BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio Edison Company, The Cleveland Electric Illuminating Company, and The Toledo Edison Company for Approval of Phase Two of Their Distribution Grid Modernization Plan	)))))))	Case No. 22-0704-EL-UNC

DIRECT TESTIMONY OF

MICHAEL P. KAGAN

ON BEHALF OF

OHIO EDISON COMPANY, THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, AND THE TOLEDO EDISON COMPANY

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I. BACKGROUND/EDUCATION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS?

A. My name is Michael P. Kagan. My business address is 1300 19th Street NW, Suite 620, Washington, D.C. 20036.

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

A. I am employed by Concentric Energy Advisors, Inc. ("Concentric") as Senior Vice President.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. I graduated from Skidmore College with a B.A. degree in economics and management. I received an M.A. in economics from the University of California at Santa Barbara, where my concentrations were industrial organization and natural resource economics. During my time in graduate school, I began work in the utility sector as a financial and regulatory consultant at the firm of Barakat and Chamberlin, Inc. My work included utility rate design, asset valuation, litigation support and business strategy. Since that time, I have worked in the energy sector as both an operator and advisor to numerous utilities. My roles as an operator have spanned 16 years with positions at PG&E, AES and Constellation Energy, including as the President of Constellation NewEnergy. For the past nine and half years, I have been employed by Concentric during which I have advised utility and commercial customers on a wide variety of topics including matters pertaining to regulation, rate design, cost benefit analysis ("CBA") and EV charging program design.

Q. WHAT ARE YOUR RESPONSIBILITIES IN YOUR CURRENT POSITION?

A. I am responsible for a range of client engagements across the power, gas and water utility sectors. I also act as the officer in charge of our Washington, DC office and serve as a member of the Board of Directors of Concentric.

Q. HAVE YOU PREVIOUSLY SUBMITTED TESTIMONY IN ANY COMMISSION PROCEEDING?

A. I have not submitted testimony in a Public Utilities Commission of Ohio proceeding, but have testified before the Illinois Commerce Commission, Maine Public Utilities Commission, and New York State Department of Public Service.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. The purpose of my testimony is to discuss and explain the distributed energy resource ("DER") and electric vehicle ("EV") charging pilot programs that Ohio Edison Company ("Ohio Edison"), The Cleveland Electric Illuminating Company ("CEI"), and The Toledo Edison Company ("Toledo Edison") (collectively, the "Companies") propose to implement as a part of the second phase of their distribution grid modernization plan ("Grid Mod II"), including anticipated pilot program costs and benefits. I have also been asked to quantify the DER Pilot and EV Charging Pilot (the "Pilots") costs and benefits using the same tools and applicable assumptions as are used for the other aspects of Grid Mod II. These estimates are incorporated into the overall CBA for Grid Mod II sponsored by Companies' Witness Burnell.

Q. ARE THE COMPANIES PROPOSING TO RECOVER ANY OF THE COSTS ASSOCIATED WITH THE PILOTS?

A. Yes, the costs of any projects approved by the Commission as part of these Pilots will be recovered through Rider AMI. The Companies' Witness McMillen testifies to the proposed cost recovery for all Grid Mod II programs and pilots through Rider AMI.

II. OVERVIEW OF THE COMPANIES' PROPOSED PILOT PROGRAMS

Q. PLEASE PROVIDE A GENERAL OVERVIEW OF THE COMPANIES' PROPOSED DER AND EV CHARGING PILOT PROGRAMS?

A. The Companies propose two pilots to assess and validate future customer benefits that may be derived from grid modernization technologies that can enhance distribution system reliability, achieve peak demand reductions, improve cost efficiency, and drive innovation. The DER Pilot will consist of a single pilot project in which an in-front-of-the-meter battery energy storage system ("FTM BESS") will be owned and operated by Toledo Edison. The EV Charging Pilot will include three distinct programs: (1) a Residential EV Charging Program, (2) a Commercial EV Charging Program, and (3) a Commercial Vehicle-to-Grid ("V2G") Program. The data gathered through these programs will be used to inform future grid modernization efforts, and to determine the potential for deploying these measures more broadly across the Companies' distribution system.

Q. WHY ARE THE COMPANIES PROPOSING A DISTRIBUTED ENERGY RESOURCES PILOT AND AN EV CHARGING PILOT?

A. As the nature of electric generation and consumption changes, the Companies require an increasingly flexible, responsive and more modern distribution system that can continue to provide safe, reliable, and affordable electric delivery service to customers. Such a distribution system will ensure the Companies are able to meet the evolving needs and changing expectations of consumers as they adopt new technologies, such as EVs, that may represent significant new loads on the distribution system. Furthermore, certain commercial customers may soon begin to take delivery of large numbers of EVs with high battery capacities which may necessitate additional distribution capacity on relatively short notice.

