4 = 2,3,4]

ST5. Did you program your previous thermostat or did you make temperature adjustments manually? Programming usually involves setting a schedule so it automatically reduces cooling and heating when you are away – for example, during nights and weekends.

1. Programmed the thermostat
2. Made temperature adjustments manually
3. Did not adjust the thermostat

ST6. Are you using your smart thermostat to control heating, cooling, or both?

1. Heating
2. Cooling
3. Both heating and cooling
0. Other, please specify: **[OPEN END]**

ST7. What motivated you to purchase a smart thermostat? Please select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0,98 LAST]**

1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
5. Smart thermostats are better looking than other thermostats
6. Rebate from AEP Ohio
7. Improved functionality
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

Central Air Conditioner Battery

[ASK CENTRAL AIR CONDITIONER BATTERY IF CENTRALAIRFLAG = 1]

AC0. The next several questions concern the central air conditioner you purchased.

AC2. Is the central air conditioner that you purchased in 2017 installed **in your home**?

1. Yes
2. No

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[ASK IF AC2=2]

AC2a. Where is the central air conditioner installed? [**RANDOMIZE, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF AC2=2]

AC2b. Does the location where the air conditioner is installed receive electric service from AEP Ohio?

1. Yes
2. No
98. Unsure

AC3. Did the central air conditioner replace an existing central air conditioner?

1. Yes
2. No

AC4. What motivated you to purchase this central air conditioner? Please select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0,98 LAST]**

1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
5. Rebate from AEP Ohio
6. Contractor recommendation
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

Air Source Heat Pump Battery

[ASK AIR SOURCE HEAT PUMP BATTERY IF AIRSOURCEFLAG = 1]

AH0. The next several questions concern the air source heat pump you purchased.

AH2. Is the air source heat pump that you purchased in 2017 installed **in your home**?

1. Yes
2. No

[ASK IF AH2=2]

AH2a. Where is the air source heat pump installed? [**RANDOMIZE, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF AH2=2]

AH2b. Does the location where the air source heat pump is installed receive electric service from AEP Ohio?

1. Yes
2. No
98. Unsure

AH3. Did the air source heat pump replace an existing air source heat pump?

1. Yes
2. No
98. Unsure

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AH4. What motivated you to purchase an air source heat pump? Please select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0,98 LAST]**

1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
5. Rebate from AEP Ohio
6. Contractor recommendation
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

Ductless Mini-split Battery

[ASK DUCTLESS MINI-SPLIT BATTERY IF DUCTLESSFLAG = 1]

DS0. The next several questions concern the ductless mini-split system you purchased.

DS2. Is the ductless mini-split system that you purchased in 2017 installed **in your home**?

1. Yes
2. No

[ASK IF DS2=2]

DS2a. Where is the ductless mini-split system installed? [**RANDOMIZE, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF DS2=2]

DS2b. Does the location where the ductless mini-split system is installed receive electric service from AEP Ohio?

1. Yes
2. No
98. Unsure

DS3. Did the ductless mini-split system replace an existing ductless mini-split system?

1. Yes
2. No
98. Unsure

DS4. What motivated you to purchase a ductless mini-split system? Please select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0,98 LAST]**

1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
5. Rebate from AEP Ohio
6. Contractor recommendation
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

Ground Source Heat Pump Battery

[ASK GROUND SOURCE HEAT PUMP BATTERY IF GROUNDSOURCEFLAG = 1]

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GH0. The next several questions concern the ground source heat pump you purchased.

GH2. Is the ground source heat pump that you purchased in 2017 installed **in your home**?
1. Yes
2. No

[ASK IF GH2=2]
GH2a. Where is the ground source heat pump installed?
1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF GH2=2]
GH2b. Does the location where the ground source heat pump is installed receive electric service from AEP Ohio?
1. Yes
2. No
98. Unsure

GH3. Did the ground source heat pump replace an existing ground source heat pump?
1. Yes
2. No
98. Unsure

GH4. What motivated you to purchase a ground source heat pump? Please select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0 LAST]**
1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
5. Rebate from AEP Ohio
6. Contractor recommendation
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

Section R: Experience with Rebate

R0. Did you use a contractor to install the <MEASURE>?
1. Yes
2. No

[ASK IF CONTRACTORFLAG=1 OR R0=1]
R1a. Do you recall receiving an instant rebate from your contractor on the <MEASURE> you purchased?
1. Yes
2. No

[ASK IF R1a=1]
R1b. Were you aware that the instant rebate you received on your <MEASURE> was provided by AEP Ohio?
1. Yes
2. No

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[ASK IF R1a=1]
R1c. How much was the instant rebate that you received from your contractor for the <MEASURE>?
1. $50
2. $75
3. $100
4. $150
5. $300
6. $500
7. $1,200
0. Other, please specify: **[NUMERIC OPEN END]**
98. Unsure

[ASK IF R1a=1]
R1d. How satisfied were you with the instant rebate application process? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF R1d<5]
R1e. Why did you rate it that way?
1. **[OPEN END]**
98. Unsure

[ASK IF CONTRACTORFLAG=0 OR R1a=2]
R3. Do you recall receiving a rebate in the mail from AEP Ohio for the <MEASURE>?
1. Yes
2. No

[ASK IF CONTRACTORFLAG=0 OR R1a=2]
R3b. How did you apply for your rebate for the <MEASURE>? **[RANDOMIZE, ANCHOR 0 LAST]**
1. Online
2. By mail
3. Over the phone
0. Other, please specify: **[OPEN END]**
98. Unsure

[ASK IF R3=2]
R4. Can you think of a reason why you haven't received a rebate for the <MEASURE> that you purchased in 2017? If so, please explain:
0. **[OPEN END]**

[ASK IF R3=1, ELSE SKIP TO R8]
R5. Once the rebate application was submitted for the <MEASURE>, about how many weeks did it take for you to receive your rebate?
1. Less than 6 weeks
2. 6 weeks
3. 7 weeks
4. 8 weeks
5. Longer than 8 weeks
98. Unsure

[ASK IF R3=1, ELSE SKIP TO R8]
R6. How satisfied were you with how long it took to receive your rebate for the <MEASURE>? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF R6<5]
R6b. What would have been an appropriate turn-around time for the <MEASURE> rebate?

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1. Less than 4 weeks
2. 5 weeks
3. **[SHOW IF R5 > 1]** 6 weeks
4. **[SHOW IF R5 > 2]** 7 weeks
5. **[SHOW IF R5 > 3]** 8 weeks
0. Other, please specify: **[OPEN-END]**
98. Unsure

[ASK IF R3=1, ELSE SKIP TO R8]

R7. How much was the rebate that you received from AEP Ohio for the <MEASURE>?

1. $50
2. $75
3. $100
4. $150
5. $300
6. $500
7. $1,200
0. Other, please specify: **[NUMERIC OPEN END]**
98. Unsure

[ASK IF (R1a = 1 and R1c ≠ 98) OR (R3 = 1 and R7 ≠ 98)]

R8. How satisfied are you with the rebate amount you received from the AEP Ohio Appliance Rebate program for the product you purchased? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF R3b = 1, 2, 3 or 0]

R9. How satisfied were you with the rebate application process? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF R9<5]

R10. Why did you rate it that way?

1. **[OPEN END]**
98. Unsure

Section C: Contractor

[ASK IF R0=1, ELSE SKIP TO NEXT SECTION]

CO. The next few questions ask about your experiences with your contractor and the AEP Ohio Appliance Rebate program.

C1. How satisfied were you with your contractor? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF C1<5]

C2. Why did you rate it that way?

1. **[OPEN END]**
98. Unsure

C2a. Through what source did you find your contractor for the installation? [**RANDOMIZE, ANCHOR 0,98 LAST]**

1. A friend
2. A retailer
3. AEP Ohio's approved contractor list
4. Angie's List
0. Other, please specify: **[OPEN END]**

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98. Unsure

C3. Did your contractor mention the AEP Ohio Appliance Rebate program or the rebate itself?
1. Yes
2. No
98. Unsure

[ASK IF C3=1]

C4. How knowledgeable was the contractor about the AEP Ohio Appliance Rebate program /rebate? **[SCALE RESPONSE, WHERE 0 = "Not at all knowledgeable" AND 10 = "Very knowledgeable"]**

C5. How influential was the contractor in your decision to purchase the <MEASURE>? **[SCALE RESPONSE, WHERE 0 = "Not at all influential" AND 10 = "Very influential"]**

Section D: Process Evaluation

D0. The next several questions concern your experiences with AEP Ohio's Appliance Rebate program.

D1a. How did you first learn about the Appliance Rebate program? **[RANDOMIZE, ANCHOR 0,98 LAST, SINGLE RESPONSE ONLY]**
1. Utility bill insert
2. TV ad
3. Friend/relative/neighbor
4. AEP Ohio website
5. Newspaper
6. Community event
7. AEP Ohio email
8. Appliance retailer
9. Social media
10. Web advertisement/search
11. Other AEP Ohio program
12. Radio ad
13. Contractor
0. Other, please specify: **[OPEN-END]**
98. Unsure

[ASK IF D1a = 11]

D1b. Through which AEP Ohio program did you learn about the Appliance Rebate program? **[RANDOMIZE, ANCHOR 13,0,98 LAST, SINGLE RESPONSE ONLY]**
1. Efficient lighting discounts **[ROLLOVER TEXT: You can get instant, in-store discounts when you buy ENERGY STAR certified LEDs at participating retailers or through our online store.]**
3. Appliance recycling **[AEP Ohio picks up and recycles your old working secondary refrigerator or freezer and provides a financial incentive.]**
4. Community Energy Savers **[ROLLOVER TEXT: The Community Energy Savers Program creates partnerships between communities and AEP Ohio that bring the benefits of energy efficiency to residents, businesses and the community itself by encouraging participation in AEP Ohio energy saving programs. Partner communities are eligible for incentives as AEP Ohio and the community work together to expand energy efficiency programs to homes and businesses that qualify.]**
5. Multifamily program **[ROLLOVER TEXT: AEP Ohio offers free, energy saving products to multifamily buildings with individually-metered residential properties with five or more units. AEP Ohio handles the installation at no cost to the property manager or resident.]**

