ENVIRONMENTAL LAW & POLICY CENTER

Environmental Law and Policy Center Final Comments
PUCO Energy Efficiency Workshops
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Introduction

In the last session where the environmental community presented its positions on energy efficiency, the Commissioners asked a number of questions about non-participant benefits, participant benefits and jobs created. During earlier comments, ELPC attempted to address these questions, and we will address them further today. But, ELPC wants to point out that the utilities are best suited to answer these questions. The utilities and their independent consultants develop the programs and do that analysis.

Having a debate about the value of utility run energy efficiency (EE) or energy waste reduction programs is a false debate. All utilities have an obligation to meet their customers' electricity needs. Utilities have two options for doing that: they can either provide generation or help customers reduce their usage through energy efficiency programs. While the previous laws did require the utilities to run energy efficiency programs, they also clearly required the Commission to find that all utility-run energy efficiency plans met cost-effectiveness tests. This means that the Commission had to find that utilities' energy efficiency plans saved Ohio utility customers money comparing the costs of energy efficiency to the cost of generation. The Commission made that finding every time.

In their presentations at the workshops OCC and OMA asserted that we don't need the utilities to continue to run programs because they don't produce real results. But OCC and OMA provided no evidence to support this argument. Similarly, IGS provided no evidence that the competitors' efforts or the competitive market provide customers the energy benefits that utility run programs provide. In contrast, the utilities base their programs on energy efficiency potential studies conducted by third parties. Those potential studies are evidence.[1] The utility witness testimony and the hundreds of pages of analysis and data they submit are evidence. Additionally, the environmental groups' experts have analyzed the programs and concluded that they produce savings. Finally, the PUCO reviews the programs to ensure they provide savings. This system ensures that the utilities will not continue to provide discounts or rebates to induce customers to invest in efficiency measures that they already invest in absent the utility program.

[1] AEP testimony in 2016: The market potential study that informs this Plan is the result of a current analysis of the EE/PDR market potential in AEP Ohio's service territory by Navigant Consulting, Inc. (Navigant), an experienced EE/PDR consultant, under the direct supervision and guidance of AEP Ohio. The market potential study included the results of a recent baseline study completed in AEP Ohio's service territory and the significant direct experience of AEP Ohio in its current program Plan implementation and performance, as well as benchmarking and best practices program analyses from other successful utility programs. Case No. 16-0574-EL-POR Exhibit JFW-1, (Volume 1) Page 10 of 180.

In the final analysis, the answer to the question "should utilities continue to run voluntary energy efficiency programs?" is a clear "yes." However, no one has ever said that the utilities cannot run *better* programs that produce *greater* savings. What the Commission should be asking is "how can we improve energy efficiency programs to ensure they produce optimal results?"

Responses to Commissioner Questions

In response to questions from Commissioners, ELPC provides short answers below and attaches the testimony of Jon Williams from the last AEP EE case, and a study by Gable Associates, "Estimating the Benefits of Waste Reduction in OH" (Gable Report). Mr. Williams testimony and the Gable study provide comprehensive answers and ELPC hopes the Commissioners review these as well as testimony submitted by witnesses in previous EE cases.

Question: Do savings benefit non-participants?

Non-participants do benefit. In AEP's most recent rate case, 20-0585, AEP witness Jon Williams put this succinctly:

> While participants in the programs save energy and reduce demand, participants and non-participants alike benefit as well through the avoidance of generation costs in the Company's service territory over the life of the demand and energy saving programs. These avoided costs are less than the DSM Plan's costs for programs, so the DSM Plan is cost effective.

Williams Testimony (withdrawn) at 5.[2]

Similarly, the Gable Report outlines that non-participants benefit in a number of ways:

- Avoided electric energy costs (energy the utilities don't need to purchase due to reduced usage);
- Avoided electric capacity costs (utilities must purchase capacity from PJM to ensure they meet peak demand);
- Demand reduction induced price effects (DRIPE which quantifies the impact EE programs have by reducing peak demand and driving down market prices);
- Avoided Transmission and Distribution Capacity (reduced usage means less need for transmission and distribution investment); and
- Reduced pollution.

The Gable Report discusses these savings in detail and concludes that over a ten-year period, with 1% annual savings targets, the four Ohio electric utilities would spend $737 million and generate $2.665 billion in savings without including any environmental benefits. Customers would save $1.7 billion on avoided electric energy costs alone. Gable Report at 4, 19.

[2] AEP settled this case and because of that stipulation Mr. Williams' testimony is not in the official record.

Additionally, Mr. Williams' testimony includes Navigant's analysis of program savings based on the Total Resource Cost (TRC) which measures the net resource benefits from the perspective of all ratepayers by combining the net benefits of the program to participants and non-participants:

> The benefits are meant to be the sum of the avoided costs of the supply-side resources avoided or deferred, and other benefits that accrue to participants or the utility. The TRC costs encompass the cost of the measures/equipment installed, and the costs incurred by the utility. The formulation: TRC = Benefits / Costs where: Benefits = net avoided costs + net other utility benefits + net other participant benefits and Costs = gross administrative costs + net incremental technology costs.

16-0574 AEP Williams Ex.2.0 at 18. From 2017-2019, AEP's programs had a savings to costs ratio of 1.6.

Question: Do EE programs create jobs?

In 2016, AEP answered this question as follows:

> To capture the full economic impacts of the investments in energy efficiency, three separate effects (direct, indirect, and induced) must be examined for each change in expenditure. The sum of these three effects yields the total effect resulting from a single expenditure. The direct effect refers to the on-site or immediate effects produced by expenditures. In the case of installing energy efficiency upgrades in a home or business, the direct effect is the on-site expenditures and jobs of the construction or trade contractors hired to carry out the work. The indirect effect refers to the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered and is able to pay others who support their businesses. This includes the equipment manufacturer or wholesaler who provided the new technology. It also includes the bank that provides financing to the contractor, the vendor's accountant, and the building owner where the contractor maintains its local offices. The induced effect derives from the change in spending that energy efficiency investments enable. Businesses and households are able to meet their energy, heating, cooling, and lighting needs at a lower total cost, due to efficiency investments. This lower cost of doing business and operating households makes greater wealth available for businesses and families to spend or invest in other goods and services such as food, clothing, entertainment, or marketing (in the case of businesses).
>
> Table 8 shows the total number of potential jobs—direct, indirect, and induced—that are estimated would be created from investing $292.5 million in electric energy efficiency and peak demand reduction in AEP Ohio customer homes and businesses in 2017 through 2019. On average, based on this analysis, one job potentially will be created for approximately $100,000 in spending.

Table 8. Number of Jobs Created – 2017 through 2019

Direct	Indirect	Induced	Total Jobs Created
1,300	975	650	2,925

Case No. 16-0574-EL-POR Exhibit JFW-1, (Volume 1) Page 22, 23.

Question: Do we still need new utility run programs?

Potential studies show that customers waste significant amounts of energy that utility run programs can reduce, even without discounting standard LED bulbs. In addition to traditional savings, ELPC believes that AEP Witness Williams provides excellent answers to this question when utilities provide programs that fit with grid modernization.

> The Company has invested in the smart grid with smart meters and a network that provides the opportunity to work with customers and a wide variety of partners in new ways to help optimize the grid through demand side management, helping all customers control cost and maximize their benefit as well as the system benefit for all customers. Many major end uses of electricity in homes, businesses and industry such as heating, ventilation and air conditioning, water heating, specialty and controlled lighting, plug loads and some industry specific processes are good candidates for reduction of peak demand through control. The customer needs to be aware of the opportunity, there should be a benefit to participate, and the customer needs the capability or technology to participate.

Case No. 20-0585, Williams Direct (withdrawn) at 9. Mr. Williams further testifies that the programs will generate $100 million in annual savings at a cost of $36.6 million. *Id.* at 6.

While the AEP's estimate for the number of participants is in a study that ELPC doesn't have access to, its description of the Efficient Products program for residential programs indicates that a large number of customers will have the opportunity to participate:

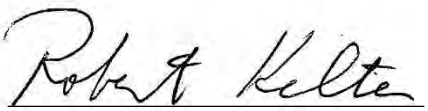
> This DSM program provides retail incentives for LED specialty lighting and incentives for efficient heating and air conditioning (Energy Star Heat Pumps and Mini Split Heat Pumps), appliances and heat pump water heaters. In addition, incentives for demand control devices are included such as smart thermostats and load controllers. This program includes a digital marketplace where consumers can compare energy efficient appliances, receive an energy efficiency rating to help them make an informed decision, and shop for efficient products. The program will also explore midstream opportunities for delivering incentives.

Case No. 20-0585-EL-AIR Exhibit JFW-1 at 7. The specialty lighting program is far from saturated, and only a small percentage of AEP customers have smart thermostats or participate in demand response programs. ELPC notes that AEP did not propose discounting standard LEDs, because those discounts would not produce real benefits.

Conclusion

Before HB 6, the utilities ran good programs that produced real results. The legislative hearings during HB 6 highlighted some of the waste in the programs and the areas where utilities could improve them. Moreover, in process of drafting HB 389, the environmental groups and utilities worked together to improve the process for developing and reviewing voluntary energy efficiency (waste reduction) programs. While ELPC welcomes the certainty that legislation would provide, regardless of what happens legislatively, the Commission can apply much of the substance of the legislation to voluntary EE programs going forward.

Submitted by:



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Estimating the Benefits of Energy Waste Reduction in Ohio

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EXECUTIVE SUMMARY

Energy waste reduction programs create far reaching benefits. The energy savings offer customers greater control of bills, improved comfort, and improved air quality. Businesses also benefit from energy waste reduction programs through lower costs of operation and reduced energy costs over time. The energy savings also displace power plant generation, which reduces the dollars sent out of state for imported electricity and regional air pollution. Finally, energy waste reduction programs create economic growth by stimulating local economies and creating jobs.

Energy waste reduction programs provide customers discounts and rebates on appliances and services that encourage them to invest in energy waste reduction measures. By law, the programs must be cost-effective, which means the programs must cost less than the electricity they are avoiding would have otherwise cost to deliver.

Significant opportunity exists to reduce energy waste at the customer level in Ohio. A 2017 study sponsored by the Department of Energy estimated that Ohio has over 23,430 GWh of total potential energy savings by 2035.[1] A 2015 study conducted by American Electric Power estimated potential savings of over 22,280 GWh, over 50% of the 2034 forecasted sales.[2] Updated energy waste reduction potential studies show significant opportunities in other states.[3,4]

This report reviews the potential benefits associated with energy waste reduction in Ohio. We examine three potential energy waste reduction policy scenarios to forecast benefits. We also consider the benefits under multiple cost estimates for energy savings. The review of costs and benefits is intended to provide policymakers in Ohio relevant data and information to determine the best approach moving forward with energy waste reduction programs in Ohio. Our review finds energy waste reduction programs have the potential to produce significant benefits in Ohio over the next ten years.

[1] *State Level Electric Energy Efficiency Potential Estimates.* Electric Power Research Institute. Technical update, May 2017. United States Department of Energy. energy.gov/sites/prod/files/2017/05/f34/epri_state_level_electric_energy_efficiency_potential_estimates_0.pdf.
[2] AEP Ohio. 2014. Volume 1: 2015 to 2019. Energy Efficiency/Peak Demand Reduction Action Plan. aceee.org/files/pdf/aep-ohio-2015-2017-ee-pdr-plan.pdf.
[3] Pennsylvania Act 129 – Phase IV Energy Efficiency and Peak Demand Reduction Market Potential Study Report. February 28, 2020. puc.pa.gov/pcdocs/1656474.pdf.
[4] Energy Efficiency Potential in New Jersey. May 24, 2019. s3.amazonaws.com/CandI/NJ+EE+Potential+Report+-+FINAL+with+App+A-H+-+5.24.19.pdf.

The three scenarios analyzed include:

1. **One percent** (1%) annual savings for ten years (2021-2030)
2. **One- and one-half percent** (1.5%) annual savings for ten years (2021-2030)
3. **Two percent** (2%) annual savings for ten years (2021-2030)

The study estimates benefits that would accrue directly from the energy savings achieved in each scenario. We estimate four specific categories of benefits: utility system, economic, environmental, and participant bill savings. We also compare the estimated benefits against a range of potential program costs. Finally, we estimate the potential customer bill impacts associated with program spending over time, comparing two specific cost recovery approaches.

The universe of benefits discussed in this report captures many, but not all potential benefits of energy waste reduction. Other benefits include avoided renewable portfolio compliance costs, avoided compliance costs with existing environmental regulations, value of reduced capacity reserve requirements, reduced arrearages, improved comfort and safety, reduced maintenance costs, reduced price volatility exposure, and other nonenergy benefits.

Table 1 shows the estimated costs and benefits for these three scenarios. All values shown in table 1 are in present value terms, meaning the values over the 24-year period are expressed in 2021 dollars.

Table 1. Cost benefit results all scenarios, Ohio cost to achieve (NPV 2021$ millions)

	Scenario		
Benefits	**1.0%**	**1.5%**	**2.0%**
Utility System Benefits	2,665	5,330	7,106
Environmental Benefits	7,142	14,283	19,044
Total Benefits	**9,806**	**19,613**	**26,151**
Costs			
Program Costs	737	1,473	1,965
Total Costs	**737**	**1,473**	**1,965**
Net-Benefits			
Total	9,070	18,139	24,186
Cost-Benefit Ratio	**13.3**	**13.3**	**13.3**

As table 1 shows, the benefits for each scenario are significant, especially when compared against the projected costs. We describe each benefit in greater detail below.

1. **Utility system benefits:** Energy waste reduction programs provide significant benefits to the electric utility system. These benefits are achieved because energy waste reduction programs displaces traditional power generation and reduces the need for

future infrastructure expansion in generation, distribution, and transmission. The displacement of traditional generation reduces system costs and saves all customers money through reduced bills in future years. Energy waste reduction programs in Ohio also reduce the need for electricity imports. Ohio imports roughly 20% of its electricity needs from out of state, which may be avoided through local energy savings.[5]

2. **Environmental benefits:** Energy waste reduction programs produce substantial environmental benefits through reduced air pollution at power plants. As energy waste reduction programs reduce demand for electricity, fossil-fueled power plants reduce output, which reduces air emissions associated with power generation. The primary power plant emissions displaced include carbon dioxide (CO_2), nitrogen oxide (NO_X), sulfur dioxide (SO_2), and particulate matter. All these emissions produce harmful effects on human health and the natural environment. This analysis estimates the displaced CO_2, NO_X, and SO_2 emissions and quantifies the value of the avoided health harms, also known as damages.

The estimated program costs shown in table 1 are based on the most recent actual program costs per unit of saved energy in Ohio. As the results show, the programs are cost effective, even when only considering the utility system benefits.

An additional benefit of energy waste reduction programs is the programs stimulate the economy, increasing the state gross domestic product (GDP) and creating jobs. These benefits are created in multiple ways. First, spending on energy waste reduction programs generates direct jobs through the implementation and delivery of programs, which also stimulate many sectors of the economy. Second, the customer bill savings produced by the programs drive significant economic growth because customers inject these dollars back into the local economy. The positive benefits associated with the increased local spending driven by bill savings provide "ripple" effects through the economy creating jobs in many other sectors and boosting the local economy.

We used IMPLAN, an industry standard input/output economic model, to estimate economic benefits. Table 2 shows the results of the economic impact assessment. According to this analysis, the implementation of a 2% energy waste reduction goal would add $4.8 billion to Ohio's economy and create 172,651 job-years over the life of the program.[6]

[5] United States Energy Information Administration. Ohio Electricity Profile 2019. eia.gov/electricity/state/ohio/.
[6] A job year is equivalent to a job in any given industry over the period of one year.

Table 2. Total net economic and job creation impacts (job-years, NPV 2021$ millions)

Energy Savings Scenario	Total Value Added to GDP	Total Job-Years
1%	1,806	64,744
1.5%	3,612	129,488
2%	4,816	172,651

The programs also produce significant customer bill savings. Bill savings are the primary reason why customers invest in energy waste reduction technologies and change behavior. The bill savings drive economic growth as customers inject dollars back into the local economy. Businesses are also able to reduce operating costs and improve profit margins, while also reducing maintenance costs. Table 3 shows the projected participant bill savings for supply and distribution costs under each scenario. As the table shows, customers would save between $4.5 and $12.1 billion over the life of the energy savings depending on the scenario. Supply cost bill savings are over 60% of the total.

Table 3. Total participant bill savings (NPV 2021$ millions)

	Energy Savings Scenario		
Cost	**1.0%**	**1.5%**	**2.0%**
Supply	2,825	5,651	7,534
Distribution	1,705	3,409	4,546
Total	**4,530**	**9,060**	**12,080**

Utility sector energy waste reduction programs are generally funded through ratepayer bills. To understand the magnitude of the potential costs of funding programs at the customer level, we analyzed the bill impacts under two scenarios. The first scenario assumes all program costs are collected in one year (current practice in Ohio). The second scenario assumes all program costs would be collected over a five-year period. Collecting costs over multiple years reduces bill impacts on customers and more closely aligns cost recovery with the realization of system benefits. Table 4 shows the estimated bill impacts for an average residential customer in Ohio for the two cost recovery approaches for the three policy scenarios. As the table shows, the bill impacts would not exceed $2.50 per month for an average residential customer over the first five years, an amount which is greatly outweighed by the benefits customers receive.

Table 4. Projected monthly bill impact for average residential customer ($/month)

Scenario	Period	PY 1	PY 2	PY 3	PY 4	PY 5
1.0%	1 yr.	0.72	0.74	0.75	0.76	0.78
1.5%	1 yr.	1.44	1.47	1.50	1.52	1.56
2.0%	1 yr.	1.93	1.96	2.00	2.03	2.08
1.0%	5 yrs.	0.25	0.43	0.60	0.76	0.90
1.5%	5 yrs.	0.50	0.86	1.20	1.51	1.80
2.0%	5 yrs.	0.66	1.15	1.60	2.02	2.40

All three scenarios produced benefits that far exceeded the costs, which means bills for Ohioans are lower because of investment in energy waste reduction programs than they would be without the programs. The utility system benefits alone are cost effective, ranging between 1.7 to 3.6 times more benefits than costs (depending on the program cost assumption). Because the benefit categories are additive, each additional benefit component category only further increases the cost-effectiveness of the programs.

1 INTRODUCTION

This report estimates the costs and benefits of energy waste reduction programs in Ohio over a ten-year period (2021-2030). We examine the costs and benefits for three distinct policy scenarios, considering multiple costs and cost recovery approaches. The intent is to provide policy makers in Ohio with estimates on the potential costs and benefits of energy waste reduction programs in Ohio. We estimate four specific categories of benefits: utility system, economic, environmental, and participant bill savings. We compare the estimated benefits against a range of potential program costs. Finally, we estimate the potential customer bill impacts associated with program spending over time, comparing two specific cost recovery approaches.

Gabel Associates is an energy, environmental and public utility consulting firm with its principal office in Highland Park, New Jersey.[7] For over 25 years, the firm has provided highly focused and specialized energy consulting services and strategic insight to its clients. Gabel Associates has applied its expertise to improve the bottom line for hundreds of clients involved in virtually every sector of the energy industry. The firm has built its reputation on its extensive knowledge and rigorous analysis of energy markets. We have successfully assisted public and private sector clients implement energy plans and projects that reduce costs and enhance environmental quality. The firm possesses strong economic, financial, project development, technical, and regulatory knowledge.

Firm personnel also serve as expert witnesses on a wide range of issues at the Federal Energy Regulatory Commission ("FERC") and at State Commissions, including those related to energy and capacity markets, ratemaking and tariff design, energy efficiency/energy waste reduction, reactive rates, interconnection, renewable energy, electric vehicles, and mergers/acquisitions.

[7] gabelassociates.com

2 Policy Scenarios

This report examines the costs and benefits of three different energy waste reduction scenarios. All three scenarios are based on different annual electric energy savings performance targets for Ohio's six investor-owned utilities. Each scenario is based on achievement of annual energy waste reduction savings as a percentage of total sales. This common metric, savings as a percentage of total sales, allows a simple assessment of results and a direct comparison to other states and program implementers. This report only estimates benefits from electric energy waste reduction programs and excludes secondary natural gas savings from electric measures and programs concentrated on natural gas savings.

These scenarios are focused on performance and results and are not based on a specific approach to implementing energy waste reduction programs in Ohio. Specifically, the scenarios do not contemplate a mandated versus voluntary approach. Instead, this report focuses on estimating the costs and benefits of energy waste reduction savings performance across the State.

The three scenarios include:

1. **One percent** (1%) annual savings for ten years (2021-2030)
2. **One- and one-half percent** (1.5%) annual savings for ten years (2021-2030)
3. **Two percent** (2%) annual savings for ten years (2021-2030)

2.1 Data Sources and General Assumptions

All three scenarios incorporate common utility avoided costs, marginal emissions rates, commercial customer opt out, energy waste reduction program mix, measure lifetime, discount rate, energy and demand forecasts, and hypothetical utility capital structure. We evaluated multiple cost to achieve energy savings and program cost recovery approaches. Except where otherwise noted, our analysis relied on Ohio specific data. The energy waste reduction program level data, including the opt out percentage, cost to achieve, measure lifetimes, types of expected programs, and demand savings were all sourced directly from actual utility results in Ohio for 2019.[8] Relying on actual results for these variables provides the most accurate estimate of possible cost and benefit outcomes for Ohio.

We based the energy savings targets on the forecasted electric sales for all six investor-owned utilities in Ohio. The utilities include Ohio Power Company, Duke Energy Ohio, Dayton Power

[8] For the 2019 Ohio utility energy waste reduction program results, see Docket Nos. 20-1042-EL-EEC (Ohio Power), 20-0612-EL-EEC (Duke), 20-0724-EL-EEC (First Energy), and 20-0916-EL-POR (Dayton Power and Light).

and Light, Illuminating Company, Ohio Edison, and Toledo Edison.[9] The forecasts relied on the long-term forecasts from 2020 through 2030 filed at the Public Utilities Commission of Ohio (PUCO).[10] For years past 2030, consumption is expected to continue at similar growth levels of the previous ten years. The energy savings target is based on a gross savings goal, but benefits were estimated based on net energy savings. This ensures that only incremental savings from energy waste reduction measures that would not have otherwise been installed are included in the analysis. This adjustment to account for only incremental savings, known as a net-to-gross ratio, was assumed to be 90%; meaning that for 100 units of energy saved, 90 would occur as a result of the program, and 10 would have occurred regardless of whether the program had been implemented. The 90% net-to-gross ratio is sourced from recent planning factors used in Michigan. Table 5 list some additional modeling assumptions.

Table 5. General modeling assumptions

Assumption	Value	Source
Opt out percentage	22%	2019 Ohio Utility Reports
Net to gross factor	90%	2020 Michigan EE Plans
Residential savings lifetime	9.7 years	2019 Ohio Utility Reports
Business savings lifetime	13.3 years	2019 Ohio Utility Reports
Discount rate	5% nominal	

[9] Three of the six companies, Illuminating Company, Ohio Edison, and Toledo Edison are wholly owned subsidiaries of First Energy Corporation.

[10] The filed utilities sales forecasts can be found in Docket Nos. 20-0501-EL-FOR (Ohio Power), 20-0375-EL-FOR (Duke), 20-0657-EL-FOR (First Energy), and 20-0768-EL-FOR (Dayton Power and Light).

3 Benefits

This report examines four specific areas of energy waste reduction program benefits. The four areas include: avoided utility system costs, avoided air emissions (and associated avoided damages), and participant bill savings. The economic and job creation impacts related to these benefits are summarized separately in Section 4.

3.1 Utility System Benefits

Energy waste reduction programs provide significant benefits to the electric utility system. Waste reduction programs achieve these benefits by reducing the need for future spending on generation, distribution, and transmission systems. The displacement of traditional generation reduces system costs and saves all customers money through reduced bills in future years. Energy waste reduction programs in Ohio also reduce the need for electricity imports. Ohio imports roughly 20% of its electricity needs from out of state, which may be avoided through local energy savings.[11]

We estimated the future value of five specific utility system benefits. These benefits include avoided electric energy costs, avoided electric capacity costs, energy and capacity price suppression (also known as demand reduction induced price effects or DRIPE), and avoided transmission and distribution capacity. While electric energy and electric are savings realized by those installing energy efficient equipment, DRIPE and avoided transmission and distribution capacity costs are realized by all customers, regardless of whether or not they invest in energy waste reduction measures. Table 6 below shows the estimated utility system benefits for all three potential policy scenarios.

Table 6. Utility system benefits by scenario (NPV 2021$ millions)

	Energy Savings Scenario		
Benefit	**1.0%**	**1.5%**	**2.0%**
Avoided Electric Energy Costs	1,728	3,456	4,608
Avoided Electric Capacity Costs	237	474	632
Electric Energy DRIPE	603	1,205	1,607
Electric Capacity DRIPE	10	21	28
Avoided T&D Costs	87	174	232
Total Benefits	**2,665**	**5,330**	**7,106**

As the table shows, energy waste reduction programs would produce significant utility system benefits in all three scenarios. The values for each benefit and each scenario are presented in

[11] United States Energy Information Administration. Ohio Electricity Profile 2019. eia.gov/electricity/state/ohio/.

net present value terms of the benefit over the life of the energy savings. By presenting the values in net present value terms, decision makers can assess impacts across a large time period against one another.

All three scenarios assume energy waste reduction programs implemented over a ten-year period, but the programs would still produce substantial energy savings beyond the final year of implementation because savings continue for several years after implementation. The most significant benefit is the avoided electric energy costs, followed by electric energy price suppression. We describe these benefits in greater detail below, including the methodological approach used to quantify the value of each benefit across the three scenarios.

3.1.1 Avoided Electric Energy Costs

The avoided electric energy costs represent the wholesale electric market purchases that utilities avoid making because of reductions in energy usage associated with energy waste reduction programs. These costs are generally composed of fuel and operations and maintenance costs. This benefit also includes the value of avoided line losses, which are losses of electricity that naturally occur between the production and delivery of electricity to end use customers.

Ohio utilities operate as part of a regional wholesale market called PJM. To calculate the avoided electric energy costs, a blend of congestion-adjusted energy market forward trading price for PJM-Western Hub, the most liquidly traded zone in PJM, and forecasted prices from the Energy Information Administration ("EIA") in its 2020 Annual Energy Outlook generation reference case for the PJM/West region were used.[12] A marginal losses adjustment was applied using the average loss factor contained in the Ohio utility long term forecast filings.

3.1.2 Avoided Electric Capacity Costs

One of the primary benefits of energy waste reduction programs is avoiding or delaying the construction of or need for new power plants. While Ohio utilities do not own power plants, they purchase electric capacity from PJM on behalf of their customers and supply it to homes and businesses. Efficiency programs reduce demand across all hours of the year, reducing the amount of capacity needed to supply Ohio's electric customers.

The forecasted value of avoided capacity purchases for delivery year 2022/2023, the next period which has yet to hold a capacity auction, were estimated based on the average of the

[12] United States Energy Information Administration. Annual Energy Outlook 2020. Table 54. Electric Power Projections by Electricity Market Module Region (Reference Case, PJM/East Region). eia.gov/outlooks/aeo/data/browser/#/?id=62-AEO2020&region=5-10&cases=ref2020&start=2018&end=2050&f=A&linechart=ref2020-d112119a.130-62-AEO2020.5-10&map=&ctype=linechart&sourcekey=0.

previous three capacity auctions.[13] We forecasted all subsequent years, beginning in delivery years 2023/2024 based upon escalations from the EIA in its 2020 Annual Energy Outlook. These values were also adjusted for losses. In addition, the savings associated with capacity reductions were delayed to account for the fact that PJM procures capacity on a forward basis.

3.1.3 Demand Reduction Induced Price Effects (Energy and Capacity)

Waste reduction programs reduce customer usage throughout the year, but they add even greater value by reducing customer usage at peak times of peak energy usage, or peak demand. In addition to the direct energy savings to customers, waste reduction programs also have an impact on market pricing dynamics, causing prices to decrease relative to if no waste reduction had occurred. The demand reduction induced price effect ("DRIPE") price suppression impact is a benefit that captures the reduction in wholesale electric energy and capacity prices to all customers, not just participants, because of energy waste reduction. PJM wholesale markets are fundamentally supply and demand based – therefore, downward movement in the demand curve because of reduced consumption result in less expensive electricity used to meet customer demands. If either market "clears" at a lower price, the associated reductions in market prices flow through to all customers. A 2019 study of this benefit in Ohio found that the price suppression benefits to all customers in Ohio from the 2017 energy waste reduction programs were estimated to be approximately $2 per month for a typical residential customer.[14] Other jurisdictions have also estimated similarly high DRIPE benefits.[15,16]

This report estimates the DRIPE benefit for wholesale energy and capacity price suppression effects. This benefit accrues to all customers in Ohio because costs are reduced for all customers. The energy market DRIPE impact was calculated based on a predictive regression model that determined how energy prices in Ohio changed as a result of changes to load and natural gas prices. The capacity market DRIPE impact was calculated based upon data from PJM's scenario analysis of past base residual auctions to determine the impact of changes in load on the capacity clearing price.

[13] PJM Interconnection. 2020. Capacity Market. pjm.com/markets-and-operations/rpm.aspx.
[14] Chernick, P. 2019. *Energy Efficiency Benefits to All Customers: Price Mitigating Effects for Ohio.* Resource Insight, Inc. June 12. resourceinsight.com/wp-content/uploads/2019/06/Energy-Efficiency-Benefits-to-All-Customers.pdf.
[15] Neme, C. and P. Chernick. 2015. *The Value of Demand Reduction Induced Price Effects.* Regulatory Assistance Project. March 19. raponline.org/wp-content/uploads/2016/05/efg-ri-dripewebinarslidedeck-2015-mar-18-revised.pdf.
[16] Synapse Energy Economics. 2018. *Avoided Energy Supply Components in New England: 2018 Report.* October 24. synapse-energy.com/sites/default/files/AESC-2018-17-080-Oct-ReRelease.pdf.

3.1.4 Avoided Transmission and Distribution Capacity

Energy waste reduction programs produce small demand savings by each customer, but in aggregate can result in significant reductions to demand across the Ohio footprint. These demand savings can avoid or delay the need for future expansion of transmission and distribution capacity. Transmission and distribution systems are constructed to serve maximum or peak demand. As demand increases over time, the utilities invest in new transmission and distribution lines to accommodate the increasing demand. The value of avoiding or delaying these costs can be substantial. This benefit also reduces costs for all customers on the electric system, not just those who participate in programs.

We assumed an avoided transmission and distribution value of $30/kW-year for this analysis. This means that each year, for every MW that is reduced through the programs, customers will save $30,000. For context, Ohio has approximately 30,000 MWs of total load in PJM; therefore a 1% reduction could result in transmission and distribution savings of approximately $8 million per year. This figure is conservative when compared to other electric companies who have estimated this benefit in energy waste reduction cost benefit analysis. Depending on the utility, this value can exceed $200/kW-year. A 2014 study found an average value of $66.03/kW-year, but the study included several northeastern utilities with higher distribution and transmission costs.[17] Our assumption of $30/kW-year is less than half of this average.

3.2 Environmental Benefits

Energy waste reduction programs produce substantial environmental benefits through reduced air pollution from power plants. As demand for electricity is reduced through energy waste reduction programs, fossil-fueled power plants reduce output, which reduces emissions (air pollution) associated with power generation. The primary power plant emissions displaced include carbon dioxide (CO_2), nitrogen oxide (NO_X), sulfur dioxide (SO_2), and particulate matter. All these emissions produce harmful effects on human health and the natural environment. This analysis estimates the reduced CO_2, NO_X, and SO_2 pollution and quantifies the value of the avoided health effects.

[17] Mendota Group. 2014. Benchmarking Transmission and Distribution Costs Avoided by Energy Efficiency Investments. October 23. https://mendotagroup.com/wp-content/uploads/2018/01/PSCo-Benchmarking-Avoided-TD-Costs.pdf.

3.2.1 Avoided Air Pollution

The volume of avoided air pollution was estimated using marginal emissions rates sourced from the Emissions and Generation Resource Integrated Database (eGRID).[18] This data source relies on publicly available emissions data for nearly all electric power generation in the United States. The non-baseload tons per MWh estimate from the most recent eGRID data release (currently eGRID2018 released in March 2020) was used to estimate reduced CO_2, NO_X, and SO_2 emissions. These rates were then de-escalated over time based upon emissions rates from the most recent EIA Annual Energy Outlook (currently 2020) for the PJM/West region. We de-escalated the amounts to reflect the likely shift away from fossil-based generation towards less polluting generation sources. Table 7 shows the estimated avoided air emissions for the three energy savings policy scenarios. The value shown in the table is the total avoided pollution for the life of the energy savings in each scenario.

Table 7. Avoided air emissions by pollutant (tons)

	Energy Savings Scenario		
Pollutant	**1.0%**	**1.5%**	**2.0%**
CO_2	70,066,300	140,132,599	186,843,466
SO_2	51,637	103,274	137,698
NO_X	46,555	93,110	124,147

3.2.2 Avoided Emissions Damages

We base the social costs estimates on human and environmental health harms. Air pollution causes significant health harms resulting in lost workdays, hospital visits, asthma, respiratory disease, and increased morbidity for adults and children. Carbon dioxide emissions are a significant contributor to human induced climate change, which causes increased wildfires, droughts, hurricanes, and other costly weather events. Climate change also contributes to rising sea levels, which present significant costs to coastal communities. The negative social costs driven by power plant pollution are substantial and energy waste reduction programs reduce them substantially.

To estimate the avoided damages for CO_2 we used the "Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866" produced by the Interagency Working Group on Social Cost of Greenhouse Gases, United States Government.[19] The avoided damages from SO_2 and NO_X, were estimated using the February 2018 Technical Support Document Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors by the U.S.

[18] United States Environmental Protection Agency. Emissions and Generation Resource Integrated Database (eGRID). Released 1/28/2020, Revised 3/9/2020. epa.gov/energy/emissions-generation-resource-integrated-database-egrid.
[19] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. 2016 Technical Support Document: -Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis -Under Executive Order 12866. August 2016. epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf.

Environmental Protection Agency Office of Air and Radiation Office of Air Quality Planning and Standards.[20] These sources quantify the social costs or damages to human health and the environment per unit of pollution. To estimate the potential benefit, the per unit damage value is multiplied by the avoided air emissions.

Table 8 shows the estimated avoided social costs by pollutant for the three energy savings policy scenarios.

Table 8. Avoided emissions damages (NPV 2021$ millions)

	Energy Savings Scenario		
Pollutant	**1.0%**	**1.5%**	**2.0%**
CO_2	3,126	6,252	8,336
SO_2	3,550	7,100	9,466
NO_X	466	931	1,242
Total	**7,142**	**14,283**	**19,044**

3.3 Participant Bill Savings

Energy waste reduction program savings produce significant electric bill savings for customers that modify behavior and invest in efficient technologies. Bill savings are the primary reason customers engage in energy waste reduction programs and are the largest driver of economic benefits. Electric customers in Ohio pay utilities for both electricity supply and delivery of electricity on a monthly basis. We estimate bill savings for both parts of the bill.

To estimate the bill savings associated with supply for residential and small/medium commercial customers, we used the cost to compare energy price posted on the Public Utilities Commission of Ohio website.[21] For large commercial and industrial customers, we used the wholesale price of electricity because there is no cost to compare for these customers. We escalated supply costs by the same escalations used for avoided electric energy and capacity costs to reflect the increase in supply costs over time. Table 9 shows the participate supply bill savings for each scenario.