To prepare for this future, the Companies must identify new ways to cost-effectively meet their obligations, including actively managing DERs to understand their interaction with the distribution system and ensure enhanced system reliability. By doing so the Companies will potentially be able to increase system hosting capacity. The Pilots proposed by the Companies provide a platform from which to test and evaluate modern distribution system solutions that leverage the diversity of customer needs, customers' interest in specific distribution services, and various forms of technology.

These needs are likely to be accelerated by the requirements of FERC Order 2222, which seeks to ensure that DERs (including EV charging) can be aggregated by third parties and thus participate in wholesale markets. One of the key challenges for electric distribution utilities relative to the goals of FERC Order 2222 is ensuring reliable and safe operation of the distribution system while simultaneously facilitating the integration of aggregated DER onto the distribution system for wholesale market participation. These simultaneous objectives will require that the Companies have the ability to monitor and manage DERs to ensure safe and reliable operation of the distribution system, while at the same time permitting third parties to aggregate and dispatch DERs.

Given the aforementioned challenges and opportunities, the Companies have established two pilot programs (*i.e.*, DER Pilot and EV Pilot) within the Grid Mod II Application, both of which are supported by a Distributed Energy Resource Management System ("DERMS") that will be implemented by the Companies. DERMS is a key distribution system enabling technology that permits monitoring, forecasting, scheduling and control of DERs on a granular and real-time basis. These capabilities enable the distribution system to effectively respond to unanticipated, unpredictable, and potentially large variations in both supply and demand from DERs, enhancing reliability and reducing the need for certain additional distribution system investment.

A. Distributed Energy Resources Pilot

Q. PLEASE DESCRIBE THE DISTRIBUTED ENERGY RESOURCES PILOT?

A. The DER Pilot is designed to evaluate the ability to use battery storage to alleviate the need for new distribution capacity at a specific site. The selected site is a public EV charging station located along the Ohio Turnpike, which would require reconductoring but for the installation and use of a FTM BESS. This is precisely the use case identified by the Commission as an opportunity to avoid costly distribution upgrades through energy storage.[1] This project configuration represents an excellent test case for the FTM BESS as there is a strong likelihood that many similar facilities will be developed in the Companies' service territories in the future and will likewise require additional distribution capacity. Management of the FTM BESS will generate a series of customer benefits which are described in greater detail below.

[1] Power Forward: A Roadmap to Ohio's Electricity Future, at 22 states, "Using storage as opposed to traditional distribution system fixes could defer costly upgrades. Typically, distribution infrastructure upgrades are driven by peak demand events that occur on only a few, fairly predictable occasions each year. Energy storage in incremental amounts could deal with these limited duration events and defer large investments to free up capital to be deployed elsewhere.

Other applications of energy storage include demand response, NWA, resource adequacy and transmission congestion relief, or what is needed to meet system peaking requirements on a day-to-day basis. Storage also has the capability to enhance power quality by keeping voltage steady, and to provide back-up power, including black start capability.

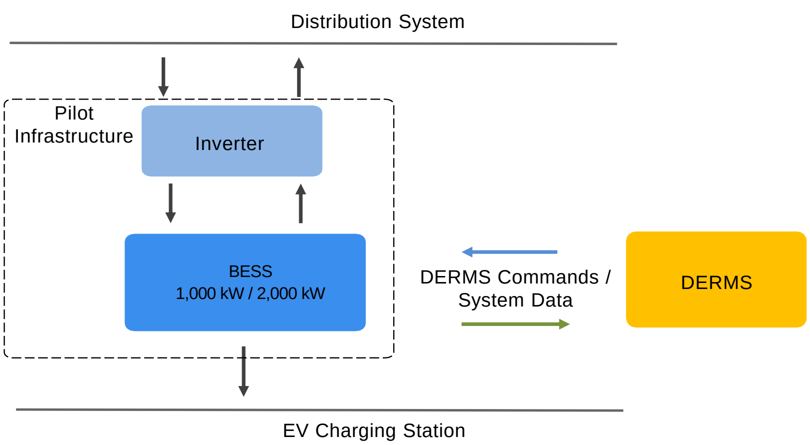
Given the evolution of energy storage technology, the reduction in costs, and the growth of renewable and distributed energy, the Commission is interested in the deployment of energy storage as a distribution grid solution. Energy storage is also included as a core component of the cyberphysical platform discussed above. Ohio EDUs are encouraged to consider energy storage as an alternative solution to problems typically addressed by traditional wires investments."