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6. Community Assistance program **[ROLLOVER TEXT: Customers enrolled in an AEP Ohio payment assistance plan can receive free energy efficiency and repair services for their home.]**
7. EfficiencyCrafted New Homes **[ROLLOVER TEXT: If you are interested in building a new home, a participating builder works with you to build an ENERGY STAR® New Home, which can help you reduce your energy usage by as much as 35%.]**
10. e3smart education programs for kids **[ROLLOVER TEXT: For this program, AEP Ohio provides energy efficiency education curriculum to schools in the AEP Ohio service area for children in grades 5 through 12. The e3smart curriculum as developed by the Ohio Energy Project meets Ohio and National Science Standards and was recognized as an Outstanding Energy Education Project by the Ohio EPA in 2008.]**
11. Agriculture program **[ROLLOVER TEXT: AEP Ohio offers qualifying agriculture customers incentives on energy consuming equipment including lighting, ventilation, motors, fans, and equipment unique to the agricultural industry.]**
12. Home Energy Report **[ROLLOVER TEXT: AEP Ohio offers provides select electric customers a report comparing electricity use with similar homes and the customers own energy use to the same period in previous years. The report also provides simple actions the participant can take to reduce electricity usage and estimates savings the customer may see on the electricity bill if a specific action is taken.]**
13. Commercial business programs, please specify: **[OPEN END]**
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

D1c. Through which other sources have you heard about AEP Ohio's Appliance Rebate program? Please select all that apply. **[DO NOT SHOW ANSWER SELECTED IN D1A AS RESPONSE OPTION, MULTIPLE RESPONSES ALLOWED, RANDOMIZE, ANCHOR 0,97 LAST]**

1. Utility bill insert
2. TV ad
3. Friend/relative/neighbor
4. AEP Ohio website
5. Newspaper
6. Community event
7. AEP Ohio email
8. Appliance retailer
9. Social media
10. Web advertisement/search
11. Other AEP Ohio program
12. Radio ad
13. Contractor
0. Other, please specify: **[OPEN-END]**
97. None **[EXCLUSIVE]**

[ASK IF D1c = 11]

D1d. Through which AEP Ohio program did you learn about the Appliance Rebate program? Please select all that apply. **[MULTIPLE RESPONSES ALLOWED, RANDOMIZE, ANCHOR 13,0,98 LAST, SINGLE RESPONSE ONLY]**

1. Efficient lighting discounts **[ROLLOVER TEXT: You can get instant, in-store discounts when you buy ENERGY STAR certified LEDs at participating retailers or through our online store.]**
3. Appliance recycling **[AEP Ohio picks up and recycles your old working secondary refrigerator or freezer and provides a financial incentive.]**
4. Community Energy Savers **[ROLLOVER TEXT: The Community Energy Savers Program creates partnerships between communities and AEP Ohio that bring the benefits of energy efficiency to residents, businesses and the community itself by encouraging participation in AEP Ohio energy saving programs. Partner communities are eligible for incentives as AEP Ohio and the**

community work together to expand energy efficiency programs to homes and businesses that qualify.]

5. Multifamily program **[ROLLOVER TEXT: AEP Ohio offers free, energy saving products to multifamily buildings with individually-metered residential properties with five or more units. AEP Ohio handles the installation at no cost to the property manager or resident.]**
6. Community Assistance program **[ROLLOVER TEXT: Customers enrolled in an AEP Ohio payment assistance plan can receive free energy efficiency and repair services for their home.]**
7. EfficiencyCrafted New Homes **[ROLLOVER TEXT: If you are interested in building a new home, a participating builder works with you to build an ENERGY STAR® New Home, which can help you reduce your energy usage by as much as 35%.]**
10. e3smart education programs for kids **[ROLLOVER TEXT: For this program, AEP Ohio provides energy efficiency education curriculum to schools in the AEP Ohio service area for children in grades 5 through 12. The e3smart curriculum as developed by the Ohio Energy Project meets Ohio and National Science Standards and was recognized as an Outstanding Energy Education Project by the Ohio EPA in 2008.]**
11. Agriculture program **[ROLLOVER TEXT: AEP Ohio offers qualifying agriculture customers incentives on energy consuming equipment including lighting, ventilation, motors, fans, and equipment unique to the agricultural industry.]**
12. Home Energy Report **[ROLLOVER TEXT: AEP Ohio offers provides select electric customers a report comparing electricity use with similar homes and the customers own energy use to the same period in previous years. The report also provides simple actions the participant can take to reduce electricity usage and estimates savings the customer may see on the electricity bill if a specific action is taken.]**
13. Commercial business programs, please specify: **[OPEN END]**
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[ASK IF CONTRACTORFLAG=0, ELSE SKIP TO D6]

D1e. Did you purchase your rebated equipment through a physical retail store? This **does not** include an online store such as Amazon.com.

1. Yes
2. No

[ASK IF D1e=1, ELSE SKIP TO D6]

D2. Do you remember seeing any AEP Ohio energy efficiency promotional materials or informational displays in the retail store that mentioned the rebate for your rebated product?

1. Yes
2. No
98. Unsure

[ASK IF D2=1]

D3. How influential were the in-store promotional materials in your decision to purchase your rebated product? **[SCALE RESPONSE, WHERE 0 = "Not at all influential" AND 10 = "Very influential"]**

[ASK IF CONTRACTORFLAG=0, ELSE SKIP TO D6]

D4. Did a sales associate at the retail store ever talk to you about the rebate available for your product though the AEP Ohio Appliance Rebate program?

1. Yes
2. No
98. Unsure

[ASK IF CONTRACTORFLAG=0 AND D4=1, ELSE SKIP TO D6]

D5. How influential was the sales associate in your decision to purchase your rebated product? **[SCALE RESPONSE, WHERE 0 = "Not at all influential" AND 10 = "Very influential"]**

D6. In the course of participating in the AEP Ohio Appliance Rebate program, how often did you contact AEP Ohio or program staff with questions?

1. Never
2. Once
3. 2 or 3 times
4. 4 times or more

[ASK IF D6=2,3,4]

D7. How did you contact AEP Ohio? Select all that apply. **[ALLOW MULTIPLE RESPONSE, RANDOMIZE]**

1. Phone
2. Email
3. Letter
4. In person
5. Through website
6. Fax

[ASK IF D6=2,3,4]

D8. How satisfied are you with your communication with AEP Ohio and program staff? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF D8<5]

D9. Why were you dissatisfied with your communication with AEP Ohio and program staff?

97. **[OPEN END]**
98. Unsure

D10. Have you noticed reduced energy usage on your electric bill since installing the program-rebated product?

1. Yes
2. No
98. Unsure

[ASK IF D10=1]

D11. How satisfied are you with any savings you noticed on your electric bill since installing the program-rebated product? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

D12. How satisfied are you with the program-rebated product? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

[ASK IF D12<5]

D13. Why were you dissatisfied with the program-rebated product?

1. **[OPEN END]**
98. Unsure

D14. How satisfied are you with the AEP Ohio Appliance Rebate Program overall? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

D15. Why do you give it that rating?

1. **[OPEN END]**
98. Unsure

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D16. How satisfied are you with the AEP Ohio as your electric service provider? **[SCALE RESPONSE, WHERE 0 = "Not at all satisfied" AND 10 = "Very satisfied"]**

D17. Why do you give it that rating?
1. **[OPEN END]**
98. Unsure

D18. What suggestions, if any, do you have to improve the program?
1. **[OPEN END]**
2. No suggestions
98. Unsure

[ASK IF KIT=1]

D19. Our records indicate that you were mailed a free Energy Efficiency Kit. You requested this kit by checking a box on your appliance rebate application form. This kit included LED bulbs and may have included a showerhead or faucet aerators. Did you receive your free Energy Efficiency Kit?
1. Yes
2. No
98. Unsure

Section E: Demographics

E0. We're just about done. We have a couple more questions about your household.

E1. Which of the following best describes your home/residence? **[ALLOW SKIP, RANDOMIZE, ANCHOR 0 LAST]**
1. Single-family home, detached construction (not A duplex, townhome, or apartment; attached garage is ok]
2. Factory manufactured/modular home (single-family)
3. Mobile home (single-family)
4. Row house
5. Two or three family attached residence
6. Apartment building (4 + families)
7. Condominium
0. Other, please specify: **[OPEN END]**

E2. Do you own or rent this residence? **[ALLOW SKIP]**
1. Own
2. Rent

[ASK IF E2=2]

E2a. Do you pay your own electric bill or is it included in your rent? **[ALLOW SKIP]**
1. Pay bill
2. Included in rent

E3. Approximately when was your home constructed? **[ALLOW SKIP]**
1. Before 1960
2. 1960-1969
3. 1970-1979
4. 1980-1989
5. 1990-1999
6. 2000-2005
7. 2006 or later

E4. Approximately how many total square feet is your residence? **[ALLOW SKIP]**
1. Less than 1,000 square feet
2. Between 1,001 and 2,000 square feet

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3. Between 2,001 and 3,000 square feet
4. Between 3,001 and 4,000 square feet
5. Between 4,001 and 5,000 square feet
6. Greater than 5,000 square feet
0. Other, please specify: **[OPEN-END]**
98. Unsure

E5. Would you estimate the above-ground living space is about: **[ALLOW SKIP]**
1. Less than 1,000 square feet
2. Between 1,001 and 2,000 square feet
3. Between 2,001 and 3,000 square feet
4. Between 3,001 and 4,000 square feet
5. Between 4,001 and 5,000 square feet
6. Greater than 5,000 square feet
0. Other, please specify: **[OPEN-END]**
98. Unsure

E6. What kind of heating fuel do you use for your home? Please select all that apply. **[ALLOW SKIP, ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0 LAST]**
1. Natural Gas
2. Electric
3. Fuel Oil
4. Propane
5. Geothermal
6. Wood
7. Kerosene
0. Other, please specify: **[OPEN END]**

[ASK IF E6=2]
E6a. What kind of electric heat equipment do you use for your home? Please select all that apply. **[ALLOW SKIP, ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0 LAST]**
1. A central forced air furnace
2. An air source heat pump
3. Baseboard or resistance heat
4. A ground source heat pump
0. Other, please specify: **[OPEN END]**

E7. What kind of electric cooling equipment do you use for your home? Please select all that apply. **[ALLOW SKIP, ALLOW MULTIPLE RESPONSE, RANDOMIZE, ANCHOR 0 LAST]**
1. A central forced AC
2. An air source heat pump
3. Window AC units
4. Electric fans
5. No electric cooling
6. A ground source heat pump
0. Other, please specify: **[OPEN END]**

E8. What is your yearly household income? **[ALLOW SKIP]**
1. Less than $15,000
2. Between $15,001 and $30,000
3. Between $30,001 and $50,000
4. Between $50,001 and $75,000
5. Between $75,001 and $100,000
6. Greater than $100,000

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Those are all the questions we have. On behalf of AEP Ohio, like to thank you very much for taking the time to participate in this study!