[20] United States Environmental Protection Agency. 2018. Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors. epa.gov/sites/production/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf.

[21] Public Utilities Commission of Ohio. Energy Choice Ohio. Accessed online on October 15, 2020. energychoice.ohio.gov/.

Table 9. Supply cost bill savings (NPV 2021$ millions)

Sector	Energy Savings Scenario		
	1.0%	1.5%	2.0%
Residential	1,208	2,416	3,222
Business	1,617	3,235	4,313
Total	2,825	5,651	7,534

To estimate bill savings for the delivery of electricity, we relied on publicly available tariff data for all six investor-owned companies. Using this data, we estimated the total effective price per kWh or kW for each tariff option for most electric rate options. We then weighted the effective rates by the total sales in 2019 to determine a weighted average effective rate for residential and commercial customers. We used these rates to estimate the direct participant bill savings. Table 10 shows the estimated participant distribution bill savings over the life of the measures for all three energy savings scenarios. It is expected that a small portion of these bill savings could be recovered from participants at a later date but were not removed from the values shown.

Table 10. Participant distribution cost bill savings (NPV 2021$ millions)

Sector	Energy Savings Scenario		
	1.0%	1.5%	2.0%
Residential	896	1,792	2,389
Business	809	1,618	2,157
Total	1,705	3,409	4,546

Customers realize substantial bill savings on both the electricity supply and delivery over the estimated ten-year life of the programs. Table 11 shows the total participant bill savings., which include both electricity supply and delivery bill savings. As noted above, we would expect a small portion of the distribution bill savings to be reallocated back to participants at a later time.[22]

[22] The effective rates included riders and other charges than may be recovered in later years if the electric utility was unable to recover all authorized revenues in the year in question. Electric utilities in Ohio are decoupled, meaning revenue shortfalls because of weather, economic conditions, or lost sales from energy waste reduction will be recovered in future periods. If a revenue shortfall exists, a company collects the unrecovered revenues from all customers and any lost bill savings are reallocated across a large number of customers. Therefore, it is unclear exactly what, if any, bill savings would be recovered from program participants at a later date.

Table 11. Total participant bill savings (NPV 2021$ millions)

Sector	Energy Savings Scenario		
	1.0%	1.5%	2.0%
Residential	2,104	4,208	5,610
Business	2,426	4,852	6,470
Total	4,530	9,060	12,080

4 Economic Impacts and Job Creation

Energy waste reduction programs can be a powerful tool for local economic development and job creation. While cost effective energy waste reduction programs provide many other benefits including lower utility system costs, improved health outcomes, and lower bills for program participants, the job creation and local economic growth benefits are critical and provide added value especially as states begin to recover from the COVID-19 pandemic.

Economic development benefits were estimated using IMPLAN, a widely used industry standard input/output model. IMPLAN estimates changes in the local economy based on spending and revenue changes to specific industries. IMPLAN is based on the interdependency between economic sectors, which allows estimations of impacts to the economy and ripple effects from changes in spending to specific sectors. The data in IMPLAN is sourced directly from the U.S. Bureau of Economic Analysis, Department of Agriculture, Bureau of Labor Statistics, and Census Bureau (among many other public sources).[23]

The economic impacts and job creation are categorized into direct, indirect, and induced impacts and jobs created. Direct impacts and jobs are those caused from the initial dollar spent or saved in the exact industry that dollar was spent or saved. Indirect impacts and jobs are those generated in the supply chain and support industries that are directly impacted by an expenditure. Induced jobs are those generated by the re-spending of received income resulting from direct and indirect job creation in the affected region. The indirect and induced jobs are created in many industries across the economy.

We modeled four distinct disruptions to the economy as a result of investing in energy waste reduction programs: (1) program expenditures; (2) participant bill savings; (3) ratepayer costs; and (4) lost revenue to generators. Program expenditures and participant bill savings represent positive impacts, while ratepayer costs and lost revenue to generators represent negative impacts. The summation of these four disruptions represents the net economic impact or jobs created as a result of energy waste reduction program spending in Ohio.

Economic impacts are evaluated by the amount of value they add to the state GDP. Job impacts are categorized by job-years created. A job-year is not a full-time permanent employee but refers to a job in a specific industry over a one-year time period. A job year is not always equal to a full time equivalent. For some industries, a job-year is greater than a full time equivalent, but for others, it can be less.
Table 12 summarizes the total net increase to the state GDP for the scenarios. The table shows the net effects, meaning all four components of the analysis were aggregated to produce the results. As noted in the description of potential costs, we relied on two estimates of the cost

[23] IMPLAN. Data Sources. implan.com/data-sources/.

to achieve energy savings; those being the actual cost to achieve of recent program expenditures in Ohio and in Michigan. The Ohio cost to achieve is based on the most recent cost of saved energy for the 2019 results. The Michigan cost of saved energy is based the most recently filed program plans for Michigan's two largest electric utilities, DTE and Consumers Energy.[24] All results shown in table 12 assume a five-year amortization of total energy waste reduction program expenditures.

Table 12. Increase in Ohio state GDP by scenario and sector (NPV 2021$ millions)

Energy Savings Scenario	Cost to Achieve Scenario	Residential Value Added to GDP	Business Value Added to GDP	Total Value Added to GDP
1%	Ohio	763	1,043	1,806
	Michigan	891	1,013	1,903
1.5%	Ohio	1,526	2,085	3,612
	Michigan	1,781	2,026	3,807
2%	Ohio	2,035	2,780	4,816
	Michigan	2,375	2,701	5,076

We estimated job creation using the same method described above. Table 13 shows the estimated job-year creation driven by the three scenarios under two cost of saved energy assumptions. Please note, a job-year is not a full-time permanent employee but refers to a job in a specific industry over a one-year time period. Values represent the total job-year creation over the life of the energy savings.

Table 13. Job-year creation by scenario and sector

Energy Savings Scenario	Cost to Achieve Scenario	Residential Job-Years	Business Job-Years	Total Job-Years
1%	Ohio	27,164	37,580	64,744
	Michigan	28,307	36,742	65,048
1.5%	Ohio	54,328	75,160	129,488
	Michigan	56,613	73,484	130,097
2%	Ohio	72,438	100,213	172,651
	Michigan	75,484	97,978	173,463

As tables 12 and 13 show, implementation of the savings target would produce significant economic benefits. Under the base cost and 1% energy savings scenario, which assumes a lower cost to deliver the program, $1.8 billion and 64,000 job-years would be added to the Ohio economy. Under the higher cost and 1% savings scenario, $1.9 billion and over 65,000 job-years would be added to the economy. All economic benefits shown in table 12 and 13 would accrue over the life of the energy savings.

4.1 Impact of Program Expenditures

Program expenditures are the funds spent by program administrators to implement and deliver energy waste reduction programs. These include the costs of energy waste reduction measures, the costs of installing energy waste reduction measures, and the costs of administering and overseeing energy waste reduction programs. This spending includes program implementation staff, utility staff, trade allies, installers, evaluators, and others. These create jobs in many industries and sectors that span retail, construction, engineering, plumbing, and other services. The spending also employs people in manufacturing, construction, wholesale trade, professional building services, retail services, and other industries.

We estimated the economic impacts and job creation of energy waste reduction program expenditures by using a program-by-program approach to break out materials and labor, mapping spending into specific industries within IMPLAN. The spending breakdown (i.e. customer incentives, program marketing, and other administrative costs) were derived from the historic spending structure of programs in Ohio.

4.2 Impact of Customer Bill Savings

Customer bill savings produced by the programs drive significant economic growth because customers inject these dollars back into the local economy. The positive benefits associated with the increased local spending driven by bill savings provide "ripple" effects through the economy creating jobs in many other sectors and boosting the local economy. Customer bill savings are partially offset by increases in customer bills related to the cost recovery of the avoided distribution costs. Because distribution costs are decoupled from energy usage in Ohio, these costs are ultimately recollected from customers. Therefore, we only calculated impacts associated with retail supply costs.

For bill savings, we mapped the increased disposable income to households by income level and to relevant commercial industries.

4.3 Impact of Ratepayer Costs

Ratepayers often fund costs associated with implementing energy waste reduction programs. These costs result in higher rates and bills associated with the cost recovery of energy waste reduction programs. The reduction in disposable income has the inverse impact as customer bill savings, and results in less money being spent throughout the economy.

To capture the negative economic impacts of higher rates and bills from the cost recovery associated with the programs, we calculated a proxy revenue requirement assuming that all costs would be expensed in the year they were spent. These costs were assumed to be borne by all ratepayers, not just those that qualify as low-income.

4.4 Impact of Generator Lost Revenues

The deregulated energy market in Ohio allows customers to choose their own energy supplier. It also means that energy suppliers, who are not regulated by the Commission, cannot collect lost revenues from customers. These lost revenues impact the energy suppliers as a corporate entity, but also their employees.

To capture the negative economic impacts of lost revenue to generators, we calculated the value of lost supply charges to customers based upon supply in Ohio. However, it is important to note that Ohio imports a portion of its energy from out of state, which means that a reduction of one MWh of consumption due to energy waste reduction does not mean that an Ohio based company would reduce its sales by one MWh.

5 Costs

Energy waste reduction program costs include costs expended by utilities to deliver the energy waste reduction programs. These costs include direct incentives to customers, administrative and implementation costs, marketing, evaluation, and other costs associated with program development and delivery. We relied on Ohio specific costs from programs delivered in 2019 to estimate future costs of programs. We calculated a weighted average of the cost of each unit of energy saved based on the results of all six Ohio utilities in 2019. We also considered an alternate cost of saved energy sensitivity based on a regional peer, Michigan. The Michigan cost to achieve is based on the weighted average of cost to achieve presented in the most recent program filings by Michigan's two largest electric utilities, DTE and Consumers Energy. We did not include participant costs in this analysis. Table 14 shows the first-year cost to achieve assumption by sector for our analysis based on this review.

Table 14. First year cost to achieve assumptions ($/first-year kWh saved)

Sector	Michigan	Ohio
Residential	0.26	0.10
Business	0.17	0.09

Using these values, we estimated the total cost of program for each scenario. Table 15 shows the net present value of program costs for each energy savings scenario under the Michigan and Ohio cost sensitivity.

Table 15. Program costs by scenario based on Michigan and Ohio assumptions (NPV 2021$ millions)

	Energy Savings Scenario		
State	1.0%	1.5%	2.0%
Ohio	737	1,473	1,965
Michigan	1,537	3,075	4,100

6 Customer Bill Impacts

Utilities recover energy waste reduction program costs from electric customers through rates. Utilities in Ohio have historically recovered annual program costs over a one-year period, known as "expensing" costs. Many utilities around the country utilize a different cost recovery approach for energy waste reduction. These utilities are permitted to invest capital in energy waste reduction and recover annual program costs over a multiple year period, earning a return on the unamortized balance. This approach utilized elsewhere in the country is analogous to how utilities invest and recover costs in typical electric distribution infrastructure By amortizing costs and spreading them out over multiple years, utilities are able to reduce bill impacts on customers, more closely align cost recovery with the realization of system benefits, and increase the attractiveness of investments in energy waste reductions.

We estimated bill impacts for all six scenarios (three energy savings and two cost to achieve). To do so, we estimated the revenue requirements per year for all six scenarios. We used the cost of capital weighted for all six Ohio utilities to estimate the return on investment. We also assumed 20% of program costs would be expensed in the amortization scenario (not all costs would be amortized) because it is unlikely the Public Utilities Commission of Ohio would allow the utilities to earn a return on the entire investment (for example, internal utility labor is often required to be expensed rather than amortized). Table 16 shows the monthly bill impact for an average residential customer in Ohio for ten years under all six scenarios.

Table 16. Projected monthly bill impact for average residential customer, expensing scenario ($/month)

Scenario	Cost	PY 1	PY 2	PY 3	PY 4	PY 5	PY 6	PY 7	PY 8	PY 9	PY 10
1.0%	OH	0.72	0.74	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.86
1.5%	OH	1.44	1.47	1.50	1.52	1.56	1.59	1.62	1.65	1.68	1.72
2.0%	OH	1.93	1.96	2.00	2.03	2.08	2.11	2.15	2.20	2.24	2.29
1.0%	MI	1.80	1.84	1.87	1.90	1.95	1.98	2.02	2.06	2.10	2.14
1.5%	MI	3.61	3.68	3.74	3.81	3.89	3.96	4.04	4.12	4.21	4.29
2.0%	MI	4.81	4.90	4.99	5.08	5.19	5.28	5.38	5.49	5.61	5.72

Table 17 shows the monthly bill impacts for an average residential customer assuming program costs are amortized over a five-year period, with the utility earning a return on investment.

Table 17. Projected monthly bill impact for average residential customer, amortizing scenario ($/month)

Scenario	Cost	PY 1	PY 2	PY 3	PY 4	PY 5	PY 6	PY 7	PY 8	PY 9	PY 10
1.0%	OH	0.25	0.43	0.60	0.76	0.90	0.97	0.99	1.01	1.03	1.05
1.5%	OH	0.50	0.86	1.20	1.51	1.80	1.94	1.98	2.02	2.06	2.10
2.0%	OH	0.66	1.15	1.60	2.02	2.40	2.59	2.64	2.69	2.74	2.80
1.0%	MI	0.62	1.08	1.50	1.89	2.25	2.43	2.47	2.52	2.57	2.62
1.5%	MI	1.24	2.15	3.00	3.78	4.50	4.85	4.95	5.04	5.14	5.24
2.0%	MI	1.65	2.87	4.00	5.04	6.00	6.47	6.59	6.72	6.86	6.99

As can be seen in tables 16 and 17 above, the ability to amortize costs over time reduces the annual bill impact to customers, even accounting for the provision of a return on investment to the utility.

7 Cost Benefit Summary and Conclusions

The universe of benefits discussed in this report captures many, but not all potential benefits of energy waste reduction. Other benefits include avoided renewable portfolio compliance costs, avoided compliance costs with existing environmental regulations, value of reduced capacity reserve requirements, reduced arrearages, improve comfort and safety, reduced maintenance costs, reduced price volatility exposure, and other nonenergy benefits.

When tabulated together, the benefits and costs provide a clear picture of the cost-effectiveness of prospective energy waste reduction programs in Ohio. Table 18 shows the cost benefit results for the three scenarios assuming the Ohio cost to achieve.

Table 18. Cost benefit results all scenarios, Ohio cost to achieve (NPV 2021$ millions)

	Scenario		
Benefits	**1.00%**	**1.50%**	**2.00%**
Avoided Electric Energy Costs	1,728	3,456	4,608
Avoided Electric Capacity Costs	237	474	632
Electric Energy DRIPE	603	1,205	1,607
Electric Capacity DRIPE	10	21	28
Avoided T&D Costs	87	174	232
Avoided CO_2 Emissions Damages	3,126	6,252	8,336
Avoided SO_2 Emissions Damages	3,550	7,100	9,466
Avoided NOx Emissions Damages	466	931	1,242
Total Benefits	**9,806**	**19,613**	**26,151**
Costs			
Program Costs	737	1,473	1,965
Total Costs	**737**	**1,473**	**1,965**
Net-Benefits			
Total	9,070	18,139	24,186
Cost-Benefit Ratio	**13.3**	**13.3**	**13.3**

Table 19 shows the cost benefit results for the three scenarios assuming the Michigan cost to achieve.

Table 19. Cost benefit results all scenarios, Michigan cost to achieve (NPV 2021$ millions)

	Scenario		
Benefits	**1.00%**	**1.50%**	**2.00%**
Avoided Electric Energy Costs	1,728	3,456	4,608
Avoided Electric Capacity Costs	237	474	632
Electric Energy DRIPE	603	1,205	1,607
Electric Capacity DRIPE	10	21	28
Avoided T&D Costs	87	174	232
Avoided CO_2 Emissions Damages	3,126	6,252	8,336
Avoided SO_2 Emissions Damages	3,550	7,100	9,466
Avoided NOx Emissions Damages	466	931	1,242
Total Benefits	**9,806**	**19,613**	**26,151**
Costs			
Program Costs	1,537	3,075	4,100
Total Costs	**1,537**	**3,075**	**4,100**
Net-Benefits			
Total	8,269	16,538	22,051
Cost-Benefit Ratio	**6.4**	**6.4**	**6.4**

Organizing each of the benefits into categories provides additional perspective into how and where the benefits from energy waste reduction flow. Table 19 arranges all nine benefits into four distinct categories. These categories are:

1) Utility system benefits, consisting of avoided electric energy costs, avoided electric capacity costs, and avoided T&D costs;
2) DRIPE benefits, consisting of electric energy DRIPE and electric capacity DRIPE; and
3) Emissions benefits, consisting of avoided CO_2 emissions damages, avoided SO_2 emissions damages, and avoided NOx emissions damages.

Table 20 displays the cost-benefit ratio of each individual component category. The sum of each individual category is equal to the total benefits, and total cost-benefit ratio, for each cost to achieve scenario.

Table 20. Cost benefit results by component category

Benefit Type	Cost Assumption	
	Ohio	Michigan
Direct Energy Benefits	2.8	1.3
DRIPE Benefits	0.8	0.4
Emissions Benefits	9.7	4.6
Total	**13.3**	**6.4**

These energy waste reduction programs also will have a direct impact on Ohio's economy. The economic impact assessment also demonstrated the potential for benefits through increases to the Ohio GDP and creation of jobs. Table 21 shows the results of this analysis.

Table 21. Economic impacts and job creation (2021$ millions, job-years)

Energy Savings Scenario	Cost to Achieve Scenario	Total Value Added to GDP	Total Job-Years
1%	Ohio	1,806	64,744
	Michigan	1,903	65,048
1.50%	Ohio	3,612	129,488
	Michigan	3,807	130,097
2%	Ohio	4,816	172,651
	Michigan	5,076	173,463

Overall energy waste reduction programs can produce substantial benefits for Ohio, even assuming program costs increase over time. As seen in table 20, the direct energy benefits alone are cost effective, ranging between 1.3 to 2.8 times more benefits than costs. Because these categories are additive, each additional benefit component category only further increases the cost-effectiveness of the programs. Overall, without consideration of environmental impacts, which are substantial, the programs would deliver 2.7 to 3.6 times the benefits as their costs to Ohio and its residents.

EXHIBIT NO. _____

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio Power Company for an Increase in Electric Distribution Rates.	)))	Case No. 20-585-EL-AIR
In the Matter of the Application of Ohio Power Company for Tariff Approval.	)))	Case No. 20-586-EL-ATA
In the Matter of the Application of Ohio Power Company for Approval to Change Accounting Methods.	)))	Case No. 20-587-EL-AAM

DIRECT TESTIMONY OF JON F. WILLIAMS ON BEHALF OF OHIO POWER COMPANY

Management Policies, Practices & Organizations

Operating Income

Rate Base

Allocations

Rate of Return

Rates and Tariffs

X Other

Filed: June 15th, 2020

INDEX TO DIRECT TESTIMONY OF JON F. WILLIAMS

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO
DIRECT TESTIMONY OF
JON F. WILLIAMS
ON BEHALF OF
OHIO POWER COMPANY

I. PERSONAL DATA

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Jon F. Williams. My business address is 301 Cleveland Ave., S.W., Canton, OH 44702.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am employed by Ohio Power Company ("AEP Ohio" or the "Company"), a subsidiary of American Electric Power Company, Inc. ("AEP"), as Managing Director of Customer Experience and Distribution Technology.

Q. WOULD YOU PLEASE DESCRIBE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. I graduated with a Bachelor of Science Degree in Mechanical Engineering from Clemson University in May 1981. I joined Appalachian Power Company, an AEP operating company, in June 1981 as a Commercial Engineer. I was promoted to Energy Services Engineer in 1985, Marketing & Customer Services Supervisor – Logan/Williamson Division in 1986, Marketing & Customer Services Supervisor – Roanoke Division in 1988, Business Services Supervisor & Healthcare Segment Manager in 1996, and Business Services Manager in 1998. I transferred to AEP Ohio and was promoted to Customer Service & Marketing Supervisor in 2000 and Customer Service & Marketing Manager in 2003. I was promoted to Manager of Energy Efficiency and Peak Demand Reduction

Programs in 2008 and was promoted to Director of Distribution Technology and Innovation in 2018. I was promoted to my current position in 2019.

Q. WHAT ARE YOUR RESPONSIBILITIES AS MANAGING DIRECTOR OF CUSTOMER EXPERIENCE AND DISTRIBUTION TECHNOLOGY?

A. I am responsible for all customer service activities for AEP Ohio, including all classes of customers. I support economic development activities to help grow Ohio businesses and communities. I am also responsible for alternative energy, the development of new "smart" distribution-related technologies for customers, as well as other projects and opportunities to benefit customers of all classes. I am responsible for the design, development, and implementation of customer programs helping customers understand and optimize their demand and energy use such as demand side management ("DSM").

Q. HAVE YOU PREVIOUSLY SUBMITTED TESTIMONY IN ANY REGULATORY PROCEEDINGS?

A. Yes. I have previously testified before the Public Utilities Commission of Ohio ("Commission") and filed testimony on behalf of AEP Ohio in proceedings concerning the Company's current and previous EE/PDR Program Portfolio Plans. I testified in support of AEP Ohio's 2009-2011 Plan (Case Nos. 09-1089-EL-POR and 09-1090-EL-POR) and AEP Ohio's 2017-2020 Plan (Case No. 16-574-EL-POR) and filed written testimony in support of AEP Ohio's 2012-2014 Plan (Case Nos. 11-5568-EL-POR and 11-5569-EL-POR). I filed testimony on behalf of AEP Ohio in the Solar Application case (Case No. 18-1392-EL-RDR).

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to support the following customer programs:

1. The AEP Ohio Demand Side Management ("DSM Plan") – provides a diverse suite of programs to cost effectively help customers overall with opportunities to optimize their peak demand with their overall energy use. This DSM Plan represents a return to a more traditional utility role of engaging customers to help manage the peak usage of energy along with ways to reduce energy through more efficient technology. Incentives to encourage customers to make more efficient choices, along with time of use, as well as low income programs, pilots and customer education and awareness are all part of the DSM Plan. In addition, the DSM Plan provides more overall benefits than costs.
2. Street and Area Light Conversion Plan ("SALC") – provides a five year conversion plan to replace inefficient and aging Company-owned and customer-provided street and area lighting to more efficient LED (light emitting diode) lighting with controls.
3. Communication Plan – provides targeted and enhanced communications to customers on safety, reliability and service as well as other opportunities to educate and raise awareness for customers.
4. Municipality Undergrounding Option – provides villages, towns and cities additional payment options to place existing Company overhead facilities in their footprint underground.

Q. ARE YOU SPONSORING ANY EXHIBITS?

A. Yes, I sponsor the following exhibits:

- Exhibit JFW-1 – DSM Plan

- Exhibit JFW-2 – DSM Plan Appendices
- Exhibit JFW-3 - Communication Plan

III. CUSTOMER PROGRAM – DEMAND SIDE MANAGEMENT PLAN

Q. ARE YOU THE ONLY COMPANY WITNESS PROVIDING TESTIMONY IN SUPPORT OF THE DSM PLAN?

A. No, I am the overall witness supporting the DSM Plan, but Company witness Lehman supports the Electric Transportation program as a part of the DSM Plan.

Q. PLEASE SUMMARIZE YOUR TESTIMONY IN SUPPORT OF THE DSM PLAN.

A. The DSM Plan proposed represents a return to the more traditional focus of the utility in helping customers save energy while also managing system demand at peak. While participants in the programs save energy and reduce demand, participants and non-participants alike benefit as well through the avoidance of generation costs in the Company's service territory over the life of the demand and energy saving programs. These avoided costs are less than the DSM Plan's costs for programs, so the DSM Plan is cost effective. The DSM Plan represents a suite of residential, business and cross sector programs that provide opportunities to benefit all customers. Additionally, the cost of the proposed DSM Plan is significantly lower than previous EE/PDR Plans submitted during the legislatively required energy efficiency period for each of the last eleven years, going back to 2010. Features of the DSM Plan include low income, small business, demand response, residential and business incentives, innovation funding for pilots to test new technology and approaches to optimize energy use, as well as community focus, education and training, and targeted outreach to raise customer awareness. Also, the DSM Plan

includes the growing use category of electric transportation to support managed charging for peak avoidance, innovation and access as electric vehicle use grows in the AEP Ohio service territory. Finally, AEP Ohio proposes an earned annual program administration fee of ten percent of DSM Plan spend if the DSM Plan is cost effective. An annual report of performance of the DSM Plan will be filed with the Commission.

Q. WHAT ARE THE DSM PLAN COSTS AND COST EFFECTIVENESS?

A. AEP Ohio proposes a diverse suite of demand side management programs to assist customers in lowering the peak demand of electricity, optimizing the use of energy, increasing customer satisfaction and supporting economic development in Ohio. The cost of the DSM Plan is $36.6 million annually, while the total benefits are $100 million annually. Net of other costs including the assumption that the Company earns the program administration fee and internal base labor costs, for every $1 spent over $3 in benefits are generated. Demand response is a key feature of the DSM Plan to develop the capability of reducing peak demand at scale for residential and business customers and helping to raise customer awareness of peak demand impacts. The DSM Plan relies on cost effective programs that are proven with the ability to upgrade the programs over time through pilots that can test new and innovative approaches. The DSM Plan cost is lower than programs approved ten years ago counting the inclusion of an electric transportation program to help customers with wider availability of charging as well as support to encourage off peak electric vehicle charging in this growing area of electric use. Annual reporting and evaluation of programs will be provided by the Company with a performance based program administration fee included for implementing a cost effective DSM Plan annually discussed in more detail later in testimony. Cost effectiveness is determined utilizing the

utility cost test ("UCT") and resource value test ("RVT") at the DSM Plan level and for each measurable program (Exhibit JFW-1, VI, Benefit-Cost Analysis). Figure 1 breaks down the annual demand and energy savings goals by program, budget, UCT benefits and ratios and RVT benefits and ratios.

Figure 1 – DSM Plan Benefit-Cost Details

Proposed Program	Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT Benefits	UCT	Non-Energy Benefits	Total Benefits	RVT
Efficient Products	5,900	30,039	$ 4,423,500	$ 13,454,935	3.0	$ -	$ 13,454,935	3.0
Retrofit Low Income	800	2,758	$ 7,000,000	$ 1,253,712	0.2	$ 7,595,000	$ 8,848,712	1.3
Residential Demand Response	17,400	58,015	$ 2,000,000	$ 2,540,391	1.3	$ -	$ 2,540,391	1.3
New Homes	2,400	4,317	$ 2,000,000	$ 2,768,313	1.4	$ -	$ 2,768,313	1.4
e3smart	400	3,817	$ 1,000,000	$ 1,535,912	1.5	$ -	$ 1,535,912	1.5
Residential Subtotal	**26,900**	**98,945**	**$ 16,423,500**	**$ 21,553,263**	**2.2**	**$ 7,595,000**	**$ 29,148,263**	**2.2**
Efficient Products for Business	13,200	88,244	$ 8,426,500	$ 34,815,742	4.1	$ 14,434,436	$ 49,250,178	5.8
Process Efficiency	900	18,068	$ 1,500,000	$ 7,629,883	5.1	$ 3,003,927	$ 10,633,811	7.1
Business New Construction	1,900	13,503	$ 1,500,000	$ 5,009,133	3.3	$ 2,174,870	$ 7,184,003	4.8
Small Business Express	1,200	7,091	$ 2,000,000	$ 2,835,349	1.4	$ 1,159,898	$ 3,995,246	2.0
C&I Demand Response	0	0	$ -	$ -	N/A	$ -	$ -	N/A
Business Subtotal	**17,200**	**126,906**	**$ 13,426,500**	**$ 50,290,107**	**3.7**	**$ 20,773,131**	**$ 71,063,237**	**5.3**
Community Energy Savers			$ 500,000					
Targeted Customer Outreach			$ 500,000					
Innovation and Technology			$ 1,300,000					
Education and Training			$ 450,000					
Electric Transportation			$ 4,000,000					
Cross Sector Subtotal			**$ 6,750,000**					
Total*	**44,100**	**225,851**	**$ 36,600,000**	**$ 71,843,370**	**2.3**	**$ 28,368,131**	**$ 100,211,500**	**3.0**

*Plan cost effectiveness tests include estimated base rate internal labor and program administration fee. Exclusions include: Retrofit Low Income and Cross Sector programs.

Q. WHY IS THE COMPANY PROPOSING A DSM PLAN AT THIS TIME?

A. The Company supports a more traditional role for DSM as discussed in previous testimony and also continues to support state policy objectives relative to this proposal. The timing fits with the elimination of requirements for electric distribution utilities to achieve mandatory annual energy and demand savings as a percent of sales. The Company has reviewed its past offerings as well as customer satisfaction with programs and determined that a return to a much smaller suite of cost effective DSM programs that focuses more on

traditional peak demand response and management along with helping customers save energy is beneficial through this cost effective DSM Plan proposal.

Q. HOW IS THIS DSM PLAN MORE OF A TRADITIONAL ROLE FOR THE COMPANY IN MANAGING ITS SYSTEM PEAK DEMAND AND HELPING CUSTOMERS SAVE ENERGY?

A. Historically, the Company has provided programs to help customers save energy and manage peak demand prior to any legislative requirements to do so. Examples include:

- programs that encourage customers to use equipment such as storage water heaters to heat water off-peak
- load management space heating equipment
- programmable thermostats to lower energy usage during peak times
- high efficiency heat pumps with a focus on proper installation and ductwork sizing to maximize comfort and system efficiency
- energy saving tips and education
- residential, business and industry analysis and audits to help customers understand and make informed decisions on options to optimize their demand and energy use
- incentives and pilot offerings to give residential and business customers the information and support to make more efficient choices in equipment
- programs targeted to provide lower income customers access to efficiency and demand reduction programs to save energy

The DSM Plan is a return to this more traditional role.

Q. WHAT ARE THE BENEFITS OF MOVING TO A MORE TRADITIONAL OFFERING OF DSM PROGRAMS TODAY?

A. It is even more important today to offer these traditional programs that the Company is uniquely positioned to provide to all customers. For example:

- The Company has invested in the smart grid with smart meters and a network that provides the opportunity to work with customers and a wide variety of partners in new ways to help optimize the grid through demand side management, helping all customers control cost and maximize their benefit as well as the system benefit for all customers. Many major end uses of electricity in homes, businesses and industry such as heating, ventilation and air conditioning, water heating, specialty and controlled lighting, plug loads and some industry specific processes are good candidates for reduction of peak demand through control. The customer needs to be aware of the opportunity, there should be a benefit to participate, and the customer needs the capability or technology to participate.
- Technology is evolving and growing. The Company can be an effective partner with customers and solution providers in taking full advantage of new opportunities. The combination of the DSM Plan along with increased technology can help customers manage demand and usage to optimize the grid. Demand management is a key component of the DSM Plan to reduce costs for customers. The DSM Plan can support and encourage the demand side management technologies that provide the most customer and system benefit. Lowering peak demand has system cost benefits at the generation, transmission and distribution levels. Generation benefits can be realized immediately. Transmission and distribution level benefits from demand response

incentives as well as participation in proposed rate offerings that encourage shifting to off peak use can be analyzed and included over time with the DSM Plan.

- In addition to the traditional role that supports offering a DSM Plan, the Company has significant experience on how to run cost effective programs and used this knowledge to inform the DSM Plan offerings.
- Another benefit is that Columbia Gas has long running energy efficiency programs and has a similar footprint as AEP Ohio. Having programs available from both companies can provide a greater benefit to shared customers. Both utilities work together on program offerings where it makes sense to maximize cost effectiveness.

Q. PLEASE PROVIDE A BRIEF COMPARISON OF THE COMPANY'S DSM PLAN TO COLUMBIA GAS OF OHIO'S MOST RECENTLY FILED DSM PLAN.

A. While each Plan focuses on improving efficiency and saving energy for customers, the energy sources, electricity versus natural gas, require differences in programs across sectors. For example, demand response, advanced or specialty lighting, air conditioning and plug loads are primarily electric options for improving efficiency, while customers have choices for improving efficiency with electricity or natural gas for space heating, water heating and cooking. Processes can also have options between the two energy sources for energy savings. The Plans of both Companies align closely on the e3smart school education program, the retrofit low income program, new homes program, energy benchmarking and incentives for business customers. AEP Ohio and Columbia Gas of Ohio have a long track record of working collaboratively to help our shared customers save energy, including working jointly to deliver similar programs to increase cost effectiveness. Recent examples are the e3smart program and energy benchmarking. Both Company's

Plans have similar levels of annual spending. AEP Ohio's total DSM Plan annual budget is $36.6 million compared to Columbia Gas proposed budget of approximately $35 million in 2020 and $35.7 million in 2021, the last year of their six year plan. (See PUCO Case No. 16-1309 Application Appendix B3 p. 25). Columbia Gas of Ohio serves approximately 1.4 million customers and AEP Ohio serves approximately 1.5 million customers.

Q. DO THE BENEFITS OF THE DSM PLAN OUTWEIGH THE PROGRAM COSTS?

A. Yes. The DSM Plan is designed to lower peak demand and energy use which avoids generation costs. Generation costs, current and forecasted, remain higher than the cost of the DSM Plan (Exhibit JFW-1, VI, Avoided Costs). By avoiding these higher costs of generation the DSM Plan is cost effective. Other financial benefits also could apply to further increase the cost effectiveness of the DSM Plan. Avoided transmission capacity costs are not included to justify cost effectiveness at this time because those benefits require further study to quantify. While avoided distribution costs are also not included as justification in this DSM Plan, reaching sufficient demand response capability for a given distribution circuit or station could defer distribution cost if additional capacity is required in that specific location. Developing scale to defer distribution cost for load growth at the distribution level would require circuit and station level concentration of customer participation sufficient to delay load growth impacts at the specific circuit and station, requiring a commitment to this effort over time. Another key financial benefit from the residential Retrofit Low Income Program is a reduction in charge-offs that occur from the energy and resulting bill savings by PIPP (percent of income payment plan) customers (Exhibit JFW-2, V, CAP Non Energy Benefits). Also, there are significant non-energy

benefits from business customer participation in programs due to operations and maintenance savings. (Exhibit JFW-2, IV, AEP Ohio C&I Non Energy Benefits Study). Participation in the DSM Plan supports sustainability goals and provides environmental benefits (Exhibit JFW-1, V.g., Benefits - Greenhouse Gas Reductions).

Finally, the Company will bid DSM Plan Resources into PJM, as opportunities are available. 80% of PJM revenues received will be utilized to supplement the DSM Plan budget in the years the revenues are realized, with 20% retained by the Company. The Company will bid eligible resources into base residual auctions, incremental auctions, or both at company discretion to manage risk and optimize revenue.

