BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application Seeking Approval of Ohio Power Company's Proposal to Enter into an Affiliate Power Purchase Agreement for Inclusion in the Power Purchase Agreement Rider.	)	Case No. 14-1693-EL-RDR
In the Matter of the Application of Ohio Power Company for Approval of Certain Accounting Authority.	)	Case No. 14-1694-EL-AAM

DIRECT TESTIMONY OF DIANE MUNNS ON BEHALF OF ENVIRONMENTAL DEFENSE FUND AND OHIO ENVIRONMENTAL COUNCIL

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COUNSEL FOR OHIO ENVIRONMENTAL COUNCIL & ENVIRONMENTAL DEFENSE FUND

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Diane Munns. My business address is 257 Park Avenue South, 17th Floor, New York, New York 10010.

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

A. I am the Senior Director of External Affairs and Regulatory Policy for the Environmental Defense Fund's (EDF) Clean Energy Program.

Q. ON WHOSE BEHALF ARE YOU SUBMITTING TESTIMONY?

A. I am testifying on behalf of EDF and the Ohio Environmental Council (OEC).

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I testify that AEP (the Company) has proven alternatives to its PPA proposal that it claims will be needed to improve reliability and reduce price stability. These alternatives include the installation of voltage optimization equipment (Volt/Var or VVO) and Conservation Voltage Reduction (CVR) I specifically recommend that, if the Commission approves the Company's PPA proposal, then the Commission should require, as a condition of approval, that the Company install all cost-effective Volt/VAR equipment and maximize Conservation Voltage Reduction (CVR) throughout its entire service territory in order to capture these reliability and price stability benefits.

Q. PLEASE PROVIDE A SUMMARY OF YOUR TESTIMONY.

A. After presenting my qualifications, I will explain Volt/VAR and CVR equipment and the benefits this equipment can provide relying on information provided by studies funded by the American Recovery and Reinvestment Act (ARRA). I will also show how the levelized cost of Volt/VAR and CVR investment needed to realize these benefits has been demonstrated to be less than the levelized cost of various types of generating resources. I will then describe the Ohio experience of deployments of Volt/VAR and CVR by Ohio utilities, including AEP. Finally, I will explain how investments in Volt/VAR and CVR can be used as a compliance option under the U.S. EPA's Clean Power Plan rule. I will posit that if the Commission decides the record supports use of ratepayer dollars to pay for the continued operation of uneconomic plants, that decision should be conditioned on system-wide deployment of cost-effective Volt/VAR, combined with CVR, a cost-effective technology that has been proven to provide various customer benefits.

II. QUALIFICATIONS

Q. PLEASE DESCRIBE YOUR WORK EXPERIENCE AND EDUCATIONAL BACKGROUND.

A. I graduated with a B.A. from the University of Iowa in 1975 (cum laude, Phi Beta Kappa). I graduated with a J.D. from Drake University in 1982 (Order of the Coif). I worked at the Iowa Attorney General's office from 1982-1983. I worked at the Iowa Utilities Board for twenty four years from 1983-2007 beginning as Assistant Counsel and ending as a Board member (this is the same as commissioner in other states). While a member of the Iowa Utilities Board, I also served as President of the National Association of Regulatory Utility Commissioners ("NARUC"). During my term as president of NARUC, I served as co-chair of the National Action Plan for Energy Efficiency, along with Jim Rogers of Duke Energy. From 2007-2008, I was Executive Director of Retail Energy Services for the Edison Electric Institute. From 2008-2014, I was Vice President for Regulatory Relations and Energy Efficiency for MidAmerican

Energy Company ("MidAmerican"), until I assumed my present position with EDF in early 2014. My full resume is attached as DM-1.

I am not an engineer nor am I a technical expert on the technology described. I am, however, familiar with the functionality of the equipment, the studies on effectiveness and the policy considerations supporting its deployment.

Q. WHAT ARE YOUR RESPONSIBILITES AS SENIOR DIRECTOR OF EXTERNAL AFFAIRS AND REGULATORY POLICY FOR THECLEAN ENERGY PROGRAM OF THE ENVIRONMENTAL DEFENSE FUND?