Q. PLEASE DESCRIBE THE COMPANIES' PROPOSED FTM BESS PROGRAM?

A. The proposed FTM BESS will be owned and operated by Toledo Edison. The Companies plan to site the FTM BESS at a rest area located along the Ohio Turnpike, which currently hosts an EV charging station with 12 charging ports. Company ownership of the FTM BESS will enable Toledo Edison to achieve distribution system objectives, such as ensuring reliability along the impacted circuit. The Companies will also use the DERMS to monitor and control the operation of the FTM BESS to meet distribution system requirements for capacity and energy. The proposed FTM BESS is solely for distribution system support; the Companies will not seek wholesale energy or capacity market revenues.

Locating the FTM BESS close to the EV charging load reduces the need for additional distribution investment. The FTM BESS will be charged during off-peak hours when capacity is not constrained and discharged during peak hours when additional capacity is needed. The configuration of the FTS BESS is shown in Figure 1 below.

Figure 1 – Simplified FTM BESS Operations



Q. WHAT ARE THE PROJECTED COSTS ASSOCIATED WITH THE FTM BESS PROGRAM?

A. The Companies' proposed investment in the FTM BESS project is $1.6 million, consisting of approximately $900,000 in capital costs and approximately $660,000 in incremental operation and maintenance ("O&M") costs.

Q. HOW WERE THE PROJECTED COSTS OF THE FTM BESS PROGRAM CALCULATED?

The Companies initial budget estimates for FTM BESS equipment, installation and for O&M are based on a review of recently published project costs for similar proposed projects and limited discussions with developers. The Companies' analysis suggests that a 1 MW / 2 MWh FTM BESS would cost approximately $1.6 million including capital costs, charging costs, and O&M over the expected ten-year useful life of the storage module. The capital cost for the FTM BESS includes the storage module, balance-of-system, power conversion equipment, and engineering procurement and construction (EPC). It is assumed that the DERMS will include any necessary software and controls, so no additional software or controls costs are included in the FTM BESS costs.

Net charging cost, which is included in incremental O&M costs for the FTM BESS, is calculated as the product of the Price-to-Compare (PTC) for Toledo Edison ($0.066542/kWh as of June 2022), one minus the FTM BESS round trip efficiency rate, and the annual MWh charged. This initial cost is escalated at an inflation rate of 3.0%, consistent with the inflation rate used elsewhere by the Companies in their Grid Mod II Application. The base assumptions for the capital costs and O&M costs were derived from Lazard's Levelized Cost of Storage Analysis, Version 7.0.

Q. WHAT ARE THE BENEFITS OF THE DISTRIBUTED ENERGY RESOURCE PILOT FROM AN OPERATIONAL PERSPECTIVE?

A. The FTM BESS described above will generate a series of quantitative and qualitative distribution system and emissions benefits. These benefits are described and quantified below. There are no wholesale energy market benefits under this configuration as the proposed FTM BESS will be used solely for distribution system support purposes.

The quantifiable benefits associated with the DER Pilot include (1) avoided transmission and distribution ("T&D") costs, and (2) carbon dioxide ("CO2") emissions reductions benefits.

The FTM BESS provides an alternate form of capacity that permits the deferral of traditional T&D investment. Carbon emissions reductions are the result of the FTM BESS charging when system-wide emissions are generally lower (*i.e.*, during off-peak periods), and discharging when system-wide emissions are generally higher (*i.e.*, during on-peak periods).

The DER project will also provide several qualitative benefits. First, storage may reduce loading on circuits and thus reduce premature failure of distribution system components. Second, the DER project will enhance the Companies' planning flexibility, as storage investments such as the proposed FTM BESS can often be deployed in lower investment increments than traditional distribution system upgrades. This flexibility can allow the Companies to rapidly deploy new distribution system capacity and defer larger investments over a longer time horizon, thereby permitting the Companies to gain additional information regarding the need for specific investments. The greater the uncertainty regarding future load requirements, the more valuable this planning flexibility becomes. Third, the DER Pilot will increase the Companies' familiarity with the integration, capabilities, and management of DER technologies and thus lower future distribution costs in the Companies' service territories. Finally, the DER Pilot will likely result in regional macroeconomic benefits as the direct spending produces subsequent cycles of additional economic benefit which include indirect macroeconomic impacts consisting of the economic activity from the supply chain that is necessary to support the direct investment in the pilot and induced macroeconomic impacts consisting of the spending by employees in newly created jobs on goods and services within the local economy.

Q. WHAT ARE THE ESTIMATED NET BENEFITS TO CUSTOMERS OF THE DISTRIBUTED ENERGY RESOURCE PILOT?

A. The Companies estimate that the proposed FTM BESS will cost $1.57 million and will generate $0.69 million in quantified benefits. These estimates are incorporated into the overall CBA for Grid Mod II sponsored by Companies' Witness Burnell.