Q. DOES THE COMPANY'S DSM PLAN PROPOSED IN YOUR TESTIMONY SUPPORT STATE POLICY OBJECTIVES?

A. Yes, the DSM Plan encourages the state policy objectives in Ohio Revised Code 4928.02, including:

Policy Objective	AEP Ohio DSM Plan supports by:
(A) Ensure the availability to consumers of adequate, safe, efficient, nondiscriminatory, and reasonably priced retail electric service	• Helping customers manage their peak demand, ensuring adequate and efficient service. (Exhibit JFW-1, III., Programs) • Increasing customers' home or business energy efficiency while also managing demand helps to ensure reasonable cost of energy. (Exhibit JFW-1, III., Programs)
D) Encourage innovation and market access for cost-effective supply- and demand-side retail electric service including, but not limited to, demand-side management, time-differentiated pricing, waste energy recovery systems, smart grid programs, and implementation of advanced metering infrastructure	• The DSM Plan is positioned to respond to current, and adjust to new opportunities for demand side management and maximize the smart grid benefits. • Pilot opportunities are included to support innovation and adopt new approaches for cost effective DSM customer solutions. (Exhibit JFW-1, III. c., Cross Sector Programs).
(J) Provide coherent, transparent means of giving appropriate incentives to technologies that can adapt successfully to potential environmental mandates	• The DSM Plan is designed to provide incentives for cost effective technologies generating other benefits, including environmental, that will be captured and

	reported. (Exhibit JFW-1, V.g., Benefits - Greenhouse Gas Reductions)
(L) Protect at-risk populations, including, but not limited to, when considering the implementation of any new advanced energy or renewable energy resource	• The DSM Plan has a focus on low income programs and low income geographic area support to provide both programming and incentive levels that are aligned with means (Exhibit JFW-1, III., Programs)
(M) Encourage the education of small business owners in this state regarding the use of, and encourage the use of, energy efficiency programs and alternative energy resources in their businesses	• Just as with low income, small business has a specific program focused on that segment to provide higher incentives to support this group. (Exhibit JFW-1, III.b.iv., Small Business Express Program).
(N) Facilitate the state's effectiveness in the global economy	• The DSM Plan is cost effective, providing a net benefit to all customers. (Figure 1). • The DSM Plan supports economic development through a focus on improving energy density of products and services, reducing the cost of those products and services and making customers more competitive. (Exhibit JFW-1, V.h., Economic Development) • The DSM Plan is an added benefit for new business and industry considering local communities throughout the Company's service territory.

Q. PLEASE PROVIDE A BRIEF OVERVIEW OF THE RESIDENTIAL CUSTOMER PROGRAMS.

A. The residential programs include low income programs, efficient products, new homes, energy education and demand response incentives to help residential customers manage their peak demand (Exhibit JFW-1, III.a., Residential Programs).

Q. PLEASE PROVIDE A BRIEF OVERVIEW OF THE BUSINESS CUSTOMER PROGRAMS.

A. The business programs include small business, efficient products for business, new construction, process efficiency and demand response incentives to help business customers manage their peak demand (Exhibit JFW-1, III.b., Business Programs).

Q. PLEASE PROVIDE A BRIEF OVERVIEW OF THE CROSS SECTOR PROGRAMS.

A. The cross sector programs (Exhibit JFW-1, III.c., Cross-Sector Programs) include raising customer awareness of programs through community based efforts and targeted customer outreach to drive participation, education and training, to help customers understand better the opportunities and benefits of demand side management and energy efficiency. Programs also include innovation and technology to support new opportunities to pilot emerging technology and foster more cost effective program implementation. The Electric Transportation program focuses on supporting the growing electric vehicle charging sector to maximize demand side management of electric vehicle charging as well as supporting fleet opportunities and corridor charging growth. See (Exhibit JFW-1, III.d., Electric Transportation Programs) for program details and for supporting testimony of the Electric Transportation program see Company witness Lehman's testimony.

Q. PLEASE DESCRIBE HOW THESE PROGRAMS WERE SELECTED AND IF THEY ARE SUPPORTED BY A MARKET POTENTIAL STUDY.

A. The focus was to identify the more traditional role for the utility and how to incorporate that with the Company's significant experience running a mix of cost effective programs. A specific focus missing from current programs was demand side management efforts such as demand response. The Company also included inputs from the latest market potential study completed in 2019 along with actual program results to develop this DSM Plan. A growing electricity demand segment of electric vehicles and charging was included because the impact on peak demand is expected to be significant. The Electric Transportation program addresses and supports this growth through managed charging,

access to charging and by raising customer awareness. The measures and programs selected were based on cost effectiveness, opportunities for customer participation across customer classes and/or covered a critical segment such as lower income customers and small businesses where additional customer assistance is needed to manage costs and increase efficiency. Demand response incentives are now included to manage peak demand, increase customer awareness of the benefits of reducing system demand at peak and reduce future associated costs of utility resources needed to meet peak demands. The DSM Plan was further supported by a market potential study completed by Navigant in 2019. The market potential study is available for review with the Company by request due to its complexity and size. The Company took the results of the market potential study and program results to determine the measures and programs to include in this DSM Plan (Exhibit JFW-2, section I, DSM Plan Measure List). The Electric Transportation program was also informed by the initial results of the EV Charging program pilot (Exhibit JFW-2, VIII., Electric Vehicle Status Report) as well as supported in Company witness Lehman's testimony.

Q. IS THE COMPANY PROPOSING A FEE FOR PROGRAM ADMINISTRATION?

A. Yes, the fee is earned if the Company achieves a cost effective overall DSM Plan performance in a program year. The Company achieves a cost effective DSM Plan by focusing on keeping administrative costs low and participation as high as possible through effective implementation and incentive levels. If the DSM Plan is cost effective for the year based on the RVT test as defined in the DSM Plan (Exhibit JFW-1, VI., Cost-Benefit Analysis), the program administration fee will be calculated by multiplying the overall DSM Plan spend in the program year (twelve months) by ten percent. However, if the

DSM Plan is not cost effective in a given program year (twelve months), the Company will not receive the program administration fee. The program year will begin two months following the date of approval of the base case to allow for ramp up of programs.

Q. HOW WILL DSM PLAN COSTS BE MANAGED?

A. The Company will manage to the DSM Plan budget of $36.6 million. Any costs incurred in excess of this limit will not be recoverable. Any unspent DSM Plan dollars will be adjusted in the annual Economic Development Cost Recovery Rider as explained by Company witness Moore. Residential costs will be recovered from residential customers and non-residential costs will be recovered from non-residential customers. The Company will be able to shift program dollars within residential and business sectors to meet customer needs and/or improve cost effectiveness, with the exception of designated low income funding.

Q. HOW WILL AEP OHIO MEASURE PROGRAM SAVINGS AND REPORT PERFORMANCE?

A. The Company will evaluate programs through Evaluation, Measurement and Verification activities to verify gross program demand and energy savings impacts and provide annual reporting to monitor program and DSM Plan performance. The Company plans to use a variety of methods to measure performance including direct measurement of savings, calculated savings using methods found in the Ohio Technical Reference Manual ("TRM") or other reasonable statistical and/or engineering methods. The Company will use the Ohio TRM as long as it is available and will justify additional measures as needed to supplement the TRM. These activities will determine actual program level gross savings and help

maximize the net benefits of each program and the DSM Plan overall. The Company will file annual reports with the Commission on performance and cost/benefits achieved at the DSM Plan and program level, including justification for the performance based program administration fee, no later than five months following the end of the program year.

Q. WILL THE COMPANY EXECUTE THESE PROGRAMS INTERNALLY OR HIRE EXTERNAL IMPLEMENTERS TO ASSIST THE COMPANY?

A. The Company has significant experience internally to manage and run programs and will bring that customer program experience to the successful execution of the DSM Plan, including internal labor costs moved into base rates from the test year of approximately $5.1 million in total (see Adjustment C-3.8). The entire labor amount moved will not be solely focused on the DSM Plan and will be utilized for other necessary work in support of customer service, customer communications and other customer program work, such as smart cities and alternative energy work. $4.2 million of the $5.1 million amount was used as an estimate of internal labor cost in the calculation of cost effectiveness of the overall DSM Plan. Any actual base rate labor costs used to manage and run programs will be included in the cost effectiveness calculations of the overall DSM Plan on an annual basis. The internal cost component is expected to be lower than historical costs due to the smaller scale of programs offered. External contractors to implement programs, process applications and pay incentives are also important. Some programs may be better served to implement with external parties such as a marketplace, the community assistance program if utilizing community action agencies or efficient products programs for residential or business that are more application and process focused. Other programs may be more cost effective to run in-house such as community programs, education and

outreach. For those programs that are implemented externally, qualified third party contractors should be selected through a competitively bid process to the extent possible and the costs should be comparable or lower than the cost of implementing the programs internally.

Q. HOW DOES THE DSM PLAN SUPPORT ECONOMIC DEVELOPMENT AND JOBS IN OHIO?

A. The DSM Plan supports economic development and jobs in Ohio as approximately 2,600 direct and indirect jobs in the energy services industry are created and retained (Exhibit JFW-1, V.h., Economic Development). Ohio based employers who manufacture, distribute, sell and install energy efficiency measures have consistently benefitted from programs to raise awareness, inform customers and incentivize highly efficient equipment and process sales. The new area of demand response and the enabling equipment that support it are provided by a number of companies in Ohio to help customers. Many energy services firms provide consulting and engineering services to help customers and the DSM Plan will provide further assistance to support their efforts. AEP Ohio already has over 600 solution provider firms that are supporting current programs with almost 1,200 employees engaged. Those jobs could be at risk without the DSM Plan.

Q. HOW DOES THE COMPANY EXPECT CUSTOMER SATISFACTION TO BE IMPACTED BY OFFERING DSM PROGRAMS?

A. From surveys, previous experience and customer feedback from similar programs, we expect that customer satisfaction will be very positive. Based on 2019 JD Power survey results of AEP Ohio residential customers, respondents familiar with AEP Ohio's Energy

Efficiency Programs were 230 points (23% higher on a scale of 1000) more satisfied with AEP Ohio overall than those respondents not at all familiar with energy efficiency.

Also, a survey completed by Opinion Dynamics in January 2020 showed 72% of customers rated the AEP Ohio Marketplace a satisfaction of 4 or 5 on a 5 point scale. Less than one percent (0.9%) said they were not at all satisfied.

According to the ESource Business Survey 2019, the question was asked of the Company's business customers: "Should the Utility offer a variety of rate options, programs, and services?" AEP Ohio customer responses were 8.2 out of 10. Another question asked was "Should the Utility provide resources that help me manage energy costs and make informed decisions?" AEP Ohio customer's response was 8.4 out of 10.

Q. DOES THE COMPANY INTEND TO USE A COLLABORATIVE PROCESS WITH STAKEHOLDERS TO INFORM AND OBTAIN FEEDBACK ON THE DSM PLAN AND PROGRAMS?

A. Yes. AEP Ohio has had a successful collaborative in place since 2010 and plans to continue that effort to help inform and gain input on DSM Plan performance and ways to improve and enhance the programs.

IV. CUSTOMER PROGRAM – STREET AND AREA LIGHT CONVERSION PLAN

Q. PLEASE SUMMARIZE YOUR TESTIMONY IN SUPPORT OF THE STREET AND AREA LIGHT CONVERSION (SALC) PLAN.

A. The Company has aging and inefficient street lights ("SL") and area lights ("AL") that need to be replaced. The choice includes staying with the same high intensity discharge ("HID") lighting sources such as high pressure sodium, mercury vapor and metal halide or moving to more efficient and higher quality LED lighting. Over the years, the Company

has studied its lighting offerings to customers to determine when a cost effective switch could be made to LED lighting. With the smart grid deployment, lighting control also became viable. Combined with that development, along with lower costs as the technology improved and more energy efficient and higher light quality, the SALC Plan with LED lighting became the best option to replacing AEP Ohio's aging infrastructure. The SALC Plan is cost effective and the Company is proposing to make the approximately $101.5 million in capital costs and $3.0 million in annual ongoing Operations and Maintenance (O&M) expenditures over five years to change out the lights. As supported by Company witness Roush, the proposed LED monthly costs are lower than the existing lighting monthly costs on average.

Q. HOW IS AEP OHIO PROPOSING TO ADVANCE SL AND AL?

A AEP Ohio is proposing a program to replace all existing SL and AL with LED fixtures with networked controllers installed at each of the approximate 225,000 locations identified. This work is planned to be completed over a period of 5 years.

Replacing existing SL and AL with LED fixtures provides a number of benefits to the customers including:

- Lower energy costs
- Lower average monthly cost across customer base
- Metered energy costs
- Capability for customers to dim lights for further savings
- Reduced carbon output
- Better quality light
- Longer life

- Better maintenance response

The Company has the opportunity to provide our customers with better lighting capability, control and service while also saving energy.

Q. WHY IS NOW THE RIGHT TIME TO EXECUTE THE SALC PLAN?

A. Not only are our customers increasingly requesting LED lighting, but over 90 percent of our lighting fixtures are past their useful life. Accordingly, it makes sense to begin to deploy customer-requested lighting that also offers a host of operational and economic benefits that our current lighting does not. Additionally, with rising maintenance costs and the industry shift to LED lighting, it is no longer practical to offer HID lighting. The overall benefits of updating the SL and AL fixtures to LED include updating obsolete fixtures with more energy efficient, longer-lasting, networked enabled hardware that provide energy and maintenance costs savings to our customers.

Q. HOW HAVE SL AND AL EVOLVED?

A. In the late 1960's, High Pressure Sodium ("HPS") fixtures were developed and over the course of a decade became the most common lighting fixtures used for SL and AL. These HPS fixtures were more efficient than their predecessors were, and their distinct yellow glow identifies them easily. They are still the most common fixtures that AEP Ohio provides as a service for SL and AL. LED lighting started to become popular for SL and AL around 2006, and although the cost of the fixtures was initially high, the quality and control of the light output as well as the energy and maintenance savings made them desirable to customers.

Q. PLEASE GIVE AN OVERVIEW OF AEP OHIO'S CURRENT STANDARD FOR SL AND AL.

A. AEP Ohio provides SL as a service on roadside poles to our municipal customers to light up roadways and provide safety and security to residents of these communities. Fixtures facing down onto the roadway (cobra head) are the most common fixture, but we also provide post-top fixtures along roadways for SL as a service as well. Additionally, AEP Ohio also provides AL as a service on roadside and non-roadside poles to residential and business customers. These AL are directed so as to light up our customers' properties from dusk to dawn.

The dominant technology currently used to provide AEP Ohio's SL and AL service are HPS fixtures. AEP Ohio installs SL and AL only on AEP Ohio's poles, and are responsible for the installation and maintenance of these fixtures and facilities under the terms of the service we provide our customers, and are responsible for billing our customers accurately for these services.

Q. HOW MANY SL AND AL DOES AEP OHIO MANAGE TODAY?

A. AEP Ohio provides a SL service for about 700 accounts with our municipal customers, with about 100,000 individual SL being billed on those accounts. Additionally, AEP Ohio also currently provides AL services to about 115,000 fixtures with our residential and business customers.

Q. WHY ARE SL AND AL IMPORTANT FOR AEP OHIO CUSTOMERS?

A. AEP Ohio's SL and AL services provide a number of important benefits for our communities and customers. Properly designed SL and AL provide a pleasant environment, discourage crime and add safety and security to the public. SL and AL can

extend the hours in which there is available light for activity to take place. SL and AL also assist drivers, cyclists, and pedestrians to find their way in what otherwise would be darkness. SL and AL provide our customers with a sense of safety and security, on the roadways, at their businesses and at their homes.

Q. IS A LARGE PERCENTAGE OF AEP OHIO'S EXISTING SL AND AL BEYOND THEIR USEFUL LIFE?

A. Yes, more than 90 percent of the currently deployed SL and AL fixtures have been installed and operating for more than twenty years, which is the useful life of an SL or AL. This includes over 50 Incandescent ("INC") and more than 9,300 Mercury Vapor ("MV") fixtures, technologies that were considered outdated about 40 years ago when the Company began installing HPS fixtures only.

Q. HAS THE CHALLENGE TO MAINTAIN THE EXISTING SL AND AL INCREASED?

A. Yes. AEP Ohio's inventory of SL and AL consists of older technology and antiquated fixtures, including INC, MV, Metal Halide ("MH"), and HPS lamps. This creates limitations that lead to higher maintenance costs. Another limitation is the inability to determine remotely whether a SL or AL is operating properly. Existing controls on Company-owned SL and AL do not alert the Company when the light malfunctions. As a result, the Company often is unaware of inoperative SL and AL until the customer informs the Company. The Company relies upon customer feedback and sometimes complaints to learn of malfunctioning lights. As a result, the Company is unable to plan and schedule maintenance efficiently. Repair crews have no way of efficiently testing whether there are additional SL or AL that need maintenance in the area they are currently dispatched.

Finally, multiple notifications of the same non-functioning SL or AL often can result in additional repairs being made to a SL or AL that had already been repaired.

The SALC Plan to upgrade to LED fixtures with networked controls remedies much of this situation where we will know which fixtures are operating well and which need repair, thereby reducing energy cost and increasing operation and maintenance savings. By deploying LED fixtures with networked controllers, the Company will immediately and automatically be alerted to lighting malfunctions, and will no longer need to rely upon customers to call in and report malfunctioning fixtures. Not only will this reduce AEP Ohio's call center volume (and thus lead to operational savings), it will also allow for more efficient dispatch of repair crews to ensure all failed SL and AL are scheduled to be repaired appropriately. These actions also improve customer satisfaction by helping the Company repair malfunctioning lights more quickly.

Q. DO YOU CURRENTLY HAVE SYSTEM AND PROCESS CHALLENGES THAT MAY LEAD TO INACCURATE BILLING?

A. Yes. The SL and AL currently deployed are not metered devices. The Company bills customers for energy use by estimating the power utilization based upon the wattage of the SL or AL fixtures and the number of hours of darkness each month based upon the U.S. Naval Observatory's astronomical chart. This system has been used for years but is unable to validate each individual SL or AL's power usage. Customers can also be billed for power usage based on unreported failed SL or AL.

Further, while pole inventories are scheduled every 5 years, SL and AL that are removed between inventories are not always trued-up until the next inventory. This can lead to customers being billed for SL or AL that have been removed for years. Municipal

customers can request an audit of their SL account to ensure the billing is accurate for the size and quantify of the provided SL service. These audits are currently done manually and are time consuming for both the Company and its customers.

Q. DO YOU CURRENTLY HAVE THE ABILITY TO EASILY TURN ON OR OFF YOUR SL OR AL?

A. No. The Company currently must send a servicer (and truck) to the location of the SL or AL in question, access the fixture either by bucket truck or by climbing the pole to connect or disconnect the fixture, and then turn the light on or off. This cost is only slightly less than having to service or replace a SL or AL fixture altogether. The request to turn on or off a fixture occurs more often with AL customers where there are more frequent tenant changes.

Q. DO YOU CURRENTLY KNOW WHEN SL OR AL ARE NOT FUNCTIONING CORRECTLY OR ARE IN NEED OF REPAIR?

A. No. AEP Ohio's current SL and AL do not have the capacity to self-identify any repair needs. The only way AEP Ohio can tell if a SL or AL is not functioning properly is by visual observation of that fixture when it should be on. Most frequently, AEP Ohio is alerted to a problem of a fixture not performing properly by notification from the municipal SL customer or a member of the municipality. Typically, we also need to be notified by AL account holders when one of their fixtures are not performing properly.

Q. DO YOU EXPERIENCE CUSTOMER FRUSTRATIONS WITH THE EXISTING SL AND AL SERVICES FROM AEP OHIO?

A. Yes, AEP Ohio has experienced customer frustration with our SL and AL programs over three central issues. The first issue is that municipal, residential and business customers

question why AEP Ohio is not able to tell the working status of our fixtures, and they are frustrated with the need for customer notification for AEP Ohio to respond and repair the fixtures.

A second issue is that our municipal SL customers often voice concern over whether we are billing for the correct number and type of SL fixtures. Inquiries can lead to requests for audits of our facilities that, depending on the size of the community, can take a considerable amount of time and effort on behalf of both parties to physically audit the fixtures in the field.

The third central frustration point is more recent. A number of our municipal customers have asked us to replace our existing SL and AL systems with LED fixtures for multiple reasons. Over time, LED SL and AL technology has proven to provide a better quality of light that enhances the appearance of the community. Customers are also very aware of the energy savings from LED lighting. The fact that we cannot yet change these fixtures to LED for our municipal customers gives them the impression that we do not want to offer them the energy savings and benefits LED fixtures provide.

Q. DOES THE SALC PLAN UTILIZE ANY EXISTING MODERN TECHNOLOGIES RECENTLY DEPLOYED?

A. Yes. AEP Ohio has pre-qualified LED SL and AL fixtures as well as networked light controllers with billing quality metering capabilities. These technologies have also been deployed on over 500,000 SL and AL at Florida Power and Light as well as another 270,000 SL and ALs in the City of Chicago. Both these locations have weather conditions meeting or exceeding the expectations for conditions within the AEP Ohio territory.

Results reported from each of these deployments have been positive for operation and reliability.

Q. WHAT ARE THE ESTIMATED DIRECT COSTS?

A. The proposed deployment of LED fixtures with networked controllers installed will require approximately $101.5 million in capital costs and $3.0 million in annual ongoing O&M expenditures. The estimated average direct capital costs of an LED street light with a networked controller is approximately $437 each. The estimated average direct capital costs of an LED area light with a networked controller is $504 each. The blended estimated direct capital costs of both LED SL and AL with network controllers is approximately $451 each for the full deployment across AEP Ohio's footprint. Figure 2 below provides the estimated direct cost across the 5-year deployment:

Figure 2 - Direct Cost of Street and Area Light Conversion Plan

Total Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Deployed	45,000	45,000	45,000	45,000	45,000	225,000
Capital Costs	$20.3M	$20.3M	$20.3M	$20.3M	$20.3M	$101.5M
Ongoing O&M Cost	$0.2M	$0.4M	$0.6M	$0.8M	$1.0M	$3.0M
Total	$20.5M	$20.7M	$20.9M	$21.1M	$21.3M	$104.5M

Q. HOW DOES PROPOSED LED TECHNOLOGY RATE COSTS COMPARE WITH CURRENT SL AND AL TECHNOLOGY RATE COSTS?

A. The proposed rates for LED replacement of AL and SL across the Company's service territory saves the customers a weighted average of $1.71 per fixture per month (including

the base rate and energy cost), over the existing SL and AL rates. AL on average save $3.25 per fixture per month across the footprint while SL saves an average of $0.03 per fixture per month. While there are different savings across historical territory boundaries, the new rates true-up charges so each customer pays the same rate for similar implementations regardless of location.

Q. WHAT IS THE PROPOSED DEPLOYMENT PERIOD?

A. AEP Ohio is proposing the replacement of all Company-owned SL and AL over 5 years. The SALC Plan proposes a balance between moving quickly to take advantage of the benefits and minimizing the disruption to Customers and cities. The plan is to address all the SL in a particular area first to minimize the confusion of mixing HPS and LED lights on the same street. We will also coordinate with customers to address changing out AL when our crews are in that area. We will move through the AEP Ohio territory coordinating with customers and our contract crews to meet the scheduled timeline. The exact number of SL and AL changed during each year of the deployment may vary based upon customer requests and schedules.

Detailed schedule planning will begin once AEP Ohio receives approval for the project. The Company estimates kicking off the project in 2021 and completing all work by the end of Q4 2026. All requests for new SL or AL installations received from Customers after the approval of the tariff will be fulfilled using the LED lights with network controller technology.

Q. PLEASE DESCRIBE HOW LED LIGHTING COMBINED WITH NETWORK CONTROLLERS LEADS TO MORE ACCURATE BILLING.

A. The networked controllers installed on the LED SL and AL provide billing-quality meter data to the Company to allow our customers to be billed for their actual energy usage instead of estimated energy usage. This becomes critically important should the customer decide to take advantage of SL or AL dimming capabilities to further reduce their energy usage.

In addition, the networked controllers provide real-time status, and identify the Global Positioning System (GPS) coordinates location to the central network control system. The Company plans to integrate this information into our pole inventory system to maintain the real-time status of the SL and AL. This system will allow the Company to true up customer accounts in a timely manner.

Q. PLEASE DESCRIBE HOW THE NETWORKED CONTROLLERS METERING CAPABILITIES WOULD BE USED FOR BILLING PURPOSES OF THE LED SL AND AL ELECTRIC ACCOUNTS.

A. The Company plan is that all LED SL and AL shall be metered and billed the metered kilowatt-hour usage each month after the transition period when the Company has metering capability.

Q. DO LED SL AND AL USE LESS ELECTRICITY AND LOWER ELECTRICITY COSTS?

A. Yes, LED SL are 63 percent more energy efficient on average and AL fixtures are 52 percent more energy efficient on average compared to the SL and AL currently deployed across AEP Ohio's footprint. Combined, a full replacement of both SL and AL results in

over 111,000 MWh of energy saved per year. This provides direct savings to our customers of approximately $6.5 million annually.

Q. HOW DO LED SL AND AL REDUCE MAINTENANCE COSTS?

A. LED SL and AL fixtures have a much longer anticipated life span than the AEP Ohio legacy lighting currently in service. The older MV, MH and HPS fixtures last between 12,000 and 24,000 hours (roughly 3 to 6 years) before they must be replaced. In contrast, LED lights last between 100,000 and 110,000 hours (up to 25 years) depending upon operation mode. LED SL and AL should only require scheduled maintenance at roughly one quarter of the rate of our current technology. The need for fewer repairs means reduced maintenance costs.

Q. ARE LED SL AND AL BETTER FOR THE ENVIRONMENT?

A. Yes. Approximately 111,000 MWh of energy saved per year translates to an annual reduction in Greenhouse gas emissions of nearly 99,000 metric tons. Further, LED lighting provides better quality light for visibility while directing the majority of the light towards the intended area. The LED SL and AL provide a clean white light that is directed at its target with little spill over or light trespass. LEDs also generate far less heat than older technologies. Simply by switching to LED SL and AL, it is possible to provide better quality lighting, lower energy consumption, and reduced CO2 emissions.

Q. ARE THERE ADDITIONAL BENEFITS OF LED SL AND AL WITH NETWORKED CONTROLLERS?

A. Yes. In addition to enabling better responsiveness to installation and repair of the lights, the LED SL and AL with networked controllers allow for additional benefits such as providing customers the capability to dim their SL or AL for additional energy savings.

The networked controllers being deployed support dimming as well as other features such as the ability to integrate external proximity sensors to detect activity in the area and bring the lights back up to full power until the activity ceases.

Q. DO LED SL AND AL WITH NETWORKED CONTROLLERS HELP FURTHER REDUCE ELECTRICITY CONSUMPTION AND LOWER ELECTRICITY COSTS?

A. Yes. In addition to the customer-controlled dimming capability, the LED SL and AL with networked controllers have the capability to allow AEP Ohio to set a maximum power setting. This feature can be used to prevent over lighting the area and provides additional savings to the Customer while extending the life of the LED fixture, further reducing operational costs.[1] The networked controller and software can be set to automatically adjust the virtual power output over time to compensate for detected reductions in lumen output. Typically, these adjustments occur in increments of a 1% increase to the fixture's virtual power output approximately once per year. This strategy has been implemented by utilities such as Florida Power and Light with great success.

Q. HAS AEP OHIO DEMONSTRATED LED SL WITH NETWORK CONTROLLERS FOR ENERGY SAVINGS AND CUSTOMER REACTION?

A. Yes, the Company has been operating a pilot with LED SL and networked controllers in several cities since December of 2019. The pilot is of limited scale within each city, with approximately 200 LED SL fixtures and networked controllers deployed. The feedback has been positive during the pilot as each of the pilot cities had some customer-owned LED

[1] SMART STREET LIGHTING 101: Control systems make street lights smarter, Smart Cities Council, http://www.lightinglab.dk/_files/Dokumenter/presse/2015decembersmartcitiescouncil.pdf, pp 5.

SL already, so each city's residents have likely become used to the LED fixtures. We did received a few initial comments regarding the brightness of the new fixtures and even reduced the power output level of one of our larger fixtures as a result of customer feedback. We had initially deployed all LED SL fixtures at 100 percent power level and have found the controllers have metered the full power levels as expected for those initial three months. We also recently utilized the controllers to reduce the power level output of about 30 of the LED SL fixtures to various levels and will analyze the data to help our customers optimize the dimming capabilities and outdoor power level settings available for their locations. AEP Ohio's strategy for deployment of the new LED fixtures and controllers will be to install each fixture type with the power output level optimized to extended the life of the fixture, and to provide the desired security and increased energy savings for our customers.

Q. HOW DO LED SL AND AL WITH NETWORKED CONTROLLERS HELP TO FURTHER REDUCE MAINTENANCE COSTS?

A. LED SL and AL with networked controllers can identify trending problems of individual SL or AL. Automatic notifications from the controllers allow analysis to spot common issues across the populations of the SL and AL and address potential future issues. Further, the LED SL and AL with networked controllers provide the voltage and power output to further assist in remote diagnostics of potential problems with the fixture or the electric circuit that powers it.

Q. DO LED SL AND AL WITH NETWORKED CONTROLLERS FURTHER IMPROVE SIGHT VISIBILITY AND SAFETY?

A. Yes. The capability to individually dim SL and AL with networked controllers provide opportunities to tune the lighting to optimal coverage and brightness. Just as lighting that is too dim can be a safety problem, lights that are too bright can be a distraction to drivers. The LED SL and AL with networked controllers provide the capability to balance the lighting control settings after the installation is complete.

An additional future strategy could be to oversize SL in dangerous intersections or known trouble spots, and then dim the light to a normal level. It is also possible to provide control to local emergency or city officials that enable them to bring the lights up to full power in the event of a traffic accident or at the request of the police.

Q. ARE LED SL AND AL WITH NETWORKED CONTROLLERS DESIGNED TO PROVIDE INSIGHT REGARDING WHEN THE FIXTURES ARE NOT FUNCTIONING CORRECTLY AND IN NEED OF REPAIR?

A. Yes, the LED SL and AL with networked controllers provide a number of discrete notifications for conditions that provide insight into LED fixture malfunctions. Included in these are the following:

- Commissioning failure
- Communication failure
- Day burner alert (using power during daylight hours)
- Door Open/Tamper alert
- High Power alert
- High Current alert

- High Voltage alert
- Invalid Program
- Lamp Failure
- Low Current alert
- Low Power alert
- Low Power Factor alert
- Low Voltage alert
- Relay Failure (for external interfaces)

Further, the networked controls system software is able to evaluate one or more groups of these discrete notifications to determine higher-level alarms. As an example, the software can generate an alarm when it stops communicating or receiving data from a controller. It can also compare data received on any day with the data received at the same time on previous days and flag a discrepancy. More commonly, it can differentiate between alarms happening on a single device, indicating a localized issue, and instances of the same alarm happening across multiple devices within the same timeframe, which may indicate a systemic issue.

Q. DO LED SL AND AL WITH NETWORKED CONTROLLERS OFFER FUNCTIONALITY TO TURN THE LIGHTS ON OR OFF REMOTELY?

A. Yes. The LED SL and AL with networked controllers communicate with a central network control system that allows remote monitoring and control capabilities. In addition to collecting alarms, LED status and meter reads, the networked control system allows operators real-time control of SL and AL. LED fixtures can be turned on, off, or even dimmed as the situation requires. If a Customer wishes to have a SL or AL removed, AEP

Ohio can turn the light off immediately until the light can be removed. This prevents future issues with customers being billed for power on a SL or AL they have asked to be removed.

V. ENHANCING CUSTOMER COMMUNICATIONS PLAN

Q. PLEASE SUMMARIZE YOUR TESTIMONY IN SUPPORT OF THE COMMUNICATIONS PLAN.

A. The enhancement to the Communications Plan funding of $1 million is needed to support reliability, safety, service, bill understanding and general customer communications for AEP Ohio's 1.5 million customers. The current budget is less than half that amount and doesn't allow the Company an effective opportunity to raise customer awareness on reliability improvements and service work under way that directly impacts customers in its service territory. Effective communications to raise customer awareness on safety, reliability and billing are important and the additional funding will support these efforts. Even with approval of the enhancement, the total Communications Plan cost is approximately $1 per customer per year.

Q. WHAT IS THE PURPOSE OF THE REQUESTED ADJUSTMENT TO ENHANCE CUSTOMER COMMUNICATIONS?

A. The Company is seeking additional funding to more broadly and more effectively communicate with customers on critical, important and educational needs. Informing customers about important issues like safety, reliability, consumer scams, outage information, infrastructure and vegetation management work in their area, available assistance programs, billing and customer programs is part of AEP Ohio's responsibility and commitment to meeting customer needs and keeping the public safe.

Q. WHAT IS THE CURRENT FUNDING FOR COMMUNICATIONS AND WHAT TYPES OF ACTIVITIES ARE BEING DONE WITH THAT FUNDING?

A. Current funding includes $452,000 to support communications activities to share information with our 1.5 million customers about the work AEP Ohio is doing to provide safe and reliable electric service. Some of these activities include media relations and content development for external materials, talking points, media releases, as well as generating website and social media content. The AEP Ohio communications team's skillset and their ability to implement a variety of communication plans has helped AEP Ohio customers better understand the work taking place to ensure we are able to provide safe, reliable electric service.

Additionally, a limited use of external support augments the efforts of the AEP Ohio communications team. The contract agency assists with the activities outlined above and offers services for creative design, video production/editing, primary research, media training, direct marketing and special event coordination. Use of an external contractor allows the team to access resources that are able to scale to accommodate needs.

Q. WHAT COMMUNICATIONS STRATEGIES AND TACTICS DOES AEP OHIO UTILIZE CURRENTLY?

AEP Ohio uses a number of strategies and tactics to engage with our customers. For example, current funding is used to communicate with a limited number of customers on reliability improvements, planned outages, safety and bill payment options. These messages are central to the mission of AEP Ohio – to provide safe, reliable electricity to our customers – and helping customers understand our efforts. We utilize traditional media

channels, social media networks, and in person interaction at community events, legally required notices, customer newsletters and community meetings to reach customers. With nearly 1.5 million customers throughout the AEP Ohio service territory, our challenges include ensuring that we are reaching a large volume of customers and engaging with customers using the method they prefer.

Q. HOW MUCH OF AN ADJUSTMENT IS AEP OHIO SEEKING TO SUPPORT ENHANCED CUSTOMER COMMUNICATION EFFORTS?

A. AEP Ohio is requesting an adjustment of $1,000,000, annually, for all customer class communications. These funds will support outreach and awareness of specific service-related activities across the state and will not be used for any general marketing or advertising efforts.

Q. WHY IS THE CURRENT FUNDING LEVEL INSUFFICIENT?

A. Relative to the number of customers we serve, AEP Ohio has maintained a small team and limited the expenditure of resources for customer communications. The current funding level would not provide enough resources to pay for the postage (not including design or printing) to mail a single postcard to every customer each year,

As outlined in Company witness Kratt's testimony, AEP Ohio has developed a work plan to make reliability improvements. The activities taking place to improve reliability requires that AEP Ohio make a greater effort than current resources allow to inform customers of these efforts. In the Columbus region alone, 40 projects have been identified in the work plan. These reliability-related communications are just one area where additional communication efforts will be required. We also project additional need for forestry and safety work, as well as continued energy use awareness communications.

Without additional communications funding we will not be able to provide customers the information necessary to understand the work taking place in their communities.

The AEP Ohio service territory includes a major media market (Columbus) and numerous smaller markets. With 1.5 million customers and 44,000 miles of distribution lines throughout the state, the current communications budget does not allow us to effectively keep customers informed about safety, reliability upgrades and other relevant information.

We believe it will be important to adopt a "meet customers where they are" approach because we understand the importance of the messages we are sharing, and want to ensure we are maximizing our opportunities to reach customers through a multi-channel approach.

For example, to help customers understand residential rate options to best fit their usage patterns, a multi-channel communications effort will be needed to inform customers and build awareness of these options.

