BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio Power Company for Authority to Establish a Standard Service Offer Pursuant to Section 4928.143, Ohio Revised Code, in the Form of an Electric Security Plan	))))))	Case No. 16-1852-EL-SSO
In the Matter of the Application of Ohio Power Company for Approval of Certain Accounting Authority	)))	Case No. 16-1853-EL-AAM

DIRECT TESTIMONY
OF
SCOTT S. OSTERHOLT
ON BEHALF OF
OHIO POWER COMPANY

Filed November 23, 2016

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SCOTT S. OSTERHOLT

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PERSONAL DATA

Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. My name is Scott S. Osterholt, and my business address is 850 Tech Center Drive, Gahanna, Ohio 43230.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Ohio Power Company, known as "AEP Ohio" or the "Company," as Director – Distribution Risk and Project Management.

Q. WHAT ARE YOUR RESPONSIBILITIES AS DIRECTOR – DISTRIBUTION RISK AND PROJECT MANAGEMENT?

A. I am responsible for directing the risk and project management activities for AEP Ohio, which involves planning and organizing activities to reduce risk associated with the operations of the Company along with managing projects and various project implementation activities. I also have day-to-day management responsibility for AEP Ohio's gridSMART[1] program.

Q. WHAT IS YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. I received a Bachelor of Business Administration from Mount Vernon Nazarene University. Following employment with an electric cooperative and serving AEP under a contracting arrangement, I joined AEP Ohio in 1996 in the Distribution Region Engineering Group. In 1997, I transferred to Appalachian Power Company, an AEP

[1] "gridSMART" is a registered trademark of American Electric Power Company, Inc.

Ohio affiliate, to lead the engineering activities for its Lynchburg, Virginia district. In 1999, I joined AEP Communications as Manager of Network Projects and was responsible for engineering, construction, and project management of new fiber optic deployments and associated telecom services. In 2002, I joined the AEP IT Telecommunication team and managed fiber maintenance and customer support. I returned to AEP Ohio in 2006 as Work Scheduling Supervisor, and between 2006 and 2009, I led a transformational project where we moved routine utility service scheduling from a local work scheduling group to the call center through a software program called eScheduler. In 2009, I was promoted to Manager – Advanced Distribution Infrastructure, and for the past seven years I have managed all aspects of the gridSMART advanced distribution technology deployment. I was promoted to my current position of Director – Distribution Risk and Project Management in 2016. All told, I have more than twenty-five years of experience in the electric utility industry, including substantial experience in implementing new technologies, and much of my twenty years at AEP have been focused on implementing new technology.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO?

A. Yes. I testified before the Public Utilities Commission of Ohio ("Commission") in Case No. 13-1939-EL-RDR on behalf of the Company.

<u>PURPOSE OF TESTIMONY</u>

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to describe AEP Ohio's proposed Distribution Technology Investment Plan ("Plan"). I will describe each technology that AEP Ohio proposes to deploy as part of the Plan, as well as the substantial benefits that each technology will bring to customers, the Company, and the public at large. I will also discuss the proposed deployment timeline and estimated direct costs for each technology.

Q. ARE YOU SPONSORING ANY EXHIBITS?

A. Yes. I am sponsoring one exhibit: Exhibit SSO-1, Avoided Emissions (PEVs, Microgrids, Smart Lighting).

SUMMARY OF AEP OHIO'S DISTRIBUTION TECHNOLOGY INVESTMENT PLAN

Q. PLEASE DESCRIBE THE COMPANY'S OVERALL APPROACH TO DEPLOYING NEW DISTRIBUTION TECHNOLOGIES.

A. In many contexts, AEP Ohio strives to update and modernize its distribution grid in order to meet its customers' needs and expectations. By updating aging infrastructure and installing state-of-the-art distribution technology, AEP Ohio seeks to provide electrical service that is as safe, reliable, and affordable as current technology and resources will allow. AEP Ohio also recognizes that advanced technologies allow AEP Ohio to provide unique opportunities to its customers that were not possible even just a few years ago. AEP Ohio is committed to using advanced technology to expand the services it provides its customers and to enhance its customers' experience – for example, by providing opportunities for customers to better understand and manage their electrical usage through behind-the-meter technologies; to develop renewable energy sources or other environmentally conscious technologies based on customer expectations and feedback; to save on individual and system-wide electrical energy and capacity costs by implementing energy efficiency and peak demand reduction technologies; and to take advantage of new electric-consuming devices such as electric vehicles. The Company's technological advancement efforts achieve these objectives while maintaining and preserving customer choices and market opportunities for distributed generation and demand response.

Q. HOW HAS THE COMPANY PREVIOUSLY SHOWN ITS COMMITMENT TO TECHNOLOGICAL ADVANCEMENT?

A. In recent years, AEP Ohio has proposed several initiatives to replace aging infrastructure and install modern distribution technology. The initiative I am most familiar with is AEP Ohio's gridSMART program, which I have managed for AEP Ohio since its inception. Phase 1 of the gridSMART program was approved by the Commission in 2009 and has been successfully implemented. Phase 2 of the gridSMART program is awaiting Commission approval in Case No. 13-1939-EL-RDR. Through these Phase 1 and Phase 2 deployments, AEP Ohio has worked with the Commission's Staff and numerous stakeholders to propose deployment of three gridSMART technologies: advanced metering infrastructure ("AMI"), which provides operational savings and promotes customer energy management; distribution automation circuit reconfiguration ("DACR"), which improves reliability; and Volt/VAR optimization technology ("VVO"), which provides energy efficiency savings.

Q. WHAT DISTRIBUTION TECHNOLOGY DEPLOYMENT IS THE COMPANY PROPOSING HERE?

A. In this proposed extension of the Company's third electric security plan ("ESP III Extension"), the Company is proposing a comprehensive Distribution Technology Investment Plan. The purpose of the Plan is to modernize the Company's infrastructure through the installation of advanced distribution technologies, and in this way the Plan complements the gridSMART program and the Company's other technological advancement efforts.

The proposed Distribution Technology Investment Plan involves three initiatives: (1) installation of electrical vehicle charging stations, microgrids, and smart lighting controls in conjunction with Smart Columbus; (2) deployment of a Next Generation Utility Communication System ("NextGen UCS"); and (3) enhancement of the physical security of AEP Ohio's critical distribution infrastructure. The Company is now requesting Commission approval of the Plan.

Q. IS AEP OHIO PROPOSING THAT ASPECTS OF THE DISTRIBUTION TECHNOLOGY INVESTMENT PLAN BE DEPLOYED IN PHASES?

A. Yes. In this proceeding, AEP Ohio is proposing a "Phase 1" deployment of several of the technologies to be deployed in conjunction with Smart Columbus – specifically, electrical vehicle charging stations, microgrids, smart lighting controls, and security infrastructure. AEP Ohio expects to make a later filing for a "Phase 2" deployment of these technologies that builds on the Company's experience in Phase 1.

The Company is not proposing a phased approach to the deployment of NextGen UCS. This is a project for which the Company is seeking full approval and cost recovery in this proceeding.

Q. WHAT ARE THE ESTIMATED DIRECT COSTS AND DEPLOYMENT TIMELINE FOR THE TECHNOLGIES PROPOSED IN THE PLAN?

A. I discuss the direct costs and deployment timeline for each component of the Distribution Technology Investment Plan below. The following is a table that summarizes AEP

Ohio's proposed deployment in this proceeding with estimated capital costs and operation and maintenance ("O&M") costs:

Table 1
Proposed Distribution Technology Investment Plan Direct Costs

Technology	Deployment	Timeline	Capital	O&M
Electric Vehicle Chargers	250 Level 2 Public Smart Chargers, 25 DC Fast Chargers, 1000 Residential Chargers	4 years for Phase 1	$6.4 million	$775,000 per year ongoing O&M
Microgrids	10 microgrids	4 years for Phase 1	$52 million	$1.5 million per year ongoing O&M
Smart Lighting	202,000 smart lighting controls, 1,000 LED replacements	4 years for Phase 1	$30 million	$2.1 million per year ongoing O&M
Next Generation Utility Communication System	Replacement of existing system	4 years	$69 million	No incremental increase in ongoing O&M; $1 million deployment O&M
Distribution Substation Security Technology	Technology deployed in up to 100 critical substations	4 years for Phase 1	$30 million	$400,000 per year ongoing O&M

Q. HOW WILL COSTS ASSOCIATED WITH THE PLAN BE RECOVERED?

A. Plan costs will be recovered through the proposed Distribution Technology Rider, which Company witness Gill discusses in greater detail.

SMART COLUMBUS – OVERVIEW

Q. WHAT IS SMART COLUMBUS?

A. In December 2015, the United States Department of Transportation ("DOT") announced a federal grant, the "Smart City Challenge," to award $40 million to a single U.S. city to implement new technologies and innovative techniques to improve its transportation system.[2] In addition to the $40 million in federal funding, Vulcan Inc., a company founded by investor and philanthropist Paul Allen, pledged an additional $10 million in funding to support decarbonization efforts by the selected city.

The DOT received seventy-eight applications from cities wishing to participate in the Smart City Challenge, and after narrowing the applications to seven finalists, the DOT selected Columbus, Ohio and the surrounding area as the winner on June 23, 2016. Columbus's winning Smart City Challenge initiative is referred to as "Smart Columbus."

Q. HAVE ANY LOCAL ORGANIZATIONS PLEDGED TO SUPPORT SMART COLUMBUS?

A. Yes. Columbus's winning application reflected substantial funding and resource commitments from municipal and state sources such as the City of Columbus, Franklin County, and the Ohio Department of Transportation; from research institutions such as the Ohio State University and Battelle; from regional organizations such as the Central Ohio Transit Authority (COTA), Columbus 2020, the Columbus Partnership, Experience Columbus, the Greater Columbus Arts Council, Clean Fuels Ohio, and the Mid-Ohio

[2] Detailed information about the Smart City Challenge can be found on the U.S. Department of Transportation's website: https://www.transportation.gov/smartcity.

Regional Planning Commission; and from businesses such as Honda of America.[3] The winning application also included critical commitments from AEP Ohio, as discussed below.

Q. WHAT ARE THE GOALS OF SMART COLUMBUS?

As explained by the DOT, the goals of Columbus's winning Smart City proposal are to "demonstrate how advanced data and intelligent transportation systems (ITS) technologies and applications can be used to reduce congestion, keep travelers safe, use energy more efficiently, respond to climate change, both connect and create opportunities for underserved communities, and support economic vitality."[4] The Smart Columbus program is also intended to "provide safety improvements, enhance mobility, increase ladders of opportunity by incentivizing reinvestment in underserved communities, reduce energy usage, and address climate change."[5]

Q. WHAT IS AEP OHIO'S ROLE IN SMART COLUMBUS?

A. As part of Columbus's winning Smart City Challenge application, AEP Ohio agreed to partner with the City of Columbus and surrounding communities to support the proposed Smart Columbus initiatives. In particular, AEP Ohio's role in the Smart Columbus project is to support "[d]ecarbonization of power supply and deployment of electric vehicles and other carbon emission reduction strategies."[6]

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[3] A complete list of organizations that have made funding or resources commitments to Smart Columbus is available at https://www.columbus.gov/smartcolumbus/committedpartners/.