Q. CAN YOU SUMMARIZE HOW THE COMPANIES CALCULATED THE BENEFITS ASSOCIATED WITH THE DISTRIBUTED ENERGY RESOURCE PILOT?

A. The estimated avoided T&D costs for the FTM BESS are based on an internal engineering cost analysis to reconductor a portion of the distribution system to support a third-party EV charging site, located along the Ohio Turnpike in the Toledo Edison service territory near the West Unity substation.

Carbon emissions reductions are the result of the FTM BESS charging during off-peak periods and discharging during on-peak periods during 250 days per year. The estimated dollar value of the net tons of CO2 avoided by the FTM BESS operations was calculated as the product of the quantity of energy shifted to off-peak periods, the difference between the PJM on-peak and off-peak CO2 emissions rate per MWh, and the unit value of CO2 emissions. The PJM 2020 annual average marginal difference between on-peak and off-peak CO2 emissions rates is 134 lbs./MWh.[2]

Figure 2 – DER Pilot Quantified Benefits

Pilot Element No.	Benefit	Description	Nominal Value
DER 1	Avoided T&D Costs	Avoided reconductoring costs due to FTM BESS	$665,918
DER 2	CO_2 Emissions Reductions	CO_2 emissions reduction value for each MWh shifted from on-peak to off-peak	$27,023
Total DER Pilot Quantified Benefits			$692,941

B. EV Charging Pilot

Q. PLEASE PROVIDE A GENERAL OVERVIEW OF THE COMPANIES' PROPOSED EV CHARGING PILOT?

A. To serve growing EV charger load while continuing to provide safe, reliable, and affordable distribution services, the Companies seek to design and manage pilot programs that use a DERMS to influence or cause EV charging to occur at times that are beneficial, or at least not detrimental, to the distribution system. To achieve these objectives, the Companies will (1) investigate and determine how to mitigate the impact that EV charging will have on the distribution system when deployed at scale, (2) analyze customers' ability and willingness to participate in a managed charging program that yields distribution system services over a multiyear period, and (3) develop an effective means of rewarding customers for charging at times when the distribution system has excess capacity. As part

[2] *See* PJM's 2016–2020 CO2, SO2 and NOX Emission Rates April 9, 2021, at 3. Available at: https://www.pjm.com/-/media/library/reports-notices/special-reports/2020/2020-emissions-report.ashx.

of this effort, the Companies propose three EV charging programs: (1) a Residential EV Charging Program, (2) a Commercial EV Charging Program, and (3) a Commercial V2G Program.

Q. CAN YOU PROVIDE A DESCRIPTION OF THE TECHNOLOGY UPON WHICH THE EV CHARGING PILOT PROGRAMS WILL OPERATE?

A. In preparing for the residential and commercial EV charging programs, the Companies will evaluate and test suitable networked electric vehicle supply equipment ("EVSE") and a charging station management system ("CSMS") service provider. The CSMS provides an interface between the EVSE and the Companies' DERMS. This interface permits the DERMS to monitor and schedule EVSE charging. The CSMS will also collect and aggregate EVSE data (*e.g.*, delivered kWh, kW, and charging session duration) for evaluation purposes.

The Companies will not own the EVSE and will seek to use non-proprietary EVSE port configurations capable of charging vehicles from multiple automakers. The EVSE in the Residential EV Program will communicate with the CSMS via the customer's Wi-Fi network while the EVSE in the Commercial EV and V2G Programs will generally communicate via cellular modems given that commercial locations often have less reliable Wi-Fi coverage as compared to residences.

1. Residential EV Charging Program

Q. PLEASE DESCRIBE THE OBJECTIVES OF THE COMPANIES' PROPOSED RESIDENTIAL EV CHARGING PROGRAM?

A. The objective of the residential EV Program is to determine how best to manage residential EV charging loads to reduce impacts on the distribution system. Residential EV charging, when performed through the typical "Level 2" EVSE, can significantly increase household electrical load. As passenger EV adoption and vehicle battery capacities increase, it is expected that residential Level 2 charging will become increasingly common and that this unmanaged charging will stress distribution system infrastructure, such as transformers. At the same time, behavioral studies of energy consumption and a study of EV charging behavior performed by BMW in the Pacific Gas and Electric ("PG&E") service territory suggest that customers can be incented to alter their charging patterns given appropriately structured program designs and customer information.[3] Furthermore, EV charging loads can be "smoothed" by a DERMS, mitigating distribution system impacts while ensuring that customers' EV charging needs are met.