Q. HOW DOES AEP OHIO INTEND TO USE THESE ADDITIONAL FUNDS TO COMMUNICATE WITH CUSTOMERS?

A. Exhibit JFW-3 provides an overview of how funds from the adjustment request might be used to enhance and expand our customer communications efforts. Our expanded communications needs include sharing information about the reliability improvements, safety, and forestry program. The exhibit, offers sample costs, based on previous efforts, for the activities necessary to provide customers with information about these topics.

Competition for customer attention has increased as customers turn to mobile phones as their main device to interact with companies. Our efforts to inform customers

through social channels, text messages, and mobile alerts are competing in a crowded space. Our focus on creating compelling educational content about electrical safety, savings opportunities, outages and service improvements will be critical to breaking through the noise.

In addition, digital channels provide us with an opportunity to have a two-way dialogue with customers through post comments and other interactions. This allows us to hear directly from customers and for customers to share their thoughts with others. This offers a richer customer experience, but also requires more resources than currently available. Monitoring digital channels and responding in a timely manner are critical for this two-way experience to work, but are not supported in the current budget.

We recognize that not all customers have transitioned to online information sources, so we also have to maintain more traditional communication channels such as post cards, door hangers, phone calls, and letters.

Digital communication opportunities haven't replaced traditional communication channels; rather they have increased the number of channels which we must utilize to connect with our customers. Increased funding allows us to support this traditional communication to a wider audience and on a broader range of topics of interest to our customers.

Q. WHY ARE A VARIETY OF COMMUNICATIONS METHODS NECESSARY?

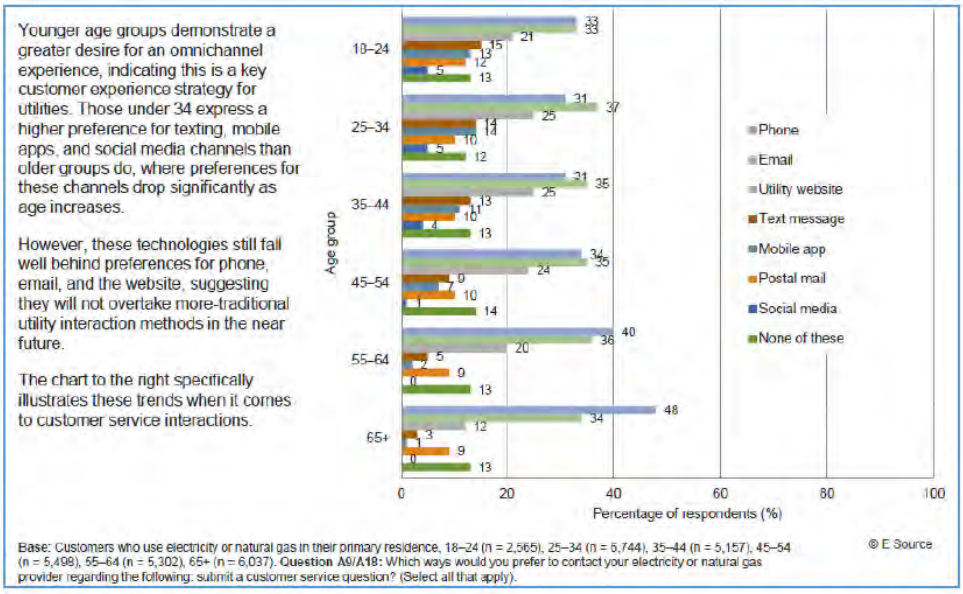
A. AEP Ohio needs to use a variety of communication methods to continue to meet customers' increasing demands and to capture their attention. Research from Questline, a leading energy utility digital communications expert, has demonstrated that customers who receive

newsletters are more receptive to other messaging from their utility, such as public safety messaging, savings tips and information about assistance programs.

Figure 3 below displays the results of a survey conducted by E-Source in 2016. With customers spanning generations with numerous communication preferences, it is critical to use multiple methods of communication.

While this information specifically summarizes attitudes related to customer service interactions, it also demonstrates that there is no "one size fits all" solution when it comes to connecting with customers.

Figure 3 – E-Source Survey Results



Q. EXPLAIN WHY SOCIAL MEDIA AND DIGITAL MESSAGES ON LOW-COST PLATFORMS REQUIRE ADDITIONAL RESOURCES.

A. While social media platforms, like Facebook and Twitter are cost effective means of communicating with customers, we have found that engaging customers requires creating compelling content. We have increased our use of video and other imagery to capture

attention. We plan to increase our use of these media forms and that will require additional investment in production elements supported by this adjustment request. Figure 4 below demonstrates that social media posts that include images and video vastly outperform text-only messages. Messages with text only generated an average of 3,000 impressions per post, while video posts earned 23,000 impressions per post and photo messages earned 7,700 impressions per post. Photo and video increase the reach of messages, but also require additional effort to effectively produce.

Figure 4 – Social Media Content Performance Comparison

AEP Ohio Content Performance Comparison

Media Type	Volume of Published Messages	Average Engagements Per Post	Total Engagements	Total Impressions - Custom
Link	55	145.13	8K	1.8M
Video	166	42.59	7.1K	3.8M
Photo	1.3K	41.64	55.4K	10.1M
Carousel	31	32.45	1K	10.8K
Text	109	20.06	2.2K	333.2K
Album	1	0	0	0

Q. DID YOU ENGAGE IN ANY SUCCESSFUL INFORMATIONAL CAMPAIGNS THAT YOU WOULD REPLICATE FOR OTHER AREAS WITH THESE ADDITIONAL RESOURCES?

A. Yes. AEP Ohio utilized to great success a public outreach campaign strategy centered on our vegetation management efforts. Tree trimming is a necessary element of our business. Traditionally, due to budget constraints, AEP Ohio had struggled to provide customers with timely information about tree trimming work taking place in their communities. This has led to an undesirable customer experience and increased commission complaints.

In 2019, AEP Ohio's forestry division worked with our corporate communications department to develop a customer communication campaign and improve communication processes to help inform customers about scheduled vegetation management activities in a timely and efficient manner. For example, before any vegetation work began, a postcard was sent to customers briefly explaining the vegetation work that would be completed. Approximately one week before vegetation management activities began, an automated phone call was sent to customers informing them that vegetation work would be starting shortly. That was followed by face-to-face contacts by contract work planners or a member of the vegetation crew that went house-to-house to notify customers, in-person, of the work to be conducted, as well as answer any questions that the customers may have had. If a customer was not home, the work planner left a door hanger with information about the vegetation management work to be completed.

More information on vegetation management communications, as well as sample collateral pieces are included as part of the Forestry portion of the Management Report (Schedule S-4.2, which is sponsored by Company witness Kratt). Funding for this effort was not earmarked in the vegetation management program, but understanding the importance of a positive customer experience we utilized a limited amount of the communications budget to execute this campaign for a limited number of projects. The communications included a customer door hanger, telephone calls, contacts via email and sharing information with community-forums on social media channels.

In Q1 2020 AEP Ohio mailed approximately 30,000 postcards at a cost of $16,000. From 2019 to present, an additional $16,000 has supported community outreach events, production of an animated hazardous tree video, a pocket card about tree trimming and two

additional video pieces. This does not include costs for boosted social media posts to promote these materials, but does demonstrate that a there can be significant cost for these campaigns.

Spending these additional funds reduced by 50% customer complaints related to AEP Ohio's tree trimming maintenance schedule. They better understood the necessity of the work and how it impacted their electric service. Also, by making them aware that work would be occurring in their area, we were able to limit the surprise of seeing forestry crews.

The adjustment request would expand the use of the multi-channel communications approach demonstrated here into additional areas, such as reliability, safety and other topics.

Q. WHAT ADDITIONAL AREAS WOULD AEP OHIO LIKE TO USE THIS MULTI-CHANNEL APPROACH TO CUSTOMER COMMUNICATION?

A. AEP Ohio proposes to use a similar strategy to engage customers in other service-related areas such as reliability and safety, and to continue the forestry effort outlined previously. Reliability communications will be critical as the work plan outlined in Company witness Kratt's testimony is put into place. In addition to previous approaches, we plan to introduce the use of the NextDoor social media platform. NextDoor is a members-only platform organized around specific neighborhoods within a geographic region. Use of this platform will allow us to target specific neighborhoods where work is taking place. We are developing a strategy to work with our planning team to identify particular circuits where work will occur and then will share information with neighborhoods about the specific work being done. This targeted approach will allow us to share relevant information with the customers the work will directly impact.

Additionally, we plan to augment our existing process of notifying customers about planned outages with NextDoor posts. Utilizing this new channel effectively, however, requires additional resources provided for in the adjustment request.

Safety is also a critically important area where additional education and outreach is necessary. In recent years, we have seen increased public contacts with electrical equipment. The contacts result in serious injury or death and are preventable. Safety audits have indicated that we need to invest more resources in this area. We have increased the inclusion of safety messaging on social channels and in our other communications. However, as outlined previously, we need to communicate in additional ways to reach more customers. Utilizing our existing "Live Line" trailer at public events and with first responders will be an important part of our safety outreach. Sharing information about public events and first-responder training where the "Live Line" trailer will be supported by the adjustment request.

VI. MUNICIPAL UNDERGROUNDING OPTION

Q. PLEASE SUMMARIZE YOUR TESTIMONY IN SUPPORT OF THE MUNICIPALITY UNDERGROUND SERVICE TARIFF.

A. As more local communities look to update streetscapes and downtown areas to serve their residents and attract new businesses, the interest in converting overhead to underground facilities in certain areas has grown. The Company receives requests each year by villages, towns and cities interested in placing some overhead facilities in their footprint underground. The upfront Contribution In Aid of Construction (CIAC) payment has been a barrier for many municipalities. This tariff provides alternatives to the upfront payment requirement to help these customers move forward with their plans.

Q. HOW DOES THIS TARIFF SOLVE THE ISSUE OF PAYING CIAC UPFRONT FOR THIS WORK?

A. The tariff provides two options for municipalities to pay the cost difference over time. However, the municipality still retains the current option of paying CIAC upfront.

Q. PLEASE DESCRIBE THE PAYMENT PROCESS.

A. The primary option in the proposed tariff involves calculation of a surcharge to be applied to all customers that are residents of the respective municipality over the life of the installed facilities. The tariff also preserves an option to provide a CIAC payment arrangement for the municipality to pay over time.

Q. DOES THE UNDERGROUND SERVICE TARIFF TRANSFER THESE COSTS TO OTHER CUSTOMERS?

A. No, it provides an alternative to municipalities to pay for underground service over time. The participating municipality or its customers pay the entire cost, depending on the option selected.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

AEP Ohio Demand Side Management Plan

6/15/2020

AEP OHIO | 700 MORRISON RD, GAHANNA, OH 43230

Table of Contents

I. Introduction

In this application, Ohio Power ("AEP Ohio", or "Company") seeks approval of its Demand Side Management ("Plan") by the Public Utilities Commission of Ohio ("Commission"). The Plan is designed to achieve a number of objectives, including delivering a cost-effective and comprehensive suite of Demand Side Management ("DSM") programs that provide participation opportunities for all classes of customers and every major customer segment of the Company's service territory in a manner that optimizes electricity usage while managing the peak demand on the AEP Ohio system. In addition, the Plan seeks to reduce inefficient uses of electricity while improving customer productivity, enhancing customer comfort and safety, increasing customer satisfaction, and supporting economic development and retention in Ohio. The Company seeks to accomplish these goals by overcoming barriers that prevent residential and business customers from adopting energy efficient technologies. The Plan aims to help customers manage electricity demand during peak periods and encourage flexible load to be shifted to lower cost off peak periods. All things being equal, this in turn avoids generation cost through a more cost effective demand side management approach, while also lowering emissions from electric generators serving Ohio customers. AEP Ohio is committed to helping its customers use energy more efficiently by implementing the Plan.

AEP Ohio proposes to invest approximately $36.6 million annually for the programs described in the Plan. In addition, a program administration fee of 10% of the annual spend is earned for cost effective delivery of the Plan to customers. The focus of the Plan is on demand side management opportunities where the Company can work with customers and solution providers to deliver programs that help customers manage their peak demand. In addition, the Company will continue to help customers save energy, particularly in the residential, low income, small and medium business segments. An area of significant projected electricity growth is electric transportation, and the Plan include an Electric Transportation Program to provide overall support for this growth while managing the system peak demand.

In conjunction with the return to a more traditional demand side management approach, the Company has taken the learnings from programs offered over the last twelve years to build a suite of programs that are combined to be both cost effective and comprehensive, yet lower cost and more focused on demand side management. Ongoing plan performance, customer acceptance, customer satisfaction and cost effectiveness are critically important; therefore, the Plan continues a rigorous research and development function in order to ensure continuous improvement of programs that deliver innovation and strong performance. The innovation and technology function will also allow new program opportunities to be tested, measured and integrated into the program offerings. AEP Ohio contracted with Guidehouse (formerly known as Navigant) in 2019 to conduct a study on the market potential for applicable DSM measures. AEP Ohio further refined this study using market conditions, budget estimates, and potential baseline changes. These estimates were used to incorporate the assumptions as a basis for goal setting.

II. Objectives

The key objectives of the DSM Program are to:

- Provide programs that provide all customers segments with opportunities for participation.
- Support at-risk customer segments with focused programs to help them manage their demand and energy use.
- Encourage peak load management in a way that ensures a cost effective, healthy and reliable grid.
- Maximize the capabilities and benefits of the Smart Grid.
- Provide customer-oriented solutions for DSM services.
- Provide the lowest cost alternative to new generation, including fossil fuels and renewable generation sources.
- Reduce inefficient uses of electricity while improving customer productivity, providing comfort and safety, and increasing customer satisfaction.
- Help provide and increase sustainable jobs for Ohio.
- Identify and promote non-energy related benefits to support program delivery, providing customers more financial benefits of participation.
- Provide environmental benefits.
- Increase and complement economic development in Ohio by reducing energy density per product or service provided thereby improving competitiveness.
- Help delay the need for new electricity generation and future related rate impacts.

Additional objectives specific to the Electric Transportation Program (one of the Cross Sector Programs) are to:

- Support increased access to electric transportation across all AEP Ohio customer segments and geographical areas.
    - Reduce range anxiety by investing in corridor charging
    - Expand customer access to electric vehicle ("EV") charging including low income customers
- Optimize EV charging infrastructure and management.
    - Utilize electric transportation as a means to reduce system costs for all customers
    - Encourage long-term customer behavior to charge EVs in off-peak periods
    - Manage system peak demand through DSM programs and rate options
- Maximize environmental and other non-energy benefits.
    - Improve air quality by reducing tail pipe emissions in all areas, but specifically in:
        - Urban areas where mass transit busing is a major transportation component.
        - Areas where school bus emissions can be reduced.

III. Programs

The Company used a four-pronged approach for designing the programs within the Plan:

1. Meet the objectives set forth in the DSM Plan,
2. Design programs to satisfy a customer need,
3. Achieve a cost effective plan to benefit to all customers, and
4. Provide programs to all customer segments.

Using these metrics, AEP Ohio has designed the following suite of programs. AEP Ohio proposes an annual budget of $36.6 million across the various programs, with total annual demand savings of 44.1 MW and annual energy savings of 226 GWhs. The Plan is cost effective, delivering total benefits of $100 million compared to a Plan cost of $36.6 million. For cost effectiveness calculations, an estimated annual base rate internal labor cost of $4.2 million and a $3.66 million administration fee has been estimated and added to the test. Excluded from cost effectiveness calculations are the Retrofit Low Income program which is not designed to be cost effective but provide a social benefit. Also excluded from cost effectiveness are the Cross Sector programs which are support programs to the Plan, and also includes the Electric Transportation program. Figure 1 shows the summary of proposed programs investments.

Figure 1. DSM Plan Savings, Budget, and Cost Effectiveness

Proposed Program	Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT Benefits	UCT	Non-Energy Benefits	Total Benefits	RVT
Efficient Products	5,900	30,039	$ 4,423,500	$ 13,454,935	3.0	$ -	$ 13,454,935	3.0
Retrofit Low Income	800	2,758	$ 7,000,000	$ 1,253,712	0.2	$ 7,595,000	$ 8,848,712	1.3
Residential Demand Response	17,400	58,015	$ 2,000,000	$ 2,540,391	1.3	$ -	$ 2,540,391	1.3
New Homes	2,400	4,317	$ 2,000,000	$ 2,768,313	1.4	$ -	$ 2,768,313	1.4
e3smart	400	3,817	$ 1,000,000	$ 1,535,912	1.5	$ -	$ 1,535,912	1.5
Residential Subtotal	**26,900**	**98,945**	**$ 16,423,500**	**$ 21,553,263**	**2.2**	**$ 7,595,000**	**$ 29,148,263**	**2.2**
Efficient Products for Business	13,200	88,244	$ 8,426,500	$ 34,815,742	4.1	$ 14,434,436	$ 49,250,178	5.8
Process Efficiency	900	18,068	$ 1,500,000	$ 7,629,883	5.1	$ 3,003,927	$ 10,633,811	7.1
Business New Construction	1,900	13,503	$ 1,500,000	$ 5,009,133	3.3	$ 2,174,870	$ 7,184,003	4.8
Small Business Express	1,200	7,091	$ 2,000,000	$ 2,835,349	1.4	$ 1,159,898	$ 3,995,246	2.0
C&I Demand Response	0	0	$ -	$ -	N/A	$ -	$ -	N/A
Business Subtotal	**17,200**	**126,906**	**$ 13,426,500**	**$ 50,290,107**	**3.7**	**$ 20,773,131**	**$ 71,063,237**	**5.3**
Community Energy Savers			$ 500,000					
Targeted Customer Outreach			$ 500,000					
Innovation and Technology			$ 1,300,000					
Education and Training			$ 450,000					
Electric Transportation			$ 4,000,000					
Cross Sector Subtotal			**$ 6,750,000**					
Total*	**44,100**	**225,851**	**$ 36,600,000**	**$ 71,843,370**	**2.3**	**$ 28,368,131**	**$ 100,211,500**	**3.0**

*Plan cost effectiveness tests include estimated base rate internal labor and program administration fee. Exclusions include: Retrofit Low Income and Cross Sector programs.

a. Residential Programs

i. Efficient Products

This DSM program provides retail incentives for LED specialty lighting and incentives for efficient heating and air conditioning (Energy Star Heat Pumps and Mini Split Heat Pumps), appliances and heat pump water heaters. In addition, incentives for demand control devices are included such as smart thermostats and load controllers. This program includes a digital marketplace where consumers can compare energy efficient appliances, receive an energy efficiency rating to help them make an informed decision, and shop for efficient products. The program will also explore midstream opportunities for delivering incentives.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
5,900	30,039	$4,423,500	3.0	3.0
Other Benefits	Improved lighting quality, comfort, improved property values, water savings. Energy efficiency education through a Marketplace.			

ii. Retrofit Low Income

This DSM program is comprised of 2 components. The Community Assistance Program ($5 million) serves low income customers (below 150% of the Federal Poverty Level) by providing energy efficiency retrofit upgrades (lighting, refrigerators and shell measures) in single and multifamily dwellings through local impact agencies. These local agencies identify households requesting and needing assistance and provide an audit to determine which measures are needed. The local agency then installs the measures, and each project is recorded and reported to the utility. The Supplemental Low Income Program ($2 million) supplements and provides financial assistance to low income customers above the 150% of Federal Poverty Level but defined as low-income. Within our service territory there are significant percentage of households that would qualify and AEP Ohio plans to help these customers more directly. The intent is to provide deeper discounts and/or incentives on the standard energy efficiency programs. This includes but not limited to smart thermostats, air source heat pumps, EV charging, water heating, and insulation. Other areas of focus could be supporting community food banks, senior citizen centers, and schools to provide and install energy efficient measures at a reduced costs and improving the payback period. Access to financing is another focus area.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
800	2,758	$7,000,000	0.2	1.3
Other Benefits	Lowering total electric bill, thus lowering the amount needed to be collected through the Universal Service Fund. Better health, indoor air quality, improved comfort, and increased safety for customers. Education on DSM to help customers understand how to manage bills.			

iii. Residential Demand Response

This DSM program lowers peak demand through behavioral coaching and incentivizing demand response (DR) by residential customers. Demand response and peak shaving will be provided with combinations of: electric water heating, air conditioning, space heating with smart thermostats, and EV charging control. These DR events will be targeted for reducing the demand during peak periods. In doing this, AEP Ohio will be able to reduce its capacity obligation for all customers, thus lowering all customer costs. Incentives will be provided to the customers who participate in the demand response events. The goal of the program is to initially use incentives and customer communications to shift demand, then educate the benefits of changing behavior, and finally migrate customer to a distribution rate plan that best benefits the customer. Once this successful transition of modifying customer behavior occurs, an incentive will no longer be provided to that customer. Incentives will be used to reach and educate other customers to continue to grow participating customers. The demand response program also includes a customer home energy report element targeted to high usage and high demand customers to educate the customer on rate designs, incentives, etc. to influence energy and demand savings over the course of the year.

Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
17,400	58,015	$2,000,000	1.3	1.3
Other Benefits	Customers retain direct control over energy usage. Real time information can be provided as a component of DSM education. Improved grid reliability during peak times.			

iv. New Homes

This DSM program encourages energy efficient construction of new single and multifamily homes well above the current building codes. This provides an easily available reference point for high performance construction, DSM and new technology opportunities in new homes including but not limited to demand response with smart thermostats, heat pump water heating, lighting controls, and EV charging control. The program will also explore enhanced building envelope improvements with air sealing, windows and insulation.

Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
2,400	4,317	$2,000,000	1.4	1.4
Other Benefits	Drives adoption of energy efficient construction for all builders and homebuyers. Educates buyers that DSM should be part of the equation when purchasing a new home.			

v. E3Smart

This DSM program educates and engages Ohio children grades 4-12 about energy, how to save energy at their homes, and new energy technologies. Classroom curriculum is provided to each participating teacher and each teacher is provided hands on training to review and go over the curriculum. Each student is provided a classroom exercise and take home project which includes a weatherization kit that the student, with the assistance of a parent, can install to utilize the energy saving measures. A parent survey is returned to the teacher to gauge the success of the project. This program is recognized as part of the Ohio STEM curriculum and has good coverage in low income school districts.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
400	3,817	$1,000,000	1.5	1.5
Other Benefits	Educates and engages the next generation on the importance of demand side management. Gives teachers additional educational materials to enhance their curriculum.			

b. Business Programs

i. Efficient Products for Business

This DSM program provides incentives for businesses to install efficient systems, including lighting, heating, ventilation and air-conditioning (HVAC), food service, compressed air, and refrigeration. Most measures will be sold and incentivized through a point-of-sale program, providing low program administration costs. In addition to DSM benefits, there are significant non-energy benefits for operation and maintenance cost reduction that have been characterized for this program. Incentives under this program can be aligned to concentrate on measures that primarily operate during peak periods. The program contains platforms and tools customers use to monitor and control their energy and demand. These tools may include automated benchmarking of buildings (Energy Star), energy model regression analysis tool, and real time data for small business.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
13,200	88,244	$8,426,500	4.1	5.8
Other Benefits	Productivity improvements, O&M reductions, access to Green Loans.			

ii. Process Efficiency

This DSM program is for cost-effective energy efficiency improvements that reduce energy consumption, peak demand, and/or increase productivity. The program will assist commercial and industrial customers with the analysis and selection of high-efficiency equipment or processes not covered under other program offerings. The program approach will identify more complex energy savings projects, provide economic analysis and aid in the design and completion of the project. The program will target measured energy savings on a per kWh and per peak kW reduction basis.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
900	18,068	$1,500,000	5.1	7.1
Other Benefits	Productivity improvements, O&M reductions, access to Green Loans.			

iii. Business New Construction

This DSM program provides education and technical assistance to design in maximum efficiency, targeting an average of 30 percent over code, for non-residential buildings of all sizes. The focus of the program is whole building energy modeling to ensure all aspects of efficiency are designed into new buildings. Energy savings in new construction ensures permanent energy efficiency over a long lifetime. New technologies will be incorporated with a focus on peak shaving opportunities.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
1,900	13,503	$1,500,000	3.3	4.8
Other Benefits	Productivity improvements, O&M reductions, access to Green Loans.			

iv. Small Business Express

This DSM program is a turnkey direct install program providing an on-site assessment for small businesses that have little understanding of energy savings or demand response opportunities. The primary measures installed are lighting, refrigeration, and heating and air conditioning.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
1,200	7,091	$2,000,000	1.4	2.0
Other Benefits	Productivity improvements, O&M reductions, access to Green Loans.			

v. Business Demand Response

This DSM program has multiple components. DR events will target 2 components: (1) where control of thermostat/HVAC, electric transportation, managed process, water heating is available, and (2) where control of networked lighting can reduce lighting levels during peak periods. AEP Ohio will call these DR events when the system demand is at its highest. These DR events will be targeted for reducing the demand for PJM critical peaks. While this program is not currently shown to be cost effective, AEP Ohio believes this program still has value and will be piloted in the Innovation and Technology program to determine more cost effective approaches. AEP Ohio will allocate dollars from other business sector programs or pilot funds if cost effectiveness is achieved.				
Coincident Demand Savings (kW)	Energy Savings (MWh)	Annual Budget	UCT	RVT
0	0	N/A	N/A	N/A
Other Benefits	Customers retain direct control over energy usage. Real time information can be provided as a component of DSM education. Improved grid reliability during peak times.			

c. Cross-Sector Programs

i. Community Energy Savers

This DSM program encourages communities of all sizes, types and socio-economic classifications to use local resources with AEP Ohio assistance to increase participation in DSM programs for both residential and small business customers. A participation goal is set and, if achieved, the community receives an award that can be used for an energy efficient project in their community such as LED community park lighting upgrade, upgrade to school classroom lighting or other initiatives selected by that community. In addition, a sustainability plan is offered to the community for reaching 50% of goal. This program can also be offered through businesses to reach employees in a more efficient manner in support of sustainability goals.

ii. Targeted Customer Outreach

This effort will focus on activities that will encourage participation in our DSM programs by completing multi-channel outreach and customer communication activities that will help customers be aware of DSM programs available to help them save money and improve comfort. Our goals are to:

(1) Increase awareness of energy savings and demand response opportunities and motivating customers to act by providing education on the financial, social and environmental benefits,

(2) Drive program DSM program participation through targeted outreach efforts utilizing segmentation data from a third party and internal data resources,

(3) Position AEP Ohio as a key source of information on DSM with a robust website, solution center product knowledge and various outreach efforts for communities in our service territory,

(4) Use cost effective channels, and

(5) Focus on digital and social media channels.

iii. Innovation and Technology

This DSM program is designed to develop and test methodologies for DSM Plan programs that, when successful, can be included with other residential and business programs in the Plan. Potential programs include new heat pump applications in packaged units, industrial demand management and advanced networked management systems. In addition, segment-specific innovation is needed to meet the unique opportunities with various customer segments on the business side and demographic needs on the residential side. For example, reaching lower income customers (between 150-400 percent above the federal income poverty line) will be an area of focus where a combination of technology options and outreach capabilities will be needed. Small businesses are another segment that can be difficult to reach, and innovative approaches are needed. Other opportunities will include looking at innovative ways, such as financing, to deliver incentives to our customers more effectively.

iv. Education & Training

This program will provide DSM education, training and materials for all customers, customer groups, contractors, trade associations, and civic associations. Activities and materials will be tailored to specific audiences: facilities managers, building operators, financial decision makers, builders, contractors, trade associations, civic organizations, workforce development practitioners and students, and AEP Ohio employees whose work brings them in contact with customers. Customer education events will continue to be offered via webinar and face-to-face seminars subject to any Ohio guidelines in effect at multiple sites throughout the service area as needed to permit customers to participate while minimizing travel. Seminars will continue to feature subject-matter experts, trade allies, and hands-on demonstrations of DSM technologies. How to and practical knowledge will be a focus to help customers understand how they use energy and how to optimize their usage. Education and training participants will be surveyed for feedback on relevance, quality and satisfaction with activities.

d. Electric Transportation Programs

This DSM program provides education, awareness, innovation and incentives to encourage adoption of electric transportation and managed charging. AEP Ohio's initial Electric Vehicle Charging Station pilot program, approved by the PUCO in 2018, was a highly utilized program across its many customer segments[1]. That program was fully subscribed within 17 months of the 4-year pilot period, and continued interest in that program remains high as we have a wait list of applications received even after customers understood the program was fully subscribed. Through that initial pilot, AEP Ohio worked with numerous stakeholders to collect data on charging behavior that has helped guide the development of this proposed program. AEP Ohio proposes to continue the momentum of the previous pilot to address numerous customer charging applications.

Many of the proposed programs provide opportunities to achieve off-peak charging, which helps mitigate incremental load during peak periods and provides downward rate pressure benefits for

[1]See JFW-2 Appendix – Section VII EVSE Report

all AEP Ohio customers. The programs also will improve air quality by reducing tail pipe emissions. It includes programs that will enable AEP Ohio to meet the electric transportation needs for all customer classes across many transportation sectors.

In each program, eligible customers will receive incentives to cover a percentage of their cost of the charger and associated infrastructure. AEP Ohio will have the flexibility to modify those percentages throughout this program as customer needs evolve. The program will ensure a portion of funds across these programs is provided to low income customers, and those customers will be eligible for higher incentive amounts. The program will also ensure that the benefits are realized across AEP Ohio's service territory by allocating a portion of the incentives to areas outside of the SMART Columbus territory[2]. Customers that are non-profits, municipalities, or government entities will also have increased incentive eligibility. The program is designed with annual budgets for each program; however, AEP Ohio will evaluate the allocation of funds each year as customer needs evolve. All customers receiving incentives will also provide the required charging data to AEP Ohio.

Figure 2. Electric Transportation Program

Program Component	Included Applications	Estimated Annual Ports	Estimated Annual Budget ($)
Corridor Charging	• Highway corridor public charging	10	$550,000
Residential Charging	• Single Family charging • Multi-Family charging	490	$950,000
Commercial and Public Charging	• Non-corridor public charging • Fleet charging • Workplace charging	120	$1,450,000
Electric Transportation Innovation and Technology	• Public transit bus • School transit bus • New EV technologies	-	$650,000
Electric Transportation Outreach and Engagement	• Program awareness and marketing • Technology information and benefits	-	$400,000
Total		620	$4,000,000
Note: Included in the Estimated Annual Budget for Low Income customers is a minimum of $500,000			

[2] The SMART Columbus team has identified that approximately 3,800 commercial chargers in the SMART Columbus footprint alone will be necessary to meet the goal of a 15% increase in Electric Vehicles (EVs) by 2025.

i. Corridor Charging

This program provides incentives for public DCFCs in key highway corridor locations. Several organizations are studying the current state of EV charging infrastructure in Ohio in order to identify the geographic gaps that need filled. AEP Ohio will coordinate with those stakeholders to identify key corridors in the Company's service territory where public charging is needed to facilitate long distance travel for EV owners. AEP Ohio plans to develop a list of key corridor sites needed in our service territory and approximately 5 corridor sites will be identified each year. AEP Ohio will guide qualifications for Direct Current Fast Charging (DCFC) equipment deployment and make incentives available to 3rd parties to deploy DCFCs in the identified locations. To qualify for incentives in these corridor locations, chargers must be available to the public.

ii. Residential Charging

This program provides incentives for residential charging applications with participation in the Company's demand response program, helping customers install 240V circuits and level 2 charging equipment so homeowners can easily avoid charging their vehicle during peak periods. Education on time of use and demand rate options will be emphasized.

Approximately 80% of an electric vehicle's charging happens at home[3], and being able to optimize those charging periods through managed charging is critical to avoid incremental load during peak periods.

Additionally, the Multi-Family segment provides incentives for the installation of 208/240V circuits and level 2 charging equipment. This segment serves residential tenants in multi-family dwellings, and encourages multi-family developments to add the capabilities necessary to reach all residential customers including those in low income communities.

iii. Commercial and Public Charging

This program provides incentives for commercial customers to install Level 2 and DCFC charging in Public, Workplace and Fleet applications, similar to AEP Ohio's Charging Station EV Incentive Program (2018-2022). This will support customers' ability to charge their EV away from their residences. The Public and Workplace programs will primarily target level 2 charging, but incentives will also be available to customers for DCFCs in locations outside the identified key corridors. The Fleet program will help enable Ohio companies to enhance, or even convert, their fleet to EVs.

iv. Electric Transportation - Innovation and Technology

[3] EPRI, "Electric Vehicle Driving, Charging, and Load Shape Analysis", available at: http://mydocs.epri.com/docs/PublicMeetingMaterials/ee/000000003002013754.pdf

This program will investigate evolving technologies in the electric transportation space to identify innovative customer solutions throughout the AEP Ohio service territory. Electric transportation will continue to evolve as technology capabilities and customer adoption increases. Initially, AEP Ohio plans to focus pilot efforts on mass transit and school buses replacements of diesel or gasoline buses with electric buses. Mass transit and school districts serve a significant number of customers, increasing the benefits of this pilot effort. Incentives will be provided for managed charging equipment, infrastructure and also toward the purchase of the electric bus. Greater incentives will be allocated for low income target areas. AEP Ohio also plans to pursue other innovative technologies such as integration with storage, autonomous transportation solutions and vehicle sharing applications. AEP Ohio will look for opportunities to match pilot funds with other grants and funding mechanisms to increase opportunities for innovation.

v. Electric Transportation – Outreach and Engagement

Educating customers on the benefits of electric transportation is a fundamental need. A variety of means will be utilized to optimize outreach to all customers, including digital engagement, direct communication and others. AEP Ohio additionally plans to tailor outreach strategies for electric vehicle dealers and business customers to broaden the knowledgebase of these customers on the benefits of electric transportation, charging and program benefits.

IV. Incentive Strategy

a. Residential

AEP Ohio's DSM Plan has programs for all customers, with a specific focus throughout to provide assistance to those with lower income. For the applicable programs with incentive payments to customers, AEP Ohio will provide larger incentive payments to those customers who qualify as low income with the additional incentives available from the Supplemental Low Income program. AEP Ohio does not have granular economic demographics for each customer, but can use various methods to determine the higher incentive low income locations. For example, AEP Ohio can look to focus higher incentives for residential customers in census tracts in AEP Ohio's service territory where 50% of households have income less than two times the federal poverty threshold as defined by 2011 – 2015 American Community Survey (ACS).