[4] *See* U.S. Department of Transportation, Cooperative Agreement Award Number DTFH6116H0013, Smart City Challenge Demonstration at 4 (Aug. 30, 2016). Relevant excerpts of this document are attached to this testimony as Appendix SSO-1.

[5] *Id.*

[6] *Id.* at 51.

Although AEP Ohio is not receiving any of the $40 million in grant funding from the DOT or the $10 million in grant funding from Vulcan, AEP Ohio has pledged to seek regulatory approval from this Commission to install technologies that further the goals of the Smart City program. AEP Ohio is now making that request for regulatory approval as part of its proposed Distribution Technology Investment Plan in this proceeding.

Q. HOW WILL AEP OHIO'S PROPOSED DISTRIBUTION TECHNOLOGY INVESTMENT PLAN SUPPORT SMART COLUMBUS?

A. AEP Ohio proposes to deploy three technologies to support the goals of Smart Columbus and integrate with other Smart Columbus projects:

First, AEP Ohio proposes to deploy electric vehicle charging stations. Promoting electric vehicles is one of the main goals of the Smart Columbus project, and installation of electric vehicle charging stations in Columbus and the surrounding area will directly support that goal. As part of its proposed electric vehicle charging station deployment in this proceeding, AEP Ohio intends to seek input from Smart Columbus representatives regarding charging station locations. This input will rely in part on a planned U.S. Department of Energy study of the Columbus area transportation corridor.

Second, AEP Ohio proposes to install 8-10 microgrids for critical infrastructure, such as police and fire stations, medical facilities, social service agencies, or other critical facilities serving public safety needs, including consideration for facilities that serve lower income communities. Microgrids are integrated batteries, smart controls, and (in some cases) small-scale generation that are capable of isolating – or "islanding" – small sections of the distribution grid and keeping power flowing when there are outages on other parts of the grid. Microgrids also provide opportunities to use batteries and small-scale generation to provide benefits to the distribution grid during normal operating conditions. As with the proposed electric vehicle charging stations, the Company intends to seek input from Smart Columbus representatives regarding the locations that would most benefit from a microgrid. Further, the microgrid deployment will complement Smart Columbus decarbonization efforts by deploying battery technology and renewable generation.

Third, AEP Ohio proposes to install smart area light and street light controls that are capable of dimming lights when appropriate and detecting malfunctioning lights to save energy and increase safety and security. The Smart Columbus initiative was the impetus for AEP Ohio to investigate smart lighting control technology, and having done so, the Company has come to understand the substantial benefits provided by smart lighting controls and proposes that they be deployed through the entire gridSMART Phase 1 and 2 areas.

I discuss each of these three technologies in greater detail below.

Q. ARE THE COMPANY'S PROPOSED SMART COLUMBUS TECHNOLOGIES LIMITED TO THE COLUMBUS MUNICIPAL AREA?

A. No. As an initial matter, the Smart Columbus initiative includes Franklin County and ten surrounding counties.[7] Accordingly, although the Company's installation of electric vehicle charging stations, microgrids, and smart lighting controls may be focused on areas where those technologies may have the most potential for customer benefits, the Company will assess deployment opportunities across the Smart Columbus footprint and other areas within the Company's service territory.

[7] The ten counties surrounding Franklin County are Delaware, Fairfield, Knox, Licking, Logan, Madison, Marion, Morrow, Pickaway, and Union Counties.

Moreover, the Company intends that the Smart Columbus technology deployment proposed in this proceeding as Phase I will serve as a demonstration project that will allow the Company to prove the value of these technologies and refine and improve their performance. Therefore, much as gridSMART Phase 1 was a proving ground for the larger deployment proposed as part of gridSMART Phase 2, the Smart Columbus deployment proposed here will facilitate a larger deployment of one or more of the Smart Columbus technologies in other parts of AEP Ohio's territory.

SMART COLUMBUS – ELECTRIC VEHICLE CHARGING STATIONS

Q. WHAT IS A PLUG-IN ELECTRIC VEHICLE?

A. A plug-in electric vehicle ("PEV") is a car, van, or truck that uses batteries that can be recharged by plugging them in to an external source of electric power. These vehicles can be powered by the electric battery alone or by the battery in combination with a gas combustion engine.

Q. WHAT RECHARGING INFRASTRUCTURE IS NEEDED TO SUPPORT PEVs?

A. There are three main type of PEV charging stations:

- Level 1 charging stations use the 120-volt current found in standard household outlets and are compatible with the power cord and equipment provided with most PEVs. Level 1 charging stations charge at a rate of 3-5 miles of range per hour of charging.
- Level 2 charging stations use 240 volt power to enable faster charging. Level 2 charging stations require the installation of a charging station unit and electrical wiring capable of handling higher voltage power. Level 2 charging stations charge at a rate of 10-20 miles of range per hour of charging.

- DC fast chargers typically provide compatible PEVs with an 80% charge in 20-30 minutes by converting high voltage AC power to DC power for direct storage in electric vehicle batteries.

All three types of charging stations can be installed in homes, business, and on public streets, though DC fast chargers are typically not installed in homes.

Q. HOW DOES THE AVAILABILITY OF CHARGING STATIONS AFFECT ADOPTION OF PEV TECHNOLOGY?

A. Currently, there are limited charging stations available, and this is a significant impediment to adoption of electric vehicle technology. Although PEV owners often install charging stations in their homes, the lack of charging stations outside the home contributes to a phenomenon commonly known as "range anxiety," in which consumers decline to purchase PEVs because they fear they will be unable to travel outside a limited area around their home due to the lack of publically available charging stations. Thus, a key factor to promote PEV adoption is increased investment in charging station infrastructure. Wider availability of charging stations can help overcome barriers to PEV adoption such as "range anxiety" and act as a catalyst for increased PEV adoption.

Q. WHAT ARE THE BENEFITS OF BUILDING CHARGING STATION INFRASTRUCTURE TO ENCOURAGE ADOPTION OF PEVs?

A. Investing in charging station infrastructure, and thereby encouraging adoption of PEVs, will lead to many benefits, and the benefits of PEV adoption are generally understood to outweigh the cost of PEV charging station infrastructure. Some of those benefits include:

- **Reduced average electric system costs.** Widespread PEV adoption will bring with it additional load, which will tend to be weighted toward off-peak hours and therefore be cheaper to serve. Over time, this could lower costs for meeting customers' needs. PEV load is also controllable, which can provide cost-saving system benefits through demand response and ancillary support capabilities.

- **Support for renewable generation.** As renewable generation increases, charging stations can be more highly utilized during daytime hours, when excess renewable generation may become available.
- **Reduced vehicle emissions.** PEVs are estimated to emit approximately 60 percent of the CO^2 emissions of internal combustion vehicles.[8]
- **Reduced vehicle fuel costs.** PEVs can be expected to cost approximately $1.00 per gasoline-gallon equivalent in electricity costs,[9] providing a significant boost in average incomes and a reduction in petroleum imports.
- **Energy independence.** PEVs help reduce our dependency on foreign energy sources and thus act as a complement to other energy independence efforts, such as shale development.

Q. WHAT ARE THE BENEFITS OF UTILITY PEV SYSTEMS?

A. The proposed PEV charging station deployment here is a complement to – and is not to the detriment or exclusion of – other parties' charging station deployments. If more charging stations are available (from whatever source), then more people will purchase PEVs, leading to demand for even further charging station deployment. Nonetheless,

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[8] U.S. Department of Energy, Alternative Fuels Data Center, Emissions from Hybrid and Plug-in Electric Vehicles (June 2016), *available at* http://www.afdc.energy.gov/vehicles/electric_emissions.php.

[9] This assumes 290 watt-hours per mile, conventional vehicle mileage of 29 miles per gallon, and 12 cents per kilowatt-hour electricity cost. *See* Electric Power Research Institute, Total Cost of Ownership for Current Plug-in Electric Vehicles (2014), *available at* http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002004054.

there are many reasons why utilities such as AEP Ohio are well suited to deploy PEV infrastructure:

- **Utilities have a long planning horizon.** Public utilities such as AEP Ohio will be providing electric service in their communities for decades to come, and they are accustomed to taking a long-term approach to electric infrastructure deployment. This makes public utilities well positioned to take a long-term approach to PEV charging infrastructure development.
- **Utilities have the ability to make capital expenditures.** Public utilities such as AEP Ohio have the financing and regulatory constructs in place to make large-scale investments in electric infrastructure such as charging stations. Unlike many private entities, utilities can amortize capital investments and recover capital expenses over a long period of time.
- **Utilities have the ability to manage demand.** Unlike private entities, utilities such as AEP Ohio have the experience and existing capability to more effectively manage the impact of demands on the power delivery system. This means that public utilities are uniquely positioned to take advantage of charging stations as demand response resources, to offset costs with additional revenues associated with demand response, and to most effectively integrate such capabilities into the grid.
- **Utilities have considerable electric system expertise.** Public utilities such as AEP Ohio have the expertise to operate charging stations safely and to ensure that no damage occurs to power delivery equipment. This expertise may also allow public utilities to operate charging stations more efficiently, reducing cost to the PEV owners.

- **Utilities are closely regulated.** Public utilities such as AEP Ohio are closely regulated by this Commission and other regulatory entities, and are responsive to regulatory and political leadership to address the state's energy policies.
- **Utilities can extend PEV opportunities to disadvantaged segments.** Unlike many private enterprises, public utilities such as AEP Ohio are accustomed to providing universal service, including service to the disadvantaged. Thus, public utility deployment of charging stations can ensure that all segments of the population are given opportunities to use PEVs.
- **Utilities can identify best practices for charging station deployment.** By deploying charging stations, public utilities such as AEP Ohio can produce a base of valuable experience for the utility and for the industry in Ohio regarding charging behavior, demand response program parameters, charging station installation and operation, and interactions with PEV owners.
- **Utilities are uniquely positioned to choose appropriate charging locations.** Public utilities can make sure that charging stations are placed in locations that are able to support the added load on the system without distribution investments.

Q. WHAT DOES AEP OHIO PROPOSE WITH RESPECT TO CHARGING STATION DEPLOYMENT?

A. As part of its Distribution Technology Investment Plan, AEP Ohio proposes to make an initial charging station deployment as a demonstration project. Specifically, over the first four years of the Plan, Phase I, AEP Ohio proposes to install 250 Level 2 public smart charging stations and 25 public DC Fast Charger charging stations. In addition, AEP Ohio will develop 1,000 residential charging stations, as discussed further below.

Charging stations will be purchased and owned by AEP Ohio, with an expected useful life of ten years. One or more charging station vendors will be selected for the pilot following requests for proposals.

AEP Ohio will install Level 2 smart charging stations that will be capable of data collection, network communications, and demand response. Data collection will include amperage, voltage, date, time, and battery state.

For the DC Fast Charging stations, AEP Ohio intends, where possible, to evolve its deployments as the DC Fast Charging infrastructure evolves and moves toward higher output power and faster customer charging times. These advancements will help match AEP Ohio technology with customer expectations.