Q. PLEASE DESCRIBE THE COMPANIES' PROPOSED RESIDENTIAL EV CHARGING PROGRAM?

A. Customers that own or lease fully electric vehicles will be eligible for the voluntary Residential EV Charging Program. Under the Residential EV Charging Program, customers will agree to a contract allowing the Companies to monitor and control the customer's ESVE for the sole purpose of supporting distribution system operations. This program will evaluate customer responses and the associated distribution system benefits. Participating customers, which may include customers who already own an EV, will be required to purchase a new EVSE from a list of compliant products through a portal established as part of the EV Pilot and will also be responsible for having the EVSE installed on a 240V circuit. While the EVSE will be utilized to control the flow of energy to the vehicle, the standard utility meter will continue to measure all kWh for billing purposes.

[3] A study by BMW found that customers responded well to a week-long test of two-hour "no-EV charging" windows (with an ability to opt-out) during which the customers received varying levels of compensation. In that study, 94% of participants stated that they are likely to participate in a similar program in the future. Source: BMW Group, BMW ChargeForward: Electric Vehicle Smart Charging Program (2020), https://bmwchargeforwardreport.com/assets/BMW-ChargeForward-Report-R4-070620-ONLINE.pdf.

Q. WHAT INCENTIVES FOR PARTICIPATING CUSTOMERS ARE THE COMPANIES PROPOSING AS PART OF THE RESIDENTIAL EV CHARGING PROGRAM?

A. Enrollment in this program will be encouraged through incentive payments totaling $750 per customer. The incentive has been set to cover the current average cost of a networked EVSE which is capable of being controlled by the Companies' DERMS. The $750 total incentive will be paid to customers in an initial $600 payment at the beginning of the program and three annual retention payments of $50 in each subsequent year (*i.e.*, years 2, 3 and 4), conditioned upon the customer's continued full participation in the program. Retention payments will cease if a customer no longer participates in the program.

Q. HOW MANY RESIDENTIAL EV CHARGING PORTS WILL THE PROGRAM SUPPORT?

A. The Companies will monitor and manage up to 600 networked single-port Level 2 EVSE at residential customer premises where a fully electric vehicle is routinely parked.

Q. WHAT ADDITIONAL COSTS DO THE COMPANIES EXPECT TO INCUR IN RELATION TO THE RESIDENTIAL EV CHARGING PROGRAM?

A. The Companies will incur start-up and on-going annual CSMS costs estimated to be $50,000 initially and $50,000 annually. Start-up costs will cover CSMS configuration of communications with the Companies' DERMS and the development of a portal through which customers can procure a compliant EVSE. A warranty will be included in the purchase price of the compliant EVSE. Annual costs will cover communication services between the DERMS and the EVSE as well as the collection of usage data (*e.g.*, session start and stop times, energy delivered and peak demand). Networking costs to transmit and receive information via the CSMS is expected to be $8 per EVSE per month. All costs reflect recent market cost indications from vendors and are subject to change. The incentive will cease when program funds have been expended or upon the termination of Grid Mod II.

2. Commercial EV Charging Program

Q. PLEASE DESCRIBE THE COMPANIES' PROPOSED COMMERCIAL EV CHARGING PROGRAM?

A. The Commercial EV Charging Program will allow the Companies to use the DERMS to schedule and adjust commercial vehicle charging while permitting the customer to fully charge its vehicles. The voluntary Commercial EV Program will be open to commercial and governmental customers who own or lease at least two fully electric vehicles and charge these vehicles daily at a single location. Commercial customers will be required to procure their EVSE from a list of compliant products through the portal described previously and will also be responsible for installing the EVSE on a 240V circuit.

Q. WHAT INCENTIVES FOR PARTICIPATING CUSTOMERS ARE THE COMPANIES PROPOSING AS PART OF THE COMMERCIAL EV CHARGING PROGRAM?

A. Customers will receive a per-port incentive of $2,000 which represents the approximate cost of a 19.2 kW networked EVSE. The $2,000 per port incentive will be paid in an initial payment of $1,250 at the beginning of the program with the remainder paid in three annual retention payments of $250 in each subsequent year (i.e., years 2, 3 and 4), conditioned upon the customer's continued full participation in the program. Retention payments will cease if a customer does not participate in the program.

Q. HOW MANY COMMERCIAL EV CHARGING PORTS WILL THE PROGRAM SUPPORT?

A. The Companies will enter into contracts with customers allowing the Companies to monitor and manage up to 600 networked Level 2 EVSE ports. EVSE may be single- or dual-port depending on the manufacturer, and each participant will be required to have at least two EVSE ports (*i.e.*, no more than 300 total locations).