1. Standard incentive amount for middle to upper income households
2. Increased incentive amount for households 151-400% federal poverty threshold
3. 100% incentive for 150% and below federal poverty threshold through the Community Assistance program.
4. Leverage interest buy-down financing or other financing opportunities for eligible customers.

b. Business

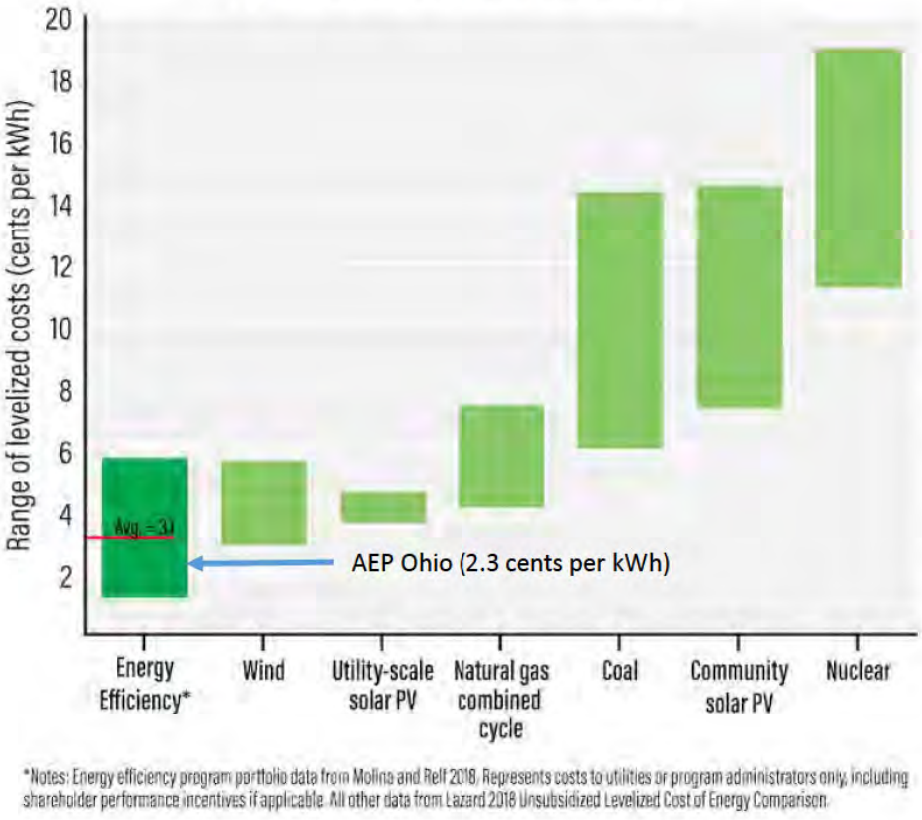
The incentive strategy for Business programs will focus on four main objectives:

1. Maximize incentives through midstream point-of-sale, reducing the higher administrative costs of application programs.
2. Focus incentive levels on measures that also produce demand savings to shape peak demand.
3. Provide incentives to those who need it most. For example, AEP Ohio can look to focus higher incentives for business in census tracts in AEP Ohio's service territory where 50% of households have income less than two times the federal poverty threshold as defined by 2011 – 2015 American Community Survey (ACS). This includes projects in the small business program and new construction program, especially for low income multifamily construction projects where more efficient units lead to lower energy bills for tenants.
4. Leverage interest buy-down financing opportunities or other financing mechanisms for eligible customers to alleviate the first cost barrier.

V. Benefits

The lifetime cost of saved energy is estimated to be $0.023/kWh for the Company's DSM Plan, comparable to a supply-side generation investment alternative. As compared with supply-side generation investment alternatives (including non-dispatchable technologies such as wind and solar), the AEP Ohio DSM Plan cost compares favorably, and is the lowest cost alternative. Additionally, AEP estimates the nominal cost of saved demand is $87 per MW/day. In contrast, using the PJM study, states that the least expensive Combined Cycle power plant to be at $269 per MW/day[4]. The value of this flexible DSM Plan resource is less than one third of the cost of a supply-side resource. AEP Ohio is proposing a cost effective portfolio below the industry average levelized costs per kWh. See Figure 3 below.

Figure 3. DSM is the lowest cost resource[5]



*Notes: Energy efficiency program portfolio data from Molina and Relf 2018. Represents costs to utilities or program administrators only, including shareholder performance incentives if applicable. All other data from Lazard 2018 Unsubsidized Levelized Cost of Energy Comparison.

[4] https://www.pjm.com/~/media/committees-groups/committees/mic/20180425-special/20180425-pjm-2018-cost-of-new-entry-study.ashx
[5] https://aceee.org/files/proceedings/2018/#/paper/event-data/p191

a. Avoided Supply Costs

The value of avoided generation and capacity refers to the costs of the electric resources that are deferred or avoided by the DSM resources. The value of the avoided generation and capacity is a fundamentally established concept in DSM. AEP Ohio is using marginal cost values as forecasted by AEP Fundamentals group, which have been used historically as a dependable benefit for DSM programs. The avoided energy generation values are separated by On Peak/Off Peak pricing and these will be blended together by the load shapes of a specific sector. For more detail, please refer to JFW-2 Appendix Section VI.

b. Avoided Transmission and Distribution Costs

The value of avoided transmission requires a separate study to determine accurately and distribution is difficult to quantify until AEP Ohio has demand response capability at sufficient scale on a given circuit or station, so AEP Ohio is proposing to gain scale before attempting quantification of this value. For the purposes of this proposal, no value for avoided transmission or distribution cost is assumed, but AEP Ohio plans to include additional avoided costs if further data becomes available. For more detail, please refer to JFW-2 Appendix section VI.

c. Discount Rate for Present Value Benefits/Costs

For the discount rate in net present value calculations, AEP Ohio will use its Weighted Average Cost of Capital (WACC) as defined by NARUC[6]. The cost of capital is a weighted average costs of all elements in the capital structure. AEP Ohio proposes to use the pre-tax value of 7.921% as its discount rate, which was the calculated WACC as detailed by witness Messner in his testimony.

d. Electric Vehicles Can Lower Rates for all Customers

As identified in a Synapse Energy study, "EVs in California have increased utility revenues more than they have increased utility costs, leading to downward pressure on electric rates for EV-owners and non-EV owners alike."[7] The need for utility involvement and guidance in grid management is essential to structuring the increased energy usage of electric transportation that will lower costs for all customers.

Electric transportation infrastructure also provides a fundamental opportunity to impact demand side management. The Synapse Energy study of two California utilities noted, when charged during off-peak hours, "EVs impose minimal costs on the grid and help to utilize resources more efficiently"[8] With AEP Ohio's ET programs in place, efficiently filing the valleys of load with ET charging will benefit all customers of AEP Ohio.

[6] https://pubs.naruc.org/pub.cfm?id=5388A091-2354-D714-5150-D873753A9C4C
[7] http://www.synapse-energy.com/sites/default/files/EVs-Driving-Rates-Down-8-122.pdf
[8] Id

Consider the example of such included in Figure 4 below. A typical EV driver traveling an average of 40 miles per weekday, charging exclusively at home, with a vehicle efficiency of 3 mi/kWh, and vehicle charging power of 7.4 kW. Using the standard residential tariff, current capacity costs, we can quantify the costs for both on-peak and off-peak charging. The incremental benefits of a single EV charging completely off-peak $207 (downward rate pressure) when compared to charging completely on-peak. Figure 4 below demonstrates the impacts of the proposed residential program cumulatively over a 5 year period.

Figure 4: Electric Vehicle Financial Impacts Scenario

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Cumulative Participants	500	1,000	1,500	2,000	2,500	**7,500**
On-Peak Downward Rate Pressure Benefit	$14,689	$29,378	$44,067	$58,756	$73,445	**$220,335**
Off-Peak Downward Rate Pressure Benefit	$117,964	$235,928	$353,892	$471,856	$589,820	**$1,769,460**
Incremental Downward Rate Pressure Benefit	$103,275	$206,550	$309,825	$413,100	$516,375	**$1,549,125**

e. Non-Energy Benefits

There are multiple benefits to DSM outside of reduced energy costs. For the residential side, AEP Ohio has only quantified a portion of available benefits to use for cost effectiveness test purposes. For the retrofit low income program, AEP Ohio has incorporated an analysis done for the Community Assistance Program. This analysis shows that every dollar spent on the program, provides approximately $1.52 in benefits to all customers in reduced collections to the Universal Service Fund. Non-energy benefits identified by AEP Ohio non-residential customers can be found in Figure 5. For more detail, please see JFW-2 Appendix section IV. For the business programs there are many various quantifiable operations and maintenance reductions associated to DSM participation, AEP Ohio proposes an additional $18.3 per MWh of benefits. These benefits will be incorporated into the testing values shown below.

Figure 5. Percent of measures resulting in non-energy benefits by type of benefit (n=79)

Benefit category	Measures resulting in benefit	Percent
Comfort Increased	41	52%
Safety Increased	34	43%
Productivity Increased	22	28%
Other Revenue Increased	3	4%
Sales Increased	2	3%
Other Increase	2	3%
Downtime Decreased	19	24%
Labor Costs Decreased	10	13%
Other Decrease	10	13%
Material Costs Decreased	5	6%
License Costs Decreased	2	3%
Waste Disposal Costs Decreased	0	0%

f. Energy DRIPE

Demand Reduction Induced Price Effects, or DRIPE, is defined from the EPA's Office of Energy Efficiency and Renewable Energy (EERE)[9] as: In wholesale electricity markets, DRIPE is usually conceptualized as a downward movement in the demand curve, leading to a new equilibrium of supply and demand being established at a lower price point. This basic theoretical model applies to price effects arising from both energy efficiency and demand response, though the duration of demand reductions is much longer in the case of energy efficiency, as the reductions continue throughout the lifetime of the project as opposed to the few minutes or hours during which a demand response resource is dispatched.

DRIPE reduces the marginal cost of electricity by exposing market inefficiencies and substituting lower cost energy efficiency for higher cost supply. This means that greater energy efficiency will decrease the need to purchase energy from higher cost sources, and lower peak demand will lessen the need to invest in new generation capacity.

AEP Ohio has utilized the study completed for ComEd in 2015[10], by Energy Futures Group and Resource Insight. The quantified value AEP Ohio is proposing to use is a 1% decrease in energy costs, thus providing a benefit for energy reductions achieved by AEP Ohio and its customers. For more detail, please refer to JFW-2 Appendix Section VI.i.

[9] https://www4.eere.energy.gov/seeaction/system/files/documents/DRIPE-finalv3_0.pdf
[10] https://www.raponline.org/knowledge-center/the-value-of-demand-reduction-induced-price-effects-dripe/

g. Greenhouse Gas Reductions

The transportation sector generates the largest portion of greenhouse gas emissions; 28.8% in 2019[11]. The current generation of EVs emits less than half the equivalent carbon dioxide of the average new combustion gasoline vehicle in Columbus. [12] Reducing tailpipe emissions is important to help address local pollution. This will support the State of Ohio in attaining federal standard for air pollutants. "We learned this year that the transportation sector is now the most significant contributor to U.S. greenhouse gas (GHG) emissions, the pollutants at the root of the climate crisis."[13] Utilizing the data available for expected lifetime of light duty vehicles[14]; average emissions of internal combustion engine[15]; and EV (Bolt)[16]; and estimated annual miles[17]; the proposed ET residential program would directly reduce 15,766 tons of carbon annually. Taking into consideration upstream effects, this equates specifically to 10,410 tons tailpipe emissions. This reduction benefits all customers.

Figure 6. Carbon Emission Inputs

Expected lifetime of light duty vehicle	11 years
Average emissions of internal combustion engine vehicle	410 grams/mile
Emissions of reference EV (Bolt)	170 grams/mile
Estimated annual miles	11,113 miles/year
Upstream GHG emissions Factor(includes production and distribution of the fuel used to power the vehicle)	1.25
Average Tailpipe emissions of internal combustion engine vehicle	328 grams/mile

Moreover, this proposed DSM plan will promote the public interest by reducing total generating plant emissions and, as a result, will provide significant environmental benefits to all customers. This plan estimates that the energy savings from programs will save almost 159,000 tons of CO2 annually.

h. Economic Development

To capture the full economic impacts of the investments in energy efficiency, three separate effects (direct, indirect, and induced) must be examined for each change in expenditure. The sum of these three effects yields the total effect resulting from a single expenditure.

[11] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
[12] FuelEconomy.gov, "Beyond Tailpipe Emissions", available at: https://www.fueleconomy.gov/feg/Find.do?zipCode=43215&year=2019&vehicleId=40520&action=bt3
[13] https://cleanenergy.org/blog/electrifying-transportation-a-holistic-approach/
[14] https://www.consumerreports.org/car-repair-maintenance/make-your-car-last-200-000-miles/
[15] FuelEconomy.gov, "Beyond Tailpipe Emissions", available at: https://www.fueleconomy.gov/feg/Find.do?zipCode=43215&year=2019&vehicleId=40520&action=bt3
[16] Id.
[17] http://mydocs.epri.com/docs/PublicMeetingMaterials/ee/000000003002013754.pdf

The **direct effect** refers to the on-site or immediate effects produced by expenditures. In the case of installing energy efficiency upgrades in a home or business, the direct effect is the on-site expenditures and jobs of the construction or trade contractors hired to carry out the work.

The **indirect effect** refers to the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered and is able to pay others who support their businesses. This includes the equipment manufacturer or wholesaler who provided the new technology. It also includes the bank that provides financing to the contractor, the vendor's accountant, and the building owner where the contractor maintains its local offices.

The **induced effect** derives from the change in spending that energy efficiency investments enable. Businesses and households are able to meet their energy, heating, cooling, and lighting needs at a lower total cost, due to efficiency investments. This lower cost of doing business and operating households makes greater wealth available for businesses and families to spend or invest in other goods and services such as food, clothing, entertainment, or marketing (in the case of businesses).

Figure 7 shows the total number of potential jobs—direct and indirect—that are estimated would be created from investing $36.6 million in electric energy efficiency and peak demand reduction in AEP Ohio customer homes and businesses in 2021. Induced effects were not included in this estimate. On average, based on this analysis, one job potentially will be created for approximately $13,890 in spending.

Figure 7. Number of Jobs Created – 2021

2021	Direct	Indirect	Induced	Total
Jobs Created	1,012	1,623	0	2,635

i. Customer Satisfaction

AEP Ohio listens to our customers and programmatic adjustments are made per their feedback. We use various tools to measure customer satisfaction with AEP Ohio that includes surveys, social media and the call center. Customer satisfaction is a key focus and we take it very serious and place emphasis on the customer. It is AEP Ohio's belief is that our customers want us to provide programs to meet their needs such as saving on their bill and for environmental purposes.

Based on the 2019 JD Power results[18], on a 1000 point scale respondents familiar with AEP Ohio's Energy Efficiency Programs were 230 points (23% higher) more satisfied with AEP Ohio overall than not at all familiar with energy efficiency. Other key findings include:

A survey completed by Opinion Dynamics in January 2020 showed 72% of customers rated the AEP Ohio Marketplace a satisfaction of 4 or 5 on a 5 point scale. Less than one percent (0.9%) said they were not at all satisfied.

[18] Source: JD Power 2019 Year End results - Residential only.

The 2018 Program Year Evaluations conducted by Guidehouse (formerly Navigant) showed over 92% of the teachers agreed that e3Smart program activities helped students better understand energy efficiency. For Community Assistance - the low income program, customer's average program satisfaction was 8.99 out of 10.

According to the ESource Business Survey 2019, the question was asked of the Company's business customers: "Should the Utility offer a variety of rate options, programs and services?" AEP Ohio customer responses were favorable at 8.2 on a scale of 10 being most positive. Another questions asked was "Should the Utility provide resources that help me manage energy costs and make informed decisions?" AEP Ohio customer responses were favorable at 8.4 on a scale of 10 being most positive. (JFW-2 DSM Plan Appendices, section XIV, Customer Satisfaction).

VI. Benefit-Cost Analysis

Energy efficiency has a long history of being valued using the California Standard Practice Manual ("CaSPM") tests. These tests were standardized in the National Standards Practice Manual (NSPM), and programs have been historically evaluated with respect to one or more of the four benefit-cost tests[19]: Utility Cost Test, Total Resource Cost Test, Ratepayer Impact Measure Test, and Participant Cost Test. The Utility Cost Test has been the primary test for cost effectiveness in measuring performance of AEP Ohio over the last eleven years. From the NSPM, there is also a new test that AEP Ohio is using to evaluate the DSM Plan for cost effectiveness, the Resource Value test, defined below.

a. Utility Cost Test ("UCT")

The purpose of the UCT is to indicate whether the benefits of an EE resource will exceed its costs from the perspective of the utility system. The UCT includes all costs and benefits that affect the operation of the utility system and the provision of electric and gas services to customers. For vertically integrated utilities, this test includes all of the costs and benefits that affect utility revenue requirements. For utilities that are not vertically integrated, this test includes all costs and benefits that affect utility revenue requirements, plus additional costs and benefits associated with market-based procurement of electricity and gas services. The UCT is sometimes referred to as the Program Administrator Cost test, to include those cases where ratepayer-funded EE programs are implemented by non-utility administrators. The UCT is a more accurate name because the costs and benefits included in this test are those that affect the utility system, not those that affect the Program Administrator.

b. Resource Value Test ("RVT") - NEW

The RVT is the primary cost-effectiveness test designed to represent a regulatory perspective, which reflects the objective of providing customers with safe, reliable, low-cost energy services, while meeting a jurisdiction's other applicable policy goals and objectives. As described in detail within the NSPM, each jurisdiction can develop its own RVT using the Resource Value Framework.

The RVT focus on the regulatory perspective differs from the three most common CaSPM traditional tests—the Utility Cost Test (UCT), Total Resource Cost (TRC) test and Societal Cost Test (SCT). These tests provide the perspective of the utility, the utility and participants, and society as a whole, respectively. Depending on a jurisdiction's energy and other applicable policy goals, the resulting RVT may or may not be different from the traditional cost-effectiveness tests. Put another way, it is possible for a jurisdiction's applicable policy goals to align with one of the traditional CaSPM tests, in which case its RVT will be identical to one of those tests. However, it is also possible—and indeed likely in many cases—that a jurisdiction's energy and other policy goals will not align well with goals implicit in any of the traditional tests. In such cases, the RVT will be different than the traditional tests. AEP Ohio is proposing to incorporate a version of the RVT into the cost tests as explained below.

[19] https://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf

Figure 8. Benefit-Cost Test Formulae

Cost Test	Formula	Key of Terms	
Utility Cost Test (UCT)	UCT = A / (B + C)	A = PV Avoided Costs	D = PV Non Energy Benefits
Resource Value Test(RVT)	RVT = (A + D) / (B + C)	B = PV Administrative Costs	PV = Present Value
		C = PV Incentive Costs	Discount Rate = WACC

c. Benefit / Costs Tests

For purposes of Cost effectiveness, AEP Ohio will use these tests to determine the value and effectiveness of a program. AEP Ohio used the UCT test to guide measure selection and which DSM programs to include that are focused on demand reduction. The Plan as a whole was valued through the RVT, including the administrative costs, and the administrative fee. We have excluded cross sector costs from the tests, and only will be included if they have measurable savings. AEP Ohio created a version of the RVT in which the UCT test incorporates various quantified Non Energy benefits. This purpose of this test is to put value to the various Non Energy Benefits associated to participation in the DSM programs. AEP Ohio plans to study more Non Energy Benefits, and if more Non Energy Benefits become quantifiable, AEP Ohio plans to incorporate them into the RVT.

Figure 9. Projected Benefit Cost Tests

Program	UCT	RVT
Efficient Products	3.0	3.0
Retrofit Low Income	0.2	1.3
Residential Demand Response	1.3	1.3
New Homes	1.4	1.4
e3smart	1.5	1.5
Residential Subtotal	2.2	2.2
Efficient Products for Business	4.1	5.8
Process Efficiency	5.1	7.1
Business New Construction	3.3	4.8
Small Business Express	1.4	2.0
C&I Demand Response	N/A	N/A
Business Subtotal	3.7	6.2
Plan Total	2.3	3.0

Evaluation, Measurement, and Verification

The DSM plan is designed to be cost-effective on a portfolio basis using the Utility Cost Test and Resource Value Test. In general, each program proposed within the plan should also be cost-effective using the Utility Cost Test and Resource Value Test. The portfolio may include programs that are not cost-effective when those programs provides substantial non-energy benefits.

The Company plans to use a variety of methods to measure performance: directly measure savings, calculate using methods found in the Ohio technical reference manual, or other reasonable statistical and/or engineering methods. The Company will use the Ohio TRM as long as it is available and current, with recommendations to justify additional measurements as needed to supplement the TRM.

Stakeholders shall be given an opportunity for participation in program portfolio updates and refinement. At a minimum updates on the energy efficiency and peak demand reductions achieved by programs shall be presented at semi-annual stakeholder meetings.

Costs incurred in implementation of programs, new programs or measures are being considered, and input from stakeholders on existing and potential new programs shall be discussed.

a. Annual Performance Verification

Four months after the end of each program year, a portfolio performance report shall be filed addressing the performance of its energy efficiency and peak demand reduction programs over the previous calendar year.

The portfolio performance report shall detail achieved annualized energy savings, achieved demand reductions, and the demand reductions that programs were reasonably designed to achieve, relative to the corresponding energy and peak demand portfolio reduction goals. At a minimum, this section of the portfolio status report shall include each of the following:

i. A comparison of actual annualized energy savings and peak-demand reductions achieved against plan goal.
ii. A description of each energy efficiency or peak-demand reduction program implemented in the previous calendar year.
iii. The key activities undertaken in each program, the number and type of participants, a comparison of the forecasted savings to the verified savings achieved by such program.
iv. An evaluation, measurement, and verification report that documents the energy savings and peak-demand reduction values and the cost effectiveness of the energy efficiency and demand-side management portfolio to be filed every year.

An AEP Company

AEP Ohio DSM Plan Appendices

6/15/2020

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Contents

I. DSM Plan Measure List

AEP Ohio contracted with Guidehouse (Navigant) to produce a Market Potential study in 2019. AEP Ohio has used this recent study to build the foundational information for its DSM plan, please see below for the measure level breakdown.

Figure 1. Measure level breakdown by program

ProgramCode	CAP	Per unit kW	Per unit kWh	Total kW	Total kWh	Quantity	Unit	Source
	Res | Home that has air sealing performed	0.417	416.667	1.3	1,329.384	3	Residential Households	Navigant Potential Study
CAP	Res | Low flow aerator	0.010	40.000	5.6	22,566.262	564	per faucet	Navigant Potential Study
CAP	Res | Low flow showerhead	0.030	188.000	39.7	248,806.639	1,323	per shower	Navigant Potential Study
CAP	Res | Pipe wrap (hot water)	0.010	0.010	1.4	1.409	141	per house	Navigant Potential Study
CAP	Res | Properly maintained CAC, 2.6 ton	0.039	78.488	13.0	26,204.669	334	Per AC System	Navigant Potential Study
CAP	Res | Residential Weatherization	0.008	459.900	0.0	1,004.010	2	Residential Households	Navigant Potential Study
CAP	Res | Sealed duct in unconditioned spaces	0.075	212.000	14.6	41,215.067	194	Per Household	Navigant Potential Study
CAP	Res | Secondary Refrigerator Not Replaced	0.110	874.000	14.2	113,087.947	129	per Freezer	Navigant Potential Study
CAP	Res | Standard flow showerhead with TSV	0.010	69.000	4.2	29,006.990	420	per shower	Navigant Potential Study
CAP	Res | Water Heater set to 120F	0.005	45.500	0.6	5,054.678	111	per water heater	Navigant Potential Study
CAP	Res | Advanced Smart (Tier 2) Power Strip	0.022	269.786	80.4	965,109.170	3,577	per advanced power strip	Navigant Potential Study
CAP	Res | ENERGY STAR CAC (16 SEER 13 EER)	0.220	226.406	296.1	304,737.753	1,346	Per Air Concitioner	Navigant Potential Study
CAP	Res | ENERGY STAR Heat Pump	0.389	2,516.266	85.5	552,978.992	220	Per System	Navigant Potential Study
CAP	Res | ENERGY STAR Mini Split HP	0.055	300.882	0.8	4,106.506	14	Per Heat Pump	Navigant Potential Study
CAP	Res | Heat Pump WH	0.423	1,765.346	62.9	262,141.988	148	per water heater	Navigant Potential Study
CAP	Res | ENERGY STAR RAC	0.336	338.535	179.7	180,773.030	534	Per Room AC	Navigant Potential Study
CUS	Ind | Air Compressor Control and Optimization	2.248	45,119.881	60.6	1,216,344.001	27	Per Project	Navigant Potential Study
CUS	Ind | Air Compressor VFD	0.285	5,712.442	7.7	153,996.289	27	Per Project	Navigant Potential Study
CUS	Ind | Efficient Motors and Drives	0.227	4,556.530	11.8	236,411.611	52	Per Project	Navigant Potential Study
CUS	Ind | Fan VFD	0.835	16,770.129	5.6	113,262.348	7	Per Project	Navigant Potential Study
CUS	Ind | HE Aerators	0.986	19,802.121	22.8	457,672.455	23	Per Project	Navigant Potential Study
CUS	Ind | HVAC Chiller Upgrade	0.855	17,156.010	5.4	108,718.203	6	Per Project	Navigant Potential Study
CUS	Ind | HVAC System Controls	0.003	56.638	15.0	300,989.362	5,314	Per Ton controlled	Navigant Potential Study
CUS	Ind | HVAC VFD Upgrade	0.432	8,662.643	0.0	307.163	0	Per Project	Navigant Potential Study
CUS	Ind | Injection Molding	3.146	63,159.456	85.9	1,723,680.386	27	Per Project	Navigant Potential Study

CUS	Ind | Lighting Controls	9.030	181,284.870	243.4	4,887,086.524	27	Per Project	Navigant Potential Study
CUS	Ind | Lighting Upgrades- LED	11.864	238,168.848	323.8	6,499,849.750	27	Per Project	Navigant Potential Study
CUS	Ind | Process Heating Improvement	9.030	181,284.870	0.7	13,577.509	0	Per Project	Navigant Potential Study
CUS	Ind | Process Optimization Controls	0.168	3,379.991	4.5	91,117.972	27	Per Project	Navigant Potential Study
CUS	Ind | Pump Sizing and Optimization	0.158	3,165.988	3.9	78,697.445	25	Per Project	Navigant Potential Study
CUS	Ind | Pump VFD	0.894	17,947.302	22.2	446,118.785	25	Per Project	Navigant Potential Study
CUS	Ind | Refrigeration System Optimization	0.097	1,950.563	8.6	173,154.391	89	Per Project	Navigant Potential Study
CUS	Ind | Strategic Energy Management	5.146	103,305.582	78.0	1,566,515.806	15	Per Project	Navigant Potential Study
EP	Res | Advanced Smart (Tier 2) Power Strip	0.022	269.786	443.2	5,318,321.559	19,713	per advanced power strip	Navigant Potential Study
EP	Res | ENERGY STAR Heat Pump	0.389	2,516.266	1,413.3	9,141,722.574	3,633	Per System	Navigant Potential Study
EP	Res | ENERGY STAR Mini Split HP	0.055	300.882	12.4	67,887.823	226	Per Heat Pump	Navigant Potential Study
EP	Res | Heat Pump WH	0.423	1,765.346	1,039.1	4,333,671.556	2,455	per water heater	Navigant Potential Study
EP	Res | LED Replacement Lamp (Tube)	0.020	11.900	830.5	494,163.921	41,526	Per Bulb	Navigant Potential Study
EP	Res | Networked/ Connected - Indoor LED Lamp	0.004	31.602	86.0	770,552.773	24,383	Per Bulb	Navigant Potential Study
EP	Res | Specialty LED Bulbs	0.008	45.421	1,633.3	9,273,435.982	204,165	Per Bulb	2019 Program Data
EP	Res | Outdoor motion sensor	0.034	124.960	2.4	8,897.865	71	Residential Households	Navigant Potential Study
EP	Res | System with WiFi thermostat	0.230	329.626	439.8	630,314.943	1,912	Per Thermostat	Navigant Potential Study
EP4B	Com | 4.4 CEF Heat Pump Multi-Family Laundromat Dryer	0.212	1,845.659	5.4	47,278.542	26	per Dryer	Navigant Potential Study
EP4B	Com | Add Door to Open Display Case	0.026	1,016.833	0.1	4,423.211	4	Per foot	Navigant Potential Study
EP4B	Com | Advanced Smart (Tier 2) Power Strip	0.022	118.466	214.0	1,152,585.438	9,729	per Power Strip	Navigant Potential Study
EP4B	Com | Anti sweat heat control	0.025	171.806	0.2	1,486.621	9	Per foot	Navigant Potential Study
EP4B	Com | Appropriately sized pump hotel	0.025	146.033	6.7	38,817.993	266	1000 ft2 of floor space	Navigant Potential Study
EP4B	Com | Bi-Level Stairway Lighting	0.025	146.033	202.6	1,167,514.599	7,995	per 1000 sq ft	Navigant Potential Study
EP4B	Com | Chiller plant optimization (Economizer, pipe insulation, cooling tower)	0.000	0.002	42.5	0.211	122	Per Project	Navigant Potential Study
EP4B	Com | Commercial Faucet Aerator	0.132	468.491	131.7	466,522.517	996	Unit	Navigant Potential Study
EP4B	Com | Commercial Fryers	0.355	1,858.000	3.8	20,085.783	11	Per Fryer	Navigant Potential Study
EP4B	Com | Commercial Griddles	0.145	758.000	92.5	482,197.942	636	Per linear foot	Navigant Potential Study
EP4B	Com | Commercial Steam Cookers	8.250	43,014.500	3.2	16,498.125	0	per cooker	Navigant Potential Study
EP4B	Com | Common area clothes washer (Lodging, university)	0.044	186.333	1.7	7,277.992	39	Clothes Washer	Navigant Potential Study
EP4B	Com | Cooling Load Optimization (CRAC/CRAH, chillers, hot/cold aisle containment, economization, other custom optimization)	0.000	0.040	28.9	2.734	68	Project	Navigant Potential Study

EP4B	Com | Cooling Optimization	0.000	0.170	58.6	8.743	51	Project	Navigant Potential Study
EP4B	Com | Cooling Tower Fan with VFD	0.038	1,258.180	0.1	4,318.432	3	per HP	Navigant Potential Study
EP4B	Com | Daylight Dimming Control	0.057	427.846	211.8	1,577,193.367	3,686	per 1000 sq ft	Navigant Potential Study
EP4B	Com | Elec Storage WH 2.30 Et	0.007	129.564	241.7	4,505,427.853	34,774	per kBtu/hr	Navigant Potential Study
EP4B	Com | Electronically Commutated Motor on Display Case	0.050	438.519	0.2	2,185.613	5	Motor	Navigant Potential Study
EP4B	Com | Electronically Commutated Motor on Walk-In	0.166	1,450.683	0.0	384.842	0	Motor	Navigant Potential Study
EP4B	Com | Energy Recovery Ventilator	0.166	1,450.683	8.4	73,231.768	50	Ton	Navigant Potential Study
EP4B	Com | ENERGY STAR Electric Convection Oven	0.442	1,661.165	32.7	122,660.829	74	per oven	Navigant Potential Study
EP4B	Com | ENERGY STAR High Temperature Commercial Dishwasher, Conveyor - Electric	0.899	5,063.991	13.2	74,280.628	15	Per Dishwasher	Navigant Potential Study
EP4B	Com | ENERGY STAR Minisplit	0.096	299.747	0.4	1,144.786	4	per ton cooling	Navigant Potential Study
EP4B	Com | ENERGY STAR Office All-in-one Printer	0.007	46.929	4.0	28,310.681	603	per printer	Navigant Potential Study
EP4B	Com | Energy Star Servers and Storage Devices	0.000	0.170	16.2	2.068	12	Per kWh consumed	Navigant Potential Study
EP4B	Com | Floating Head- Air Cooled	0.137	2,167.600	0.9	13,971.117	6	Per Ton	Navigant Potential Study
EP4B	Com | Horticulture Interior LED Grow Lighting	0.083	547.500	210.3	1,391,804.928	2,542	per 1000 sq ft	Navigant Potential Study
EP4B	Com | HVAC with CO2-based control	0.089	82.685	305.6	284,833.792	3,445	Per 1000 sq ft	Navigant Potential Study
EP4B	Com | HVAC with WiFi thermostat	0.230	465.786	93.3	189,025.006	406	per thermostat	Navigant Potential Study
EP4B	Com | Interior Occupancy Sensor	0.057	366.725	586.2	3,741,332.503	10,202	per 1000 sq ft	Navigant Potential Study
EP4B	Com | IT Load Optimization (server refresh and virtualization)	0.000	0.039	4.5	37,873.290	966,596	Per kWh consumed	Navigant Potential Study
EP4B	Com | LED Low/High Bay	0.132	588.475	1,849.7	8,238,730.273	14,000	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Other Linear Fixture	0.014	64.206	174.1	816,093.605	12,711	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Parking Garage and Canopy	0.017	148.697	224.7	1,968,484.646	13,238	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Refrigerator Case	0.004	36.416	8.0	70,819.672	1,945	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Replacement Lamp (Tube)	0.092	487.838	1,685.6	8,966,488.440	18,380	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Track Lighting	0.019	89.217	257.0	1,184,040.142	13,271	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Traffic Signals	0.104	911.537	7.8	68,484.038	75	per 1000 sq ft	Navigant Potential Study
EP4B	Com | LED Troffer/Surface/Suspended	0.146	706.269	2,254.4	10,917,985.752	15,459	Per Fixture	Navigant Potential Study
EP4B	Com | LLLC - High Impact Application	0.128	985.024	1,511.1	11,665,819.321	11,843	per 1000 sq ft	Navigant Potential Study
EP4B	Com | Low Flow Pre-Rinse Spray Valves	0.642	6,925.226	71.4	771,025.129	111	Unit	Navigant Potential Study
EP4B	Com | Networked/Connected - High Impact Application	0.642	6,925.226	1,778.7	19,200,232.261	2,773	per 1000 sq ft	Navigant Potential Study
EP4B	Com | New Construction 25% increase Elec	0.000	0.250	74.6	199,384.987	797,540	kWh Saved	Navigant Potential Study
EP4B	Com | Parking garage exhaust fan (office)	0.211	925.000	83.0	364,064.826	394	1000 ft2 of floor space	Navigant Potential Study

EP4B	Com | Power Delivery (Primarily UPS but also PDS, transformers, etc.)	0.000	0.020	7.0	60,148.519	3,024,283	Per kWh consumed	Navigant Potential Study
EP4B	Com | PTAC/PTHP with occupancy sensor	0.022	305.389	0.6	8,436.569	28	Per ton	Navigant Potential Study
EP4B	Com | Refrigerated Vending Machine with control system	0.155	1,355.056	4.0	34,677.029	26	Vending Machine	Navigant Potential Study
EP4B	Com | Solid State (LED) Recessed Downlight	0.036	167.043	385.7	1,766,746.665	10,577	per 1000 sq ft	Navigant Potential Study
EP4B	Com | Strategic Energy Management	0.000	0.035	273.1	6,414,687.411	183,276,783	kWh Consumed	Navigant Potential Study
EP4B	Com | VRF HP	0.172	710.173	17.7	73,415.503	103	per ton cooling	Navigant Potential Study
EP4B	Com | Zero-Energy Doors and Frames MT	0.022	188.900	0.2	1,985.959	11	Per foot	Navigant Potential Study
EXP	Com | LED Low/High Bay	0.132	588.475	227.6	1,013,884.459	1,723	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Other Linear Fixture	0.014	64.206	21.4	100,431.085	1,564	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Parking Garage and Canopy	0.017	148.697	27.7	242,248.007	1,629	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Refrigerator Case	0.004	36.416	1.0	8,715.295	239	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Replacement Lamp (Tube)	0.092	487.838	207.4	1,103,444.703	2,262	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Track Lighting	0.019	89.217	31.6	145,711.761	1,633	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Traffic Signals	0.104	911.537	1.0	8,427.864	9	per 1000 sq ft	Navigant Potential Study
EXP	Com | LED Troffer/Surface/Suspended	0.146	706.269	277.4	1,343,602.195	1,902	Per Fixture	Navigant Potential Study
EXP	Com | LLLC - High Impact Application	0.128	985.024	186.0	1,435,632.982	1,457	per 1000 sq ft	Navigant Potential Study
EXP	Com | Networked/Connected - High Impact Application	0.150	1,158.292	218.9	1,688,895.832	1,458	per 1000 sq ft	Navigant Potential Study
GM	Res | Home Energy Report	0.023	180.323	7,029.2	54,067,702.857	299,839	Residential Households	Navigant Potential Study
GM	Res | Demand Response	0.970	427.050	8,964.9	3,946,882.139	9,242	Thermostats	2019 EM&V
GM	Res | Electric Vehicle Controls: Demand Response	1.504	-	1,405.8	-	935	Per Charger	Navigant Potential Study
NH	Res | Energy STAR 56 HERS Index (30% more efficient than reference home)	1.200	2,144.953	2,291.1	4,095,187.374	1,909	per living unit	Navigant Potential Study
NH	Res | E-STAR Manufactured Home	1.020	2,074.620	108.9	221,594.042	107	per living unit	Navigant Potential Study
NRNC	Com | 4.4 CEF Heat Pump Multi-Family Laundromat Dryer	0.212	1,845.659	0.8	6,805.245	4	per Dryer	Navigant Potential Study
NRNC	Com | Add Door to Open Display Case	0.026	1,016.833	0.0	636.674	1	Per foot	Navigant Potential Study
NRNC	Com | Advanced Smart (Tier 2) Power Strip	0.022	118.466	30.8	165,902.449	1,400	per Power Strip	Navigant Potential Study
NRNC	Com | Anti sweat heat control	0.025	171.806	0.0	213.983	1	Per foot	Navigant Potential Study
NRNC	Com | Appropriately sized pump hotel	0.025	146.033	1.0	5,587.438	38	1000 ft2 of floor space	Navigant Potential Study
NRNC	Com | Bi-Level Stairway Lighting	0.025	146.033	29.2	168,051.344	1,151	per 1000 sq ft	Navigant Potential Study
NRNC	Com | Chiller plant optimization (Economizer, pipe insulation, cooling tower)	0.000	0.002	6.1	0.030	18	Per Project	Navigant Potential Study
NRNC	Com | Commercial Faucet Aerator	0.132	468.491	19.0	67,150.968	143	Unit	Navigant Potential Study
NRNC	Com | Commercial Fryers	0.355	1,858.000	0.6	2,891.135	2	Per Fryer	Navigant Potential Study