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APPENDIX C. EFFICIENT PRODUCTS ENERGY EFFICIENCY KITS SURVEY

Section A: Introduction

Thank you for taking the time to complete this survey! Your responses will help AEP Ohio better serve their customers. Click the button below to begin the survey.

[ASK IF PORTAL = 1]

S1. Our records indicate you completed an online Home Energy Profile on AEP Ohio's website at some point in 2017. This interactive tool helps evaluate how you use energy in your home and pinpoints changes you can make to save money. At the end of the profile, the tool calculates your energy efficiency score and displays an energy efficiency meter similar to the one pictured below. Do you recall completing the Home Energy Profile?

1. Yes
2. No
98. Unsure

[ASK ALL PARTICIPANTS]

S2. **[SHOW IF PORTAL=0:** On your Appliance Rebate application(s), you indicated you would like to receive a free Energy Efficiency Kit.**]** Our records indicate that AEP Ohio mailed your household **<KITCOUNT>** Energy Kit(s), which may include any of the following measures: LED light bulbs, low-flow showerhead(s), faucet aerators, or LED nightlights. Do you remember receiving the Energy Efficiency Kit(s)?

1. Yes
2. No
98. Unsure

[TERMINATE IF (S1 = 2 OR S1 = 98) AND (S2 = 2 OR S2 =98)]
[TERMINATE IF PORTAL=0 AND (S2 = 2 OR S2 =98)]

Home Energy Profile Information Retention and Satisfaction

[ASK IF S1=1, ELSE SKIP TO MV1]

OS1. How would you rate your knowledge of energy efficiency **before** you participated in the Home Energy Profile? **[Scaled response where 0 is Not at all knowledgeable and 10 is Extremely knowledgeable]**

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OS2. How much did you learn about energy efficiency from the Home Energy Profile? Would you say you learned...? Please select one:
1. Nothing **[SKIP TO OS3]**
2. Very Little **[SKIP TO OS3]**
3. Some
4. A lot

OS2a. Do you remember anything specific that you found helpful? If so, what did you find helpful? **[OPEN ENDED]**

OS3. Did the Home Energy Profile influence you to purchase any additional energy-saving equipment?
1. Yes
2. No
98. Unsure

[ASK IF OS3 = 1]
OS3A. What energy-saving equipment did you purchase? **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 LAST]**
1. LED light bulbs
2. Air sealing products for your windows or doors
3. Insulation for your walls or attic
4. An energy-efficient air conditioner or heat pump
5. An energy-efficient furnace
6. An energy-efficient water heater
7. An energy-efficient refrigerator
8. An energy-efficient freezer
9. A programmable thermostat **[ROLLOVER TEXT**: **A programmable thermostat is a thermostat which is designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day.]**
10. A Wi-Fi programmable thermostat featuring remote thermostat control through a cell phone application **[ROLLOVER TEXT**: **A Wi-Fi programmable thermostat is a thermostat which is designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day and also features remote thermostat control through internet-connected devices such as a smart phone or computer.]**
11. A smart thermostat, featuring either occupancy detection or optimized heating/cooling based on customer behavior patterns **and also** remote thermostat control through a phone application
0. Other, please specify: **[OPEN END]**

[ASK IF OS3 = 2]
OS3B. Which of the following describes the main reason you decided not to purchase any of the Online Energy Profile's recommended equipment? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Haven't got around to it yet
2. The recommendations were not helpful
3. The cost of improvements was too high
4. The improvements wouldn't have saved enough energy
5. Needed other equipment or improvements more
6. Couldn't find a contractor to do the job
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

OS4. How satisfied were you with the Home Energy Profile overall? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

[ASK IF OS4 < 5]
OS5. Why did you rate it that way? **[OPEN END]**

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OS5A. We would like to focus on the report you received after the Home Energy Profile, which included your energy efficiency score and displayed an energy efficiency meter. This report contained recommendations for ways to reduce your energy consumption and your utility bill. Would you say that you...?
1. Read the report thoroughly
2. Read some portions of the report
3. Just glanced through it, or
4. Did not read the report at all
98. Unsure

[ASK IF OS5A<4]
OS5B. Please rate the usefulness of the recommendations contained in the report. **[0 to 10 SCALE: 0 = Not at all useful, 10 = Extremely useful]**

OS6. Please indicate how much you agree or disagree with the following statements. **[RANDOMIZE ORDER, 0 to 10 SCALE: 0 = Strongly Disagree, 10 = Strongly Agree]**
A. The information provided in the Home Energy Profile was easy to understand.
B. The Home Energy Profile helped me learn about other sources of energy efficiency information.
C. I learned something new from the Home Energy Profile.
D. The Home Energy Profile provided information that I needed in order to take action to save energy and money in my home.
E. The Home Energy Profile gave me a better understanding of where I can save energy and money in my home.
F. The time needed to complete the Home Energy Profile was reasonable.
G. The Home Energy Profile was easy to complete.
H. The Home Energy Profile helped me learn about AEP Ohio energy efficiency programs.

Measure Verification

[ASK SECTION IF S2 = 1; ELSE SKIP TO P1]

MV1. Does your home receive electric service from AEP Ohio?
1. Yes
2. No

MV2. Does your home have a gas water heater or an electric water heater?
1. Gas
2. Electric
98. Unsure

LED BATTERY

[ASK LED BATTERY IF BULBCOUNT > 0; ELSE SKIP TO NEXT BATTERY]

LED1. Each Energy Efficiency Kit included four LED light bulbs. Did you install **all <BULBCOUNT>** LED light bulbs you received?
1. Yes
2. No

[ASK IF LED1 = 2]
LED2. How many of the **<BULBCOUNT>** LED light bulbs did you install? **[NUMERIC, 0-8]**

[CALCULATE INSTALLEDBULB = LED2 IF LED1 = 2]
[CALCULATE INSTALLEDBULB = BULBCOUNT IF LED1 = 1]

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[ASK IF LED1 = 2 AND BULBCOUNT <> INSTALLEDBULB]

LED3. Why didn't you install **all <BULBCOUNT>** LED light bulbs from the Energy Efficiency Kit? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 1 & 2 FIRST, ANCHOR 0 & 98 LAST]**

1. Already have LED light bulbs installed
2. Already have CFL light bulbs installed
3. Do not like the light quality of the LED light bulbs
4. The LED light bulb was broken
5. The LED light bulbs did not work
6. Haven't gotten around to it yet
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[CALCULATE REMAININGBULB = BULBCOUNT - INSTALLEDBULB]

[ASK IF LED1 = 2 AND BULBCOUNT <> INSTALLEDBULB AND REMAININGBULB = 1]

LED4. What did you do with the LED light bulb that you did not install? **[RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Gave it to a friend
2. Put it in storage
3. Threw it away
0. Other, please specify: **[OPEN END]**
98. Unsure

[ASK IF LED1 = 2 AND BULBCOUNT <> INSTALLEDBULB AND REMAININGBULB > 1]

LED5. What did you do with the LED light bulbs that you did not install? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Gave them to a friend
2. Saved them for later
3. Threw them away
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[ASK IF INSTALLEDBULB > 0]

LED6. Are **all <INSTALLEDBULB>** LED light bulb(s) **still installed**?**]**

1. Yes
2. No

[ASK IF LED6=2 AND INSTALLEDBULB > 1]

LED7. How many of the **<INSTALLEDBULB>** LED light bulbs that you originally installed are **still installed**? **[NUMERIC, 0-12; 98=Unsure]**

[ASK IF INSTALLEDBULB > 0]

LED8. Of the **<INSTALLEDBULB>** LED light bulb(s) you originally installed, did you install those LED light bulb(s) **in your home or somewhere else**?**]**

1. Installed in my home
2. **[SHOW IF INSTALLEDBULB > 1:** Installed some in my home and some elsewhere
3. Installed elsewhere

[ASK IF LED8 = 3 AND INSTALLEDBULB = 1]

LED10. Where else did you install your LED light bulb?

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

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[ASK IF (LED8 = 2 OR LED8 = 3) AND INSTALLEDBULB > 1]

LED11. Where else did you install your LED light bulb(s)? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF LED8 = 3 AND INSTALLEDBULB = 1]

LED12. Does AEP Ohio provide electricity to the location where you installed your LED light bulb?

1. Yes
2. No
98. Unsure

[ASK IF (LED8 = 2 OR LED8 = 3) AND INSTALLEDBULB > 1]

LED13. Does AEP Ohio provide electricity to all, some or none of the other locations where you installed your LED light bulb?

1. All
2. Some
3. None
98. Unsure

LED14. How satisfied were you with the LED light bulbs? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

SHOWERHEAD BATTERY

[ASK SHOWERHEAD BATTERY IF SHOWERHEADCOUNT > 0; ELSE SKIP TO NEXT BATTERY]

SH1. Did you install the showerhead you received in the Energy Efficiency Kit(s)?