Q. WHERE DOES AEP OHIO INTEND TO INSTALL THE PROPOSED CHARGING STATIONS?

A. AEP Ohio intends to develop a plan for charging station installations to best promote PEV adoption. As noted above, AEP Ohio will seek input from Smart Columbus representatives about charging station location in order to best complement Smart Columbus programs designed to promote PEV use. In addition, AEP Ohio will consult the planned DOT transportation corridor analysis of Columbus as a guide to best position charging stations.

Q. WHAT WILL AEP OHIO CHARGE PEV OWNERS TO USE THE PUBLIC CHARGING STATION SYSTEMS?

A. Recognizing that this is a demonstration project, and because a primary goal of the proposed development is to encourage PEV adoption, AEP Ohio proposes to allow PEV owners to use Company-installed public charging stations free of charge during an initial period. After gathering and analyzing data from the installed charging stations during the initial phase of the project, the Company plans to submit for the Commission's approval a schedule of charges for public charging station usage after the initial demonstration period.

Q. HOW WILL THE COSTS OF PUBLIC CHARGING STATION USAGE BE REFLECTED IN AEP OHIO'S RATES?

A. AEP Ohio proposes that public charging station energy, capacity, and other costs will be recovered through the Distribution Technology Investment Rider based on the Company's Standard Service Offer ("SSO") rate. AEP Ohio witness Gill describes this in greater detail in his testimony.

Q. WHAT DO CHARGING STATIONS COST TO INSTALL?

A. Installation costs of the charging stations will vary considerably across the typical voltage levels identified above. Table 2 below provides estimates of installed costs across the charging station types, with an additional variability for Level 2 systems depending on their location:

Table 2
Average Charging Station Installation Costs

Charging Station Type	Total Cost per Port
Level 2 (Residential)	$1,000-$2,000
Level 2 (Workplace)	$5,000-$10,000
Level 2 (Public)	$10,000-$20,000
DC Fast Chargers	$50,000-$100,000

Q. DOES AEP OHIO PLAN TO OFFER A RESIDENTIAL ELECTRIC VEHICLE CHARGING PROGRAM?

A. Yes. AEP Ohio understands that a large portion of electric vehicle charging will be done at customers' residences. It is important for the Company to invest in the residential charging infrastructure because it will allow AEP Ohio to develop load management functionality to ensure no negative impacts on the distribution grid. Through a limited demonstration of not more than 1,000 units, AEP Ohio plans to study these impacts and to develop a Phase 2 residential electric vehicle charging program.

For the 1,000 unit residential electric vehicle charging demonstration, customers will be provided with a Company-owned Level 2 charger at no charge for the demonstration period. Customers will continue to be responsible for their energy usage. The customer will also be required to provide a 240 volt electric outlet at the desired charging location that meets the Company's specifications. This charger will have demand reduction capabilities, and the customer would need to agree to AEP Ohio initiating demand reduction events. AEP Ohio would be able to call these events when the electricity demand is the greatest and for experimental purposes. The estimated deployment cost per location is $1000. The ongoing expenses associated with maintaining this equipment including the communication fees are estimated at $200 per location per year.

Q. WHAT ARE THE COSTS OF AEP OHIO'S PROPOSED CHARGING STATION DEPLOYMENT?

A. Estimated expenditures for capital costs and ongoing O&M over the four-year charging station demonstration project are shown in Table 3 below. Ongoing O&M costs include software vendor fees, other IT costs, and Company overhead.

Table 3
Estimated Charging Station Deployment & Program Direct Costs

	Year 1	Year 2	Year 3	Year 4	Total
Level 2 Chargers	30	50	85	85	250
DC Fast Chargers	5	6	7	7	25
Residential Chargers	250	250	250	250	1000
Total	285	306	342	342	1275
Capital Cost	$1,111,000	$1,429,780	$1,928,673	$1,932,684	$6,402,137
Ongoing O&M Cost	$125,000	$293,000	$534,000	$775,000	$1,727,000
Total	$1,236,000	$1,722,780	$2,462,673	$2,707,684	$8,129,137

Q. DOES AEP OHIO PLAN ADDITIONAL CHARGING STATION DEPLOYMENT DURING THE INITIAL FOUR-YEAR DEMONSTRATION PROJECT PROPOSED HERE?

A. Yes. While Table 3 above reflects the initial plan, AEP Ohio is requesting the ability to deploy twice the number of charging stations during this initial phase. Based on information gathered during Phase 1 regarding charging station best practices, including where best to deploy charging stations, how consumers use charging stations, and how best to price usage, AEP Ohio proposes to deploy additional level 2 public chargers, DC fast chargers, and residential chargers prior to the commencement of Phase 2. In order to expedite the deployment of the Company's additional Phase 1 deployment, AEP Ohio is requesting that the Commission approve the additional chargers in this proceeding. However, AEP Ohio commits that it will obtain the Commission Staff's consent prior to additional Phase 1 deployment.

AEP Ohio also reserves the right to file for modifications to its Phase 1 charging station program, including, potentially, for a plan to charge customers for charging station usage during Phase 1 or another time.

Lastly, there are many possible electrification projects that the Company could propose after the Phase 1 deployment at issue here. For instance, the Company could work with COTA or car rental companies (such as Car2Go) on planning and developing the network required for future electric bus or car rental fleets. Initiatives like these, which target public transportation infrastructure, could provide electric transportation options to lower income neighborhoods.

Q. WHAT ARE THE EXPECTED ENVIRONMENTAL BENEFITS OF THE ELECTRIC VEHICLE CHARGING STATIONS INCLUDED IN THE PLAN.

A. By encouraging PEV ownership and increased PEV utilization, the Plan will reduce internal combustion vehicle emissions. Exhibit SSO-1, page 1, provides estimates of avoided carbon dioxide emissions based on the differential between emissions from internal combustion engine vehicles and those from the marginal power supply resources that would serve increased load due to charging activity at the stations. The estimate reflects the planned numbers of charging stations for each type of station and reasonable assumptions regarding charging activity and internal combustion engine efficiency and emissions rates. Marginal generation to serve the increased load associated with the charging activity has been estimated on the basis of reasonable assumptions regarding the operating characteristics of combined cycle combustion turbines. As shown in Exhibit SSO-1, page 1, AEP Ohio estimates that, at the conclusion of deployment, avoided greenhouse gases for the electric vehicle charging station component of the Plan will be approximately 10,283 Tons per year. There would also be avoided carbon monoxide, particulate matter, and other emissions, which have not been estimated at this time.

<u>SMART COLUMBUS – BATTERIES AND MICROGRIDS</u>

Q. WHAT IS A MICROGRID?

A. A microgrid is a small-scale power grid that can operate independently (called "islanding") or in conjunction with an area's main electrical grid. The critical components of a microgrid are a battery storage system and smart controls that can island the microgrid and keep power flowing within the microgrid using energy stored in the batteries. Microgrids sometimes also include small-scale generation such as solar arrays, wind turbines, or small gas-fired generators that can supplement the energy and capacity provided by battery storage systems during islanding.

In normal conditions, a microgrid is interconnected to the electric distribution system and operates as a part of that system. During normal conditions, critical facilities on a microgrid will be served by a mix of energy from the distribution grid and energy from the batteries or small-scale generation installed as part of the microgrid. The microgrid may also backfeed energy over the grid, serving other loads.

When there is an outage on the distribution grid, however, the microgrid's smart controls will island the microgrid from the wider distribution system. When islanding, the microgrid's smart controls will use the microgrid's batteries and small-scale generation to keep electricity flowing to the critical facilities within the microgrid. When service is restored to the grid, the microgrid will revert back to the standard interconnection with the distribution system.

Q. WHAT IS AEP OHIO PROPOSING WITH RESPECT TO MICROGRIDS?

A. As part of its Distribution Technology Investment Plan in this proceeding, AEP Ohio proposes to install 8-10 microgrids over a four-year period. Although the exact specifications of each microgrid must be determined by the particular characteristics of the load to be served, AEP Ohio anticipates that a typical microgrid will consist of smart controls, a battery storage system, and a small-scale photovoltaic (i.e., solar) generation system sized to meet the load requirements. AEP Ohio may also allow customers on the microgrid to elect to have a Company-owned generator connected to the microgrid, though this would be a customer option that the Company would expect the customer to pay for.

AEP Ohio envisions this proposed microgrid deployment as a demonstration project designed to prove the benefits of microgrids and help the Company gain experience with microgrid planning, installation, and operations. AEP Ohio hopes that this initial demonstration project will create the blueprint for additional, larger-scale microgrid deployment to be proposed in a later proceeding.

Q. HOW WILL AEP OHIO CHOOSE THE LOCATION OF MICROGRID INSTALLATIONS?

A. AEP Ohio anticipates that locations for microgrids will include critical community assets such as fire and police stations, medical facilities, social service agencies, emergency shelters, water and sewer infrastructure facilities, grocery stores, and gas stations. The Company will select specific sites by a qualitative assessment that evaluates the suitability of potential sites (e.g., based on criticality, resiliency requirements, easements, ease of access, and capital and operating cost). Site selection factors may evolve over time but will include the following:

- Criticality of the customer loads that would benefit from the microgrid deployment – for example, whether the load is a hospital or public safety building.
- Amount of customer load (size, type, etc.)
- The amount of existing backup generation already available for the customer loads
- The historic reliability of the circuit serving the customer loads (i.e., 3 year average SAIDI)

Q. WHAT ARE THE BENEFITS OF MICROGRIDS?

A. Microgrids provide numerous customer and societal benefits:

- **Improved resiliency and reliability for critical infrastructure.** The primary purpose of a microgrid is to maintain electric service to critical facilities during outages. Extended outages are possible due to severe weather events. By placing critical facilities such as police and fire stations, disaster shelters, other health and safety facilities on microgrids, power can be maintained during outages to provide emergency services and to support the wider population during extended outages.
- **Reduced system peak demands.** Microgrids also reduce peak system demand by using energy stored in batteries and from small-scale generation to serve the microgrid load during peak hours. Reduction in peak system demand can lead to cost-saving system benefits.

- **Integration of intermittent renewable generation.** One of the most significant obstacles to the deployment of renewable generation is the fact that solar, wind, and other renewable generators are generally non-dispatchable – whether the generator is capable providing power to grid depends on the weather. Microgrids help address this problem – and thereby promote the deployment of renewable resources – by incorporating battery storage in an integrated system with renewable generation. Using smart controls, the microgrid is able to use its renewable generation to recharge its batteries or feed power back to the grid during times of peak renewable power generation; but, critically, it can also draw on its battery storage to augment its power needs during times of diminished renewable generation.
- **Clean energy generation and reduced emissions.** Additionally, because they use renewable generation with battery storage, microgrids provide significant environmental benefits and can be used for compliance with renewable portfolio standards and environmental regulations targeting greenhouse gas emissions.
- **Ancillary services.** Microgrids also help meet ancillary requirements (i.e., load following, spinning reserves). Battery storage systems are able to quickly increase and decrease energy output, allowing them to compete in the ancillary services market. In fact, according to the Energy Storage Association, battery storage can respond to electric control area operator requests to adjust power output considerably faster and more accurately than can combustion turbine generators.[10] Utilizing a battery storage system, microgrids can provide both demand response and, potentially, ancillary services to the PJM market.