NRNC	Com | Commercial Griddles	0.145	758.000	13.3	69,407.279	92	Per linear foot	Navigant Potential Study
NRNC	Com | Commercial Steam Cookers	8.250	43,014.500	0.5	2,374.730	0	per cooker	Navigant Potential Study
NRNC	Com | Common area clothes washer (Lodging, university)	0.044	186.333	0.2	1,047.590	6	Clothes Washer	Navigant Potential Study
NRNC	Com | Cooling Load Optimization (CRAC/CRAH, chillers, hot/cold aisle containment, economization, other custom optimization)	0.000	0.040	4.2	0.394	10	Project	Navigant Potential Study
NRNC	Com | Cooling Optimization	0.000	0.170	9.9	1.258	7	Project	Navigant Potential Study
NRNC	Com | Cooling Tower Fan with VFD	0.038	1,258.180	0.0	621.592	0	per HP	Navigant Potential Study
NRNC	Com | Daylight Dimming Control	0.057	427.846	30.5	227,020.257	531	per 1000 sq ft	Navigant Potential Study
NRNC	Com | Elec Storage WH 2.30 Et	0.007	129.564	34.8	648,508.555	5,005	per kBtu/hr	Navigant Potential Study
NRNC	Com | Electronically Commutated Motor on Display Case	0.050	438.519	0.0	314.596	1	Motor	Navigant Potential Study
NRNC	Com | Electronically Commutated Motor on Walk-In	0.166	1,450.683	0.0	55.394	0	Motor	Navigant Potential Study
NRNC	Com | Energy Recovery Ventilator	0.166	1,450.683	1.2	10,540.936	7	Ton	Navigant Potential Study
NRNC	Com | ENERGY STAR Electric Convection Oven	0.442	1,661.165	4.7	17,655.725	11	per oven	Navigant Potential Study
NRNC	Com | ENERGY STAR High Temperature Commercial Dishwasher, Conveyor - Electric	0.899	5,063.991	1.9	10,691.909	2	Per Dishwasher	Navigant Potential Study
NRNC	Com | ENERGY STAR Minisplit	0.096	299.747	0.1	164.780	1	per ton cooling	Navigant Potential Study
NRNC	Com | ENERGY STAR Office All-in-one Printer	0.007	46.929	0.6	4,075.022	87	per printer	Navigant Potential Study
NRNC	Com | Energy Star Servers and Storage Devices	0.000	0.170	2.3	0.298	2	Per kWh consumed	Navigant Potential Study
NRNC	Com | Floating Head- Air Cooled	0.137	2,167.600	0.1	2,010.994	1	Per Ton	Navigant Potential Study
NRNC	Com | Horticulture Interior LED Grow Lighting	0.083	547.500	151.4	1,001,677.789	1,830	per 1000 sq ft	Navigant Potential Study
NRNC	Com | HVAC with CO2-based control	0.089	82.685	44.0	40,998.803	496	Per 1000 sq ft	Navigant Potential Study
NRNC	Com | HVAC with WiFi thermostat	0.230	465.786	13.4	27,208.145	58	per thermostat	Navigant Potential Study
NRNC	Com | Interior Occupancy Sensor	0.057	366.725	84.4	538,525.133	1,468	per 1000 sq ft	Navigant Potential Study
NRNC	Com | IT Load Optimization (server refresh and virtualization)	0.000	0.039	0.6	5,451.458	139,131	Per kWh consumed	Navigant Potential Study
NRNC	Com | LED Low/High Bay	0.132	588.475	266.2	1,185,877.842	2,015	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Other Linear Fixture	0.014	64.206	25.1	117,468.019	1,830	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Parking Garage and Canopy	0.017	148.697	32.3	283,342.487	1,905	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Refrigerator Case	0.004	36.416	1.2	10,193.741	280	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Replacement Lamp (Tube)	0.092	487.838	242.6	1,290,630.912	2,646	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Track Lighting	0.019	89.217	37.0	170,430.020	1,910	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Traffic Signals	0.104	911.537	1.1	9,857.551	11	per 1000 sq ft	Navigant Potential Study
NRNC	Com | LED Troffer/Surface/Suspended	0.146	706.269	324.5	1,571,528.252	2,225	Per Fixture	Navigant Potential Study

NRNC	Com | LLLC - High Impact Application	0.128	985.024	217.5	1,679,170.963	1,705	per 1000 sq ft	Navigant Potential Study
NRNC	Com | Low Flow Pre-Rinse Spray Valves	0.642	6,925.226	10.3	110,980.890	16	Unit	Navigant Potential Study
NRNC	Com | Networked/Connected - High Impact Application	0.642	6,925.226	256.0	2,763,669.795	399	per 1000 sq ft	Navigant Potential Study
NRNC	Com | New Construction 25% increase Elec	0.000	0.250	10.7	28,699.354	114,797	kWh Saved	Navigant Potential Study
NRNC	Com | Parking garage exhaust fan (office)	0.211	925.000	12.0	52,403.270	57	1000 ft2 of floor space	Navigant Potential Study
NRNC	Com | Power Delivery (Primarily UPS but also PDS, transformers, etc.)	0.000	0.020	1.0	8,657.741	435,313	Per kWh consumed	Navigant Potential Study
NRNC	Com | PTAC/PTHP with occupancy sensor	0.022	305.389	0.1	1,214.355	4	Per ton	Navigant Potential Study
NRNC	Com | Refrigerated Vending Machine with control system	0.155	1,355.056	0.6	4,991.391	4	Vending Machine	Navigant Potential Study
NRNC	Com | Solid State (LED) Recessed Downlight	0.036	167.043	55.5	254,304.444	1,522	per 1000 sq ft	Navigant Potential Study
NRNC	Com | Strategic Energy Management	0.000	0.035	39.3	923,326.218	26,380,749	kWh Consumed	Navigant Potential Study
NRNC	Com | VRF HP	0.172	710.173	2.6	10,567.383	15	per ton cooling	Navigant Potential Study
NRNC	Com | Zero-Energy Doors and Frames MT	0.022	188.900	0.0	285.858	2	Per foot	Navigant Potential Study
CLM	Com | Commercial Load Control	2.500	-	-	-	-	Engineering Estimate	Engineering Estimate
E3S	Res | Home that has air sealing performed	0.417	416.667	4.0	3,989.457	10	Residential Households	Navigant Potential Study
E3S	Res | Low flow aerator	0.010	40.000	16.9	67,720.941	1,693	per faucet	Navigant Potential Study
E3S	Res | Low flow showerhead	0.030	188.000	119.1	746,664.190	3,972	per shower	Navigant Potential Study
E3S	Res | Pipe wrap (hot water)	0.010	0.010	4.2	4.229	423	per house	Navigant Potential Study
E3S	Res | Standard flow showerhead with TSV	0.010	69.000	12.6	87,049.449	1,262	per shower	Navigant Potential Study
E3S	Res | Water Heater set to 120F	0.005	45.500	1.7	15,168.997	333	per water heater	Navigant Potential Study
E3S	Res | Advanced Smart (Tier 2) Power Strip	0.022	269.786	241.4	2,896,275.033	10,735	per advanced power strip	Navigant Potential Study

II. CAP Program 150% Poverty level and below

In an effort to review the program design, AEP Ohio analyzed the historic participants for the Community Assistance Program (CAP). These results indicate that 86% of our CAP participants are below the 150% poverty threshold[1]. AEP Ohio has reviewed this data, and designed the program to target below 150% poverty level. This will allow AEP Ohio to better serve the most vulnerable demographic, and align to Ohio's Electric Partnership Program (EPP) for consistency. See below for the CAP participation data analyzed going back to 2012.

Figure 2. Historic distribution of CAP participants by poverty level

2012-2019 Historic Participant distribution	% Percent
0-100% of Federal Poverty Level	64%
101-150% of Federal Poverty Level	22%
151-200% of Federal Poverty Level	14%
201 -300% of Federal Poverty Level	0%
301-400% of Federal Poverty Level	0%

III. Federal Poverty Level Definition

To ensure all customers have the means to participate, AEP Ohio has reviewed the Federal Poverty level definition. This review can help the company provide the best possible incentive levels to those that need it most. These values are updated annually and will help inform the Supplemental Low Income mechanism in the Retrofit Low Income program.

What Is the Federal Poverty Level?

The Federal Poverty Level (FPL), or the "poverty line" is an economic measure that is used to decide whether the income level of an individual or family qualifies them for certain federal benefits and programs. The FPL is the set minimum amount of income that a family needs for food, clothing, transportation, shelter, and other necessities.

Understanding the Federal Poverty Level (FPL)

Each year, the US Census Bureau issues a public report on the level of poverty in the country. The report provides an estimate of the number of people that are poor; the percentage of people living below the poverty level; the poverty distribution by age, sex, ethnicity, location, etc.; and the level of income inequality. The Department of Health and Human Services (HHS) uses this report to set a poverty guideline on who should be eligible for certain federal programs. The Federal Poverty Level (FPL) is typically issued annually in January by the HHS which uses household income and size to determine the

[1] In 2020, this came to roughly $36,900 per year for a family of four. See U.S. Department of Health and Human Services, "2020 Poverty Guidelines," https://aspe.hhs.gov/2020-poverty-guidelines.

poverty level. The information on the annual report shows the total cost needed by the average person per year to cover basic necessities like food, utilities, and accommodation. This number is adjusted annually for inflation. To calculate percentage of poverty level, divide income by the poverty guideline and multiply by 100. A family of five in New Jersey with annual income of $80,000 has a poverty level that is ($80,000/$28,780) x 100 = 278% of the federal poverty guidelines, and will likely not qualify for Utility Assistance or Medicaid, but may be eligible for an advanced premium tax credit subsidy.

Figure 3. 48 Contiguous States and D.C. – 2020 Poverty Guidelines

Persons in Household	48 Contiguous States and D.C. Poverty Guidelines (Annual)							
	100%	133%	138%	150%	200%	250%	300%	400%
1	$12,760	$16,971	$17,609	$19,140	$25,520	$31,900	$38,280	$51,040
2	$17,240	$22,929	$23,791	$25,860	$34,480	$43,100	$51,720	$68,960
3	$21,720	$28,888	$29,974	$32,580	$43,440	$54,300	$65,160	$86,880
4	$26,200	$34,846	$36,156	$39,300	$52,400	$65,500	$78,600	$104,800
5	$30,680	$40,804	$42,338	$46,020	$61,360	$76,700	$92,040	$122,720
6	$35,160	$46,763	$48,521	$52,740	$70,320	$87,900	$105,480	$140,640
7	$39,640	$52,721	$54,703	$59,460	$79,280	$99,100	$118,920	$158,560
8	$44,120	$58,680	$60,886	$66,180	$88,240	$110,300	$132,360	$176,480
Add $4,480 for each person over 8								

IV. AEP Ohio C&I Non Energy Benefits Study

Non-energy impacts (NEIs) include positive (Non-Energy Benefits) or negative effects attributable to energy efficiency (EE) programs separate from energy savings. *"Participant benefits (or NEIs) are monetary and non-monetary benefits (positive or negative) that directly benefit a program partner, stakeholder, trade ally, participant, or the participant's household."*[2] AEP Ohio engaged DNV GL to estimate NEIs resulting from their commercial and industrial (C&I) programs. DNV GL conducted the study presented in this report to document and monetize the following types of NEIs that are experienced by program participants and attributable to AEP Ohio's EE programs:

- Operations and maintenance (O&M) cost savings
- Revenue / sales increases
- Increased worker and equipment productivity
- Increased safety
- Reduced downtime
- Decreased compliance costs
- Reduction in product loss

DNV GL provided the following recommendation based on the study results:

- DNV GL recommends inclusion of NEIs in regulatory cost-effectiveness testing for EE programs.
- DNV GL recommends using O&M cost savings derived from the life-cycle cost analysis for the lighting, motors, VSD, custom, and "other" (agriculture and compressed air) measure categories. DNV GL recommends that AEP Ohio use the accompanying NEI Excel spreadsheet for more granular O&M cost savings by industry and measure type.
- DNV GL recommends using industry specific estimates of NEIs resulting from productivity or sales increases for HVAC, VSD, compressed air, and lighting measures.
- DNV GL recommends that AEP Ohio use the industry specific key findings and quotes to develop marketing materials for customers that address customer pain points specific to firms in their industry.

The report details DNV GL's study of the NEIs resulting from AEP Ohio's EE C&I programs.

- Our analysis shows that O&M cost savings for lighting measures varies by the type and quantity of lamps installed and being replaced as well as the height above the ground or floor in which lamps are placed and whether labor rates are union or non/union workers.
- EE HVAC, lighting, and VSD/compressed air measure can reduce downtime, which is a key pain point across industries. For example, HVAC improvements in hospitals can result in increased use of surgical rooms, recovery rooms, nurseries, and laboratories other spaces for which the temperature, humidity, air pressure and ventilation are tightly governed by CDC and local regulations. Expanding the hours of operation of these spaces can increase revenue for hospitals. In office settings, improved lighting is shown to increased staff performance by increasing focus and alertness leading to fewer breaks, and greater attention on tasks.

[2] Non-Energy Impacts Approaches and Values: an Examination of the Northeast, Mid-Atlantic, and Beyond. NEEP. June 2017. http://www.neep.org/sites/default/files/resources/NEI%20Final%20Report%20for%20NH%206.2.17.pdf

- Evidence that natural light improves learning, mood, and attention dates back over 100 years. More recent studies have proven that increasing daylight and luminescence contributes to worker performance, resulting in fewer breaks and increased cognitive function. [3] Further, controlling lighting color to represent the Circadian Rhythms decreases the release of melatonin, the brain's natural chemical to induce restfulness in the afternoon and evening. [4] Unlike LEDs, convectional fluorescent tubes cannot control the color index to provide greater blue (morning) light. This can result in workers having melatonin released during times in which they are expected to be more productive at work, resulting in fatigue, increase in errors, and decreased productivity. Increase luminescence can also minimize safety hazards that would otherwise result from poor lighting.
- Recent studies have shown that LED lighting can mimic natural morning light, resulting in increased attention, performance, and mood. [5] [6] In contrast, fluorescent lighting can suppress melatonin release toward the end of the worker's shift, which can result in sleep disorders such as insomnia, a common problem for second- and third-shift workers. For example, improved lighting in hospitals is shown to increase surgical and nursing staff performance by enhancing mood and alertness, particularly during night shifts.
- Improved HVAC systems better regulate the temperature of retail areas, resulting in increased comfort for customers and reducing humidity and temperature fluctuations that can result in product loss. In fact, increased comfort can have interactive effects with other NEIs. For example, increased comfort in retail settings results in customers staying in the store longer, which likely translates into increased revenue.
- VFD/VSDs result in less wear on pumps and other equipment by allowing variation in motor operation. This can increase the overall operation of the system, decrease equipment failures, and reduce downtime. Integrating control systems into a process can provide for better predictive maintenance of equipment, reduces equipment/system failure, product/material loss, and downtime. For chemical and petrochemical manufacturers, system failure is a major concern as it often results in loss of material inputs, extensive downtime, and lost revenue. Use of control systems that can aid in predictive maintenance can provide substantial gains to profitability. [7]
- Downtime is a major concern for manufacturers. *"Power quality problems cost U.S. manufacturers up to $188 billion a year—$9.6 billion in the plastics industry alone—with 80 percent of those problems created by manufacturers' own internal power systems. Bad power is wrecking motors, transformers, electronics and other components way before their times. It's causing lost production and product quality issues, and it's unnecessarily driving energy bills up higher and higher."* [8] VFDs can help reduce downtime by reducing wear and tear on other equipment. Integrating control systems into a process can provide for better predictive maintenance of equipment, and reduces equipment/system failure, product/material loss, and downtime. For chemical and petrochemical

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[3] *Natural Light and Productivity: Analyzing the Impacts of Daylighting on Students' and Workers' Health and Alertness Int'l Journal of Advances in Chemical Eng., & Biological Sciences (IJACEBS) Vol. 3, Issue 1 (2016) ISSN 2349-1507 EISSN 2349-1515 N. Shishegar, M. Boubekri*

[4] Riemersma-van der Lek, Rixt F. MD. Dick F. Swaab, MD, PhD, Jos Twisk, PhD, Elly M. Hol, PhD, Witte J. G. Hoogendijk, MD, PhD, Eus J. W. Van Someren, PhD. Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities: A Randomized Controlled Trial." American Medical Association. JAMA, June 11, 2008—Vol 299, No. 22.

[5] *Eo, Ik-soo and Keum-yeon Choi. "Study of learning by Changing the Color-Temperature LED Lamp." Honam University, Gwang-Ju City, Korea. International Journal of Multimedia and Ubiquitous Engineering. Vol. 9, No 3 (2014). Pp. 309-316.)*

[6] *Natural Light and Productivity: Analyzing the Impacts of Daylighting on Students' and Workers' Health and Alertness Int'l Journal of Advances in Chemical Eng., & Biological Sciences (IJACEBS) Vol. 3, Issue 1 (2016) ISSN 2349-1507 EISSN 2349-1515 N. Shishegar, M. Boubekri*

[7] *"Plastics Manufacturing Systems Engineering: A System Approach. Kazmer, David O. Hansfer Publisher, Munich. Cincinnati, Oh. June. 2006.*

[8] https://www.ptonline.com/articles/Bad-Power-is-the-Root-of-Many-Plastics-Production-Problems

manufacturers, system failure is a major concern, as it often results in loss of material inputs, extensive downtime, and lost revenue. Control systems that aid in predictive maintenance can provide substantial gains to profitability.

Program or Portfolio Cost-Effectiveness Testing

Accounting for NEIs in the evaluation of EE programs allows for more optimal program evaluation and planning, as NEIs, along with program costs and energy savings, account for the full range of impacts that EE programs have on the population. An increasing number of states allow investor-owned utilities and EE program administrators to include NEIs as potential benefits that are included in the BCA of portfolios. For example, in 2008, Massachusetts passed the Green Communities Act, which directed all gas and electric program administrators to seek out and implement all cost-effective EE measures that are less expensive than supply. The Massachusetts program administrators, per direction from the Department of Public Utilities, use the TRC test to determine cost-effectiveness.[9]

Benefits vs. Costs

DNV GL classified respondent-reported impacts into benefits and costs based on whether the impact would be regarded as increasing or decreasing the profitability (or net revenue for public entities) of the organization, and asked whether end-users' measures resulted in those impacts.

Figure 4. Percent of measures resulting in NEI by non-energy benefits by type of benefit

Benefit category	Measures resulting in benefit	Percent
Comfort Increased	41	52%
Safety Increased	34	43%
Productivity Increased	22	28%
Other Revenue Increased	3	4%
Sales Increased	2	3%
Other Increase	2	3%
Downtime Decreased	19	24%
Labor Costs Decreased	10	13%
Other Decrease	10	13%
Material Costs Decreased	5	6%
License Costs Decreased	2	3%
Waste Disposal Costs Decreased	0	0%

Reported possible non-energy costs, which include *decreases* in sales/revenue, productivity, comfort, and safety, as well as *increases* in costs, downtime, and waste disposal. Just 2 out of 79 measures were reported to result in non-energy costs. Due to the rarity of non-energy costs cited by end-users, the results section focuses on non-energy benefits.

[9] Final Report – Commercial and Industrial Non-Energy Impacts Study." Prepared for the Massachusetts Program Administrators by DNV KEMA and TetraTech. June 29, 2012

Figure 5. Respondents reporting NEI non-energy cost by type cost

Non-energy cost category	Measures resulting in cost	Percent
Materials Costs Increase	1	1%
Labor Costs Increase	1	1%
Downtime Increase	0	0%
Waste Disposal Increase	0	0%
Sales Decrease	0	0%
Other Revenue Decrease	0	0%
Productivity Decrease	0	0%
Comfort Decrease	0	0%
Safety Decrease	0	0%

NEIs that result from O&M cost savings by industry, as determined by the life-cycle cost analysis. In the far right column, the table shows the average payback period, which indicates the number of years required to pay off the initial measure cost given the program incentive, annual energy savings, and O&M cost savings. The payback value does not consider other NEIs such as productivity gains, reduced downtime, or increased sales; only O&M cost savings.

The table shows that all industries receive positive NEIs from their installed measures. The average annual O&M cost savings (Average NEI $/yr column) range from just over $170 per year for Utilities to over $2,200 per year for Warehousing. Select industry-specific NEIs resulting from O&M cost savings are presented for Manufacturing, Retail, Grocery, Hospitals, and Offices in the sections that follow. For these industries, O&M cost savings vary considerably by measure type and industry; therefore, average results do not represent the actual impacts that individual firms should expect.

Figure 6. NEI's from O&M savings

Sector	Industry	NEI $/kWh savings	Average of kwh savings	Incentives	Average of Energy cost savings	NEI $/yr	Average of Measure Cost	Average of Payback Years
Commercial	Construction	$0.0202	52,229	$4,354	$6,268	$665	$ 14,542	1.90
	Hospitality	$0.0152	13,945	$890	$1,673	$187	$ 11,017	1.74
	Hospitals	$0.0205	31,323	$1,821	$3,759	$548	$ 10,826	1.61
	Other Service	$0.0225	8,985	$673	$1,078	$204	$ 7,833	1.45
	Professional Services	$0.0202	18,809	$2,012	$2,257	$299	$ 10,901	2.47
	Public Assembly	$0.0188	25,745	$1,877	$3,089	$443	$ 10,652	1.89
	Retail	$0.0175	14,701	$1,148	$1,764	$213	$ 9,330	2.35
	Transportation	$0.0112	36,975	$3,688	$4,437	$271	$ 20,229	2.10
	Utilities	$0.0194	9,208	$597	$1,105	$172	$ 7,790	1.79
	Warehousing	$0.0209	128,026	$17,524	$15,363	$2,233	$ 44,270	1.65
	Wholesale Trade	$0.0205	25,451	$2,017	$3,054	$433	$ 9,670	1.86
Commercial Total		**$0.0188**	**19,345**	**$1,549**	**$2,321**	**$297**	**$ 10,097**	**2.07**
Manufacturing and Industrial	Agriculture and Forestry	$0.0217	49,797	$3,415	$5,976	$1,129	$ 6,507	0.81
	Discrete	$0.0156	101,324	$7,211	$12,118	$918	$ 31,409	1.67
	Process	$0.0173	79,528	$4,465	$9,543	$1,023	$ 22,396	1.47
Manufacturing and Industrial Total		**$0.0168**	**86,690**	**$5,457**	**$10,390**	**$987**	**$ 25,249**	**1.54**
Public	Education	$0.0202	22,745	$2,004	$2,729	$338	$ 11,705	2.61
	Government	$0.0210	37,311	$1,938	$4,477	$304	$ 10,122	3.16
Public Total		**$0.0204**	**27,322**	**$1,983**	**$3,279**	**$327**	**$ 11,208**	**2.82**
Grand Total		**$0.0183**	**29,565**	**$2,331**	**$3,547**	**$381**	**$ 12,211**	**1.95**

Participant economic benefits resulting from EE programs are good for Ohio as they reverberate through the overall economy. Increased C&I profitability can result in an increase in jobs for Ohio residents or put money back on the pockets of companies and individuals. The money saved can be reinvested in the local economy in greater wages or capital investments. Health benefits translate into lower state healthcare costs, and increased security and safety will decrease the strain on state and local law enforcement budgets. Finally, increased sales, output, and property values provide additional tax revenue for the state. The full study is available on the AEP Ohio website[10].

[10] https://www.aepohio.com/global/utilities/lib/docs/save/business/nonenergy/NEIFinalReport7-25-18.pdf

V. CAP Non Energy Benefits

There are substantial Non Energy Impacts associated to the Community Assistance Program such as:

1. Reduced Charge offs
2. Increased Safety
3. Increased Indoor Air Quality
4. Increased Comfort and Health
5. Reduced bill collections through USF
6. Economic Development and Job Creation
7. Other Fuel Benefits
8. Water and Other Resource Benefits

For this plan, we have only quantified the reduction in Charge offs and the reduction in collections needed for the Universal Service Fund. If more research becomes available that has quantified other Non-Energy impacts, AEP Ohio will look at potential ways to incorporate into Benefit / Cost tests.

For the reduction in amount collected, we monetized the energy savings from the previous program year filings for the participant benefits used for the Participant test (PCT). See below for the outputs:

Figure 7. Annual spend and benefits for Community Assistance Program

Year	Program Costs	Nominal Bill Reduction	PV Bill Reductions (3%)	Docket[11]
2009	$ -	$ -	$ -	
2010	$ 292,341	$ 1,133,819	$ 1,009,548	11-1299-EL-EEC
2011	$ 12,457,533	$ 13,143,898	$ 11,376,777	12-1537-EL-EEC
2012	$ 6,836,262	$ 14,140,045	$ 11,295,801	13-1182-EL-EEC
2013	$ 12,739,555	$ 28,337,770	$ 22,527,870	14-0853-EL-EEC
2014	$ 11,709,065	$ 28,255,099	$ 22,222,938	15-0919-EL-EEC
2015	$ 6,651,548	$ 14,723,345	$ 11,553,249	16-1099-EL-EEC
2016	$ 9,213,291	$ 18,506,547	$ 14,266,232	17-1229-EL-EEC
2017	$ 6,280,112	$ 12,052,628	$ 8,970,201	18-0835-EL-EEC
2018	$ 5,755,596	$ 7,481,105	$ 5,666,183	19-1099-EL-EEC
Total	**$ 71,935,303**	**$ 137,774,256**	**$ 108,888,799**	

Using the societal discount rate, this provides a present value benefit of $108,888,799 dollars that we do not need to collect from all residential customers. To calculate the reduction in charge offs, we looked at the rate participants in the CAP program are subject to charges off versus the non-participants. This value provides a benefits of $396,406 dollars.

[11] The values shown are used in the Participant Cost Test for bill reductions.

Figure 8. Charge off Comparison

Variable	Value
(A) 2019 PIPP Annualized Charge off %	10.15%
(B) 2019 CAP Participant Charge off %	5.63%
(C) Cost of a PIPP Charge off	$182.57
(D) Total Participants Estimated Through CAP	48,009
Total Value = (A - B) * C * D	**$396,406.11**

Using these values we take the benefits divided by the costs (108,888,799 + 396,406) / 71,935,303 = 1.519. Another way of looking at this value is, for every $1 spent in Community Assistance, there is $1.52 dollars returned to all residential customers. This multiplier is then then applied to the program spend to derive the quantified Non Energy Benefits for the Community Assistance Program.

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VI. Avoided Costs

For the purposes of cost tests, Avoided Costs refers to the costs of the electricity resources that are avoided by the DSM resources. AEP Ohio has defined these values in JFW-1 DSM Plan, and their use in the cost effectiveness tests. These forecasted generation costs come from the AEP Fundamentals team. The values used are most recent available titled "2019H1_LTF_FT_Base_2019-04-23." Please see below for the total quantified values table.

Figure 9. Avoided Cost values

Avoided Costs	The calculations are first year + NPV(remaining years)							
Discount Rate	A+B	C+D	E	A	B	C	D	E
7.83%								
Year	On-Peak $/Annual kWh	Off-Peak $/Annual kWh	On-Peak $/KW	On-Peak $/Annual Energy	On-Peak $/DRIPE	Off-Peak $/Annual Energy	Off-Peak $/DRIPE	Avoided Capacity $/KW
2020	$0.03128	$0.02544	$31.50	$30.97000	$0.31	$25.42917	$0.25	$31.50
2021	$0.03144	$0.02571	$41.45	$31.12750	$0.31	$25.70417	$0.26	$41.45
2022	$0.03257	$0.02679	$31.91	$32.25083	$0.32	$26.78417	$0.27	$31.91
2023	$0.03393	$0.02795	$29.86	$33.59583	$0.34	$27.93500	$0.28	$29.86
2024	$0.03537	$0.02922	$28.07	$35.02333	$0.35	$29.20583	$0.29	$28.07
2025	$0.03653	$0.03015	$26.53	$36.16917	$0.36	$30.14333	$0.30	$26.53
2026	$0.03762	$0.03108	$25.27	$37.24583	$0.37	$31.06583	$0.31	$25.27
2027	$0.03909	$0.03228	$24.31	$38.69917	$0.39	$32.27417	$0.32	$24.31
2028	$0.04805	$0.04104	$23.67	$47.57000	$0.48	$41.02750	$0.41	$23.67
2029	$0.04832	$0.04112	$23.37	$47.84250	$0.48	$41.10833	$0.41	$23.37
2030	$0.04937	$0.04192	$23.43	$48.88583	$0.49	$41.91167	$0.42	$23.43
2031	$0.05023	$0.04239	$23.85	$49.72917	$0.50	$42.37667	$0.42	$23.85
2032	$0.05181	$0.04318	$24.67	$51.29417	$0.51	$43.17333	$0.43	$24.67
2033	$0.05291	$0.04390	$25.91	$52.38917	$0.52	$43.88833	$0.44	$25.91
2034	$0.05411	$0.04516	$27.58	$53.57417	$0.54	$45.14583	$0.45	$27.58
2035	$0.05616	$0.04660	$29.72	$55.60333	$0.56	$46.59167	$0.47	$29.72
2036	$0.05641	$0.04696	$32.34	$55.85583	$0.56	$46.94583	$0.47	$32.34
2037	$0.05790	$0.04831	$35.47	$57.32667	$0.57	$48.32833	$0.48	$35.47
2038	$0.05999	$0.04980	$39.14	$59.40000	$0.59	$49.78917	$0.50	$39.14
2039	$0.06156	$0.05090	$43.35	$60.94583	$0.61	$50.88583	$0.51	$43.35
2040	$0.06236	$0.05195	$48.13	$61.74083	$0.62	$51.94000	$0.52	$48.13
2041	$0.06295	$0.05302	$53.52	$62.32833	$0.62	$53.01417	$0.53	$53.52
2042	$0.06440	$0.05462	$59.51	$63.76250	$0.64	$54.60917	$0.55	$59.51
2043	$0.06494	$0.05586	$66.13	$64.30000	$0.64	$55.84667	$0.56	$66.13
2044	$0.06723	$0.05809	$73.40	$66.56333	$0.67	$58.08000	$0.58	$73.40

	2045	$0.06796	$0.05963	$81.34	$67.28250	$0.67	$59.61750	$0.60	$81.34
	2046	$0.06962	$0.06156	$89.97	$68.93083	$0.69	$61.54583	$0.62	$89.97
	2047	$0.07127	$0.06320	$99.31	$70.56167	$0.71	$63.18750	$0.63	$99.31
	2048	$0.07274	$0.06487	$109.40	$72.02417	$0.72	$64.86417	$0.65	$109.40
	2049	$0.07306	$0.06586	$120.29	$72.33250	$0.72	$65.84667	$0.66	$120.29
	2050	$0.07477	$0.06741	$126.73	$74.03333	$0.74	$67.40343	$0.67	$126.73
	2051	$0.07632	$0.06891	$128.56	$75.56750	$0.76	$68.90400	$0.69	$128.56
	2052	$0.07787	$0.07039	$130.42	$77.09917	$0.77	$70.37842	$0.70	$130.42
	2053	$0.07942	$0.07189	$132.30	$78.63167	$0.79	$71.88127	$0.72	$132.30
	2054	$0.08086	$0.07319	$134.70	$80.05564	$0.80	$73.18299	$0.73	$134.70
	2055	$0.08232	$0.07452	$137.14	$81.50540	$0.82	$74.50829	$0.75	$137.14
	2056	$0.08381	$0.07587	$139.62	$82.98141	$0.83	$75.85759	$0.76	$139.62
	2057	$0.08533	$0.07724	$142.15	$84.48415	$0.84	$77.23132	$0.77	$142.15
	2058	$0.08687	$0.07864	$144.72	$86.01411	$0.86	$78.62994	$0.79	$144.72
	2059	$0.08845	$0.08006	$147.34	$87.57177	$0.88	$80.05388	$0.80	$147.34
	2060	$0.09005	$0.08151	$150.01	$89.15764	$0.89	$81.50360	$0.82	$150.01

i. Demand Reduction Induced Price Effect

For AEP Ohio's source for valuing Demand Reduction Induced Price Effect, or DRIPE, we have utilized a 2015 study done for Illinois. The results of the regression show that for every 1% reduction in load, there is a corresponding 2% drop in wholesale energy prices. Using this as a proxy, AEP Ohio is proposing the linear assumption as we are projecting portfolio savings to be ~0.5% of total sales. Therefore, we have quantified DRIPE as having a 1% reduction in Energy Prices[12].

[12] https://www.raponline.org/knowledge-center/the-value-of-demand-reduction-induced-price-effects-dripe/

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VII. Electric Transportation

a. Market Factors Supporting the Electric Transportation Program

Although electric vehicle sales nationally are accelerating, they still only represented approximately 2.2% of new car sales nationally from January 2019 through June 2019.[13] Looking back to 2013, only 0.61% of national new car sales were EVs, and market share has continued to accelerate toward EV models even as the quantity of new car sales has contracted slightly.[14] Adoption of electric transportation options has been slow in Ohio compared to other states.