1. Yes
2. No

[ASK IF SH1 = 2 AND SHOWERHEADCOUNT > 1]

SH2. How many of the **<SHOWERHEADCOUNT>** showerheads did you install? **[NUMERIC OPEN-END, 0-4]**

[CALCULATE INSTALLEDSHOWERHEAD = SH2 IF SH1 = 2 AND SHOWERHEADCOUNT > 1]
[CALCULATE INSTALLEDSHOWERHEAD = 1 IF SH1 = 1 AND SHOWERHEADCOUNT = 1]
[CALCULATE INSTALLEDSHOWERHEAD = 0 IF SH1 = 2 AND SHOWERHEADCOUNT = 1]
[CALCULATE INSTALLEDSHOWERHEAD = SHOWERHEADCOUNT IF SH1 = 1 AND SHOWERHEADCOUNT > 1]

[ASK IF SH1=2 AND SHOWERHEADCOUNT <> INSTALLEDSHOWERHEAD]

SH3. Why didn't you install the showerhead(s)? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Already have an efficient showerhead installed
2. I like my current showerhead
3. Too difficult to install
4. Worried about the possible reduced pressure of the showerhead
5. Haven't gotten around to it yet
6. Didn't like the appearance
7. Don't know how to install the showerhead
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[CALCULATE REMAININGSHOWERHEAD = SHOWERHEADCOUNT - INSTALLEDSHOWERHEAD]

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[ASK IF SH1=2 AND SHOWERHEADCOUNT <> INSTALLEDSHOWERHEAD AND REMAININGSHOWERHEAD = 1]

SH4. What did you do with the showerhead that you did not install? **[RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Gave it to a friend
2. Saved it for later
3. Threw it away
0. Other, please specify: **[OPEN END]**
98. Unsure

[ASK IF SH1=2 AND SHOWERHEADCOUNT <> INSTALLEDSHOWERHEAD AND REMAININGSHOWERHEAD > 1]

SH5. What did you do with the showerhead(s) that you did not install? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Gave them to a friend
2. Put them in storage
3. Threw them away
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[ASK IF INSTALLEDSHOWERHEAD > 0]

SH6. Are the showerhead(s) that you originally installed **still installed?]**

1. Yes
2. No

[ASK IF SH6=2 AND INSTALLEDSHOWERHEAD > 1]

SH7. How many of the **<INSTALLEDSHOWERHEAD>** showerheads that you originally installed **are still installed**? **[NUMERIC, 0-4; 98=Unsure]**

[ASK IF INSTALLEDSHOWERHEAD > 0]

SH8. Did you originally install the showerhead(s) **in your home or somewhere else**?**]**

1. Installed in my home
2. **[SHOW IF INSTALLEDSHOWERHEAD > 1:** Installed some in my home and some elsewhere
3. Installed elsewhere

[ASK IF SH8 = 3 AND INSTALLEDSHOWERHEAD = 1]

SH10. Where else did you install your showerhead?

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF (SH8 = 2 OR SH8 = 3) AND INSTALLEDSHOWERHEAD > 1]

SH11. Where else did you install your showerheads? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF SH8 = 3 AND INSTALLEDSHOWERHEAD = 1]

SH12. Does AEP Ohio provide electricity to the other location where you installed your showerhead?

1. Yes
2. No
98. Unsure

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[ASK IF (SH8 = 2 OR SH8 = 3) AND INSTALLEDSHOWERHEAD > 1]

SH13. Does AEP Ohio provide electricity to all, some or none of the other locations where you installed your showerhead?
1. All
2. Some
3. None
98. Unsure

SH14. How satisfied were you with the showerhead(s)? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

FAUCET AERATORS BATTERY

[ASK FAUCET AERATOR BATTERY IF FAUCETAERATORCOUNT > 0; ELSE SKIP TO NEXT BATTERY]

FA1. Each Energy Efficiency Kit included two faucet aerators. Did you install **all <FAUCETAERATORCOUNT>** faucet aerators? **[ROLLOVER TEXT: Faucet aerators are installed on the spout of the faucet and conserve water by reducing the flow rate.]**
1. Yes
2. No

[ASK IF FA1 = 2]

FA2. How many of the **<FAUCETAERATORCOUNT>** faucet aerators did you install? [**NUMERIC, 0-2]**

[CALCULATE INSTALLEDFAUCETAERATOR = FA2 IF FA1 = 2]
[CALCULATE INSTALLEDFAUCETAERATOR = FAUCETAERATORCOUNT IF FA1 = 1]

[ASK IF FA1 = 2 AND FAUCETAERATORCOUNT <> INSTALLEDFAUCETAERATOR]

FA3. Why didn't you install **all <FAUCETAERATORCOUNT>** faucet aerators? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Already have faucet aerators installed
2. Do not like the pressure of the faucet aerator
3. The faucet aerator(s) were broken
4. The faucet aerator(s) did not work
5. Haven't gotten around to it yet
6. Too difficult to install
7. Did not like the appearance
8. Aerator did not fit my faucet
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[CALCULATE REMAININGFAUCETAERATOR = FAUCETAERATORCOUNT - INSTALLEDFAUCETAERATOR]

[ASK IF FA1 = 2 AND FAUCETAERATORCOUNT <> INSTALLEDFAUCETAERATOR AND REMAININGFAUCETAERATOR = 1]

FA4. What did you do with the faucet aerator that you did not install? **[RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Gave it to a friend
2. Saved it for later
3. Threw it away
0. Other, please specify: **[OPEN END]**
98. Unsure

[ASK IF FA1 = 2 AND FAUCETAERATORCOUNT <> INSTALLEDFAUCETAERATOR AND REMAININGFAUCETAERATOR > 1]

FA5. What did you do with the faucet aerators that you did not install? Please select all that apply. **[ALLOW MULTIPLE**

RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]
1. Gave them to a friend
2. Put them in storage
3. Threw them away
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[ASK IF INSTALLEDFAUCETAERATOR > 0]
FA6. Are the faucet aerator(s) **still installed**?**]**
1. Yes
2. No

[ASK IF FA6=2 AND IINSTALLEDFAUCETAERATOR > 1]
FA7. How many of the **<INSTALLEDFAUCETAERATOR>** faucet aerators that you originally installed are **still installed**? **[NUMERIC, 0-10; 98=Unsure]**

[ASK IF INSTALLEDFAUCETAERATOR > 0]
FA8. Did you originally install the faucet aerator(s) **in your home or somewhere else**?
1. Installed in my home
2. **[SHOW IF INSTALLEDFAUCETAERATOR > 1:** Installed some in my home and some elsewhere
3. Installed elsewhere

[ASK IF FA8 = 3 AND INSTALLEDFAUCETAERATOR = 1]
FA10. Where else did you install your faucet aerator?
1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF (FA8 = 2 OR FA8 = 3) AND INSTALLEDFAUCETAERATOR > 1]
FA11. Where else did you install your faucet aerator(s)? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 LAST]**
1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF FA8 = 3 AND INSTALLEDFAUCETAERATOR = 1]
FA12. Does AEP Ohio provide electricity to the other location where you installed your faucet aerator?
1. Yes
2. No
98. Unsure

[ASK IF FA8 = 2 OR FA8 = 3) AND INSTALLEDFAUCETAERATOR > 1]
FA13. Does AEP Ohio provide electricity to all, some or none of the other locations where you installed your faucet aerator(s)?
1. All
2. Some
3. None
98. Unsure

FA14. How satisfied were you with the faucet aerators? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

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NIGHTLIGHT BATTERY

[ASK NIGHTLIGHT BATTERY IF NIGHTLIGHTCOUNT > 0; ELSE SKIP TO NEXT BATTERY]

NL1. Did you install the nightlight you received in the Energy Efficiency Kit?
1. Yes
2. No

[ASK IF NL1 = 2 AND NIGHTLIGHTCOUNT > 1]
NL2. How many of the **<NIGHTLIGHTCOUNT>** nightlights did you install? **[NUMERIC OPEN-END, 0-4]**

[CALCULATE INSTALLEDNIGHTLIGHT = NL2 IF NL1 = 2 AND NIGHTLIGHTCOUNT > 1]
[CALCULATE INSTALLEDNIGHTLIGHT = 1 IF NL1 = 1 AND NIGHTLIGHTCOUNT = 1]
[CALCULATE INSTALLEDNIGHTLIGHT = 0 IF NL1 = 2 AND NIGHTLIGHTCOUNT = 1]
[CALCULATE INSTALLEDNIGHTLIGHT = NIGHTLIGHTCOUNT IF NL1 = 1 AND NIGHTLIGHTCOUNT > 1]

[ASK IF NL1=2 AND NIGHTLIGHTCOUNT <> INSTALLEDNIGHTLIGHT]
NL3. Why didn't you install the nightlight(s)? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Already have an efficient nightlight installed
2. I like my current nightlight
3. Too difficult to install
4. Haven't gotten around to it yet
5. Didn't like the appearance
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[CALCULATE REMAININGNIGHTLIGHT = NIGHTLIGHTCOUNT - INSTALLEDNIGHTLIGHT]

[ASK IF NL1=2 AND NIGHTLIGHTCOUNT <> INSTALLEDNIGHTLIGHT AND REMAININGNIGHTLIGHT = 1]
NL4. What did you do with the nightlight that you did not install? **[RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Gave it to a friend
2. Saved it for later
3. Threw it away
0. Other, please specify: **[OPEN END]**
98. Unsure

[ASK IF NL1=2 AND NIGHTLIGHTCOUNT <> INSTALLEDNIGHTLIGHT AND REMAININGNIGHTLIGHT > 1]
NL5. What did you do with the nightlight(s) that you did not install? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. Gave them to a friend
2. Put them in storage
3. Threw them away
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[ASK IF INSTALLEDNIGHTLIGHT > 0]
NL6. Are the nightlight(s) that you originally installed **still installed**?**]**
1. Yes
2. No

[ASK IF NL6=2 AND INSTALLEDNIGHTLIGHT > 1]
NL7. How many of the **<INSTALLEDNIGHTLIGHT>** nightlights that you originally installed **are still installed**? **[NUMERIC, 0-4; 98=Unsure]**

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[ASK IF INSTALLEDNIGHTLIGHT > 0]

NL8. Did you originally install the nightlight(s) **in your home or somewhere else**?

1. Installed in my home
2. **[SHOW IF INSTALLEDNIGHTLIGHT > 1:** Installed some in my home and some elsewhere
3. Installed elsewhere

[ASK IF NL8 = 3 AND INSTALLEDNIGHTLIGHT = 1]

NL10. Where else did you install your nightlight?

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF (NL8 = 2 OR NL8 = 3) AND INSTALLEDNIGHTLIGHT > 1]

NL11. Where else did you install your nightlights? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 LAST]**

1. My business
2. A friend's home
3. A family member's home
0. Other, please specify: **[OPEN END]**

[ASK IF NL8 = 3 AND INSTALLEDNIGHTLIGHT = 1]

NL12. Does AEP Ohio provide electricity to the other location where you installed your nightlight?

1. Yes
2. No
98. Unsure

[ASK IF (NL8 = 2 OR NL8 = 3) AND INSTALLEDNIGHTLIGHT > 1]

NL13. Does AEP Ohio provide electricity to all, some or none of the other locations where you installed your nightlights?