Q. WHAT ADDITIONAL COSTS DO THE COMPANIES EXPECT TO INCUR IN RELATION TO THE COMMERCIAL EV CHARGING PROGRAM?

A. Start-up and on-going annual CSMS costs are estimated to be $50,000 initially and $50,000 annually. Start-up costs will cover CSMS configuration of communications with the Companies' DERMS and the development of a portal through which customers can procure a compliant EVSE. Annual costs will cover communication services between the DERMS and the EVSE as well as the collection of usage data (*e.g.*, session start and stop times, energy delivered, and energy demand). Networking costs to transmit and receive information via the CSMS is expected to be $38 per EVSE per month. Commercial EV charging warranty costs are estimated to be $25 per EVSE per month. All costs reflect recent market cost indications from vendors and are subject to change. The incentive will cease when program funds have been expended or upon the termination of Grid Mod II.

3. Commercial V2G Charging Program

Q. PLEASE DESCRIBE THE COMPANIES' V2G PROGRAM?

A. The third EV charging program within the EV Pilot is a voluntary Commercial V2G Program in which the vehicles and charging equipment are capable of both taking power from and placing power back onto the distribution system (*i.e.*, bidirectional power flows) in order to support distribution system operations. The Companies will enter into contracts with eligible customers to manage and control those bidirectional power flows. The ability of V2G to act as both a load and a resource has the potential to create unique challenges for the distribution system, and for this reason is it critical that the Companies gain an understanding of how to manage such bidirectional power flows under real-world circumstances. The Companies will seek to undertake this program using widely available vehicles such as the Nissan Leaf. Experiences with these vehicles will be directly applicable to management of large high capacity V2G fleets that will likely be deployed in the Companies' service territories in the coming years.[4]

Q. WHAT INCENTIVES FOR PARTICIPATING CUSTOMERS ARE THE COMPANIES PROPOSING AS PART OF THE V2G PROGRAM?

A. The V2G incentive level will be set at $20,000 per EVSE which represents the estimated cost differential between a standard commercial EV charger and a more expensive V2G-enabled EV charger. The Companies will provide an up-front incentive of $16,250 per EVSE and three annual retention payments of $1,250 in each subsequent year (*i.e.*, years 2, 3 and 4), conditioned upon the customer's continued participation in the V2G Program. Retention payments will cease if a customer does not participate in the program. All V2G costs reflect recent market cost indications from vendors and are subject to change.

Q. HOW MANY V2G CHARGING PORTS WILL THE PROGRAM SUPPORT?

A. The V2G Program will include up to six commercial or governmental customer sites, each with at least ten fully electric vehicles capable of bidirectional power flows for a total of 60 ports.

Q. WHAT ADDITIONAL COSTS DO THE COMPANIES EXPECT TO INCUR IN RELATION TO THE V2G PROGRAM?

A. Utilizing the full capabilities of the V2G EVSE will require V2G vendor services for telemetry, recording and reporting data, interfacing with the Companies' DERMS, and optimizing charging in accordance with instructions from the DERMS. Preliminary

[4] One indicator of momentum in this space is the recently signed "Memorandum Of Understanding To Establish The Vehicle-To-Everything Collaboration" executed by the U.S. Department of Energy and numerous utility and industry stakeholders. The V2G Program will provide an opportunity for the Companies to participate and be a beneficiary of the Collaborative's learnings as they apply to leveraging a DERMS to manage DERs.

discussions with vendors indicate this cost for such services will be approximately $800 per year per vehicle. The V2G service provider will include a warranty cost in its service agreement for the duration of the program. In the event that the V2G EVSE is proprietary, the Companies anticipate that the V2G vendor will provide the option to continue using the EVSE following the end of the program, and that the customer will continue to pay associated V2G vendor fees.

Q. WHAT ARE THE TOTAL PROJECTED COSTS ASSOCIATED WITH THE EV CHARGING PILOT?

A. The total costs of the EV Charging Pilot, including customer incentive payments, CSMS costs, warranty costs, and program administration costs, are estimated at $6.94 million ($1.16 million for the Residential EV Charging Program, $4.06 million for the Commercial EV Charging Program and $1.73 million for the V2G Program). These costs include customer incentive payments, CSMS costs, and warranty costs as described previously. Estimated program administration costs are based on vendor indications and internal estimates and include the costs of program implementation, outreach, education, customer care, and administering customer incentive payments. All costs related to the EV Charging Pilot will be considered O&M for purposes of cost recovery.

Q. WHAT ARE THE BENEFITS OF THE EV CHARGING PILOT FROM AN OPERATIONAL PERSPECTIVE?

A. The EV Charging Pilot will generate a series of benefits from distribution system operation optimization and carbon emissions reductions. Specifically, the EV Charging Pilot will result in the quantitative benefits of (1) avoided T&D costs through the use of managed charging, (2) reduced carbon emissions through the use of electricity rather than liquid transportation fuels, and (3) reduced carbon emissions through the use of managed charging. The EV Charging Pilot will also result in the qualitative benefits of (1) enhanced reliability, (2) improved system planning and management of intermittent resources (*i.e.*, V2G), and (3) regional macroeconomic benefits.