[10] *See* Energy Storage Association, Facts and Figures, http://energystorage.org/energy-storage/facts-figures.

Q. WHAT ARE THE BENEFITS OF MICROGRID SYSTEMS INSTALLED BY UTILITIES?

A. Although there are third-party vendors that install private microgrid systems, these private microgrids are installed behind the utility meter and benefit a single customer. AEP Ohio does not intend to compete with these private systems, but instead is offering a different product: A utility-owned microgrid installed in front of the meter. Such utility owned microgrids place multiple customers on the same microgrid and also interact with the utility's distribution grid in ways that private microgrid systems cannot – for example, by integrating with the utility's distribution system to maximize the benefits of demand response and sectionalizing.

Q. HOW DOES AEP OHIO'S PROPOSED MICROGRID DEPLOYMENT INTEGRATE WITH THE SMART COLUMBUS PROJECT?

A. As noted above, AEP Ohio will seek input from Smart Columbus representatives and other sources about the best location for microgrids. By utilizing battery and renewable generation technology, the proposed microgrids also contribute to the decarbonization goal of the Smart Columbus project.

Q. WHAT ARE THE DIRECT COSTS OF AEP OHIO'S PROPOSED MICROGRID DEPLOYMENT?

A. AEP Ohio proposes to install ten microgrid systems over a four-year period, at total capital cost of $51.87 million. Ongoing O&M expenses will be approximately $1.5 million annually at full deployment.

Table 4
Estimated Microgrid and Battery Storage Program Direct Costs

	Year 1	Year 2	Year 3	Year 4	Total
Microgrids Deployed[11]	2.5	2.5	2.5	2.5	10.0
Capital Cost	$12,967,500	$12,967,500	$12,967,500	$12,967,500	$51,870,000
Ongoing O&M Cost	$375,000	$750,000	$1,125,000	$1,500,000	$3,750,000
Total	$13,342,500	$13,717,500	$14,092,500	$14,467,500	$55,620,000

Q. HOW WILL ENERGY USAGE AND PRODUCTION FROM MICROGRIDS BE SETTLED?

A. When microgrid batteries are being charged, they use energy from connected small-scale generation or from the grid. When microgrid batteries discharge, they put energy back onto the grid. Likewise, small-scale generation as part of a microgrid produces energy that will be distributed to the grid.

For settlement of this energy usage and production, AEP Ohio proposes that the microgrid energy be treated as unaccounted for energy. This means that the energy usage or production will be socialized to all load-serving entities in AEP Ohio's territory – i.e., to all CRES providers and SSO auction providers. This approach also has the benefit of having no effect on the metered usage of customers on the microgrid.

Q. WHAT ARE THE EXPECTED ENVIRONMENTAL BENEFITS OF THE PROPOSED MICROGRID DEPLOYMENT?

[11] Company plans to add 2-3 deployments on an annual basis.

A. Microgrids developed as part of the Distribution Technology Investment Plan would incorporate photovoltaic (PV) systems to provide electricity to the grid and, in combination with battery systems, to the critical facilities that are inside the microgrid “fence” in the event of grid outages. PV systems do not have emissions, and any generation would offset generation that would otherwise be required from emission-producing generation facilities. Exhibit SSO-1, page 2, provides estimates of avoided carbon dioxide emissions based on the emissions from marginal power supply resources that would have otherwise served system load that will be served by the PV systems. The estimate reflects the planned numbers and capacity of microgrids and reasonable assumptions regarding the operating characteristics of combined cycle combustion turbines, which are assumed to be representative of the marginal generation resources on the AEP Ohio system. As shown in Exhibit SSO-1, page 2, AEP Ohio estimates that, at the conclusion of deployment, avoided greenhouse gases for the microgrid component of the Plan will be approximately 3,176 Tons per year. There will also be some avoided sulfur dioxide, particulate matter, and other emissions, which have not been estimated at this time.

SMART COLUMBUS – SMART STREET LIGHTING

Q. WHAT IS SMART STREET LIGHTING?

A. Currently, the street and area lights owned by AEP Ohio are controlled by simple photocells or motion sensors. But new, smart lighting controls have recently been developed that provide considerable advantages over these existing technologies. Specifically, modern lighting controls now allow two-way communication so that a utility such as AEP Ohio can instantaneously monitor lighting outages and can control lighting levels based on a wide variety of inputs and scenarios. These modern lighting controls also have the ability to interact directly with consumer-owned devices and vehicles, providing context-sensitive lighting.

Q. WHAT ARE THE BENEFITS OF SMART LIGHTING CONTROLS?

A. Smart lighting controls offer numerous customer benefits:

- **Improved safety and security through rapid light repair.** Company-owned street lighting provides important customer and public benefits. Properly designed street and area lighting can help reduce crime. Street lighting and area lighting also increase pedestrian traffic and provide an added sense of security to the public. However, existing controls on Company-owned street and area lights do not alert the Company when the light malfunctions. As a result, the Company often is unaware of inoperative street lights. Inoperative street lights create gaps in lighting coverage and thereby reduce public safety and security. In addition, gaps in lighting on roadways can impair driver visibility as the eye reacts to changes from light to dark. With the smart lighting controls proposed by the Company in this proceeding, the Company will be able to detect inoperative lights immediately and schedule prompt replacement, and undetected gaps in street and area lighting plans will be virtually eliminated. As a result, public safety and security will be enhanced, and customer satisfaction will increase with quicker repair of inoperable lighting.
- **Energy savings through repair of day burners.** Another problem with existing street light controls is that they fail to alert the Company to "day burners" – street lights that have malfunctioned so that they stay on all day. These day burners lead to increased costs for all lighting customers by wasting energy and contributing to peak

demand. With smart lighting controls, however, the Company will be able to detect and repair day burners quickly, saving costs.

- **Operational savings and customer satisfaction through reduced call center volume.** Because existing lighting controls do not alert the Company to lighting malfunctions, the Company often depends on customers calling in to its call center to inform the Company that a street light is out or operating incorrectly. With smart lighting controls, however, the Company will be immediately and automatically alerted to malfunctions, and will not need to rely upon customers to call in. Not only will this reduce AEP Ohio's call center volume and thus lead to operational savings; it will also improve customer satisfaction by helping the Company repair malfunctioning lights more quickly.
- **Additional operational savings through streamlined repairs.** Reduced call center volume is not the only operational savings that smart controls will achieve. They will also lead to operational savings through their ability to streamline. Currently, when a customer reports a malfunctioning light, the Company's call center representative must manually create a work order. The work order is then routed to the maintenance department, where it is placed in a queue and service is scheduled. When maintenance crews are dispatched to repair the lights, they often do not know what the problem is until they are able to examine the light. Maintenance crews may not carry a full complement of parts necessary for such repairs. With smart lighting controls, however, this process is streamlined. The controls continuously monitor the status and performance of the light and communicate this data to a wireless gateway in real-time. When smart controls detect a malfunction, an alert is generated

providing specific information about the outage, and a work order is automatically generated. This allows maintenance personnel to schedule and conduct repairs more efficiently.

- **Potential for dimming and other advanced functionality.** Although AEP Ohio's proposed smart lighting deployment (discussed in detail below) will not use this functionality immediately, smart lighting controls also have several advanced functions that could be utilized at a later time. For instance, advanced lighting controls allow the utility to dim lights when full lighting is not needed. Thus, street or area lighting could be dimmed in the early hours of the morning, when most of the population is asleep, or during certain environmental conditions, such as nights with a full moon.
- **Faster response to lighting restoration requests.** If a customer requests restoration of a street or area light that has been previously decommissioned using smart lighting controls, the Company can remotely recommission the light, either as soon as the Company processes the customer request (potentially immediately), or on a date requested by the customer. Smart lighting controls also eliminate the need for the Company to send a crew to physically re-install the light.

Q. WHAT IS AEP OHIO PROPOSING WITH RESPECT TO SMART STREET LIGHTING?

A. As part of its Distribution Technology Investment Plan in this proceeding, AEP Ohio proposes to install approximately 202,000 smart lighting controls on Company-owned street and area lights. The Company expects the deployment to take four years.

AEP Ohio also intends to install 1,000 light emitting diode ("LED") fixture replacements as part of its smart lighting control installation. This modest deployment of LED technology will allow the Company to demonstrate the considerable energy efficiency potential of LED lighting for Company-owned street and area lights.

Q. WHERE DOES AEP OHIO PLAN TO INSTALL SMART LIGHTING?

A. AEP Ohio plans to deploy smart lighting controls across its entire gridSMART Phase 1 and Phase 2 footprint. In this way, AEP Ohio will leverage existing grid modernization elements, such as AMI, to further improve the additional functionality and benefits of the smart lighting system. In addition, in order to evaluate the benefits of smart lighting, AEP Ohio plans to install smart lighting in a variety of areas representing a wide range of customer demographics and populations, including single- and multi-family residential neighborhoods, low-income areas, and commercial retail and commercial business settings.

Q. WHAT IS AEP OHIO PROPOSING WITH RESPECT TO LED LIGHTING?

A. In conjunction with its deployment of smart lighting controls, the Company also intends to replace some street light fixtures with LED lamps as a demonstration project for the benefits of LED technology. Specifically, AEP Ohio plans to replace approximately 1,000 Company-owned 100W high pressure sodium vapor (HPS) street light fixtures with an equivalent LED light fixture. LED fixtures use significantly less energy but provide the same or greater lumens, resulting in energy savings. The light quality of LED fixtures provides increased visual clarity, resulting in increased safety and security to the public. LED fixtures also require less maintenance due to their longer life.

An initial deployment of approximately 1,000 LED fixtures will allow AEP Ohio to further evaluate the operational and customer impacts of the new LED fixtures, without making the full investment for complete replacement of street and area lighting fixtures. AEP Ohio anticipates that after a period of evaluation and the anticipated release of LED dimming standards by the Illuminating Engineering Society (IES), additional LED fixture replacements will be contemplated.

This proposed LED replacement program is in addition to new tariff options for LED lighting, which are discussed in greater detail by AEP Ohio witness Moore.

Q. WHAT ARE THE DIRECT COSTS OF AEP OHIO'S PROPOSED SMART LIGHTING DEPLOYMENT?

A. The proposed smart lighting control deployment will require $29.9 million in capital costs and $2.1 million in annual ongoing O&M expenditures. Direct costs are shown in Table 5 below:

Table 5
Estimated Smart Street Lighting Program Deployment & Direct Costs

	Year 1	Year 2	Year 3	Year 4	Total
Smart Lighting	50,500	50,500	50,500	50,500	202,000
LED	500	500	-	-	1,000
Capital Cost	$8,873,490	$7,257,490	$6,868,495	$6,868,495	$29,867,969
Ongoing O&M Cost	$657,424	$1,142,224	$1,627,024	$2,111,824	$5,538,496
Total	$9,530,914	$8,399,714	$8,495,519	$8,980,319	$35,406,465

Q. WHAT ENVIRONMENTAL BENEFITS FROM THE SMART STREET LIGHTING PORTION OF THE PLAN DO YOU EXPECT?

A. The smart street lighting component of the Plan reflects the conversion of a certain number of lamps from high pressure sodium to LED technology, which would dramatically reduce the electricity consumption of these lamps and therefore decrease the emissions associated with the resulting generation requirements. Exhibit SSO-1, page 3, provides estimates of avoided carbon dioxide emissions based on the emissions from marginal power supply resources that would have otherwise been required to serve the previously greater consumption. The estimate reflects the planned numbers and estimated consumption level of converted street lights and reasonable assumptions regarding the operating characteristics of combined cycle combustion turbines. As shown in Exhibit SSO-1, page 3, AEP Ohio estimates that, at the conclusion of deployment, avoided greenhouse gases for the smart street lighting component of the Plan will be approximately 133 Tons per year. There will also be some avoided sulfur dioxide, particulate matter, and other emissions, which have not been estimated at this time.