1. All
2. Some
3. None
98. Unsure

NL14. How satisfied were you with the nightlight(s)? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

ENERGY EFFICIENCY KIT BATTERY

KT1. How satisfied were you with the Energy Efficiency Kit(s) overall? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

[ASK IF KT1 < 5]

KT2. Why did you rate it that way? **[OPEN END]**

KT3. Once the application form was submitted, about how many weeks did it take for you to receive your Energy Efficiency Kit(s)? **[NUMERIC OPEN END, RANGE 1-50, Unsure=98]**

KT4. How satisfied were you with how long it took to receive your Energy Efficiency Kit(s)? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

[ASK IF KT4 < 5]

KT5. Why do you rate your satisfaction with the time it took to receive the kit(s) this way?

1. **[OPEN END]**
98. Unsure

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Process Questions

[ASK IF S1 = 1, ELSE SKIP TO P7]

P1. How did you find out about the Home Energy Profile? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 14, 0, 98 LAST]**

1. Bill insert
2. Community event, county/state fair
3. Contractor (such as a plumber, electrician, or general contractor)
4. Email from AEP Ohio
5. Family / friend
6. I work in the energy or utility industry
7. Utility company (general)
8. AEP Ohio Website
9. Website other than AEP Ohio
10. Yard signs
11. Property management company or building owner
12. Program information on electric bill
13. Facebook or Twitter
14. Other AEP Ohio energy efficiency program
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

[IF P1 HAS MORE THAN ONE ANSWER, ASK P2, OTHERWISE AUTO-FILL AND SKIP TO P4]

P2. Which one of these sources of information was **the most influential** in your decision to participate in the program? **[CARRYFORWARD ALL ANSWERS GIVEN IN P1]**

P4. In the course of participating in the AEP Ohio program, how often did you contact AEP Ohio or program staff with questions?

1. Never **[Skip to P7]**
2. Once
3. 2 or 3 times
4. 4 times or more
98. Unsure **[Skip to P7]**

P5. How did you contact them? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Phone
2. Email
3. Fax
4. Mailed a letter
5. In person
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

P6. How would you rate your communications with AEP Ohio and program staff? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

[CALCULATE ANYKITMEASURESINSTALLED = 1 IF INSTALLEDFAUCETAERATOR > 0 OR INSTALLEDSHOWERHEAD > 0 OR INSTALLEDBULB > 0 OR INSTALLEDNIGHTLIGHT > 0; ELSE ANYKITMEASURESINSTALLED = 0]

[ASK IF ANYKITMEASURESINSTALLED = 1]

P7. Have you noticed reduced energy usage on your electric bill since installing items from your Energy Efficiency Kit?

1. Yes

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2. No
98. Unsure

[ASK IF P7=1]
P8. How satisfied are you with the reduced energy usage on your electric bill? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

[ASK IF P8 < 5]
P9. Why did you give this rating? **[OPEN END]**

P10. How would you rate your overall satisfaction with the program? This program includes **[SHOW IF S1 = 1:** the online Home Energy Profile you completed**] [SHOW IF S1 = 1 AND S2 = 1:** and**] [SHOW IF S2 = 1:** the Energy Efficiency Kit you received**]. [0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

P11. Why do you rate your overall satisfaction with the program this way? **[OPEN END]**

P12. What was your primary goal in trying to improve the efficiency of your home? **[RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**
1. To reduce energy costs
2. To make my home more comfortable
3. To make general improvements to my home
4. To benefit the environment
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

P13. How satisfied are you with the AEP Ohio as your electric service provider? **[0 to 10 SCALE: 0 = Not at all satisfied, 10 = Very satisfied]**

P14. Why do you rate your satisfaction with AEP Ohio this way?
1. **[OPEN END]**
98. Unsure

OTHER PROGRAMS

OP1. Have you participated in any other AEP Ohio energy efficiency programs in past two years?
1. Yes
2. No
98. Unsure

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[ASK IF OP1=1, ELSE SKIP TO D1]

OP2. Which other programs have you participated in? Please select all that apply. **[ALLOW MULTIPLE RESPONSE; RANDOMIZE RESPONSE ORDER, ANCHOR 0 & 98 LAST]**

1. Efficient lighting discounts **[ROLLOVER TEXT: You can get instant, in-store discounts when you buy ENERGY STAR certified LEDs at participating retailers or through AEP Ohio's online store.]**
2. Appliance rebates **[ROLLOVER TEXT: These are cash rebates offered by AEP Ohio for the purchase of qualifying ENERGY STAR Appliances.]**
3. Appliance recycling **[AEP Ohio picks up and recycles your old working secondary refrigerator or freezer and provides a financial incentive.]**
4. Community Energy Savers **[ROLLOVER TEXT: The Community Energy Savers Program creates partnerships between communities and AEP Ohio that bring the benefits of energy efficiency to residents, businesses and the community itself by encouraging participation in AEP Ohio energy saving programs. Partner communities are eligible for incentives as AEP Ohio and the community work together to expand energy efficiency programs to homes and businesses that qualify.]**
5. Multifamily program **[ROLLOVER TEXT: AEP Ohio offers free, energy saving products to multifamily buildings with individually-metered residential properties with five or more units. AEP Ohio handles the installation at no cost to the property manager or resident.]**
6. Community Assistance program **[ROLLOVER TEXT: Customers enrolled in an AEP Ohio payment assistance plan can receive free energy efficiency and repair services for their home.]**
7. EfficiencyCrafted New Homes **[ROLLOVER TEXT: If you are interested in building a new home, a participating builder works with you to build an ENERGY STAR® New Home, which can help you reduce your energy usage by as much as 35%.]**
8. e3smart education programs for kids **[ROLLOVER TEXT: For this program, AEP Ohio provides energy efficiency education curriculum to schools in the AEP Ohio service area for children in grades 5 through 12. The e3smart curriculum as developed by the Ohio Energy Project meets Ohio and National Science Standards and was recognized as an Outstanding Energy Education Project by the Ohio EPA in 2008.]**
9. Agriculture program **[ROLLOVER TEXT: AEP Ohio offers qualifying agriculture customers incentives on energy consuming equipment including lighting, ventilation, motors, fans, and equipment unique to the agricultural industry.]**
10. Home Energy Report **[ROLLOVER TEXT: AEP Ohio offers provides select electric customers a report comparing electricity use with similar homes and the customers own energy use to the same period in previous years. The report also provides simple actions the participant can take to reduce electricity usage and estimates savings the customer may see on the electricity bill if a specific action is taken.]**
11. Commercial business programs **[SPECIFY]**
0. Other, please specify: **[OPEN END]**
98. Unsure **[EXCLUSIVE]**

OP3. Did you participate in the selected program(s) before or after you **[SHOW IF S1=1:** completed the Home Energy Profile**] [SHOW IF S1=1 & S2=1:** and**] [SHOW IF S2=1:** received the Energy Efficiency Kit**]**?

1. Before I **[SHOW IF S1=1:** completed the Home Energy Profile**] [SHOW IF S1=1 & S2=1:** and**] [SHOW IF S2=1:** received the Energy Efficiency Kit**]**
2. After I **[SHOW IF S1=1:** completed the Home Energy Profile**] [SHOW IF S1=1 & S2=1:** and**] [SHOW IF S2=1:** received the Energy Efficiency Kit**]**
3. **[SHOW IF MORE THAN ONE RESPONSE SELECTED IN OP2] Both** before and after I **[SHOW IF S1=1:** completed the Home Energy Profile**] [SHOW IF S1=1 & S2=1:** and**] [SHOW IF S2=1:** received the Energy Efficiency Kit**]**
98. Unsure

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Demographics

We're just about done. We have a couple more questions about your household.

[FOR DEMGRAPHIC BATTERY, ALLOW PARTICIPANT TO SKIP QUESTIONS WITHOUT A VALID RESPONSE]

D1. Which of the following best describes your home/residence? **[ALLOW SKIP]**
1. Single-family home, detached construction (not a duplex townhome, or apartment; attached garage is acceptable)
2. Single-family home, factory manufactured/modular
3. Single-family, mobile home
4. Row House
5. Two or three-family attached residences
6. Apartment (4+ families in your building)
7. Condominium
0. Other, please specify: **[OPEN END]**

D1A. Do you own or rent this residence? **[ALLOW SKIP]**
1. Own
2. Rent

[ASK IF D1A=2]

D2. Do you pay your own electric bill or is it included in your rent?
1. Pay bill
2. Included in rent

D3. Approximately when was your residence constructed?
1. Before 1960
2. 1960-1969
3. 1970-1979
4. 1980-1989
5. 1990-1999
6. 2000-2005
7. 2006 or later
98. Unsure

D4a. Would you estimate the <u>above-ground</u> living space is about:
1. Less than 1,000 square feet
2. Between 1,001 and 2,000 square feet
3. Between 2,001 and 3,000 square feet
4. Between 3,001 and 4,000 square feet
5. Between 4,001 and 5,000 square feet
6. Greater than 5,000 square feet
0. Other, please specify: **[OPEN-END]**
98. Unsure

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D4b. Would you estimate the below-ground living space is about:
1. Less than 1,000 square feet
2. Between 1,001 and 2,000 square feet
3. Between 2,001 and 3,000 square feet
4. Between 3,001 and 4,000 square feet
5. Between 4,001 and 5,000 square feet
6. Greater than 5,000 square feet
0. Other, please specify: **[OPEN-END]**
98. Unsure

D5. What is your yearly household income?
1. Less than $15,000
2. Between $15,001 and $30,000
3. Between $30,001 and $50,000
4. Between $50,001 and $75,000
5. Between $75,001 and $100,000
6. Greater than $100,000

D6. Finally, is there anything you would like us to know about the **[SHOW IF S1=1:** Home Energy Profile**] [SHOW IF S1=1 & S2=1:** or**] [SHOW IF S2=1:** Energy Efficiency Kit**]**? **[ALLOW SKIP, OPEN END]**

Those are all the questions we have. On behalf of AEP Ohio, we like to thank you very much for taking the time to participate in this study.

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APPENDIX D: MEMO SUMMARIZING RESULTS OF THE HVAC BILLING ANALYSIS

Memorandum

To: Brian Billing, AEP Ohio
Vrushali Joshi, AEP Ohio

From: Robert Saul, EMI Consulting
Donna Whitsett, EMI Consulting

CC: Stu Slote, Navigant
Damon Clark, Navigant
Jessica Minor-Baetens, Navigant
Randy Gunn, Navigant

Date: April 26, 2018

Re: Results of the AEP Ohio Efficient Products HVAC Billing Analysis

Memo Overview

This memo contains results from a billing analysis conducted by EMI Consulting of 2016 AEP Ohio HVAC appliance rebate program participants. Due to warming weather trends in Ohio, AEP Ohio Efficient Products program staff were interested in exploring the accuracy of the full load cooling hours parameter used to calculate savings for program-rebated HVAC equipment. The main objective of the research effort was to compare the Draft Ohio TRM full load cooling hours value to an implied full load cooling hours value calculated based on billing analysis results.