A. I am responsible for defining the overall strategy for EDF Clean Energy Program's collaborative efforts, including identifying potential partners and nurturing shared dialogue to maximize clean energy advances. I also develop opportunities to leverage common work and implement tactical joint efforts to achieve effective collaborative alliances. I serve as a key contact point with external partners, such as policymakers, industry allies and other non-governmental organizations in the clean energy sector, and act as a national thought leader and expert on topics including energy efficiency, smart grid, renewables, and utility business models.

Q. WHAT IS YOUR EXPERIENCE WITH STATE UTILITY REGULATORY COMMISSIONS AND PUBLIC UTILITY ISSUES?

A. As a general counsel within a state commission for sixteen years, I prepared evaluations of and advised public utility commissioners on contested issues in regulatory filings concerning gas, electric and telecommunications companies. I also defended these decisions before the Iowa Supreme Court, 8^{th} Circuit Court of Appeals, and United States Supreme Court. During my six year tenure as a commissioner, I participated in regulatory decisions as a member of a three member board. These cases included rate cases, rulemakings, depreciation proceedings, cost of service proceedings, facility sitings, certificate of need proceedings, energy efficiency plan approvals, avoided cost determinations, complaints and reorganizations. Since leaving the commission, I have testified before state utility regulatory commissions in Illinois on energy efficiency, North Carolina on avoided costs, and Hawaii on performance ratemaking. I recently filed testimony in Kansas on rate design.

III. VOLT/VAR, CVR AND BENEFITS

Q. PLEASE EXPLAIN WHAT VOLT/VAR IS.

A. Volt / VAR Optimization (VVO) involves the management of various electric distribution system assets and advanced control technologies to ensure that power delivered to customers is with acceptable limits, while minimizing losses and maximizing efficiencies. Investments in Volt / VAR technologies can enable a platform that increases visibility, efficiency and flexibility of the electric system, to the benefit of customers, utilities, and society in general.

Q. PLEASE EXPLAIN WHAT CVR IS.

A. Conservation Voltage Reduction is a specialized practice that makes use of Volt / VAR Optimization equipment to lower voltage levels for the specific purpose of reducing energy consumption. Electric utilities are tasked with providing voltage to customers within a specified range (typically 120 Volts plus or minus six Volts) in order to ensure that the operation of customer appliances is not adversely impacted. Providing an operating system voltage in the lower end of this range has been demonstrated to result in lower energy use across customer equipment and appliances.

Volt / VAR Optimization equipment also provides the added visibility and control to reduce voltage levels resulting in increased energy savings, while ensuring service to customer remains within acceptable levels. If voltage was "right-sized" through the use of Volt / VAR equipment, customers would be able to run their appliances and equipment efficiently, but not consume more electricity than needed. Conservation Voltage Reduction results in energy savings and peak demand reductions across the grid, energy savings on the customer side of the meter, and significant greenhouse gas emission reductions. Electric customers across circuits with active VVO management and lower voltage levels typically consume less energy without making any changes to their individual consumption behavior.

Q. PLEASE EXPLAIN WHAT BENEFITS VOLT/VAR AND CVR PROVIDE.

A. Customers can benefit directly from managed, lower system voltage levels without the need to take any action on their part – translating into potentially lower fuel costs and lower bills. In addition, Volt / VAR optimization can provide value that goes beyond energy savings associated with Conservation Voltage Reduction. Active management of these assets can also reduce losses associated with the energy delivery. With respect to system planning – if the energy reduction impact of CVR is included in forecasts of future system needs, it can potentially offset the need for future energy and capacity procurements.

The system awareness and control that is provided by the enhanced and active management of voltage and reactive power resources can be especially valuable during contingencies, emergencies and dynamic system conditions. These same capabilities in visibility and control can facilitate the integration of distributed energy resources.

Society in general can also benefit from the corresponding lower levels of emissions from electricity generation, as a result of lower levels of consumption.

IV. THE REPORTED EXPERIENCE WITH THE TECHNOLOGY

Q. PLEASE SUMMARIZE THE DATA AVAILABLE ON VOLT/VAR AND CVR EFFECTIVENESS.

A. The U.S. Department of Energy awarded grants for 26 Volt/VAR and CVR projects around the country, which were funded by the ARRA. These were generally five-year grants, which started in 2010 and are ending this year. I understand that the Department of Energy will issue a report summarizing the results of these projects in the near future. In addition, there have been other deployments around the country which did not receive ARRA funding.