<u>NEXT GENERATION UTILITY COMMUNICATION SYSTEM</u>

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NEXT GENERATION UTILITY COMMUNICATION SYSTEM.

A. As part of its Distribution Technology Investment Plan, the Company is proposing to replace its increasingly obsolete Enhanced Digital Access Communication System (“EDACS”) two-way radio system with a modern communication system, the NextGen UCS. AEP Ohio’s communications system supports numerous business critical functions, including dispatching field crews, providing data connectivity to field crews, supporting restoration efforts during emergencies and natural disasters, and protecting the health and safety of workers and the public. As described below, the current EDACS is obsolete and in need of replacement, and the proposed NextGen UCS will provide considerable additional functionality that will lead directly to better utility operations and customer benefits.

Q. WHAT IS THE IMPORTANCE OF A COMMUNICATION SYSTEM TO UTILITY OPERATIONS?

A. The purpose of a communication system is to provide reliable voice communications in order to ensure the safe and efficient operation of the distribution grid by Company employees and contractors. Additionally, the communication system is used to provide data connectivity to the Mobile Data Computers ("MDCs") in Company vehicles to allow field personnel to use distribution applications, such as accessing global positions system ("GPS") data, and information for dispatching purposes. Therefore, the communication system is the primary first communication tool used by field personnel to complete all of their assigned work, including dispatching and switching. Without a reliable, dedicated communication system that can provide voice and data connectivity, Company personnel and contractors are severely limited in their ability to receive, perform, and complete their assignments.

Q. WHY IS THE CURRENT EDACS IN NEED OF REPLACEMENT?

A. The existing EDACS is well beyond its useful life and does not have the necessary functionality that AEP Ohio requires to maintain the reliability and integrity of its distribution grid and customer service operations.

The existing EDACS is old technology. The system is so out-of-date that spare parts are no longer available through the manufacturer, and the Company must procure used spare parts on the secondary market. The Company has also struggled to find qualified personnel to maintain and repair the system. There are few people remaining with the experience and skill set to repair EDACS. Because EDACS is so out-of-date, it currently does not meet AEP cybersecurity standards. It is a weak link in the Company's efforts to protect its electronic systems from cyberattacks. Specifically, due to its age and the lack of manufacturer support, there are no security patches or software updates available to adequately protect and secure EDACS from attempts to access the system by uninvited parties or attacks by persons or groups attempting to penetrate the system for malicious purposes. Additionally, the need to procure spare parts on the secondary market does not allow for a secure and protected chain of control for hardware purchases. A transition to NextGen UCS will provide the Company with the platform necessary to satisfy its cybersecurity standards.

Q. DOES THE AGE OF EDACS HAVE AN EFFECT ON COMPANY OPERATIONS?

A. Yes. The age of EDACS is a serious issue for Company operations and needs to be addressed. For example, in recent years there have been complete outages of EDACS. When there is such an outage, nearly all field work comes to a halt or experiences substantial delays – there are no trouble tickets issued to repair crews; routine maintenance is delayed; and if there is an outage, it is extremely difficult to coordinate repair crews. Moreover, because spare parts and skilled technicians are difficult to come by, the length of EDACS outages can be unpredictable. Luckily, no outage has yet occurred during a major storm event, but such an outage could be catastrophic to efforts to get power flowing again following a storm. AEP Ohio believes it should be proactive in replacing EDACS before the system goes down during a storm or system functionality continues to degrade.

Q. WHAT FUNCTIONALITY AND ADVANTAGES DOES THE PROPOSED NEXTGEN UCS PROVIDE?

A. AEP Ohio's proposed NextGen UCS will provide considerable functionality and numerous advantages over the current EDACS:

- **Availability of parts.** Unlike the outdated EDACS, the NextGen UCS is a modern system currently used throughout the country for utilities and public safety (e.g., police and fire departments). Thus, spare parts are readily available from the manufacturer.
- **Availability of skilled technicians.** Unlike EDACS, there is currently no shortage of qualified personnel to maintain and repair the NextGen UCS.
- **Cybersecurity compatibility.** Unlike EDACS, which currently does not meet AEP cybersecurity standards, cannot receive security patches and software updates, and does not have secure and protected chain of control regarding third-party purchases, the NextGen UCS will provide the Company with the platform necessary to satisfy its cybersecurity standards.
- **Redundancy during outages.** In AEP Ohio's service territory, EDACS is currently divided into three regions. If the EDACS core infrastructure fails in any of these regions, there is no redundancy. With NextGen UCS, however, the core infrastructure for one region will be able to serve as a backup to the core infrastructure in the other

region. This will significantly reducing the possibility that the NextGen UCS would go out during a major storm event.

- **Voice dispatching.** NextGen UCS allows for centralized dispatchers to communicate with many people at one time, which supports efficient and effective communications between field crews and dispatchers.
- **Emergency "mayday."** Field crews and personnel have the ability to initiate an emergency call for help through NextGen UCS. This "mayday" signal alerts fellow workers and dispatchers that the person sending the mayday is hurt or in danger. GPS coordinates of the mayday are sent to dispatchers so that the nearest crews in the field can be sent to assist with the emergency situation. AEP Ohio has had several recent incidents in which a mayday function would have reduced employees' exposure to potential harm.
- **Emergency "all call."** With EDACS, it is difficult for dispatchers to send a system-wide "all call" broadcast to a large group of field crews. Such "all calls" are critically important in the event of a storm, natural disaster, or any other occasion that would require the broadcasting of a safety message. NextGen UCS solves these problems by allowing dispatchers to initiate an "all call."
- **Data connectivity for field crews –** Data transmissions over EDACS are slow, and there is limited bandwidth, meaning that it is difficult to send large amounts of data. The use of voice communications, moreover, can "crowd out" data transmissions on the system. This is particularly problematic during major storm events, when high voice traffic in an area with an outage can prevent transfer of data such as trouble tickets. The NextGen UCS provides substantial data improvements. Data

transmission under NextGen UCS will be faster, and more data can be sent to and from Company line crews. This will allow the Company to conduct maintenance and repair work faster. In addition, the NextGen UCS system will allow the Company to monitor many aspects of line crew work, such as the length of time a truck boom is in the air, the length of time a truck engine idles, the fuel efficiency of Company vehicles, and so on. In this way, NextGen UCS will allow the Company to gather critical fleet management data to achieve operational savings.

- **Substation communications**. NextGen UCS may be used for substation communication connectivity at small substations with limited data requirements.
- **New technology communications.** NextGen UCS may provide a communication path for evolving new technologies that have limited data requirements. Use of this communication technology could allow for quick technology deployments at limited scale.
- **Improvements in driver safety and efficiency.** The NextGen UCS will allow the Company to monitor the driving behavior of employees driving Company vehicles. These telematics data will be integral to the Company's ability to study and promote safe driving protocols with its employees and eliminate inefficient driving behaviors.

Q. DID AEP OHIO EVALUATE WHETHER IT COULD USE A PUBLIC CELLULAR SOLUTION OR OTHER TECHNOLOGIES AS A REPLACEMENT FOR EDACS?

A. The Company conducted an exhaustive review using a third-party expert to determine which system was best for AEP Ohio's operational needs to replace EDACS. This review concluded that NextGen UCS was the only EDACS replacement that would meet

AEP Ohio's operational needs for voice and data communications. NextGen UCS will provide coverage for more than 90% of AEP Ohio's service territory. In rural and mountainous area, public cellular service is unreliable. Also, the NextGen UCS tower sites will maintain several days of standby electric power, whereas public cellular tower sites commonly have much less backup power capability if any at all. In addition, cellular systems can be congested during emergencies, which could impair the Company's restoration efforts.

Q. WHAT ARE THE DIRECT COSTS AND TIMELINE OF AEP OHIO'S PROPOSED NEXTGEN UCS DEPLOYMENT?

A. Replacement of EDACS with NextGen UCS will take up to four years and require the expenditure of approximately $69 million of capital and $1 million of deployment O&M during that period. The NextGen UCS will not involve any incremental increase in ongoing O&M. Direct costs are as shown on Table 6 below:

Table 6
Estimated NextGen UCS Program Direct Costs

	Year 1	Year 2	Year 3	Year 4	Total
Capital Cost	$24,150,000	$20,700,000	$24,150,000	-	$69,000,000
Deployment O&M	$333,000	$333,000	$334,000	-	$1,000,000
Increase in Ongoing O&M	-	-	-	-	-
Total	$24,483,000	$21,033,000	$24,484,000	-	$70,000,000

<u>SECURITY TECHNOLOGY FOR DISTRIBUTION SUBSTATIONS</u>

Q. PLEASE PROVIDE AN OVERVIEW OF AEP OHIO'S PROPOSED DISTRIBUTION SUBSTATION PHYSICAL SECURITY PLAN.

A. As part of its Distribution Technology Investment Plan, AEP Ohio proposes to install modern intrusion deterrence and detection technology to protect critical distribution substations from theft and vandalism. By hardening AEP Ohio's security infrastructure in this manner, the Company will improve the reliability of its distribution grid, reduce repair and maintenance costs associated with thefts and vandalism, enhance the safety of both Company personnel and the public at large, and improve customer satisfaction.

Q. WHY DOES AEP OHIO NEED TO IMPROVE THE SECURITY OF ITS DISTRIBUTION SUBSTATIONS?

A. AEP Ohio's distribution and transmission substations face two principal threats: copper theft and vandalism. With high copper prices in recent years, AEP Ohio has experienced more than 250 incidents over the last eight years of individuals scaling or cutting substation fences to steal copper wiring. AEP Ohio has also experienced more than 50 additional acts of vandalism and other theft at its substations. Over the last ten years, AEP Ohio customers have experienced nearly 17 million customer minutes of interruption (CMI) associated with vandalism and theft at distribution substations.

Q. WHAT HARM DOES COPPER THEFT AND VANDALISM CAUSE?

A. Copper theft and vandalism create many problems. As an initial matter, both copper theft and vandalism can disable substations and cause reliability issues for all customers fed by a damaged substation. When copper wires are stolen from the substation, it can take a long time for AEP Ohio to safely replace the stolen wires and restore service. Likewise, when an individual fires weapons into a substation, it can be difficult and time-consuming for AEP Ohio to determine what equipment has been damaged and to implement a repair plan.