Through the HVAC billing analysis, the evaluation team estimated per-unit annual energy savings ranging from 1,181 kWh to 3,080 kWh, depending on equipment type (Table 1). The evaluation team did not find significant per-unit annual energy savings for ductless mini-splits.

Table 1. Billing Analysis Estimated Per-Unit Energy Savings (kWh) by Equipment Type

Equipment Type	Estimated Per-Unit Annual Energy Savings (kWh)
Central Air Conditioning	1,181
Air Source Heat Pumps	2,324
Ground Source Heat Pumps	3,080
All HVAC Measures	1,333

Note: all results are statistically significant (confidence interval does not overlap zero).

Using these results, the evaluation team calculated an implied full load cooling hours value of 876 for central air conditioners and 1,356 for air source heat pumps. Note that the evaluation team did not estimate the implied full load cooling hours for ductless mini-splits and ground source heat pumps as these equipment types had very small participant pools in the HVAC billing analysis.

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Based on these results, the evaluation team determined:

1. The annual energy savings estimated through the HVAC billing analysis were notably higher than the per-unit estimated energy savings in the 2016 evaluation report for air conditioners and for air source heat pumps.

2. The estimates for implied full load cooling hours were notably higher than the TRM deemed value (552 hours). These implied estimates were much more closely aligned with the TRM-estimated full load cooling hours before controlling for over-sized cooling equipment (estimated at 828 hours).

This memo first presents background information that drove the study and an introduction to the methodology, followed by a detailed description of the methodology used to complete the billing analysis and calculate implied values for the full load cooling hours. The memo then discusses the results of the analyses in greater detail.

Background and Introduction

Since the Draft Ohio TRM was developed in 2010, Ohio has experienced several hotter-than-average summers. Due to the increase in warmer weather, AEP Ohio Efficient Products program staff believe that the Draft Ohio TRM does not capture accurate estimates for HVAC full load cooling hours. Currently, the Draft Ohio TRM assumes 552 hours of cooling in the Columbus area.[1] The TRM estimate for full load cooling hours were reduced from an original estimate of 828 to 552 based on research conducted in 1999 that suggested that the average air conditioning system is oversized by 50%.[2] However, there are wide variations in the impact of HVAC oversizing by geographic region, and the accuracy of the air conditioning oversizing assumption is unclear.

In order to calculate the implied value for full load cooling hours, the evaluation team conducted a billing analysis of customers receiving HVAC appliance rebates in 2016. The billing analysis compared AEP Ohio customers who used a rebate to install HVAC equipment (treatment) to the non-participant population of AEP Ohio residential customers (comparison). The evaluation team accomplished this by constructing a matched comparison group of non-participants that were similar to program participants based on location and monthly energy consumption in the year before the customer participated in the program. The billing analysis methodology also controlled for energy savings resulting from participation in other AEP Ohio programs. The evaluation team then estimated how much participants' consumption changed relative to the comparison group after participation in the HVAC appliance rebate program, controlling for weather and energy savings from other AEP Ohio energy efficiency programs. The evaluation team then calculated the implied full load cooling hours by applying the billing-analysis-estimated energy savings to TRM calculations.

Methodology

This section details the evaluation team's methodology, including descriptions of the datasets used, criteria for comparison group development, and an outline of the regression model used to estimate savings.

[1] Vermont Energy Investment Corporation, 2010; "State of Ohio Energy Efficiency Technical Reference Manual".

[2] Neme, Proctor, Nadal, 1999; "National Energy Savings Potential from Addressing Residential HVAC Installation Problems"

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Data

Rather than collect primary data, the evaluation team relied on several sources of secondary data from AEP Ohio, as well as weather data, to estimate energy savings. The following sources provided secondary data for the evaluation team's analyses:

Energy consumption: Energy (kWh) usage for all HVAC appliance rebate program participants from January 2014 through December 2017 and a sample of 100,000 non-participants between the same time period. These data were used to calculate average monthly consumption by calendar month and year in the analysis period for each customer.

AEP Ohio HVAC appliance rebate program participation data: Program tracking data for customers participating in the AEP Ohio HVAC appliance rebate program during the treatment period (January 2016 to December 2016).[3] This dataset included rebated equipment type and customer location data.

Other AEP Ohio program tracking data: Program tracking data for all applicable AEP Ohio residential energy efficiency programs between August 2010 and January 2017.[4] This data included information on the type of AEP Ohio energy efficiency programs a customer participated in (such as the Appliance Recycling program or the Home Energy Report program) and the savings associated with each measure installed as a part of the program. Though data for the Home Energy Report program was not included in the data extract, the evaluation team applied the average per-customer annual energy savings (kWh) estimates from the Home Energy Report evaluation reports corresponding to each customer's year of participation and their customer segment (higher than average electricity users, low income, or residences equipped with Advanced Metering Infrastructure).

Weather data: National Oceanic and Atmospheric Administration (NOAA) Weather Bureau Army Navy (WBAN) station sub-hourly dry bulb Fahrenheit temperature data from all active weather stations in the states of Ohio, West Virginia, and Kentucky between January 2015 and December 2017. These data were used to calculate average heating degree days (HDD) and cooling degree days (CDD) for each billing period. The evaluation team then identified the nearest weather station for each customer so that HDD and CDD could be used as control variables in the billing analysis.

Customer data were aggregated together for HVAC appliance rebate participants who participated in the program during the 2016 program year and non-participants with consumption data for the entire analysis period (January 2015 to December 2017). The evaluation team then identified ideal matching records for participants.

[3] The HVAC billing analysis considered any customer who installed their equipment in 2016 to be a 2016 participant. This participant definition does not match the participant definition from the 2016 In-Home evaluation report, which defines a 2016 participant as an invoiced rebate in 2016. We chose to define a participant as any customer who installed their equipment in 2016 because this resulted in a larger possible pool of participants with valid data.

[4] Program participation for the Efficient Products downstream lighting rebate, E3smart, Efficient Crafted Homes, Manufactured Homes, and Powerley programs were not used for this analysis. Programs were excluded if they did not have data at the customer-level, if they were programs focused on new construction, or if they did not have savings for the billing analysis period. For the Efficient Products downstream lighting rebate program, this analysis assumes that HVAC appliance rebate participants and HVAC appliance rebate non-participants participated in Efficient Products downstream lighting rebate program at the same rate.

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Customer Data Cleaning

The evaluation team attempted to use the largest number of HVAC appliance rebate program participants in the billing analysis while still preserving the integrity of the regression model. HVAC appliance rebates were excluded from the model only in cases in which customers: did not have usable data (tracking data contained no model information and no savings data), did not have energy consumption that spanned the defined billing analysis period (January 2015 through December 2017), or recorded zero energy consumption over multiple billing periods (Table 2). After excluding the aforementioned records, the evaluation team isolated 2,215 usable HVAC appliance rebate program participant records. For additional detail on data cleaning methods, see Appendix A.

Table 2. HVAC Rebate Program Participant Accounts and Rationale for Exclusion

Description	Count of Accounts
Total count before excluding accounts	2,507
Exclusion 1: Did not have a full year of pre-period and post-period consumption data	252
Exclusion 2: Customer has consistent consumption of zero over multiple billing periods	30
Exclusion 3: No data other than account number	8
Exclusion 4: Did not have a full year of pre-period and post-period consumption data and consistent consumption of zero over multiple billing periods	2
Total After Exclusions	2,215

The evaluation team considered excluding participants on other factors such as extreme energy usage, large standard deviations from average consumption, and negative consumption values. After testing models, the evaluation team decided to include the largest possible treatment group in the billing analysis and did not exclude records based on these additional criteria.

Participation in Other AEP Ohio Programs

To isolate the energy savings derived specifically from upgraded HVAC equipment (and not from other energy saving measures), the evaluation team accounted for participation in other AEP Ohio programs in the HVAC billing analysis calculations. A majority of HVAC appliance rebate program participants participated in other AEP Ohio programs (approximately 76% of all HVAC appliance rebate participants) while very few customers from the non-participant dataset participated in other AEP Ohio programs (Table 3). The vast majority of HVAC appliance rebate participants included in the billing analysis also participated in the Home Energy Report program (83%), for which customers are randomly recruited.

Table 3. Participation in Other AEP Ohio Programs

Group	Description	Count of Accounts	Percent of Total Group Accounts
HVAC Appliance Rebate Participant	Participated in Other Programs	1,896	75.6%
HVAC Appliance Rebate Participant	Did Not Participate in Other Programs	611	24.4%
HVAC Appliance Non-Participant	Participated in Other Programs	323	0.3%
HVAC Appliance Non-Participant	Did Not Participate in Other Programs	99,677	99.7%

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To account for other program participation in the HVAC billing analysis model, the evaluation team added the estimated monthly savings from other programs to energy consumption in the months following a customer's participation in another AEP Ohio program. These estimated monthly savings were calculated using the estimated annual energy savings values from the AEP Ohio tracking database for each measure customers installed through other AEP Ohio programs. The evaluation team considered other methods for controlling for program participation including backing out other program savings after running the billing analysis model and including binary indicators in the model for other program participation. The evaluation team chose the approach described above to select the most similar non-participant match, controlling for other program participation. Other methods would not control for other program participation prior to running the matching algorithm.

Comparison Group

One goal of the billing analysis was to determine how much HVAC appliance rebate participants' energy consumption changed due to the installation of their equipment. Because it is impossible to know how much participants would have consumed in the absence of the program and because consumption varies considerably over time, the evaluation team compared how much program participants' energy consumption changed to how much similar non-participants' energy consumption changed over the same time period. Because different customers have different usage patterns and respond differently to external forces like economic changes and weather, the evaluation team selected a comparison group of non-participants who were similar to HVAC appliance rebate program participants from the larger set of non-participants.