Q. WHAT IS YOUR UNDERSTANDING OF THE RESULTS OF THESE STUDIES TO DATE?

A. A good example of the results can be found in AEP's report on its *gridSMART* Phase 1 project, which I discuss in more detail later in my testimony. AEP's pilot program achieved that 3 percent reduction in energy consumption and a 2 to 3 percent reduction in peak demand. This is generally consistent with the results of other studies to date.

V. COST OF VOLT/VAR AND CVR COMPARED TO COST OF TRADITIONAL GENERATION RESOURCES

Q. IS THIS TECHNOLOGY COST-EFFECTIVE FOR UTILITIES TO DEPLOY?

A. Yes, generally. The amount of Volt/VAR and CVR investment which will be cost-effective depends on the characteristics of each utility's service territory. The equipment is installed on the utility's circuits and at substations. How much investment will be cost-effective will depend on factors such as the number of circuits and substations, the length of the circuits, the number of customers served on each circuit, and whether the utility has deployed AMI meters. Many utilities have investigated this equipment and decided that it would be cost-effective to deploy. I'm not aware of any cases where a utility did a cost/benefit analysis and concluded that it would not be cost-effective to deploy. Any utility which is deciding whether to deploy this equipment should first do a thorough cost/benefit study to determine how much investment would be cost-effective.

Q. ARE YOU AWARE OF ANY REPORTS WHICH COMPARE THE COST OF VOLT/VAR AND CVR TO THE COST OF TRADITIONAL GENERATION RESOURCES?

A. Yes.

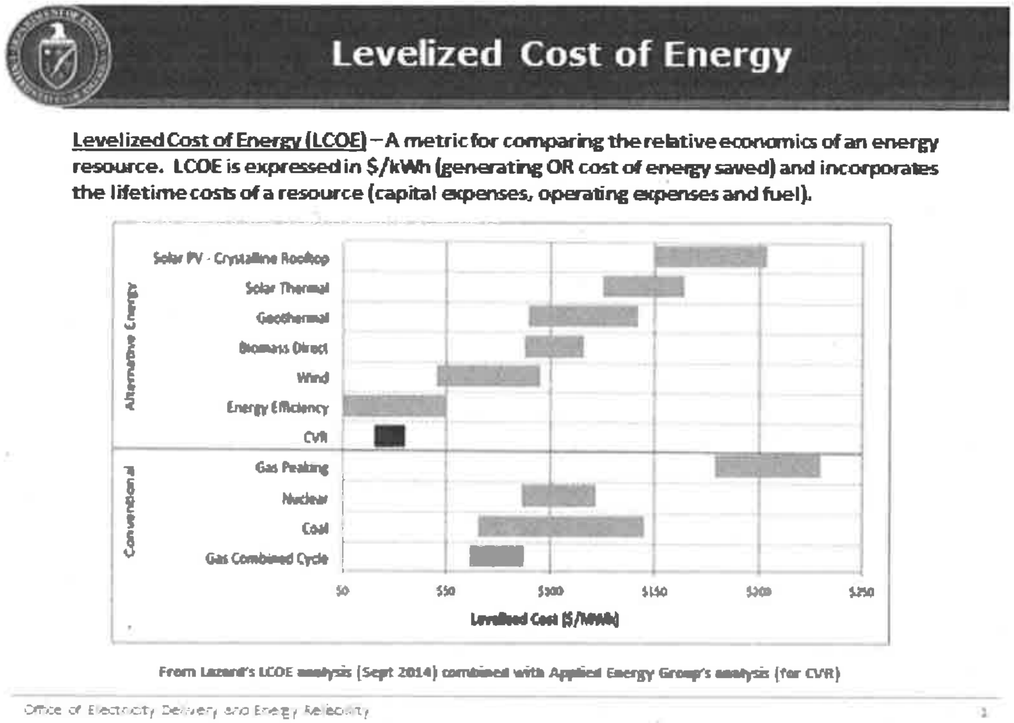
Q. PLEASE EXPLAIN.