Copper theft and vandalism also create safety risks. Would-be thieves have been electrocuted and killed trying to steal copper from substations. The risk from copper theft is not limited to the thieves, however; it extends to AEP Ohio's personnel and the public. For example, AEP Ohio's substations are protected by a "ground grid," a network of underground copper cable that provides grounding of the station equipment and the station fence. The ground grid is a vital safety feature for personnel inside the station and for the public. In the event of a fault on the electrical system, the ground grid serves to disperse electrical fault current into the earth, "clearing" the fault and protecting systems and personnel. When copper thieves cut the ground grid, however, this safety function is compromised. This means that system faults could possibly energize substation equipment, including the substation fence. This creates the possibility for serious risk to safety, either for AEP Ohio employees or the general public. Anyone who approaches a substation – whether for business purposes or through accidental conduct – may not realize that the ground grid has been compromised, and may be subject to substantial safety risk. Even members of the public are at risk. While properly grounded fences typically pose no danger, when the ground grid is disabled by copper theft or vandalism, the fence could be energized, posing substantial risks to anyone who accidentally touches a substation fence.

Finally, copper theft and vandalism are costly to remediate. Re-grounding a substation, for instance, is a labor-intensive task that requires crews to dig by hand within the substation without the aid of heavy machinery. It also may require that all power be shut off to the substation during repairs.

Q. IS NERC ALREADY REGULATING AEP OHIO'S DISTRIBUTION SUBSTATIONS?

A. No. There has been a great deal of national emphasis over the past several years in improving the security of the electric grid, but much of the attention has been focused on the bulk electric system, which includes the regional transmission grid and transmission substations. The bulk electric system security is regulated by the North American Electric Reliability Corporation ("NERC") through its Critical Infrastructure Protection ("CIP") standards. The transmission grid that serves AEP Ohio's customers must be compliant with all NERC CIP standards.

NERC CIP does not, however, currently apply to distribution-level substations. The security of AEP Ohio's distribution-level substations is regulated by this Commission, and as discussed above, there is a need to harden the physical security of distribution-level substations.

Q. HOW ARE AEP OHIO'S DISTRIBUTION SUBSTATIONS CURRENTLY PROTECTED?

A. AEP Ohio's substations are currently protected by fences and padlocks. For a limited set of substations, a rudimentary incursion detection system has been installed. The current protection measures provide a basic level of security.

Q. HOW WILL AEP OHIO DETERMINE WHAT TECHNOLOGY TO INSTALL AT EACH SUBSTATION?

A. The Company will analyze the critical substations at which intrusion detection and deterrence technology will be installed, and the Company will develop a technology deployment plan tailored to each substation's unique characteristics.

Q. HOW WILL AEP OHIO DETERMINE WHICH SUBSTATIONS WILL RECEIVE THE SECURITY TECHNOLOGY?

A. AEP Ohio will determine the critical substations to receive security technology based on numerous factors, including:

- Number of customers connected to the station (i.e. the number of customers who would experience an outage due to theft or vandalism).
- The criticality of the customers served from the distribution station.
- History of theft and vandalism at the station.
- Existing security measures in place.
- Existing communication system availability at the station.
- Distribution station load growth as an indicator that potential future construction activity may be taking place. With construction, there is an increase in activity and a higher risk of tools stolen from crews parking at the distribution station.

Q. WHAT TECHNOLOGY IS AEP OHIO PROPOSING TO INSTALL TO HARDEN SUBSTATION SECURITY?

A. Technologies have been developed that would substantially improve the Company's ability to deter and detect theft and vandalism at substations. AEP Ohio proposes to install some or all of the following technologies at up to 100 of the most critical distribution substations:

- **Cameras.** Cameras will be installed to detect and monitor security incursions. Many substations have no theft detection system installed. Others have only rudimentary motion detection sensors that simply sends an alarm when it detects motion. This leads to many false alarms, and it does not provide security personnel any detail as to the nature of the security threat. AEP Ohio proposes to install cameras that can be controlled remotely by AEP Ohio personnel at a centralized security command center. Once a security intrusion alarm is received, AEP Ohio personnel will be able to switch among multiple cameras and to move cameras to investigate the nature of the alarm. This will allow AEP Ohio personnel to investigate what a potential thief has done – for example, whether the ground grid has been cut, what equipment has been damaged, or whether there are any other safety risks. This will not only give repair personnel the information they need to stay safe; it will also allow them to more quickly diagnose and repair any damage. Cameras will also help AEP Ohio to coordinate with law enforcement to apprehend thieves and vandals. The cameras can capture images of thieves and will allow AEP Ohio security personnel to relay vital information to law enforcement – for example, whether the thieves are still at the substation or whether (and in what direction) they fled. Lastly, the installed cameras will greatly reduce false alarms. Some cameras will be equipped with technology that will automatically detect whether the alarm has been caused by a human being or something else, such as an animal. Cameras will also allow AEP Ohio security personnel to confirm that the intrusion is due to thieves or vandals, rather than an accident or other false alarm.

- **Intrusion sensors.** AEP Ohio also plans to install different types of intrusion sensors; which type will depend on the unique circumstances of each substation. For instance, the Company will install motion sensors that are integrated with cameras. When the sensor detects motion, it will send an alert to AEP Ohio security personnel and automatically bring up the associated camera for the security personnel to review. The Company may also install fence detection cables. These cables run through the chain link fence surrounding the substation. They are under tension, and when the fence is disturbed, they send an alert much like a motion sensor. In certain circumstances, fence detection cables can be more sensitive to intrusions – yet less susceptible to false alarms – than motion sensors. For smaller substations, the Company will install ground radar with associated cameras. Though it has a limited range, ground radar is highly effective at detecting human intrusions and distinguishing between actual threats and false alarms.
- **Audibles and lights.** AEP Ohio intends to install "audibles" – essentially, sirens – in conjunction with flashing lights. Loud sirens and flashing lights are highly effective at deterring would-be thieves and vandals. The Company will only install these deterrent devices in areas where they would be appropriate. For example, the Company will not install lights and sirens in substations located within residential subdivisions.
- **Signs.** Currently, it is Company policy not to display false warning signs at its substations – that is, the Company does not display a sign saying a substation is "Monitored by Camera" if that is not true. Yet when the above technologies are installed, AEP Ohio will install appropriate signage warning that the substations are

under constant surveillance. Though they are complementary to the primary intrusion detection and deterrence technologies discussed above, signs nonetheless play an important role in deterring theft and vandalism.

Q. WOULD THE PROPOSED SECURITY TECHNOLOGY PROTECT ANY OTHER COMPANY ASSETS?

A. Yes. AEP Ohio crews sometimes park Company trucks within the fence of distribution substations. As a result, installing the proposed security technology would also protect Company trucks from theft and vandalism when they are parked within a substation.

Q. WHAT ARE THE TIMELINE AND DIRECT COSTS OF AEP OHIO'S PROPOSED DISTRIBUTION SUBSTATION SECURITY IMPROVEMENTS?

A. AEP Ohio proposes to install security technology at up to 100 critical substations over a four year period. Expected capital costs for this deployment are $30 million, with expected ongoing O&M of $1 million total for the first four years. The deployment and estimated costs are shown below on Table 7:

Table 7
Estimated Substation Security Deployment & Direct Costs

	Year 1	Year 2	Year 3	Year 4	Total
Substations	25	25	25	25	100
Capital Cost	$7,500,000	$7,500,000	$7,500,000	$7,500,000	$30,000,000
Ongoing O&M Cost	$100,000	$200,000	$300,000	$400,000	$1,000,000
Total	$7,600,000	$7,700,000	$7,800,000	$7,900,000	$31,000,000

CONCLUSION: OHIO ENERGY POLICY

Q. DO THE INITIATIVES PROPOSED ABOVE ADVANCE OHIO ENERGY POLICIES?

A. Yes, the technological deployments proposed by the Company as part of its Distribution Technology Investment Plan in this proceeding advance several statutory energy policies:

- **Modernization.** The Electric Security Plan statute, Ohio Revised Code ("R.C.") 4928.143(h), references "modernization initiatives for the electric distribution utility." Each of the technologies described above – PEV charging stations, microgrids, smart lighting controls, Next Gen UCS, and modern distribution security equipment – are unquestionably modernization initiatives that would help bring AEP Ohio's territory into the forefront of electric distribution technology.
- **Encourages small generation facilities.** R.C. 4928.02(C) expresses a state policy to "encourage[e] the development of distributed and small generation facilities." As described above, the Company's microgrid proposal will involve deployment of small renewable generators and battery technology.
- **Encourages supply- and demand-side resources.** R.C. 4928.02(D) calls for "[e]ncourag[ing] innovation and market access for cost-effective supply- and demand-side retail electric service including, but not limited to, . . . smart grid programs, and implementation of advanced metering infrastructure." Several aspects of the Company's proposal here – including PEV charging stations, smart lighting controls, and microgrids – can be considered "smart grid programs," since they are capable of using sensors, data, and smart controls to provide grid benefits and enhance customers' experience. In addition, the PEV charging stations proposed by

the Company have the potential to be important sources of "supply- and demand-side retail electric service," since the smart chargers proposed by the Company here have the capability to serve as demand response resources. The same is true of the proposed microgrid technology – the batteries and small renewable generators on microgrids can provide important "supply- and demand-side" resources during times of peak usage.

- **Promotes information gathering for reliability.** R.C. 4928.02 seeks to encourage "cost-effective and efficient access to information regarding the operation of the transmission and distribution systems of electric utilities in order to promote . . . the development of performance standards and targets for service quality for all consumers." Several components of the Distribution Technology Investment Plan will provide the Company with critical data concerning the operation of its distribution grid, including the proposed PEV charging stations, which will gather data concerning customer PEV usage, and the proposed smart lighting controls, whose principal purpose is to give the Company real-time data concerning lighting performance. In addition, both the NextGen UCS and substation security deployments are directly intended to give the Company information concerning its distribution system – the NextGen UCS by facilitating fast and efficient communication with line crews and other Company personnel, and the substation security technology by allowing the Company to monitor the integrity of its most important substations. All of the information gathering features of the proposed technology, furthermore, will improve "service quality for all consumers" – by maintaining service during outages for critical infrastructure (microgrids), by detecting lighting outages (smart lighting controls), by detecting and deterring theft (substation security), and by facilitating repair and restoration efforts (NextGen UCS).