The goal of the comparison group was two-fold: to select non-participants who had similar consumption patterns as participants, and to select non-participants who were likely to have had a similar response as participants based on experienced weather patterns, were they offered the program. The first goal helped ensure the evaluation team estimated the impact of the program, rather than other characteristics of the participants that the evaluation team are unable to observe. To ensure the non-participant group reflected similar consumption patterns to participants before the installation of their rebated HVAC equipment, the evaluation team selected non-participants who had similar monthly consumption in the year before participants installed their equipment (consumption in 2015). The second goal helped ensure the evaluation team estimated changes resulting from the program rather than other influences like weather and seasonal factors. To achieve this goal, the evaluation team selected non-participants from roughly the same geographic region as program participants.[5] This approach controlled both for observable consumption patterns, as well as for unobserved characteristics that are likely to be shared by homes in the same areas.

To construct the comparison group, the evaluation team used a matching algorithm to match each participant to a similar non-participant. The evaluation team matched by calculating the Euclidean distance in consumption between each participant and each non-participant over time. Then each participant was matched to a non-participant in the same geographic region so that the total distance for all participants was as small as possible.

Billing Analysis

To estimate savings, the evaluation team developed a "Difference-in-Differences" (DiD) model. A DiD model compares the difference in consumption between the pre- and post-participation periods for program participants to the difference in consumption between those periods for the comparison group, that is, the difference in the differences. This comparison can be improved by controlling for additional factors that influence energy consumption, particularly weather. In addition, because the evaluation team had repeated observations over time for each customer,

[5] The evaluation team geographically matched participants and non-participants using a grouping of the nearest weather stations (six total groups).

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characteristics that are fixed in time for a customer and characteristics that are fixed across customers at a given time are controlled through the use of fixed effects that cancel these impacts out. The evaluation team applied the model described in Equation 1 below.

Equation 1. DiD Specification

$$Consumption_{it} = \alpha_{1i} + \alpha_{2t} + \beta_1 * PostTreatment_{it} + \beta_2 * HDD_{it} + \beta_3 * CDD_{it} + \beta_4 * (HDD_{it} * PostTreatment_{it}) + \beta_5 * (CDD_{it} * PostTreatment_{it}) + \varepsilon_{it},$$

where *i* indexes customer and *t* indexes month, and β is the DiD estimate of the change in consumption from the HVAC appliance rebate equipment. The definitions of the variables and parameters are given in Table 4.

Table 4. Regression Terms and Definitions

Term	Definition
$\boldsymbol{Consumption_{it}}$	Estimated average monthly calendarized energy consumption for customer *i* in month *t*, reflecting total monthly consumption.
$\boldsymbol{\alpha_{1i}}$	Fixed effect for customer *i*, encompassing all time-invariant customer characteristics. These parameters are not estimated, but are projected by the model.
$\boldsymbol{\alpha_{2t}}$	Fixed effect for month *t*, encompassing all customer-invariant time characteristics. These parameters are not estimated, but are projected by the model.
$\boldsymbol{\beta_1}$	Difference-in-differences estimator of program impact on energy consumption, estimating the average difference between pre- and post- consumption among the treatment versus comparison group customers.
$\boldsymbol{PostTreatment_{it}}$	An indicator that takes a value of one if customer *i* is in the treatment group and month *t* is after the customer *i* installed their rebated HVAC equipment, and zero otherwise. Note that the indicator for being in the treatment group is subsumed into the customer fixed effect.
$\boldsymbol{\beta_2}$	A slope coefficient indicating the average slope of energy consumption with respect to heating degree days (HDD).
$\boldsymbol{HDD_{it}}$	An indicator of the number of heating degree days (HDD) experienced by customer *i* in month *t*.
$\boldsymbol{\beta_3}$	A slope coefficient indicating the average slope of energy consumption with respect to cooling degree days (CDD).
$\boldsymbol{CDD_{it}}$	An indicator of the number of cooling degree days (CDD) experienced by customer *i* in month *t*.
$\boldsymbol{\beta_4}$	A slope coefficient indicating the average slope of energy consumption with respect to the interactive effect between HDD and $\boldsymbol{PostTreatment_{it}}$.
$\boldsymbol{\beta_5}$	A slope coefficient indicating the average slope of energy consumption with respect to the interactive effect between CDD and $\boldsymbol{PostTreatment_{it}}$.
$\boldsymbol{\varepsilon_{it}}$	An idiosyncratic error in energy consumption of customer *i* in month *t* outside of the modeled impacts.

The model (Equation 1) estimated the impact of participation in the HVAC appliance rebate program taking other savings estimates into account. As such, it indicated whether the

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participants reduced their consumption after installing their HVAC equipment compared to what their consumption would be if they had not installed the equipment. By comparing participants to a comparison group, the evaluation team measured savings above and beyond what customers would have normally done without the program, thus providing savings associated with the program. For program participants, months prior to the installation of their equipment are considered "pre-treatment" months in the model, whereas months following the installation of their equipment are considered "post-treatment" months. In order to address concerns about correlation between participant and matched-control consumption during the matching period, the evaluation team clustered standard errors at the matching-group level, allowing for arbitrary covariance between observations in those groupings.[6]

Calculating Implied Full Load Cooling Hours

The evaluation team calculated the implied full load cooling hours ($\mathrm{FLH_{cool}}$) for both central air conditioners and for air source heat pumps for participants included in the HVAC billing analysis. As the billing analysis estimated energy savings relative to the previously-installed equipment, the evaluation team used as-found conditions to estimate the implied $\mathrm{FLH_{cool}}$ value. The evaluation team did not calculate the implied $\mathrm{FLH_{cool}}$ for ground source heat pumps and ductless mini split heat pumps as these equipment types had very small participant pools in the HVAC billing analysis.

The evaluation team first examined the $\mathrm{FLH_{cool}}$ of central air conditioners. To calculate the implied $\mathrm{FLH_{cool}}$ using the results of the HVAC billing analysis, the evaluation team applied the average of the parameter values found in the tracking data for central air conditioner participants included in the HVAC billing analysis. By applying algebraic methods to the TRM energy savings calculations,[7] the evaluation team isolated FLH_{cool} on one side of the equation (Equation 2).

Equation 2. TRM Central Air Conditioner Energy Savings Calculation Solved for Full Load Cooling Hours

$$FLH_{cool} = \frac{(1000 * \Delta\mathrm{kWH})}{(\mathrm{BtuH} * (1/\mathrm{SEER}_{base} - 1/\mathrm{SEER}_{ee}))} \frac{(1000 * \Delta\mathrm{kWH})}{(\mathrm{BtuH} * \left(\frac{1}{\mathrm{SEER}_{base}} - \frac{1}{\mathrm{SEER}_{ee}}\right))}$$

Where ΔkWH is the HVAC billing analysis estimated energy savings for participants installing central air conditioners, BtuH is the average size of the installed central air conditioning equipment in British Thermal Units (BTUs), $\mathrm{SEER_{base}}$ is the average SEER efficiency of baseline equipment, and $\mathrm{SEER_{ee}}$ is the average SEER efficiency of the upgraded equipment.[8]

The evaluation team applied similar methods to calculate the implied FLH_{cool} for air source heat pump participants included in the HVAC billing analysis, but modified the equation to reflect the TRM air source heat pump energy savings calculation (Equation 3).[9]

[6] By clustering standard errors at the matching-group level, the model treats all observations within those groupings as possibly correlated, even beyond the matching period. This may be overly-conservative, leading to overly-conservative standard errors.

[7] Vermont Energy Investment Corporation, 2010; "State of Ohio Energy Efficiency Technical Reference Manual". pg. 31.

[8] Average values for SEER_{base}, and SEER_{ee} were calculated as the average of $\frac{1}{\mathrm{SEER}_{base}}$, and $\frac{1}{\mathrm{SEER}_{ee}}$ to increase the accuracy of average estimates and the evaluation team did not apply the corresponding divisions in the equation. The evaluation team describes the equation as above for ease of traceability back to the TRM calculation.

[9] Vermont Energy Investment Corporation, 2010; "State of Ohio Energy Efficiency Technical Reference Manual". pg. 34.

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Equation 3. TRM Air Source Heat Pump Energy Savings Calculation Solved for Full Load Cooling Hours

$$FLH_{cool} = \frac{(\Delta\text{kWH} - ((FLH_{heat} * BtuH * (1/HSPF_{base} - 1/HSPF_{ee})/1000\,) * 1000)}{(\text{BtuH} * (1/\text{SEER}_{base} - 1/\text{SEER}_{ee}\,)}FLH_{cool}$$
$$= \frac{(\Delta\text{kWH} - ((FLH_{heat} * BtuH * (1/HSPF_{base} - 1/HSPF_{ee})/1000\,) * 1000)}{(\text{BtuH} * \left(\frac{1}{\text{SEER}_{base}} - \frac{1}{\text{SEER}_{ee}}\right))}$$

Where ΔkWH is the HVAC billing analysis estimated energy savings for participants installing air source heat pumps, BtuH is the average size of the installed air source heat pump equipment in British Thermal Units (BTUs), $\text{SEER}_{\text{base}}$ is the average SEER efficiency of baseline equipment, SEER_{ee} is the average SEER efficiency of the upgraded equipment, $\text{HSPF}_{\text{base}}$ is the deemed value for the HSPF efficiency of baseline equipment, HSPF_{ee} is the average HSPF efficiency of the upgraded equipment, and FLH_{heat} is the deemed value for full load heating hours.[10]

Results

This section describes the results of the evaluation team's analysis, including a discussion of matching program participants to comparison customers.

Matching Results

As discussed above, the evaluation team constructed a matched comparison group of non-participants to provide a counterfactual for participants' consumption in the absence of the program. Comparison group customers were selected using a matching algorithm that matched participants to similar non-participants based on monthly consumption and geographic area.

Figure 1 below shows comparisons of the average monthly kWh consumption between the participant group, the matched non-participant comparison group, and non-matching non-participants (non-participants who were not chosen to be in the comparison group). As seen in Figure 1, the matched comparison group was more similar to the participants than the non-matching non-participant group load profiles. The fact that participants and their matched comparison group were quite close in their profile throughout the pre-treatment period indicates the comparison group should provide a strong counterfactual for what participants' consumption would have been in the absence of the program. As participants' consumption, on average, was below matching non-participants in the post-treatment period, the installation of rebated HVAC equipment appears to have reduced energy consumption. The evaluation team found that participants had higher average consumption than non-participants during several pre-period months. In examining the differences between the groups over time, there did not appear to be a trend in the differences that would notably impact the model.