A. The Department of Energy performed an assessment of the state of Conservation Voltage Reduction across the nation. Findings of this assessment were presented at the "Harnessing the Hidden Efficiency - Using Voltage and Reactive Power Management as a Compliance Mechanism for the Clean Power Plan" panel at the National Council for Science and the Environment in January 2015 and more recently in the "Major Findings from a DOE-Sponsored National Assessment of Conservation Voltage Reduction (CVR) IEEE Volt-Var Task Force" Panel in July 2015.[1]

One finding of this investigation was a comparison of the cost of Volt/VAR and CVR deployments to the cost of traditional generation resources. The cost of Volt/VAR and CVR compares favorably to end-use energy efficiency, the most cost-effective

[1] http://grouper.ieee.org/groups/td/dist/da/doc/Major%20Findings%20from%20a%20DOE-Sponsored%20National%20Assessment%20of%20Conservation%20Voltage%20Reduction%20(CVR)%20-%20Ronald%20Willoughby.pdf

energy resource. Here is a DOE slide from the reported findings which compares these technologies:



IV. OHIO VOLT/VAR AND CVR DEPLOYMENTS

Q. HAVE ANY OHIO UTILITIES DEPLOYED VOLT/VAR AND CVR?

A. Yes.

Q. PLEASE DESCRIBE THE OHIO UTILITIES' EXPERIENCE WITH THIS TECHNOLOGY.

A. Duke Energy Ohio (DEO) has fully deployed Volt/VAR and CVR throughout its Ohio service territory. The U.S. Department of Energy awarded DEO a grant under the American Recovery and Reinvestment Act of 2009, which funded one-half of the cost. DEO's cost/benefit analysis concluded that it would be cost-effective to fully deploy Volt/VAR and CVR. The Commission approved a Stipulation which accepted the deployment, on the condition that the Company net the operational cost savings from the deployment against the costs of deployment to fairly allocate the benefits between shareholders and ratepayers. *In the Matter of the Application of Duke Energy Ohio, Inc. to Adjust and Set its Gas and Electric recovery Rate for 2009 SmartGrid Costs Under Rider AU and Rider DR-IM,* Case No. 10-867-GE-RDR (Opinion and Order) (March 23, 2011); *Id.* (Stipulation at ¶ 14)(February 14, 2011).

Ohio's FirstEnergy implemented a pilot deployment of Volt/VAR and CVR technology. This deployment is discussed in a U.S. Department of Energy report, attached as DM- 2 to my testimony. Its finding are consistent with the other findings on technology effectiveness.

Finally, Ohio Power also deployed a Volt/VAR and CVR pilot program. The Company filed a report on this program with its application in *In the Matter of the Application of Ohio Power Company to Initiate Phase 2 of its gridSMART Project and to Establish the gridSMART Phase 2 Rider*, Case No. 13-1939-EL-RDR. Ohio Power described the benefits of Volt/VAR as follows:

> **VVO Benefits**
>
> **Efficiency Benefits**
>
> AEP Ohio's gridSMART® Phase 2 VVO is designed to realize a reduction in energy consumption where deployed, and a reduction in peak demand on circuits where VVO is deployed. Voltage standards exist in the electric utility industry, such as ANSI C84.1, that mandate an acceptable voltage range at the secondary of the distribution transformer. VVO enables a reduction of the average voltage that each customer on the circuit receives, thereby reducing the annual energy consumption of the feeder while maintaining the quality of service to the end-use customer. Based on results obtained through field demonstrations, AEP Ohio estimates that a 3 percent reduction in energy consumption and a 2 to 3 percent reduction in peak demand can be obtained on those circuits on which the technology is deployed.

Other Benefits

> Along with the expected efficiency benefits, the technology associated with VVO also provides VAR support, offsetting the need for Generation and Transmission resources to provide VARs. VVO also promotes a "self-healing" grid by maintaining acceptable voltages after a "self-healing" event has occurred. The technology required for VVO will also augment other technologies to improve visibility into system performance and circuit automation.

In addition to this report, Ohio Power prepared a presentation for an industry conference explaining the benefits of Volt/VAR and CVR. This presentation is as DM-3 to my testimony. The report states that energy savings and peak demand reductions of up to 4% can be achieved with this technology – even higher than what the Company reported to the Commission in its summary of *gridSmart* Phase 1.