The estimated benefit of improved reliability for each EV program is based on the Companies' potential to mitigate outages through managed charging. Transformers are engineered and deployed based on historic usage conditions. EV charging can represent relatively large loads on the distribution system which have the potential to cause transformer overloading and overheating conditions. Managed EV charging can mitigate these risks and thereby enhance reliability. Vehicles in the V2G Program will have the ability to inject power onto the distribution system at times when doing so would be beneficial to the distribution system.

The EV Charging Pilot will also create direct program spending associated with customer incentives, CSMS payments, and program administration. This program spending also will lead to indirect and induced economic benefits, similar to the macroeconomic benefits described in the context of the DER Pilot.

The Companies will not seek any wholesale energy or capacity market revenues through the EV Charging Pilot.

Q. WHAT ARE THE ESTIMATED FINANCIAL BENEFITS TO CUSTOMERS OF THE EV CHARGING PILOT?

A. The EV Charging Pilot is expected to result in total quantifiable benefits to customers of $3.86 million and total costs of $6.94 million. These estimates are incorporated into the overall CBA for Grid Mod II sponsored by Companies' Witness Burnell.

Q. PLEASE SUMMARIZE HOW THE COMPANIES CALCULATED THE BENEFITS ASSOCIATED WITH THE EV CHARGING PILOT?

A. The estimated benefit of avoided T&D costs for the EV Pilot is based on the Companies' savings from deferring or avoiding the upgrade of a transformer to serve the premises after an EVSE load is added. Given the relatively large size of Level 2 EVSE loads and the extended duration of charging, any transformer currently loaded at 85% or greater to which one or more Level 2 EVSE is added will be identified as potentially requiring an upgrade. This benefit for each program is described below.

Residential sites, defined as detached single-family homes, are typically served by single-phase transformers rated at 25 or 50 kVA. Each transformer, in turn, typically serves approximately five customer premises. To determine the number of transformers potentially at risk of being overloaded by residential EV charging, the Companies surveyed the distribution system to identify transformers that are both (a) 50 kVA single-phase or less and (b) loaded at 85% of capacity or greater. This survey found that 25% of all the Companies' transformers serving residential customers met these criteria. Based on a program size of 600 participants, and applying a participation rate of 94%[5], the Companies project that 141 sites will be served by transformers that are at risk of being overloaded by an EVSE and whose replacement can be deferred or avoided through managed charging. The cost of upgrading a typical residential transformer is approximately $5,000, resulting in a nominal benefit from avoided T&D investment of $705,000.

Commercial customers are typically served by three-phase transformers. When pole-mounted, the typical configuration is a bank of three 25 or 50 kVA transformers for a combined total of 75 or 150 kVA. When pad-mounted, the transformer is a single-enclosed unit that is typically rated at 150, 300, or 500 kVA. To determine the number of

[5] A study by BMW found that customers responded well to a week-long test of two-hour "no-EV charging" windows (with an ability to opt-out) during which the customers received varying levels of compensation. In that study, 94% of participants stated that they are likely to participate in a similar program in the future. Source: BMW Group, BMW ChargeForward: Electric Vehicle Smart Charging Program (2020), https://bmwchargeforwardreport.com/assets/BMW-ChargeForward-Report-R4-070620-ONLINE.pdf.

transformers potentially at risk of being overloaded by commercial EV charging, the Companies surveyed the distribution system to identify transformers that are both (a) 75 kVA three-phase (the most common configuration) and (b) loaded at 85% or higher. This survey found that 5.3% of the commercial transformers meet these criteria. Based on a Commercial Program size of 600 participants at 300 sites, and again applying a participation rate of 94%, the Companies project that 15 sites will be served by transformers that are at risk of being overloaded by EVSE and whose replacement can be deferred or avoided through managed charging. The cost of upgrading a typical commercial transformer is approximately $25,500, resulting in a nominal benefit from avoided T&D investment of $382,500.

Under the V2G Program, the Companies expect approximately 200 kW of bidirectional power flows at each location with customers charging in such a manner so as to not increase peak load at the host location. As such, the V2G EVSE are not expected to require the installation of an upgraded transformer at their respective host locations. The avoided cost of a commercial transformer able to reasonably handle an additional 200 kW is $35,000, resulting in a nominal benefit from avoided T&D investment of $210,000.

The estimated benefit of avoided CO2 emissions from lower liquid fuel usage for each EV program is calculated as the product of the quantity of liquid fuel displaced through the given program, the difference in carbon intensity of these liquid fuels and electricity, the percentage of customers that would not have purchased an EV but for program and the unit value of avoided CO2 emissions.[6] These calculations yield avoided CO2 benefits from lower liquid fuel usage of $411,984, $823,968, $411,984, for the Residential, Commercial and V2G Charging Programs, respectively.