[10] Average values for $HSPF_{ee}$, SEER_{base}, and SEER_{ee} were calculated as the average of $\frac{1}{HSPF_{ee}}$, $\frac{1}{\text{SEER}_{base}}$, and $\frac{1}{\text{SEER}_{ee}}$ to increase the accuracy of average estimates and the evaluation team did not apply the corresponding divisions in the equation. The evaluation team describes the equation as above for ease of traceability back to the TRM calculation.

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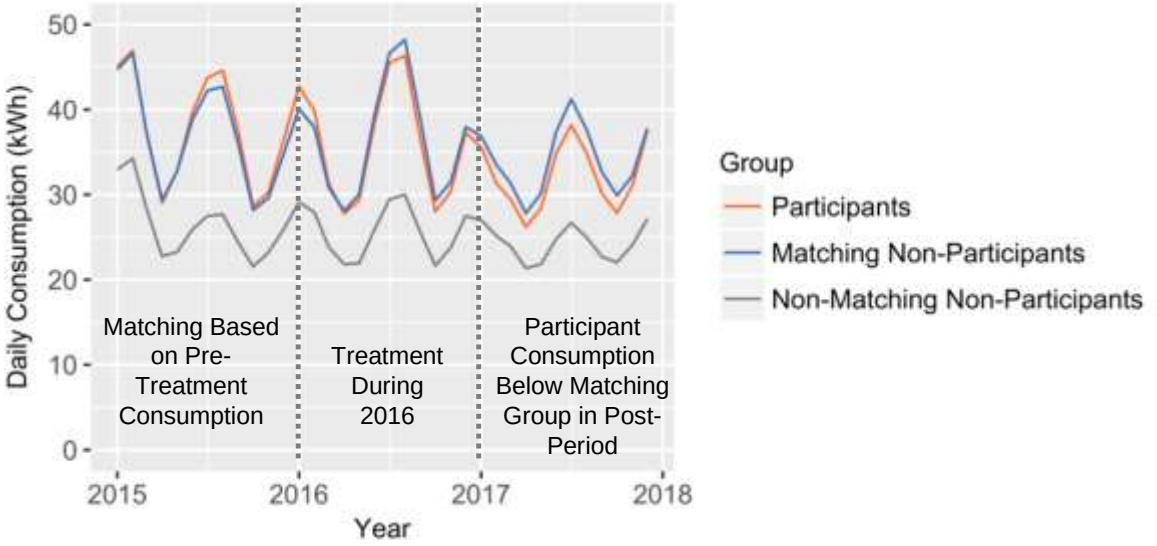
Figure 1. Comparison of Average Consumption between Participants and Matched Groups



HVAC Billing Analysis Results

The evaluation team compared results of the HVAC billing analysis to the results from the 2016 In-Home program evaluation report. The 2016 report applied TRM-specified methods to calculate energy savings. It should be noted that the comparison was impacted by differences in methodologies, as the program evaluation calculated savings using baseline SEER_{base} values and the HVAC billing analysis inherently used as-found conditions for SEER_{base} values. The evaluation team found that the billing analysis annual savings estimates for central air conditioners and air source heat pumps were much higher than the evaluation report estimates, as seen in Table 5 and Table 6. The annual energy savings estimate for central air conditioners from the HVAC billing analysis was about two and a half times greater than the 2016 In-Home program evaluation report (1,181 kWh vs 472 kWh). The annual energy savings estimate for air source heat pumps from the HVAC billing analysis was 82% higher compared to the 2016 In-Home program evaluation report (2,324 kWh vs 1,278 kWh). For ground source heat pumps, the calculated annual energy savings values were significantly different from zero, but the confidence interval is quite large due to the small population of participants. Ductless mini-splits also had a small population of participants, and results are not statistically significant (i.e., the confidence interval overlaps zero).

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Table 5. Billing Analysis Estimated Energy Savings (kWh) by Equipment Type

Equipment Type	Number of Accounts	Estimated Daily Energy Savings in kWh (90% Confidence Interval)	Estimated Annual Per-Unit Energy Savings in kWh (90% Confidence Interval)
Central Air Conditioning	1,832	3.23 (2.71, 3.75)	1,180.68 (990.89, 1,370.47)
Air Source Heat Pumps	306	6.37 (4.30, 8.44)	2,323.64 (1,568.31, 3,078.97)
Ductless Mini-Splits	45	1.01 (-2.75, 4.77)	369.2 (-1,004.32, 1,742.71)
Ground Source Heat Pumps	32	8.44 (0.75, 16.13)	3,080.49 (273.57, 5,887.41)
All HVAC Measures	2,215	3.65 (3.08, 4.22)	1,333.34 (1,125.91, 1,540.77)

Table 6. 2016 HVAC Appliance Energy Savings from In-Home Program Evaluation Report

Equipment Type	Number of Rebated Units	Overall Annual Energy Savings (MWh)	Annual Energy Savings per Unit (kWh)
Central Air Conditioning	2,095	988	472
Air Source Heat Pumps	371	474	1,278
Ductless Mini-Splits / Ground Source Heat Pumps	96	190	1,979

The evaluation team estimated the highest per-unit annual energy savings for ground source heat pumps. Though the 2016 In-Home evaluation report does not provide data readily for comparison,[11] the 2017 Efficient Products evaluation report estimated per-unit annual energy savings for ground source heat pumps at 3,000 kWh. This estimate is very close to the billing analysis estimated savings of 3,080 (Table 5).

Implied Full Load Cooling Hours

Using the HVAC billing analysis results, the evaluation team estimated the implied value for full load cooling hours for 2016 HVAC appliance rebate participants. The evaluation team focused on central air conditioners and air source heat pumps as these equipment types had more robust participation in 2016. The evaluation team estimated implied full load cooling hours at 876 hours for central air conditioners and 1,356 for air source heat pumps (Table 7). Both values were much higher than the 552 full load cooling hours estimate specified in the TRM and were more closely aligned to the TRM-estimated full load cooling hours before controlling for over-sized cooling equipment (estimated at 828).

[11] Savings for ground source heat pumps and ductless mini-splits were reported as a single field in the 2016 In-Home program evaluation report,

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Table 7. Implied Full Load Cooling Hours

Equipment Type	Implied Full Load Cooling Hours Estimate
Central Air Conditioners	876
Air Source Heat Pumps	1,356

Potential Sources of Error

The implied estimate for central air conditioner full load cooling hours may characterize the full load cooling hours more effectively than the estimate for air source heat pump full load cooling hours as the full load cooling hours equation for air source heat pumps contains additional deemed parameters. These deemed parameters (FLH_{heat} and $HSPF_{base}$) may have a large effect on the full load cooling hours value and add additional error to the calculation. Another source of error may stem from the use of average tracking data values for BtuH, SEER_{base}, SEER_{ee}, $HSPF_{base}$, and $HSPF_{ee}$. The evaluation team applied average values from the tracking database and using these averages may not completely characterize the full load cooling hours experienced by each customer household. For a more precise estimate of the full load cooling hours, the evaluation team recommends conducting a metering study of HVAC equipment.

Conclusions

Based on these analysis, the evaluation team arrived at the following conclusions:

1. The billing analysis resulted in higher per-unit annual energy savings estimates for central air conditioners and air source heat pumps than found in the 2016 evaluation. These differences may be largely attributable to the differences in underlying assumptions of the two approaches. Savings estimates for the 2016 evaluation report applied both time-of-sale and early replacement assumptions, while the HVAC billing analysis more closely mirrors an early replacement program logic (i.e., savings compared to as-found baseline equipment). The annual energy savings estimate for ground source heat pumps was inconclusive due to the small sample size and the fact that savings for ground source heat pumps and ductless mini-splits were reported in aggregate in 2016.

2. The billing analysis also resulted in higher estimates for full-load cooling hours compared to the Draft Ohio TRM, which assumes 552 hours for central air conditioners, air source heat pumps, and ground source heat pumps. For central air conditioners, the implied value was much closer to the TRM-estimated full load cooling hours value before adjusting for oversizing (828 hours). Differences between the central air conditioner implied value and the TRM estimated value may stem from the application of average BtuH, SEER_{base}, and SEER_{ee} values in the tracking data that the evaluation team used to derive the implied value. The implied air source heat pump full load cooling hours value was higher than the implied central air conditioner value, though the air source heat pump implied value may be impacted by variation in additional calculation parameters. The underlying air source heat pump calculation included two deemed values (FLH_{heat} and $HSPF_{base}$) and an additional average value from the tracking data ($HSPF_{ee}$). For air source heat pumps, the derivation of full load cooling hours assumes that the FLH_{heat} and $HSPF_{base}$ values are accurate; if these values are inaccurate, this would impact the full load cooling hours estimate. For a more precise estimate of the full load cooling hours, the evaluation team recommends conducting a metering study of HVAC equipment.

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APPENDIX A: DATA PREPARATION

The evaluation team prepared the dataset for analysis using the following procedure:

1. Removed observations and customers within the consumption data if they met exclusion criteria (Table 2).
2. Determined average daily kWh consumption for each customer within each billing period between January 2015 and December 2017.
3. Used the above values to create average daily consumption for each customer within each calendar month between January 2015 and December 2017.
4. Created calendarized monthly consumption estimate by aggregating average daily energy usage to a uniform monthly consumption estimate.
5. Formatted the program data for other AEP Ohio program participation by creating categories for each measure installation and calculated cumulative installed savings in order to control for other energy efficiency program installed savings at each point in time.
6. Identified HVAC appliance rebate program participants and their equipment type.
7. Merged in consumption data.
8. Created a treatment variable that identified the pre- and post-participation periods of each AEP Ohio appliance rebate participant.
9. Merged in weather data by matching to the closest available weather station based on customers' latitude and longitude.
10. Calculated average heating degree days (HDD) and cooling degree days (CDD) for each billing period. Heating degree-days (HDD) are equal to max(0,[65 °F – T_{it} °F]) and Cooling degree-days (CDD) are equal to max(0,[T_{it} °F – 65 °F]), where T is the minimum or maximum temperature for time day *t* at the most proximal weather station to customer *i*.
11. Matched program participants to non-participants based on location and pre-program consumption.

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Case No(s). 18-0835-EL-EEC

Summary: Annual Report - Ohio Power Company submits the 2017 Portfolio Status Report pursuant to Rule 4901:1-39-05(C), Ohio Administrative Code
(Part 1 of 6) electronically filed by Mr. Steven T Nourse on behalf of Ohio Power Company