Ohio is in the bottom half nationally in terms of state EV adoption levels, with 1.01% of new car sales sold as EVs in in the first half of 2019, while EV adoption levels in non-California Zero Emission Vehicle ("ZEV") states ranged from 1.28% to 3.93% of new car sales during this same period.[15]

The variety of EVs now manufactured is growing. Where only three models within limited segments were available to purchase in 2011, there are now over 30 models available nationwide spanning all major vehicle segments, with 132 models projected to be available by 2022.[16]

b. Utility Engagement

It is important that load from electric transportation be integrated into the grid in a manner that minimizes or eliminates additional system costs. This is generally accomplished by programs and rates that incent charging behavior to occur during off-peak times. When this happens, additional energy sales occur without requiring additional fixed assets to be deployed. This increases electric utility system utilization and can provide downward price pressure on electricity rates for *all* customers as the fixed system asset costs are spread over those additional energy sales. Incentivizing EVs to charge off-peak benefits each and every utility customer, not only those who drive electric.

Conversely, if electric utilities do not engage to align incentives for customers to charge EVs during off-peak times, the system is highly likely to see greater peak capacity demands as default charging behavior coincides with existing system peaks, therefore reducing overall system optimization and raising costs for all customers. This increase in peak capacity demand will require additional system investments and maintenance, including distribution feeders, customer transformers and transmission infrastructure.

It is important for AEP Ohio to have robust and scalable electric transportation programs, including customer education and outreach, in place as EV adoption continues to accelerate. Engaging with customers as they consider and decide on EV adoption is more likely to achieve greater program participation - beginning this program as quickly as possible ahead of the EV

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[13] Auto Alliance, "Advanced Technology Vehicle Sales Dashboard", available at: https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/
[14] *Id.*
[15] *Id.*
[16] Electric Power Research Institute (EPRI), "Consumer Guide to Electric Vehicles", available at: https://www.epri.com/#/pages/product/000000003002015368/?lang=en-US

adoption curve will allow AEP Ohio the greatest chance of success in achieving benefits for all AEP Ohio customers.

While additional benefits exist for specific utility programs, there are three primary benefits of electric transportation generally:

1. Downward electricity rate pressure: This benefit accrues if programs are in place to ensure efficient electric transportation load integration. The benefit value accrues to all who drive electric vehicles, as well as all customers of the same utility as the electric driver.
2. Reduction of transportation costs – fuel and maintenance: This benefit accrues directly to those that choose to drive electric, and also has potential to accrue to ride-hailing customers of shared mobility (*i.e.*, Lyft, Uber) as the expenses involved in ride-share enterprises decline.
3. Reduction of transportation emissions: This benefit accrues to many parties, including:
    a. Electric vehicle drivers;
    b. People that regularly ride with and live in immediate proximity of the electric driver (*e.g.*, family);
    c. People that live within close proximity to the electric driver (*e.g.*, neighbors);
    d. Individuals within the community adjacent to regular routes of the electric driver; and
    e. The broader region surrounding the electric driver.

Synapse Energy quantified the downward rate pressure benefit in California where supporting data is significant and available, concluding that "EVs in California have increased utility revenues more than they have increased utility costs, leading to downward pressure on electric rates for EV-owners and non-EV owners alike."[17] These revenues were shown to be approximately 200-300% of costs in the utility areas studied.[18] Off-peak charging was particularly important in accomplishing this downward rate pressure – when charged during off-peak hours, "EVs impose minimal costs on the grid and help to utilize resources more efficiently."[19]

If electric load from transportation is integrated efficiently through utility programs to increase system utilization, this downward rate pressure is extensively scalable and sustainable. This is because the electric grid currently has significant available capacity in off-peak periods. Although not specific to Ohio, the illustration for Texas is representative and shows the general significance of this off-peak opportunity.[20] If the Texas electric grid were fully utilized, Davidson, Tuttle, Rhodes, and Nagasawa show that it could accommodate 120% of all current Texas passenger vehicles if they were to immediately become all-electric and charge off-peak as illustrated in Figure 11.

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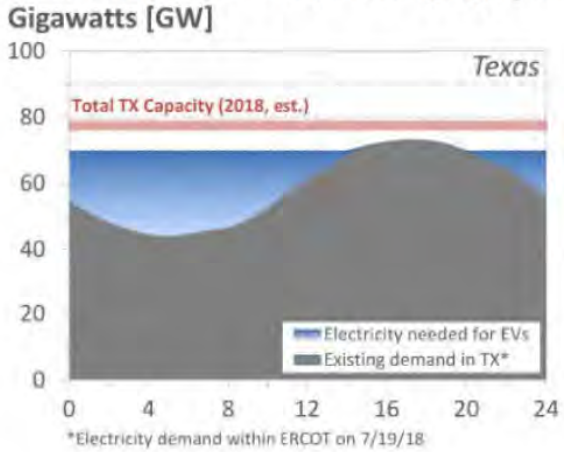
[17] Synapse Energy Economics Inc., "Electric Vehicles Are Driving Electric Rates Down", available at: https://www.synapse-energy.com/sites/default/files/EVs-Driving-Rates-Down-8-122.pdf

[18] *Id.*

[19] *Id.*

[20] CityLab, "Is America's Power Grid Ready for Electric Cars?", available at: https://www.citylab.com/transportation/2018/12/americas-power-grid-isnt-ready-electric-cars/577507/

Figure 11: ERCOT Texas EV off peak charging potential[21]



This shows that the opportunity to achieve downward rate pressure from electric transportation is not short term or limited - it will be sustainable for many years, if not decades.

An EV is fundamentally an electric appliance that follows its owner/driver – when the owner/driver is at work, the vehicle is also at work; when the owner/driver is at home, the vehicle is also at home. It is most simple and convenient for the owner/driver to connect the vehicle to an Electric Vehicle Supply Equipment (EVSE, commonly referred to as a charger) if one is available, upon arrival at their destination. By default, unless the owner is encouraged with utility program incentives, the vehicle will begin to charge at this time at the full power allowed by the connected EVSE. This is the same time when the owner/driver will be using lights, cooking appliances, space heating, space cooling, and many other electric appliances – thereby adding the EV load coincident to their existing electricity demand.

Customers who participate in programs designed to achieve off-peak EV charging have been observed to significantly shift their EV charging load to the desired times regardless of program design approach or geography. Examples of this include Salt River Project ("SRP"), Pacific Gas and Electric ("PG&E"), Southern California Edison ("SCE"), San Diego Gas and Electric ("SDG&E"), and Indiana Michigan Power Company ("I&M").

With their E29-EV-TOU plan, SRP observed more than 80% of EV charging to occur away from on-peak times.[22] Where PG&E was able to specifically measure the EV charging that occurred off-peak and without distributed generation complexity, called 'All Separate Metering (EV-B), excluding NEM', it found this group to charge their EVs 92% off-peak on average.[23] Where SCE was able to specifically measure the EV charging that occurred off-peak, called 'Separate Meter (TOU-EV-1)', it found this group to charge their EVs between 86.6-88.4% off-peak.[24] Where SDG&E was able to specifically measure the EV charging that occurred off-peak, called 'EVTOU', it found this group to charge their EVs between 89.5-95.49% off-peak.[25]

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[21] *Id.*

[22] EPRI, "Electric Vehicle Driving, Charging, and Load Shape Analysis", available at: https://www.epri.com/#/pages/summary/000000003002013754/?lang=en

[23] California Energy Commission, "7th Joint IOU Electric Vehicle Load Research Report: April 2019", available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=228787-14&DocumentContentId=60075

[24] *Id.*

[25] *Id.*

Internal observations of the I&M residential off-peak charging pilot program are in line with the preceding program reports – Midwest program participants shift EV charging to off-peak periods when incentives exist.

EVs that operate in all-electric mode have zero direct emissions in the communities and regions where they travel. When including upstream emissions attributed to electricity and gasoline production and delivery, a current generation EV emits less than half the equivalent carbon dioxide of the average new combustion gasoline vehicle in Columbus, Ohio.[26] This advantage is also corroborated by the Union of Concerned Scientists, which shows that the latest generation of EVs have equivalent total emissions of a 74 mile-per-gallon combustion gasoline vehicle in Ohio, while the average new combustion gasoline vehicle actually achieves only 31 miles per gallon.[27]

As EV efficiencies continue to improve with industry maturity and electric grid carbon intensity continues to decline, the sustainability advantage of electric transportation will continue to improve as well. Stated differently, customers' EVs provide immediate local sustainability benefits, and are likely to become *less* carbon intensive over time.

c. Electric Vehicle Charging – Residential

Customer behavior studies have consistently found that when available, residential charging comprises 80% or more of the transportation energy needs. This was most recently substantiated in an EPRI study in collaboration with Salt River Project.[28] The data again shows that when residential charging is available, it dominates customer choice. Consumers have good reason to prefer charging at home – it is a low cost energy location, and it is extremely convenient. Customers typically simply plug in the vehicle when arriving home, and leave for work the next morning with a full charge.

Residential charging is also critically important to allow efficient load integration and improve electric system utilization, leading to downward rate pressure and benefitting all utility customers. To be most effective, customers should have access to a dedicated 240 volt circuit. This will allow them to charge their vehicle overnight within small windows of time. A driver using a median 7 kilowatt vehicle with 240 volt charging at home who drives 40 miles each day would only need approximately two hours to charge their EV each night.

This added flexibility – the ability to quickly charge at home – is important, yet most homes do not have dedicated 240 volt circuits at their vehicle parking spaces. The cost of this electrical installation by a qualified professional can become a barrier for customers who could otherwise choose to charge their EV using a 120 volt source for much longer. Using the same daily drive distance of 40 miles, an EV charging with a 120 volt source would require approximately 12 hours instead of only 2 hours when using 240 volt charging. This extended charging time would significantly increase the probability that this vehicle contributes to the coincident peak of the electrical system, does not allow for maximum downward rate pressure and benefit to all utility customers, and is also less energy efficient for customers.

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[26] FuelEconomy.gov, "Beyond Tailpipe Emissions", available at: https://www.fueleconomy.gov/feg/Find.do?zipCode=43215&year=2019&vehicleId=40520&action=bt3

[27] Union of Concerned Scientists, "Are Electric Vehicles Really Better for the Climate? Yes. Here's Why", available at: https://blog.ucsusa.org/dave-reichmuth/are-electric-vehicles-really-better-for-the-climate-yes-heres-why

[28] EPRI, "Electric Vehicle Driving, Charging, and Load Shape Analysis", available at: https://www.epri.com/#/pages/summary/000000003002013754/?lang=en

Residential charging is incredibly important to customers, and it is a key opportunity for providing downward rate pressure and benefits to all customers. Residential customers are currently billed volumetrically, with relatively small customer charges and no demand charges. As a result, they have no incentive to alter their EV charging behavior. Providing customers with appropriate and aligned incentives to charge EVs when energy costs are lower, *i.e.,* during times when the system is underutilized and away from existing system peaks -- enables greater system utilization and drives benefit for all utility customers. Without 240 volt electrical service at the parking location, a typical driver may not be able to charge their EV entirely away from the system peak.

Customers can easily use the scheduling technology in their EV, charging equipment, or associated smartphone apps to charge their EV during defined off-peak hours. A dedicated 240 volt circuit is likely to incur initial electrical installation costs, but allows the EV to charge entirely during the off-peak period and provides the opportunity for maximum future EV charging coordination flexibility as adoption continues to accelerate. By helping customers who drive electric remove cost barriers to electrical installation and understand off-peak incentives, all EV charging can occur within the off-peak period, maximizing benefits to all AEP Ohio customers.

If EV charging facilities are not provided at Multi-Family Dwellings ("MFDs"), tenants who drive electric vehicles will be unable to charge their EV at home, overnight. This eliminates the primary charging application that provides the most benefit for system utilization and downward rate pressure, and vastly increases the probability that these vehicles will charge at a time that coincides with system peaks, increasing system costs to AEP Ohio's customers.

MFD owner/operator customers have existing tariff options that align price signals with the needs of the electrical system, and will participate in demand response mechanisms to ensure additional electrical system stress and costs are avoided. These existing tariffs and program participation, when coupled with the installation of charging facilities the electric transportation program will encourage, incent facility owners/operators and tenants to charge their EVs at times that improve system utilization and ultimately benefit all AEP Ohio customers.

d. Electric Vehicle Charging – Fleet and Workplace

Fleets, which can be light, medium, or heavy-duty vehicles in return-to-base operations for commercial, industrial, or municipal customers, largely have a use pattern that fits within typical societal working hours – especially one or two shift operations. These return-to-base fleets discharge during use and require charging during the evening and overnight period. They can contribute to downward rate pressure and benefit to all utility customers in the same way as residential charging.

Fleet and workplace charging customers have existing tariff options that align price signals with the needs of the electrical system via demand and energy charges, and can participate in demand response mechanisms to ensure additional electrical system stress and costs are avoided. This incents fleet and energy managers to charge their fleet EVs at times that improve system utilization and ultimately benefit all AEP Ohio customers.

e. Electric Vehicle Charging – Long Distance Travel

Interstate corridor charging describes EV fast-charging equipment installed along major highway corridors. This equipment enables drivers with electric vehicles to travel long distances away from their home. Tesla has been a pioneer of interstate corridor charging, which has enabled coast-to-coast electric long distance travel for many years.[29] The Tesla Supercharger network can only be used by Tesla vehicles however, due to their proprietary connector.

Significant work is underway through the Volkswagen Settlement[30] and Electrify America,[31] but long distance electric travel for non-Tesla all-electric vehicles is still limited. To date, this equipment is not sufficiently installed along corridors because the business case is extremely challenged: equipment and installation are very expensive, and an already low utilization case (long distance travel) is compounded by the current environment of relatively low EV adoption.

[29] Tesla, "Find Us | Tesla", available at: https://www.tesla.com/findus?v=2&bounds=46.2881684085389%2C-71.08494227938075%2C34.18232538319406%2C-105.95554774813075&zoom=6&filters=supercharger

[30] U.S. EPA, "Volkswagen Clean Air Act Civil Settlement", available at: https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement

[31] Electrify America, "Locate a Charger", available at: https://www.electrifyamerica.com/locate-charger

VIII. Electric Vehicle Status Report

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AEP Ohio Electric Vehicle Charging Station Rebate Program – December 2019 Status Report

AEP Ohio's Electric Vehicle Charging Station Rebate Program (the program), as authorized by the Public Utilities Commission of Ohio (PUCO) in April 2018, was launched in August 2018. As of December 31, 2019, the program is essentially fully subscribed and has installed and activated 116 EV charging stations across 75 projects. The program incentivizes installations of network-connected charging infrastructure at government, commercial and multi-family locations. The first activated sites began serving customer charging sessions in May 2019. The program is currently working with Electric Vehicle Service Equipment (EVSE) vendors ChargePoint, Greenlots, and EV Connect. This report includes only project and session data from one of the EVSE vendors, as the data from the other 2 EVSE vendors was not yet available as of 12/31/2019.

Charging session data used in this analysis (including charging costs, connection durations, and anonymized driver data) was provided by the EVSE vendors. Project cost and incentive payments data was provided by AEP Ohio. Note that program enrollment and incentive data is continuously changing as additional charging stations are installed throughout the program. This report only includes installed and activated projects. A snapshot of the application queue is provided in the Appendix.

Program Summary Statistics – as of December 31, 2019

75
Activated Projects

116
Stations

15,940
Charging Sessions

$1.78M
Incentives Paid

11 DCFC / 198 L2
Ports

1,785
Drivers served

Glossary:

- L2 – Level 2 EV charging station (typically 7.2-9.6 kW)
- DCFC – Direct Current Fast Charging station (typically 50-200 kW)
- Station – The charging kiosk that has been installed. A project may have multiple charging stations
- Port – A charging connection point for a vehicle. Each station may have 1-2 ports
- Installed Project – A charging station where construction is complete
- Activated Project – Installed project that is available for customer charging
- Charging Session – A customer charging visit

Project Cost and Incentive Status

The program initially targeted the installation of 300 L2 stations and 75 DCFC stations through its four-year duration. Of the $9.5M total program funding for rebates, $3.7M is allocated for L2 stations, and $5.8M is allocated for DCFC stations.

Incentives can be applied to offset charging infrastructure costs, including initial installation costs and hardware, and EVSE network service costs. Incentive payments occur after project activation is completed. As of December 31, 2019, **$1,780,077** incentives had been paid on 98 of the 116 activated projects, and AEP Ohio is in the process of reviewing and processing the remaining project incentives.

Average total project costs are approximately $30,000 for projects installing L2 stations and $111,000 for projects installing DCFC stations. Incentives have covered on average 65% of L2 project costs and 91% of DCFC project costs.

Table 1 – Program Incentive and Cost Summary by Location Type

Location Type	Total Activated Projects	Activated Projects with Paid Incentives	Total Activated Stations	Total Incentives Paid	Average Incentives per Paid Project	Average Incentives per Station	Total Project Costs on Paid Projects	Average Project Cost on Paid Projects	Average Station Cost on Paid Projects
DCFC Public on Government Sites	4	4	6	$446,828	$111,707	$74,823	$446,977	$111,744	$74,842
DCFC Public on Non-Government Sites	3	2	5	$161,212	$80,606	$55,606	$219,235	$109,617	$74,295
L2 Multi-Family	10	9	19	$147,166	$16,352	$8,938	$246,758	$27,418	$14,513
L2 Public	42	40	56	$354,606	$21,365	$15,428	$1,131,617	$28,290	$20,935
L2 Workplace	16	11	30	$170,265	$15,479	$9,557	$411,177	$37,380	$23,173
Total	**75**	**66**	**116**	**$1,780,077**	**$26,971**	**$18,382**	**$2,455,764**	**$37,209**	**$25,316**

Table 2 – Program Incentive and Cost Summary by Station Type

Station Type	Total Activated Projects	Activated Projects with Paid Incentives	Total Activated Stations	Total Incentives Paid	Average Incentives per Paid Project	Average Incentives per Station	Total Project Costs on Paid Projects	Average Project Cost on Paid Projects	Average Station Cost on Paid Projects
DCFC	7	6	11	$608,040	$101,340	$68,417	$666,212	$111,035	$74,660
L2	68	60	105	$1,172,037	$19,534	$13,378	$1,789,553	$29,826	$20,382
Total	**75**	**66**	**116**	**$1,780,077**	**$26,971**	**$18,382**	**$2,455,764**	**$37,209**	**$25,316**

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Paid Incentives and Installations – Monthly Activity

The following charts include the monthly installation activity of projects, segmented by station types and targeted location types. The appendix provides a more comprehensive update on the project pipeline and remaining incentives available in the program.

Chart 1 – 2019 Activated Stations by Paid Month and Station Type

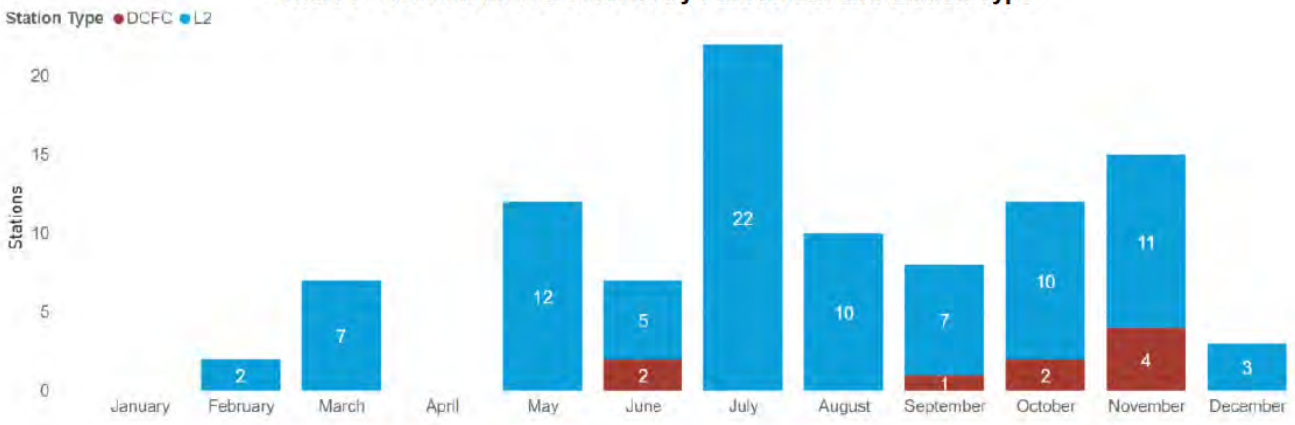
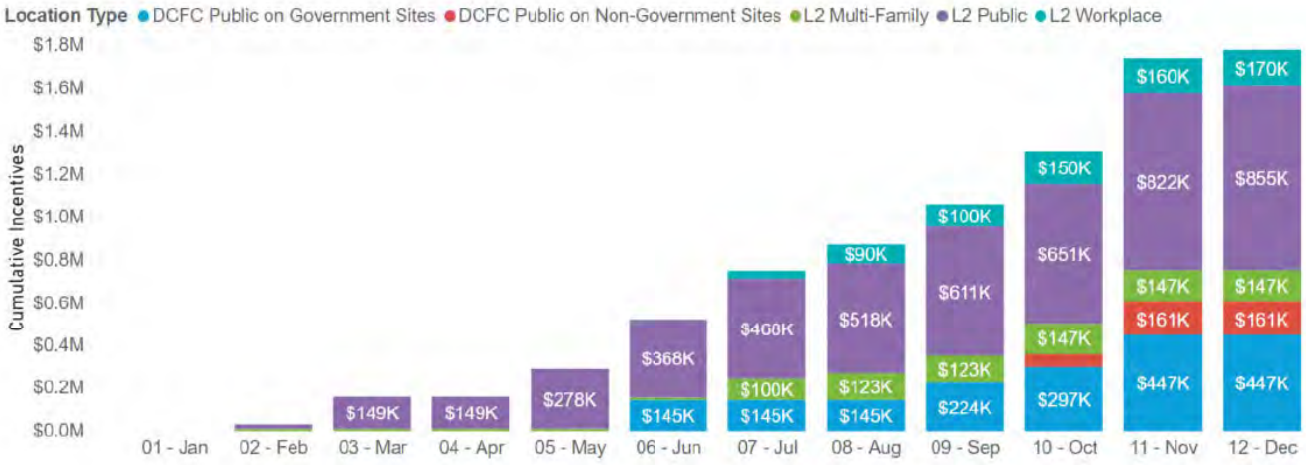


Chart 2 – 2019 Running Incentives by Location and Paid Month



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Targeted Location Segments

The program is currently targeting charging station installations across all the following location types:

- Publicly available charging at government sites (public libraries, airports, municipalities, schools, etc.)
- Publicly available charging at non-government sites (privately owned public parking garages, shopping centers, banks, restaurants, hospitals, etc.)
- Workplaces
- Multi-family complexes

DCFC stations must be available to the public. A goal of the program is to encourage installation of 2 stations per DCFC project. Currently, there are 11 DCFC stations installed across 7 public charging sites.

Chart 3 – L2 Stations by Location Type

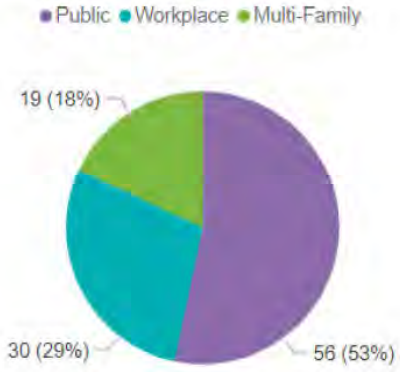
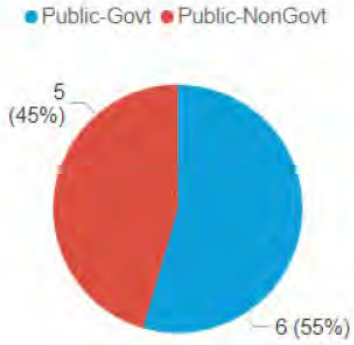


Chart 4 – DCFC Stations by Location Type



Outreach Strategies

Initially this first-come, first-served program accepted applications for projects to meet target allocations for Level 2 projects of 50% workplace, 30% public and 20% multi-family. DCFC applications were only accepted for public projects. Additionally, 10% of the incentives for both L2 and DCFC projects were required to go to low income geographic areas.

Outreach strategies were similar for all three segments. AEP Ohio's outreach team and customer service representatives educated AEP Ohio's business and government customers about the program. AEP Ohio shared program information with Ohio EPA staff and upon invitation attended Ohio EPA community meetings to answer questions.

AEP Ohio also partnered with the three EVSE vendors and SMART Columbus to promote the incentives to SMART Columbus Acceleration Partnership members from both public and private entities. Staff from AEP Ohio and SMART Columbus worked closely with applicants to help them organize and submit complete project applications.

The City of Columbus also engaged assistance from Clean Fuels Ohio to co-promote multi-family projects that were eligible for rebates from both the program and the City of Columbus. This was coordinated to ensure that the value of the combined incentives did not exceed the total project costs.

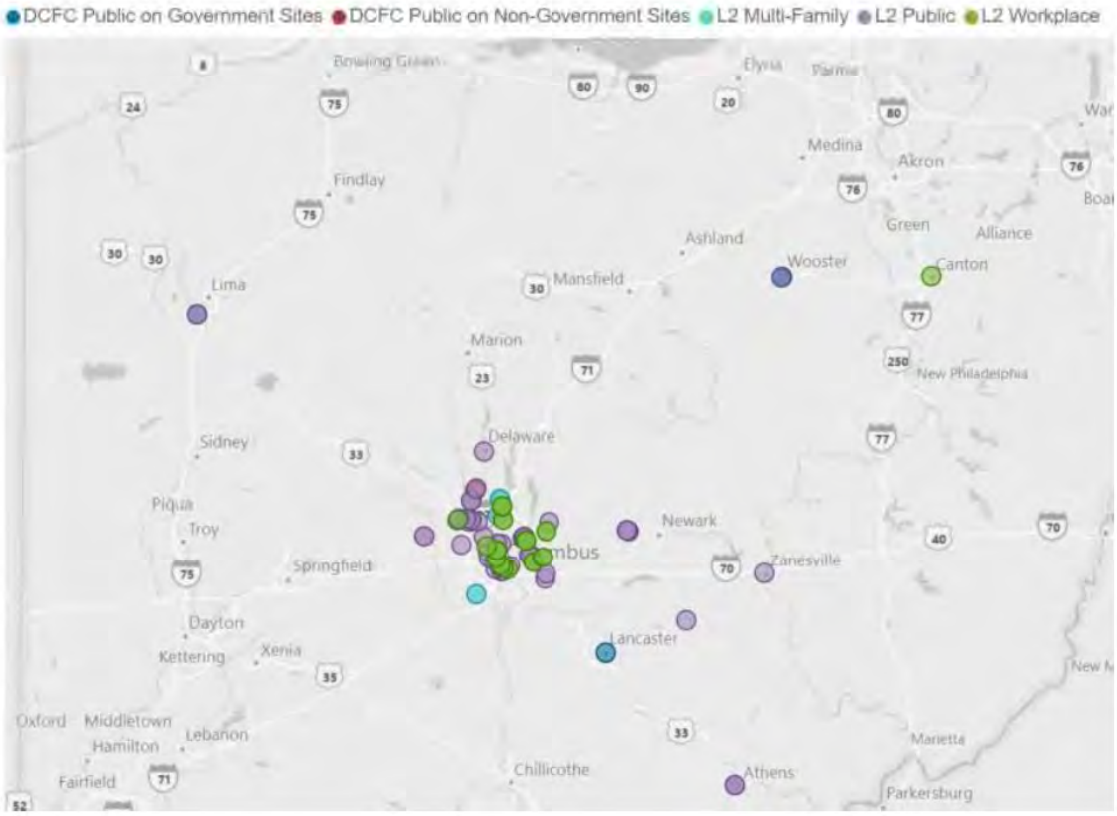
By the first quarter of 2019, the 30% public allocation for Level 2 had been met and, though there was still significant interest, applications were no longer accepted. By the second quarter of 2019, multi-family applications had also met their target. After that point, only applications for the Level 2 workplace and DCFC projects were being accepted.

Following a midstream review of the program and an open discussion with PUCO staff and interested parties on June 28, 2019, AEP Ohio implemented changes mid-November 2019. For Level 2 charging, all segments were reopened and applications were accepted for public, multi-family and workplace without the constraints of the original allocation targets. For DCFC projects, there were two changes. First, the incentive limit per customer was increased from 5% ($475,000) to 10% ($950,000). Second, the definition of public charging was clarified to also include customers who provide transportation to the public such as mass transit, shuttle buses for communities/airports, taxis or other public serving transportation.

Current Installation Locations

116 charging stations have been installed and activated throughout the AEP Ohio service territory, with the highest concentration in the Metro Columbus area.

Map 1 – Installations across AEP Ohio Service Territory



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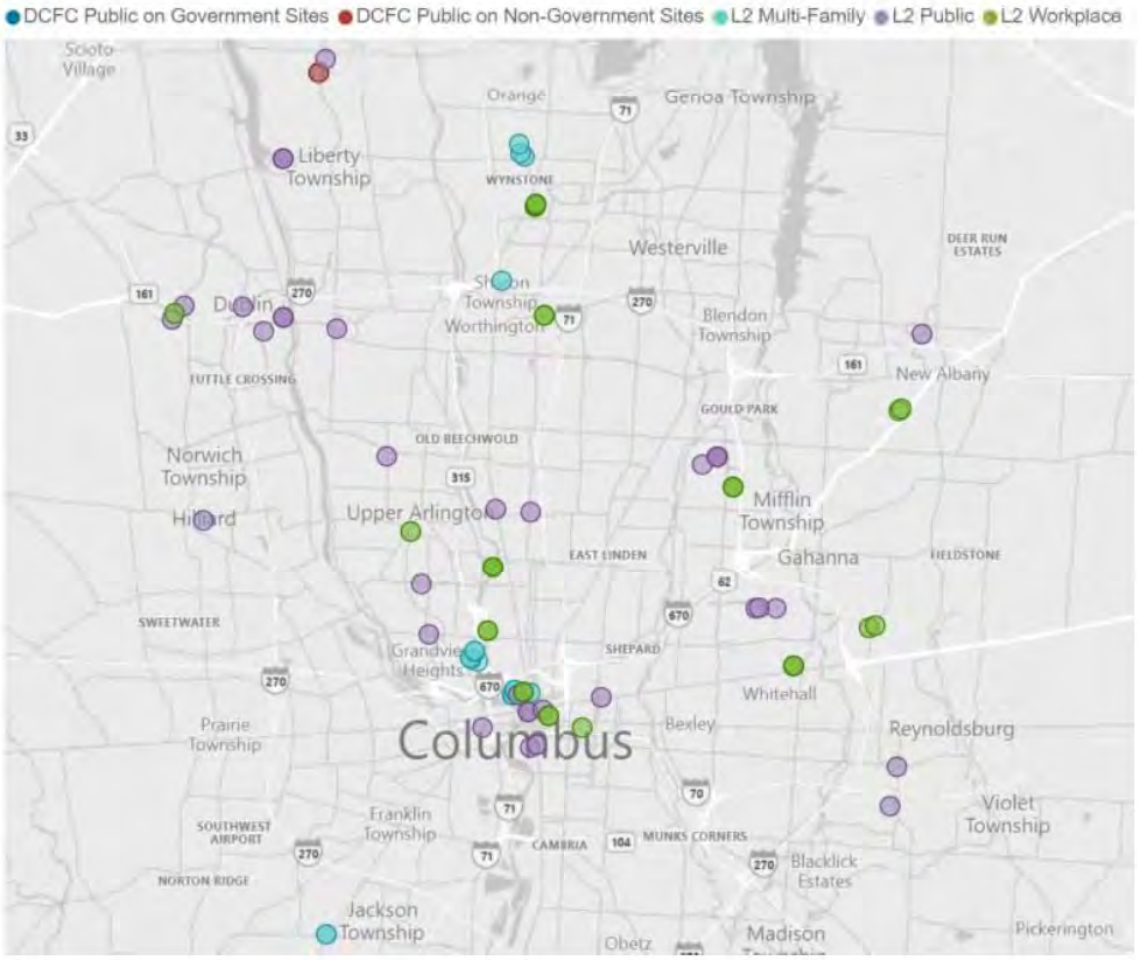
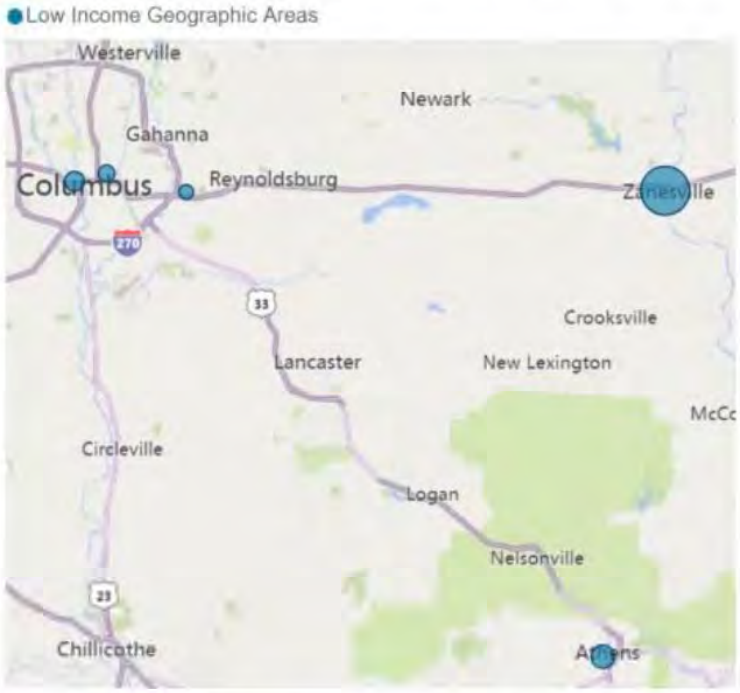
Map 2 – Installations within Columbus Metro Area



Installations in Low Income Geographic Areas

As of December 31, 2019, 17 charging stations (15 L2 and 2 DCFC) had been installed in census blocks with higher percentages of low income geographic areas. A requirement of the program is that at least 10% of the incentivized stations be located in those areas.

Map 3 – Installations within Low Income Geographic Areas (Map Bubble Size by Incentives Paid)



16% of stations located in Low Income Geographic Areas

A map of the low income geographic areas can be accessed on the AEP Electric Vehicle website: https://aepohio.com/save/business/ElectricVehicles/

Charging Session Cost and Usage Patterns

Through December 31, 2019, the installed charging stations served roughly 1,785 unique drivers and 15,940 charging sessions. The average connected session duration is 245 minutes, as reported by the EVSE vendors. Within each connected session, there may be a period of active charging, followed by idle time. The average charging duration per session is 157 minutes, indicating that on average approximately 65% of a connection session is active charging time. Average energy consumed is 11.5 kWh per session for L2 and 17.5 kWh per session for DCFC.

Most site hosts (AEP Ohio's customers receiving rebates) are offering free charging for the use of their charging stations. Out of roughly 16,000 charging sessions served thus far in the program, 13.7% of the sessions were paid by the driver, at an average total session cost of $3.48 ($3.40 for L2 and $4.66 for DCFC).

Note that the charging session data provided for this analysis by the EVSE vendors included a total session cost for each unique charging session, however this data does not include pricing and rate structure data (for example, cost per kWh, etc.). However, excluding free sessions, the derived average cost per kWh for each session is $0.26/kWh for L2, and $0.34/kWh for DCFC.

Only 11 DCFC stations had been activated at the time of this report. As more DCFC stations are installed and higher volumes of session data become available, AEP Ohio will conduct more analysis of session durations and costs between DCFC and L2 stations.