The estimated benefit of the carbon emissions reduction from managed charging for each EV program is based on the quantity of electric energy that is consumed during the PJM off-peak hours rather than during on-peak hours.[7] The total benefits of shifting energy consumption to the off-peak period are $214,064, $670,357, and $28,166, for the Residential, Commercial and V2G Charging Programs, respectively.

The details of these quantified EV Charging Pilot benefits are shown in Figure 3, below.

[6] Total vehicle CO2 emissions, which include both tailpipe and upstream emissions, are determined by the vehicles' efficiency (MPG and/or MPGe), the fuel used to power the vehicle (electricity, gasoline or diesel), and how that fuel is produced and distributed. Battery EVs have zero tailpipe emissions but may have upstream emissions based on the source of the electricity used for charging. Carbon emissions for light duty EV and gasoline-powered vehicles in Ohio are 130g/mile and 410g/mile, respectively. Based on an estimated 12,000 miles driven per year, vehicles in the program will avoid 3.4 tons and 6.7 tons for light-duty and medium-duty vehicles, respectively. For medium-duty vehicles, it is assumed that fuel efficiency is half that of light-duty vehicles. The Companies' incentives are generally expected to accelerate residential and commercial customer decisions to purchase an EV by one year, so it is assumed the Residential EV Charging Program and Commercial EV Charging Program are responsible for 10% of this total benefit, based on an EV life expectancy of 10 years.

[7] 2020 CO2 emissions for on-peak power in PJM are 1,180 lbs./MWh, while CO2 emissions for off-peak power are 1,046 lbs./MWh. Shifting one MWh of energy consumption from on-peak to off-peak therefore results in a net savings of 134 lbs./MWh, or 0.067 metric tons of CO2/MWh. Participants in the EV Charging Pilot are not expected to fully comply with all managed charging requests. To adjust for lack of full compliance with all managed charging requests, participation rates in the Residential EV Charging, and Commercial EV Charging have been reduced by two factors described below resulting in a participation rate of 76%, 68% and 100%, respectively. In the Residential EV Program, each participating vehicle is projected to consume 3.4 MWh of energy per year, for a total of 2,057 MWh per year. The Companies project that 1,563 MWh, or 76%, of this energy will be shifted from on-peak to off-peak as a result of the program, which is based on a combination of the findings of a study by BMW indicating that 94% of customers would not opt out of time-shifted charging, and the Companies have further reduced participation to account for a program design feature under which managed charging will always allow customers to charge at Level 1 (*i.e.*, 1.8 kW, reduced from full power at 10 kW). Similarly, in the Commercial EV Program, each participating vehicle is projected to consume 12 MWh of energy per year, for a total of 7,200 MWh per year. The Companies project that 4,896 MWh, or 68%, of this energy will be shifted from on-peak to off-peak as a result of the program, which is based on a combination of the findings of a study by BMW indicating that 94% of customers would not opt out of time-shifted charging, and the Companies have further reduced participation to account for a program design feature under which managed charging will always allow customers to charge at 5 kW (reduced from full power of 19.2 kW). In the V2G Program, each participating vehicle is projected to consume 3.4 MWh of energy per year, for a total of 206 MWh per year. The Companies project that 206 MWh, or 100%, of this energy will be shifted from on-peak to off-peak as a result of the program; this number is based on the premise that the purpose of a V2G investment is to charge off-peak and be available to discharge energy on-peak.

Figure 3 - EV Pilot Quantified Benefits

Element No.	Benefits Description	Calculation Approach	Nominal Value		
			Residential	Commercial	V2G
EV 1	Avoided T&D Costs	Avoided transformer upgrades	$705,000	$382,500	$210,000
EV 2	CO_2 Emissions Reduction – Lower Liquid Fuel Usage	Reduced CO_2 emissions from lower consumption of liquid transportation fuels	$411,984	$823,968	$411,984
EV 3	CO_2 Emissions Reduction – Peak Load Shift from Managed Charging	Each MWh shifted from on-peak to off-peak reduces CO_2 emissions by 134 lbs. per MWh	$214,064	$670,357	$28,166
Total EV Pilot Quantified Benefits			**$1,331,048**	**$1,876,826**	**$650,151**

Q. WILL THE COMPANIES PROVIDE REPORTS ON THE DER AND EV CHARGING PILOTS?

A. Yes, the Companies propose to provide annual reports to their quarterly stakeholder collaborative group summarizing the performance of and learnings from the Pilots during the term of Grid Mod II. Those annual reports will include various program data such as spend to date, FTM BESS and EVSE operational metrics and a narrative of the status of the Pilots.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.