- **Encourages renewable energy resources.** The state has also expressed a clear policy, in R.C. 4928.64, of encouraging the development of renewable energy resources. Here, the proposed microgrids involve deployment of small-scale renewable energy sources along with battery storage.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

Electric Vehicle Charging Station - Emissions

	Year 1	Year 2	Year 3	Year 4
EVSE				
Public Stations (Level 2)	30	80	165	250
Ports	2	2	2	2
Charging Per Event (kWh)	13.2	13.2	13.2	13.2
Events per Week[1]	25	25	25	25
Public DC Fast Chargers	5	11	18	25
Ports	2	2	2	2
Charging Per Event (kWh)	19.0	19.0	19.0	19.0
Events per Week[1]	25	25	25	25
Residential (Level 2)	250	500	750	1,000
Ports	1	1	1	1
Charging Per Event (kWh)	19.0	19.0	19.0	19.0
Events per Week	7	7	7	7
EVSE Consumption (kWh)	3,005,600	6,747,000	11,739,000	16,731,000
PEV Electric Efficiency (kWh/mi)[2]	0.29	0.29	0.29	0.29
Total Miles Driven (mi)	10,364,138	23,265,517	40,479,310	57,693,103
System Generation[3]				
System Losses (to generator)	5.0%	5.0%	5.0%	5.0%
EVSE Energy Requirements (kWh)	3,163,789	7,102,105	12,356,842	17,611,579
Emissions Rate (lbs/MMbtu)[4]	120	120	120	120
Heat Rate (btu/kWh)[4]	7,000	7,000	7,000	7,000
Total CO_2 Emissions (Tons)	1,329	2,983	5,190	7,397
Equivalent ICE Vehicle				
Total Mileage (mi)	10,364,138	23,265,517	40,479,310	57,693,103
ICE Vehicle Efficiency (mi/gal)[2]	29.0	29.0	29.0	29.0
Emissions Rate (tons/gal)[5]	0.009	0.009	0.009	0.009
Total CO_2 Emissions (Tons)	3,176	7,130	12,405	17,680
Avoided CO_2 Emissions (Tons)	**1,847**	**4,147**	**7,215**	**10,283**

Notes:

1. Represents a Medium Event Case derived from an average of the High and Low Charging Event cases.
2. Electric Power Research Institute. Total Cost of Ownership for Current Plug-in Electric Vehicles (2014).
3. Assumes gas-fired combined cycle combustion turbines serve as the marginal system resources.
4. Numbers represent average emissions and heat rates for combined cycle units.
5. U.S. Environmental Protection Agency. Greenhouse gas equivalencies calculator.
   https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references

Microgrid - Emissions

	Year 1	Year 2	Year 3	Year 4
Microgrid Operations				
Microgrids Deployed (#)	2.5	5.0	7.5	10.0
PV Capacity (kW)	1,250	2,500	3,750	5,000
PV Capacity Factor (%)	16.4%	16.4%	16.4%	16.4%
PV Generation (kWh)[1]	1,795,790	3,591,581	5,387,371	7,183,162
Avoided System Generation[2]				
System Losses (to generator)	5.0%	5.0%	5.0%	5.0%
System Generation (kWh)	1,890,306	3,780,611	5,670,917	7,561,223
CO_2 Emissions Rate (lbs/MMbtu)[3]	120	120	120	120
Heat Rate (btu/kWh)[3]	7,000	7,000	7,000	7,000
Avoided CO_2 Emissions (Tons)	**794**	**1,588**	**2,382**	**3,176**

Notes:

1. Derived from PVWatts solar genearation profile for Columbus, OH.
2. Assumes gas-fired combined cycle combustion turbines serve as the marginal system resources.
3. Numbers represent average emissions and heat rates for combined cycle units.

Smart Lighting - Emissions

	Year 1	Year 2	Year 3	Year 4
Smart Lighting Consumption Savings				
Converted Fixtures (#)	500	1,000	1,000	1,000
Existing Lamp Consumption (W)	100	100	100	100
LED Lamp Consumption (W)	25	25	25	25
Difference (W)	75	75	75	75
Annual Lighting Duration (Hrs)	4,000	4,000	4,000	4,000
Avoided Energy (kWh)	150,000	300,000	300,000	300,000
Avoided System Generation[1]				
System Losses (to generator)	5.0%	5.0%	5.0%	5.0%
Avoided Energy Req'ts (kWh)	157,895	315,789	315,789	315,789
CO_2 Emissions Rate (lbs/MMbtu)[2]	120	120	120	120
Heat Rate (Btu/kWh)[2]	7,000	7,000	7,000	7,000
Avoided CO_2 Emissions (Tons)	**66**	**133**	**133**	**133**

Notes:

1. Assumes gas-fired combined cycle combustion turbines serve as the marginal system resources.
2. Numbers represent average emissions and heat rates for combined cycle units.

SECTION A – PROGRAM DESCRIPTION

1. STATEMENT OF PURPOSE

The purpose of the Smart City Challenge is to demonstrate and evaluate a holistic, integrated approach to improving surface transportation performance within a city and integrating this approach with other smart city domains such as public safety, public services, and energy. The United States Department of Transportation (USDOT) intends for this challenge to address how emerging transportation data, technologies, and applications can not only be integrated with existing systems in a city to address transportation challenges, but used to spur reinvestment in underserved communities. The Recipient shall carry out the Smart City Challenge to effectively test, evaluate, and demonstrate the significant benefits of smart city concepts.

The Recipient shall demonstrate how advanced data and intelligent transportation systems (ITS) technologies and applications can be used to reduce congestion, keep travelers safe, use energy more efficiently, respond to climate change, both connect and create opportunities for underserved communities, and support economic vitality.

The Smart City Demonstration is expected to provide safety improvements, enhance mobility, increase ladders of opportunity by incentivizing reinvestment in underserved communities, reduce energy usage, and address climate change.

2. LEGISLATIVE AUTHORITY

Specific statutory authority for conducting this effort is found in the Intelligent Transportation Systems Research Program in 23 U.S.C. §516(a), which authorizes the Secretary of Transportation to “…carry out a comprehensive program of intelligent transportation system research and development, and operational tests of intelligent vehicles, intelligent infrastructure systems, and other similar activities.”

Funding is authorized under Section 6002(a) of Public Law 114-94, the Fixing America’s Surface Transportation Act (FAST Act).

The authority to enter into a cooperative agreement for this effort is found under 23 U.S.C. § 502 - Surface Transportation Research, Development, and Technology, paragraph (b), which states:

concepts that leverage the sharing economy – within the context of a city will provide enhanced travel experiences and makes moving people and goods safer, more efficient, and more secure. By enhancing the effective management and operation of the transportation system, smart city solutions can leverage existing infrastructure investments, enhance mobility, sustainability, and livability for citizens and businesses, and greatly increase the attractiveness and competitiveness of cities and regions.

4. VISION AND GOALS OF THE SMART CITY DEMONSTRATION

This section describes the USDOT's vision of a successful Smart City, and the specific goals that collectively describe important elements of the demonstration.

To show what is possible when communities use technology to connect transportation assets into an interactive network, the USDOT's Smart City Challenge concentrates federal resources into one city, selected through a nationwide competition. The Smart City Challenge seeks to demonstrate and evaluate a holistic, integrated approach to improving surface transportation performance within a city and integrating this approach with other smart city domains such as public safety, public services, and energy. The USDOT intends for this challenge to address how emerging transportation and other data, technologies, applications, and clean energy can be integrated with existing and new systems in a city to address transportation challenges.

This section presents the USDOT's high-level vision and goals without making each item an award requirement. Rather, this section provides a framework for the Recipient to consider in conducting the demonstration.

The USDOT's vision for the Smart City Challenge is to identify an urbanized area where advanced technologies are integrated into the aspects of a city and play a critical role in helping cities and their citizens address the challenges in safety, mobility, access to opportunity, sustainability, clean energy, economic vitality, and climate change. Advancements in ITS, connected vehicles, automated vehicles, electric vehicles, and other advanced technology will be a critical part of meeting these transportation challenges, as will the merging Internet of Things (IoT) which offers data from various sectors (e.g., energy and weather) and sources (e.g., the private sector and connected citizens). A smart city uses these data to maximize efficiencies within their management systems while enabling an open, growing ecosystem of third party services that provide additional benefits to citizens.

The Smart City Demonstration shall seek to improve access to reliable, clean, safe, and affordable transportation for a wider spectrum of its underserved communities. The Smart City Demonstration shall develop novel ways to reform the digital divide and use smart technologies and concepts to strengthen connections to jobs, remove physical barriers to access, and strengthen communities through neighborhood redevelopment. The Smart City Demonstration shall sequence deployment of these technologies and innovations so they benefit underserved communities early in the process. The Smart City Challenge identifies these concepts as Ladders of Opportunities. Ladders of Opportunity projects may increase connectivity to employment, education, services and other opportunities, increase access to digital resources, broaden the availability of affordable clean transportation options, support workforce development, or contribute to community revitalization, particularly for underserved areas.

The Smart City Demonstration shall seek to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transportation to clean transportation, and address climate change. Specific goals of the Smart City Demonstration include:

- Identify the transportation challenges and needs of the citizen and business community and demonstrate how advanced technologies can be used to address issues in safety, mobility, access to opportunity, energy efficiency, and climate change, now and into the future.
- Determine which technologies, strategies, applications, and institutional arrangements demonstrate the most potential to address and mitigate, if not solve, transportation challenges identified within a city.
- Support and encourage cities to take the evolutionary and revolutionary steps to integrate advanced technologies – including connected vehicles, automated vehicles, and electric vehicles – into the management and operations of the city, consistent with the USDOT vision elements (see Attachment 1).
- Demonstrate, quantify, and evaluate the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods.
- Examine the technical, policy, and institutional mechanisms needed for realizing the potential of these strategies and applications – including identifying technical and policy gaps and issues – and work with partners to address them.
- Assess reproducibility of interoperable solutions and qualify successful smart city systems and services for technology and knowledge transfer to other cities facing similar challenges. Follow systems engineering best practices and utilize

available architectures and standards to develop interoperable, reproducible systems with national extensibility, including the use of open source technologies.

- Work with Federal partners and programs focused on providing technical and financial resources for optimizing the usage of advanced and affordable clean transportation options.
- Collaborate with regional agencies on the best use of a city's Federal transportation assets and Federal workforce to accelerate the deployment of clean transportation and connected and automated vehicle technologies.

The Smart City Demonstration shall include a commitment to integrating with the sharing economy; and a clear commitment to making open, machine-readable real-time and archived data accessible, discoverable and usable by the public to fuel entrepreneurship and innovation.

The USDOT identified twelve vision elements that comprise a Smart City. The Smart City Demonstration shall align to some or all of the USDOT's vision elements and foster integration between the elements. Through alignment with these vision elements, the Smart City Demonstration is expected to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transition to clean transportation, and address climate change. See Attachment 1, Smart City Vision Elements.

5. STATEMENT OF WORK

The Recipient shall conduct the Smart City Demonstration in accordance with the approved Technical and Budget Applications, incorporated herein as Attachments 2 and 3, subject to the terms of the award.

The Recipient shall perform and provide the following tasks (Tasks A – J, below) and deliverables needed to demonstrate, quantify, and evaluate the impact of advanced technologies, strategies, and applications towards improved safety, efficiency, ladders of opportunity, and sustainable movement of people and goods. The following tasks and deliverables are also needed to foster transferability/reproducibility to support technology and knowledge transfer to other cities facing similar challenges.

Ideally, the awardee, on a self-sustaining basis, will continue to operate the systems and services implemented in the Smart City Challenge after completion of the USDOT funded demonstration.

The Recipient may charge to the Federal award only allowable costs incurred during the period of performance (except as described in 2 CFR §200.461 Publication and printing costs) and any costs incurred before the Federal awarding agency made the Federal award that were authorized by the Federal awarding agency.

4. DEGREE OF FEDERAL INVOLVEMENT

The USDOT anticipates substantial Federal involvement between it and the Recipient during the course of this demonstration. The anticipated Federal involvement will include technical assistance, education and guidance to the Recipient.