Chart 5 – Number of Charging Sessions Started by Time of Day for All L2 Location Types

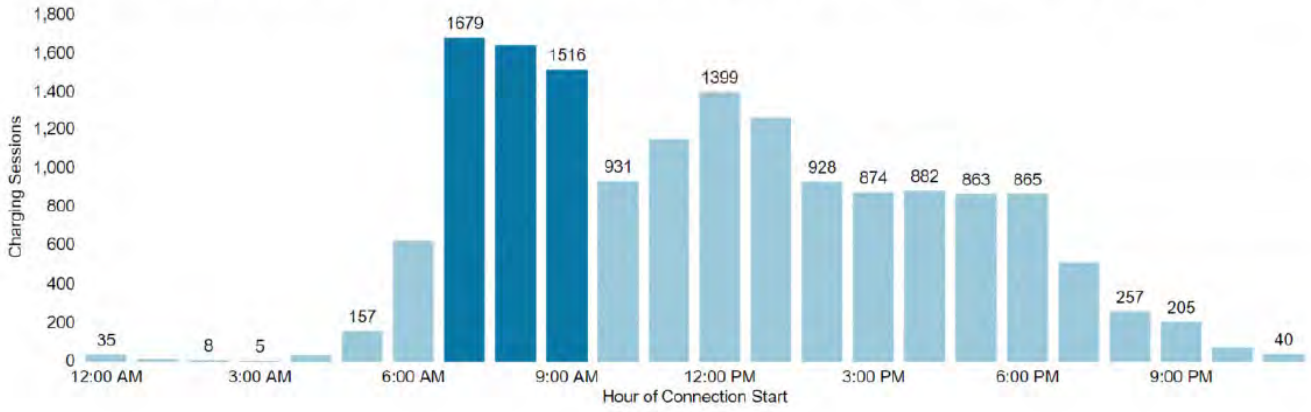


Chart 6 – Number of Charging Sessions Started by Time of Day for L2 Workplace

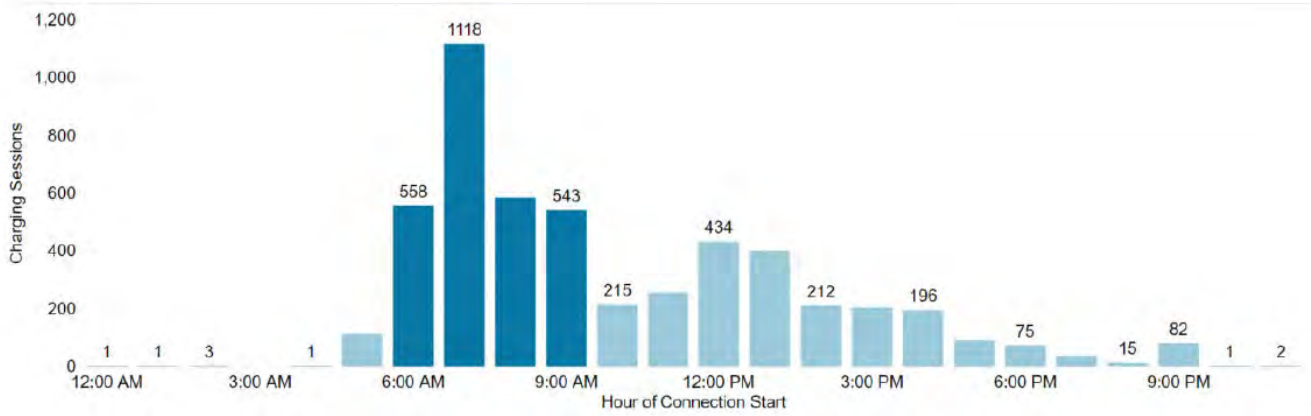


Chart 7 – Number of Charging Sessions Started by Time of Day for L2 Public

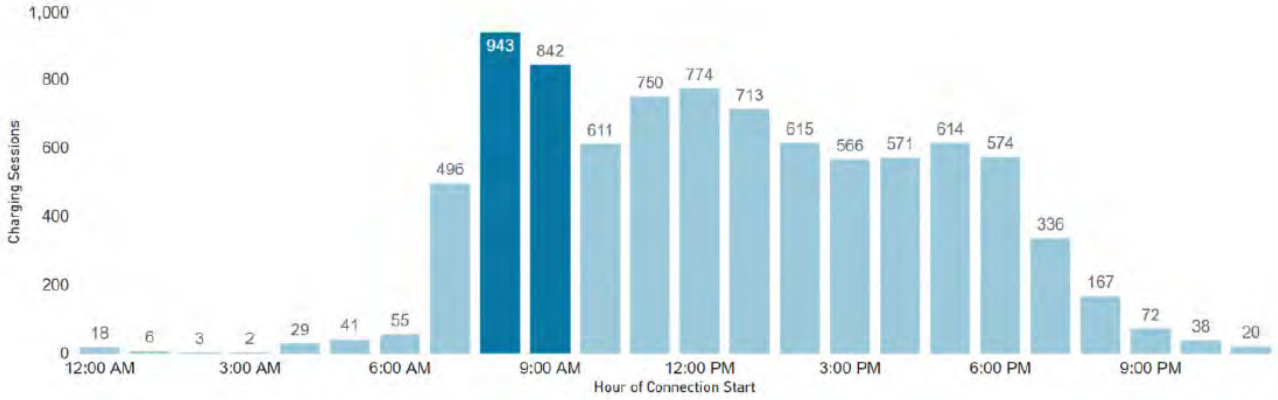
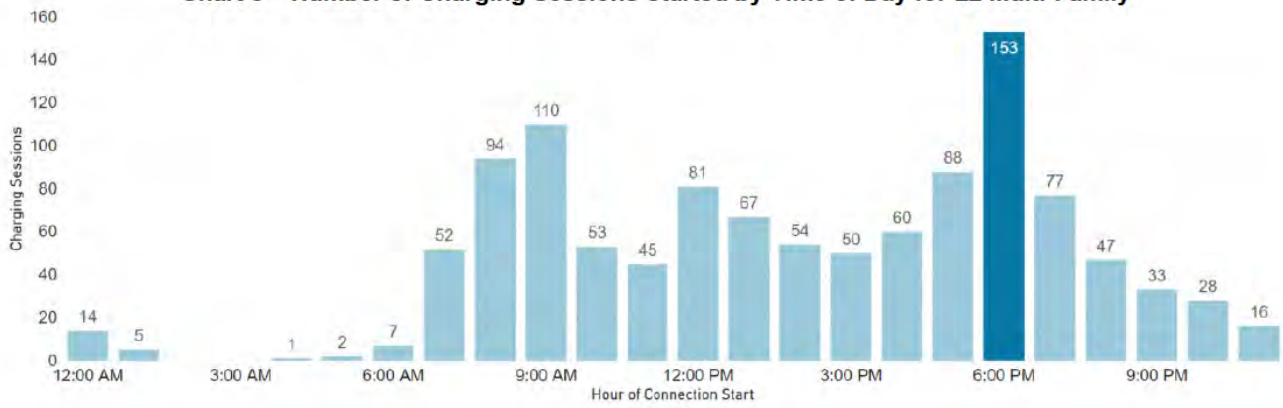


Chart 8 – Number of Charging Sessions Started by Time of Day for L2 Multi-Family



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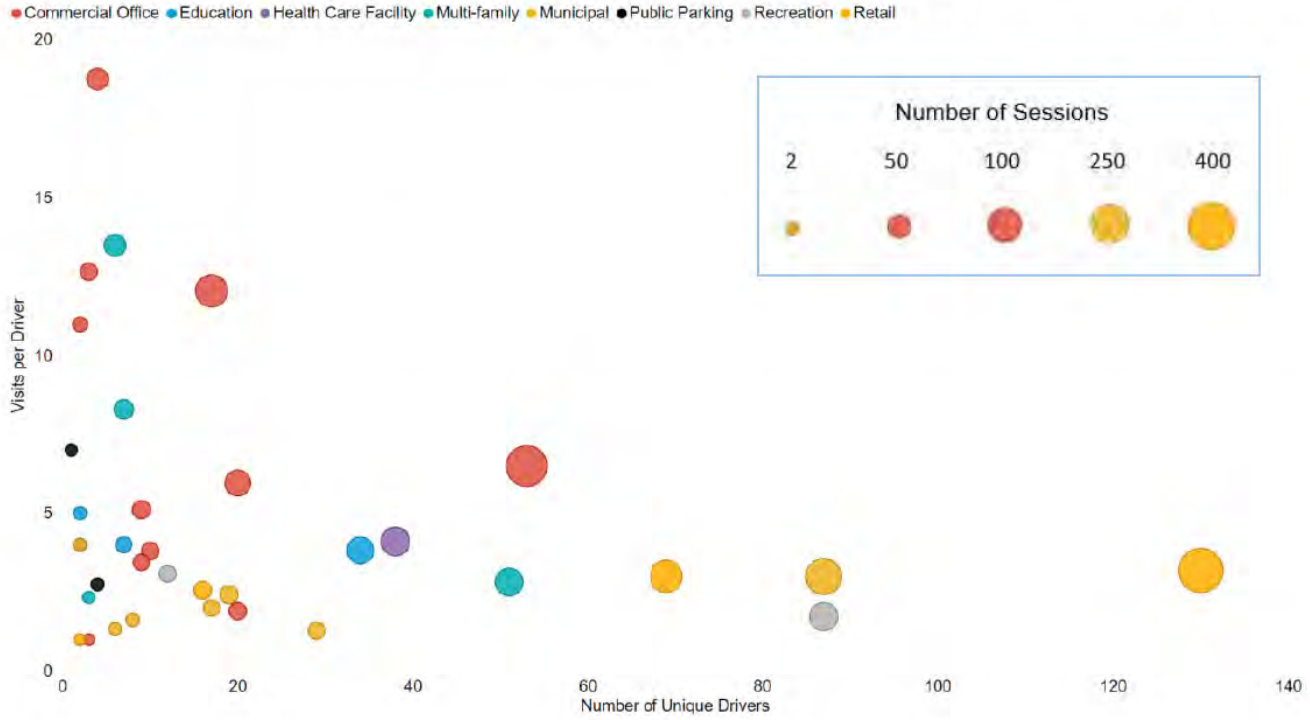
Charging Station Utilization Patterns

The number of repeat visits per driver based on location type were analyzed to look at utilization patterns. Workplace and multi-family charging sites had the most repeat visits from the same drivers, while public charging station sites had the highest unique driver visits. Sessions between October and December 2019 are analyzed in Chart 9 below to look at patterns of the number of times drivers revisit the same sites, and the average session times. The bubble sizes are proportionate to total sessions.

Chart 9 – Charging Station – Visits per Driver (Size by Unique Sessions) – Average Monthly (Oct to Dec 2019)



To better understand trends in session duration, the distribution of Connection Durations and Charging Durations are shown in the boxplot Charts 10 and 11. Connection durations represent the length of time a vehicle remains plugged into a charging station. The Charging Duration represents the length of time a vehicle is actively charging during that session. The "whiskers" for each segment show the minimum and the 98% percentile sessions, by session length. The dark gray and light grey portions of the plot show the bounds of the 25% and 75% percentile sessions. The white circle shows the mean duration for each segment. As expected, Charging Duration is shorter than Connection Duration.

DCFC sessions are much shorter in duration than L2 sessions. Workplace and Multi-family L2 charging sessions tend to be longer than Public charging sessions. Extreme outliers (e.g. sessions that lasted beyond 15 hours) were filtered out so that the mean values would not be overly impacted by a few unusually long sessions.

Chart 10 – Average Minutes of Connection Duration by Segment – October to December 2019

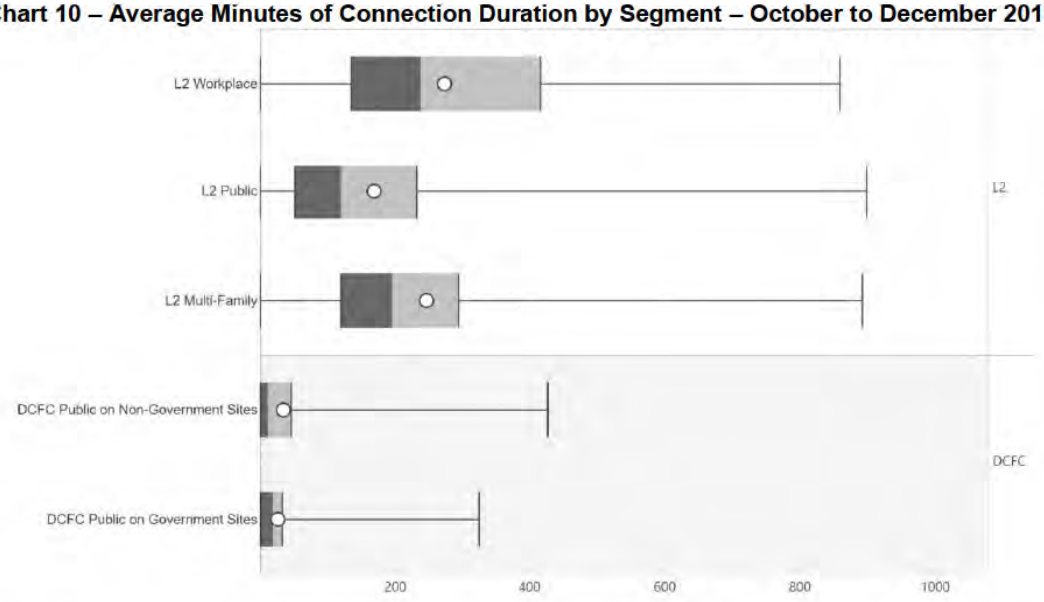
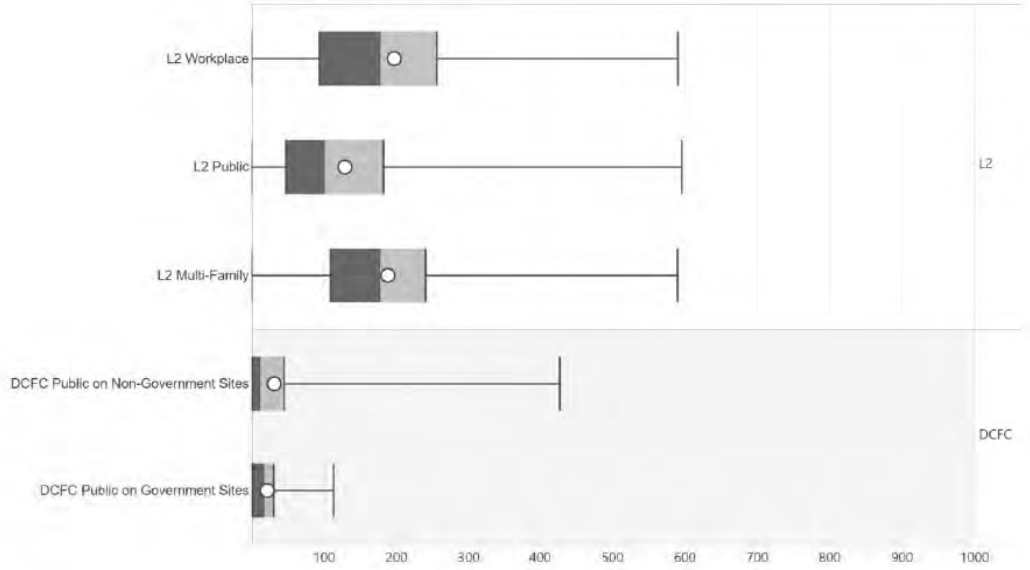


Chart 11 – Average Minutes of Charging Duration by Segment – October to December 2019



The load profile by time of day was analyzed to look at the total simultaneous load of all the installed stations. Chart 12 shows the total simultaneous load for all stations, segmented by day of week. The total simultaneous load on an average weekday, segmented by location type, is shown on Chart 13.

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Chart 12 – Average Daily Load Profile (kW) by Day of Week – averaged Oct to Dec 2019

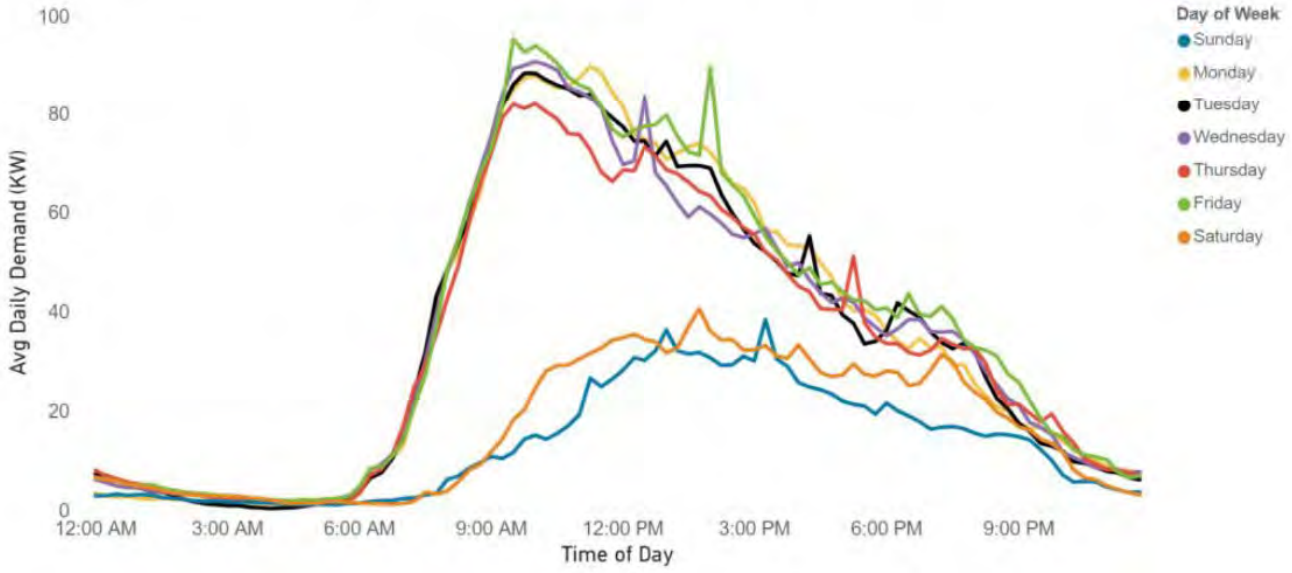
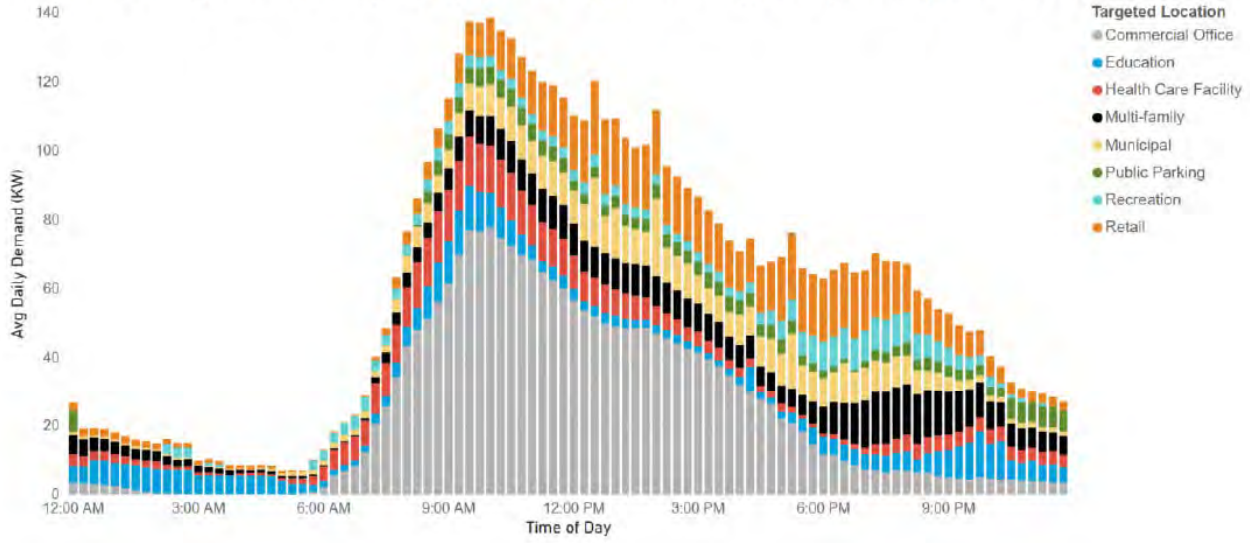


Chart 13 – Average Load Profile (kW) by Location Types– Monday through Friday - averaged Oct to Dec 2019



Vehicle Make and Model Distribution

The distribution of vehicle types that have had the most charging sessions across the fleet of installed charging stations is shown in Chart 14. Tesla Model 3, Chevy Volt, and Nissan Leaf models are the most common vehicle types. Those labeled as "None" are from charging sessions whereby the vehicle type is not identified in the driver's account profile (it is optional for the user to input that data field). Total charging sessions by Battery Electric Vehicles (BEV) versus Plug-in Hybrid Electric Vehicles (PHEV) are also compared in Chart 15.

Chart 14 – Distribution of Charging Sessions by Vehicle Make and Model

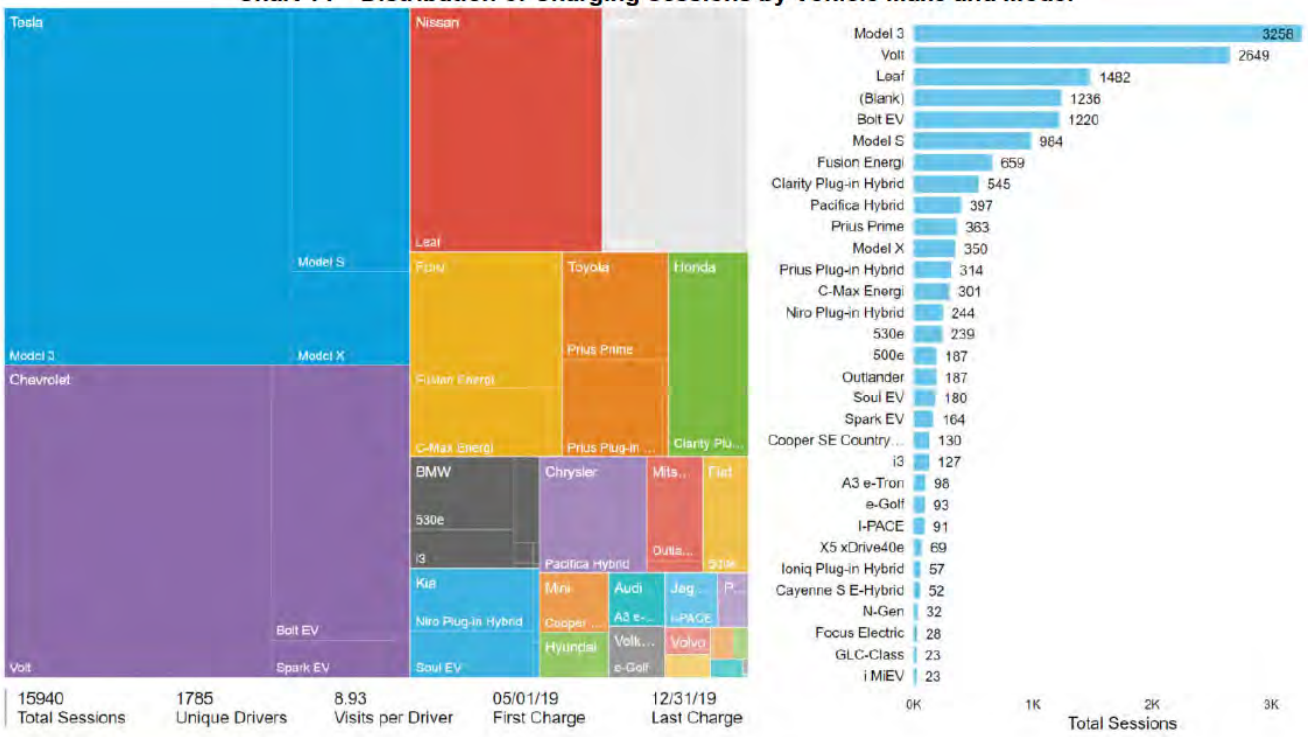


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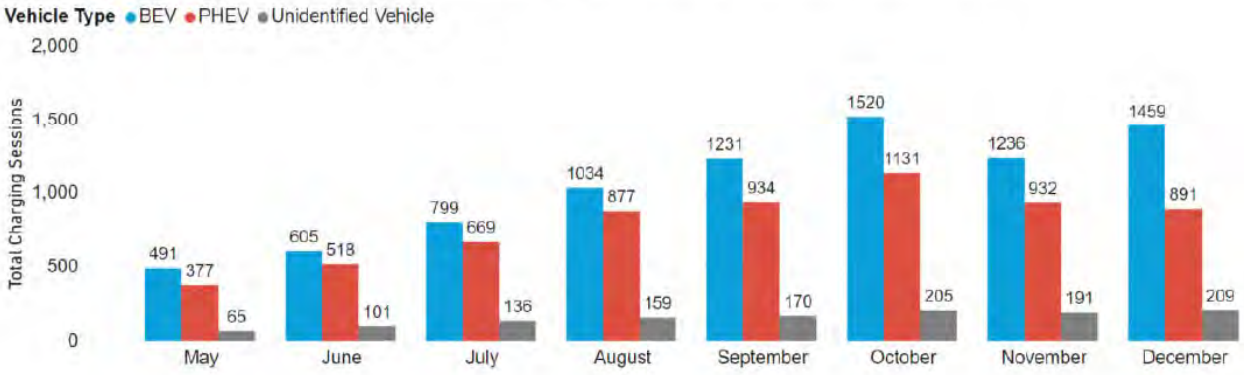
Chart 15 – Total Charging Sessions by Vehicle Type and Month



Charging Station Data Validation

AEP Ohio is installing AMI meters in conjunction with the charging stations in the program. AEP Ohio is analyzing the usage data received from the AMI meters as well as the charging session data received from the charging stations. AEP Ohio will provide this analysis in subsequent reports.

Summary

The program is essentially fully subscribed as of 12/31/2019. AEP Ohio is maintaining a wait list of customers with pre-approval applications pending, and those customers could become eligible for consideration should dollars become available as actual costs for projects underway fall below projected costs, or if reserved projects are not completed.

See the Appendix for a snapshot of program applications as of 1/31/2020. As projects progress through installation and activation, their data will be added in subsequent reports throughout the duration of the program.

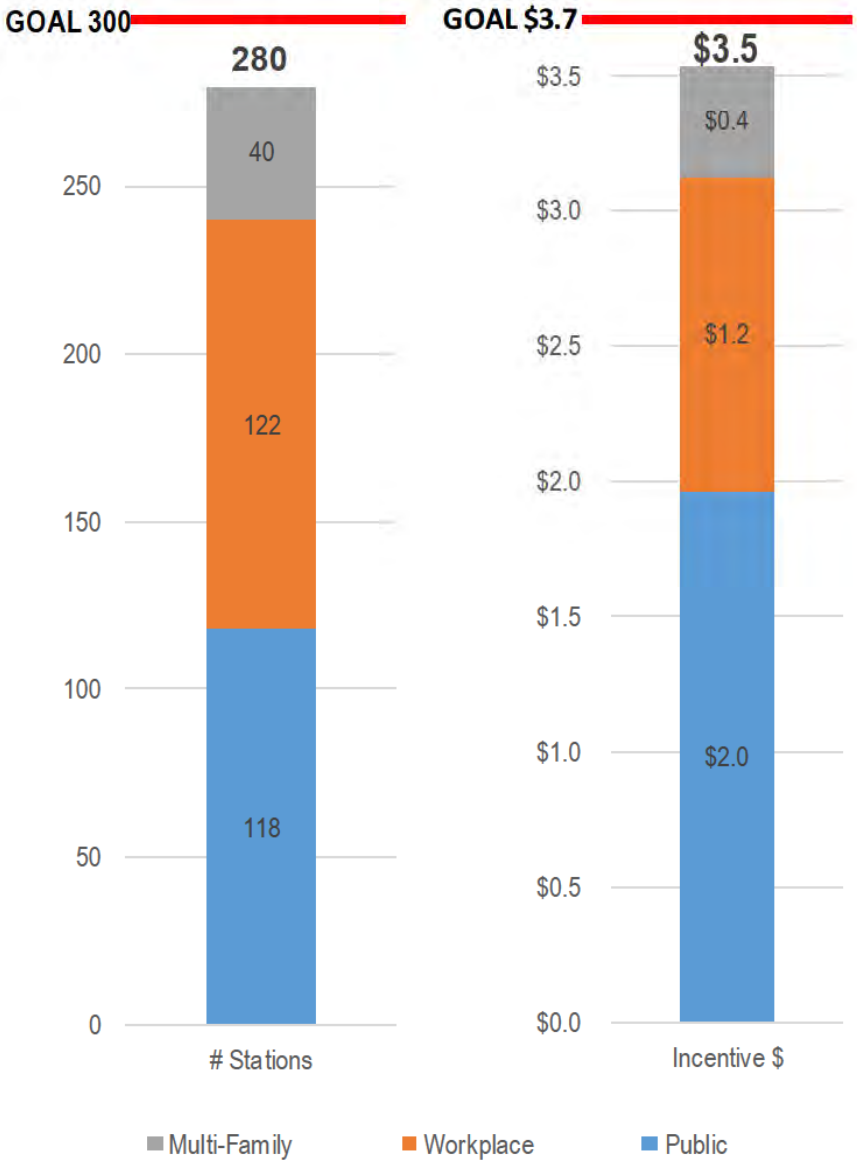
As additional stations are installed, more electric vehicles enter the market, and more historical session data is collected, this analysis will evolve to capture AEP Ohio's insights of consumer practices and emerging trends.

Appendix

The following charts show the status of the DCFC and L2 project pipelines as of January 31, 2020. The program incentives are near fully reserved.

Chart 16 – DCFC Program Overview: Stations and Incentive Spend

Chart 17 – Level 2 Program Overview: Stations and Incentive Spend



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IX. Economic Development Report

AEP Ohio analyzed the Economic development activity in the service territory and created values sourced in the plan. The detail of these numbers are sourced below:

Table 12. DSM Spend Job Creation

Residential	Direct	Indirect
AEP Ohio Implementation Contractors	41	202
Low Income	256	51
Business		
AEP Ohio Implementation Contractors	51	66
Cross Sector		
AEP Ohio Implementation Contractors	21	26
Targeted Marketing	8	16
Education and training	0	12
C&I audits	5	0
R&D	10	10
Evaluation	6	12
Total	**398**	**395**
Registered Trade Allies*	580	1160
New Trade Allies since 6/1/2019 for Business mid-stream*	34	68
Total	**1012**	**1623**

*Number of trade Allies employees indirect involved is conservatively estimated at 2 per Trade Ally and Induced is conservatively estimated at 2 per trade Ally

X. AEP Ohio PEV Forecast – Number of Vehicles

The table below is the EV forecast of electric vehicles in AEP Ohio service territory. This forecast was prepared by AEPSC Economic Forecasting.

Table 13. PEV Forecast

Scenario	Year	Quantity
Base	2025	33,400

Exhibit JFW-3 – Communication Plan

Communications Activity	Activity Description	Activity Cost	Activity Rationale
Monthly customer newsletters, including new customer welcome series-content writing, third party purchased content.	Electronic newsletters covering important customer-related topics including customer programs, bill paying options, scams, neighbor to neighbor, reliability improvements, rules and regulations, educate customers on tariff/rates best for them, etc.	$60,000	Required under OAC - 4901:1-10-12 to provide customer rights and obligations. Use newsletter and links to meet customer handbook distribution requirements for customers willing to receive electronically. Customers expect and want frequent and up to date information.
Monthly newsletter for managed accounts managed by a third party vendor	Information sent to our managed accounts and provides the customer with useful information	$55,000	Required under OAC - 4901:1-10-12 to provide customer rights and obligations. Use newsletter and links to meet customer handbook distribution requirements for customers willing to receive electronically. Customers expect and want frequent and up to date information. Content tailored to large commercial and industrial customers.
Community outreach events throughout the AEP Ohio service territory.	Allows AEP Ohio employees to have face-to-face interactions with customers to answer questions and promote customer billing programs, low income programs, etc.	$90,000	Provides an opportunity to reach all areas within our service territory to help customers with questions and addressing concerns they have, plus helps build and support community relations.
Support Live Line trailer	Traveling exhibit which demonstrates electrical dangers with working or otherwise coming in contact with energized equipment	$70,000	Public contacts have recently been an increasing concern. The Live Line Trailer is a highly engaging teaching tool. Coordinating and promoting public events and trainings for first responders is a necessary, and new, activity.
Ongoing customer satisfaction surveying phone and online via third party vendor to remove bias.	Customers will be surveyed frequently throughout the year following solution center contacts, program participation, social media responses, etc.	$125,000	AEP Ohio believes this is necessary to measure customer feedback to make improvements in a timely manner and better meet the needs of our customers.
AEP Ohio Blog (aepohiowire.com)	Electronic message board which can be accessed any time by customers to get real time update information as well as view historical messaging	$12,000	Enhance this medium to provide customers with timey and critical information about the complete range of topics related to their electric service
Manage new platform NextDoor	Share hyper-local information about service-related matters	$25,000	This platform allows us to address reliability concerns on a neighborhood or potentially circuit-level geographic area. By providing targeted and relevant information we can increase customer readership and attention to the information.

Customer postcards concerning reliability, forestry and other specific improvement projects	Direct mail postcards	$110,000	Direct mail postcards are the most effective way to reach all customers including customers not on email or social media. Includes printing and postage fees.
Collateral materials	General education pieces sent to customers or distributed at community centers, churches, schools, etc.	$18,000	Provide an alternative channel for community outreach in printed form to reach customer segments without regular access to internet/email or other electronic means.
Focus Groups – one per year	Conduct annual focus group to measure the pulse of the customer. (Mix of residential and small businesses)	$45,000	Used to measure customers feedback on service levels, improvements the customer would like to see, etc.
Produce digital media/Production of photos and videos of AEP Ohio	Messaging on electrical safety and company programs such as rate options, paperless billing and mobile alerts etc.	$20,000	Educate customers on reliability, safety and forestry work. Used frequently in social media messaging and digital newsletters
Major Accounts Business Roundtable	One face to face customer meeting per district per year	$10,000	Offers C&I customers the opportunity to learn about programs and service unique to their segment and to hear from peers how they are leveraging energy improvement ideas in their facilities. Opportunity for AEP Ohio to get feedback from customers on needs and evolving expectations to improve service.
Third Party Support Contract	Utilizing third-party support allows us to scale resources depending on current demand.	$360,000	The work required is more efficiently and cost effectively managed by augmenting AEP Ohio's current three-person staff with an external support provider. This allows AEP Ohio to be cost effective while ensuring customers receive the information they need.
TOTAL		$1.000M	

CERTIFICATE OF SERVICE

In accordance with Rule 4901-1-05, Ohio Administrative Code, the PUCO's e-filing system will electronically serve notice of the filing of this document upon the following parties. In addition, I hereby certify that a service copy of the foregoing *Direct Testimony of Jon F. Williams* was sent by, or on behalf of, the undersigned counsel to the following parties of record this 15th day of June 2020, via electronic transmission.

/s/ *Steven T. Nourse*
Steven T. Nourse

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Case No(s). 20-0585-EL-AIR, 20-0586-EL-ATA, 20-0587-EL-AAM

Summary: Testimony -Direct Testimony of Jon F. Williams on Behalf of Ohio Power Company electronically filed by Mr. Steven T Nourse on behalf of Ohio Power Company