5. LEVERAGED PARTNER RESOURCES

In addition to the Federal Share and the Recipient Cost Share identified on page 2 of the agreement, the Recipient shall use Leveraged Partner Resources to fund and perform the demonstration. Leveraged Partner Resources are resources from third party organizations in support of the demonstration. "Key" Leveraged Partner Resources, listed below, are considered essential to the demonstration and are, therefore, approved and incorporated into this award for informational and reporting purposes. The Key Leveraged Partner Resources listed herein are **<u>not</u>** subject to the requirements of 2 CFR 200, or the terms of the award, except as cited below.

The Technical Application and Budget Application dated July 29, 2016 are based on knowledge of partnership agreements as of the application date. Any new partnership agreements may affect the Applications, requiring updates/amendments in the future.

<u>Requirement to Provide Copies of Key Partner Agreements</u>: The Recipient shall provide to the Agreement Officer electronic copies of all signed Key Partner agreements, and any subsequent agreement amendments executed during the award period of performance. The Recipient shall submit such agreements and amendments within one week after execution of the agreement or amendment.

<u>Requirement for Prior Approval of Changes to Key Partners and Agreements</u>: The following list of Key Leveraged Partner Resources is hereby approved and incorporated into this award for informational and reporting purposes. In the event the Recipient

determines the need to remove, replace, or divert a Key Leveraged Partner Resource, or significantly change the nature of a Key Partner agreement, the Recipient must notify the Agreement Officer in writing to request prior written approval of the change. The Recipient's request shall provide details of the proposed change, describe the circumstances of the change, and provide the Recipient's assessment of the impact of the change upon the demonstration. The Recipient must obtain prior written approval from the Agreement Officer before entering into a new agreement with the proposed replacement partner or resource, or executing an amendment that significantly changes a Key Partner agreement. This requirement will enable the USDOT to review and approve in advance significant changes in the planned use of Key Leveraged Partner Resources.

Requirement for Notification of Non-Key Partner Changes: In the event the Recipient determines the need to remove, replace, or divert Leveraged Partner Resources that are part of the demonstration but are not designated as Key in the list below, the Recipient must notify the Agreement Officer in writing of the proposed change in partner, circumstances surrounding the change, and the Recipient's analysis of the impact upon the demonstration.

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Paul Allen's Vulcan, Inc.	Funding to support the deployment of electric vehicles and other carbon emission reduction strategies.	$ 10,000,000
Mobileye	Installation of Mobileye's Shield +TM technology on transit buses.	$ 1,950,000
Autodesk	A year-long subscription to *Infraworks*, an information modeling platform that uses 3-D visualizations and real-world data to plan major engineering projects as well as on-site training.	$ 34,520

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Amazon Web Services (AWS)	Credits to AWS Cloud services and AWS Professional Services. AWS will also provide solution architecture and best practices guidance to the Recipient.	$1,000,000
NXP	Wireless communication modules that allow cars to securely exchange data, such as hazard warnings, over distances of more than a mile to prevent accidents and improve traffic flow.	$2,500,000
Alphabet's Sidewalk Labs	Flow technology, an analytics platform that the Recipient can use to identify traffic-prone areas and parts of a city that are underserved by public transportation — all by using traffic patterns culled from aggregated, anonymized data. From that information the software can suggest solutions like ride-sharing, new transportation access or a rerouting of traffic to better serve the community.	$230,000
AT&T	AT&T has committed to provide in-kind partnering to the City to assist with the deployment of the Columbus Connected Transportation Network (CCTN). The proposed partnering includes professional services and technical support resources; communications and data management technologies; USB cellular modems and SIM cards and connectivity; hardware to support communications and data management services.	$1,000,000

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
DC Solar	DC Solar will partner with the City to deploy eight to ten mobile solar generators or EV charging stations in 11 month increments at locations in the City to be determined. Mobile solar generators and EV charging stations will demonstrate the use of renewable energy sources in support of fleet electrification and power generation.	$1,500,000
Continental	Continental will deploy a roadside infrastructure sensing system; onboard V2X system, and DSRC communication systems to enable communication between roadside and onboard systems; API interfaces on cloud backend comprised of APIs for accessing data from both onboard and roadside V2X systems; basic safety messages to demonstrate the effectiveness of the CCTN on alleviating transportation-related issues such as intersection safety warnings, traffic management, automated system to regulate the flow of traffic according to real time traffic information, in-car productivity and safety, V2X warnings based on driver profile, route optimization or navigation, and reduced traffic congestion through load balancing via rerouting services enhanced with real time navigation data; and gamification of driving with incentives for drivers to behave responsibly to improve traffic condition and safety.	$1,000,000
Experience Columbus	Included in Event Parking (Downtown)	$100,000

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Ohio State University	Included in EAV (Commercial)/Program Management	$2,000,000
Greater Columbus Art Council	Included in Communications and Outreach	$1,000,000
HERE, Inc.	Included in Information Data Exchange (Enabling Technology)	$1,000,000
INRIX	Included in Information Data Exchange (Enabling Technology)	$1,424,000
Mass Factory (App&Town)	Included in Enhanced Human Services (Enabling Technology)	$40,000
SPARC	Included in CCTN Vehicles (Enabling Technology)	$388,200
Peloton	Included in Truck Platooning (Logistic)	$165,000
Honda	Included in CCTN Vehicles (Enabling Technology)	$2,600,000
Battelle	Included in Program Management	$1,000,000
Econolite	Included in CCTN (Enabling Technology)	$280,000
Columbus Partnership	Included in Testing of Autonomous Vehicles (Commercial)	$5,000,000
Columbus Partnership	Sustainment Cash Available as needed for USDOT and/or electrification deployments	$10,000,000
TOTAL		$44,211,720

In addition to the Federal Share and the Recipient Cost Share identified on page 2 of the agreement, the Recipient shall use Leveraged Electrification Partner Resources to fund and perform demonstrations in conjunction with the Vulcan electrification grant. Leveraged Electrification Partner Resources are resources from third party organizations in support of the Vulcan electrification demonstration. "Key" Leveraged Partner Resources, listed below, are considered essential to the Vulcan electrification demonstration and are, therefore, referenced and incorporated into this award for informational and reporting purposes. The Key Leveraged Electrification Partner Resources listed herein are **not** subject to the requirements of 2 CFR 200, or the terms of the award.

Key Leveraged Electrification Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
City of Columbus	Deploying EV and EV charging infrastructure.	$ 2,500,000
American Electric Power	Decarbonization of power supply and deployment of electric vehicles and other carbon emission reduction strategies.	$ 29,100,000
The Ohio State University	Deploying EV and EV charging infrastructure, and University investment in mobility and smart grid related research.	$ 13,000,000
Columbus Partnership	Deploying EV and EV charging infrastructure, and investment in mobility and smart grid related research.	$ 7,500,000
Mid-Ohio Regional Planning Commission	Installation of EV charging infrastructure	$ 600,000
FleetCarma	Installation of advanced telematics devices to track and optimize fleet fuel efficiency strategies.	$ 300,000
TOTAL		$ 53,000,000

SMART CITY VISION ELEMENTS

The USDOT identified twelve vision elements that comprise a Smart City. The Smart City Demonstration shall align to some or all of the USDOT's vision elements and foster integration between the elements. Through alignment with these vision elements, the Smart City Demonstration is expected to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transition to clean transportation, and address climate change.

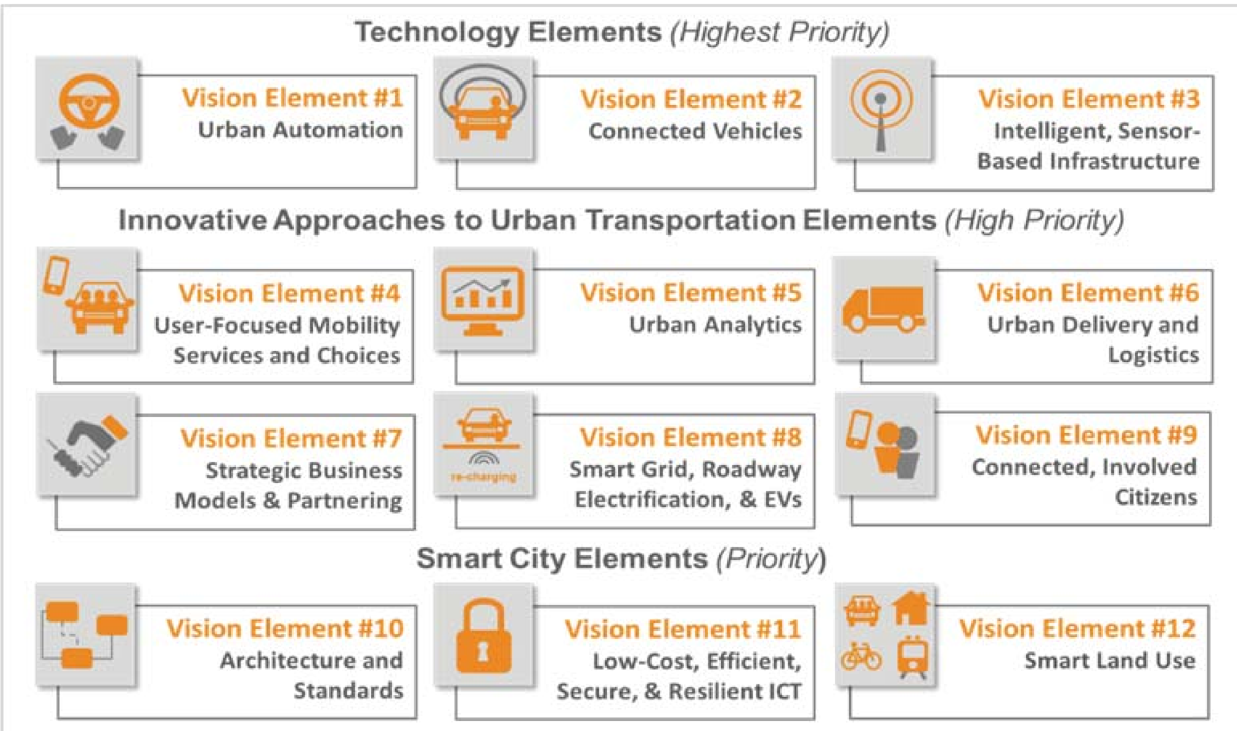

Figure 1. Beyond Traffic: The Smart City Challenge Vision Elements

The vision elements reflect the strategic priorities and themes put forth in the USDOT's ITS Strategic Plan 2015-2019 (http://www.its.dot.gov/strategicplan/) and the USDOT's Strategic Plan 2014-2018 (https://www.transportation.gov/dot-strategic-plan). Vision elements were derived from foundational research conducted by the ITS JPO's Connected Cities Research Program and communicated to 570 stakeholders during a free public webinar held by the ITS JPO on February 26, 2015. The USDOT vision elements build on enablers defined by the Smart Cities Council (http://smartcitiescouncil.com/smart-cities-information-center/the-enablers). The twelve vision elements are depicted in Figure 1 and described in more detail below.

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 *Ohio Power Company's Direct Testimony of Scott S. Osterholt* was sent by, or on behalf of, the undersigned counsel to the following parties of record this 23rd day of November 2016, via electronic transmission.

/s/ Steven T. Nourse
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