Q. CAN VOLT/VAR AND CVR BE USED AS A COMPLIANCE OPTION UNDER THE U.S. EPA'S CLEAN POWER PLAN.

A. Yes. The final version of the rule states:

> (6) Transmission and distribution (T&D) measures.
>
> Electricity T&D measures that improve the efficiency of the T&D system and/or reduce electricity use may be used to adjust a CO2 emission rate. This includes T&D measures that reduce losses of electricity during delivery from a generator to an end-user (sometimes referred to as "line losses" and T&D measures that reduce electricity use at the end-user, such as conservation voltage reduction (CVR). The EPA received many comments in support of advanced energy technologies, including energy storage and transmission and distribution upgrades, and including these technologies in the suite of potential measures that states could consider for emission rate adjustments in their state plans. Comments pointed out that in addition to helping achieve emission standards, T&D efficiency improvements make the grid more robust and flexible, as well as delivering environmental benefits. In many parts of the country, grid operators, transmission planners, transmission owners and regulators are already taking steps to

> expand and modernize T&D networks. Commenters suggested that the EPA clarify the eligibility and criteria under which such measures would be permitted in a state plan.
>
> To be eligible, T&D measures must be installed after 2012.This general eligibility requirement is discussed above in section VIII.K.1.a. The MWh of avoided losses or reduction in end-use that result from T&D measures must be appropriately quantified and verified, as discussed in section VIII.K.3.

Q. SHOULD THIS INVESTMENT BE CONSIDERED AS A COMPLIANCE OPTION FOR OHIO?

A. In my opinion, this investment should be among the first compliance measures considered by a state. As discussed, it is cost-effective and delivers proven benefits.

VII. RECOMMENDATIONS AND CONCLUSION

Q. PLEASE EXPLAIN YOUR RECOMMENDATIONS.

A. I recommend that, if the Commission approves the Company's PPA proposal, then the Commission should condition its approval on the Company installing all cost-effective Volt/VAR and implementing CVR. This would require the Company to submit a cost/benefit study to establish how much investment is cost-effective. Once filed, other stakeholders should have a right to do discovery and file comments or testimony on the report.

Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?

A. Yes.

CERTIFICATE OF SERVICE

I hereby certify that a true copy of the foregoing has been served upon the following parties by electronic mail this 11th day of September, 2015.

/s/Trent A. Dougherty
Trent A. Dougherty

stnourse@aep.com mjsatterwhite@aep.com msmckenzie@aep.com dconway@porterwright.com christopher.miller@icemiller.com Bojko@carpenterlipps.com; chris@envlaw.com Christopher J. Allwein callwein@keglerbrown.com Christopher.Miller@icemiller.com cmooney@ohiopartners.org dstinson@bricker.com dboehm@BKLlawfirm.com dconway@porterwright.com dwilliamson@spilmanlaw.com fdarr@mwncmh.com ghull@eckertseamans.com glpetrucci@vorys.com; haydenm@firstenergycorp.com; mhpetricoff@vorys.com hussey@carpenterlipps.com; jeffrey.mayes@monitoringanalytics.com jkylercohn@BKLlawfirm.com jlang@calfee.com jmcdermott@firstenergycorp.com Jodi.bair@occ.ohio.gov joliker@igsenergy.com Allison@carpenterlipps.com joseph.clark@directenergy.com Katie.johnson@puc.state.oh.us Kevin.moore@occ.ohio.gov	Larry.sauer@occ.ohio.gov lhawrot@spilmanlaw.com mjsatterwhite@aep.com msmckenzie@aep.com mdortch@kravitzllc.com mfleisher@elpc.org msoules@earthjustice.org mjsettineri@vorys.com mkurtz@BKLlawfirm.com mpritchard@mwncmh.com msmalz@ohiopovertylaw.org mswhite@igsenergy.com myurick@taftlaw.com ricks@ohanet.org sam@mwncmh.com scasto@firstenergycorp.com schmidt@sppgrp.com Scott.Campbell@ThompsonHine.com sfisk@earthjustice.org sasloan@aep.com Stephanie.Chmiel@ThompsonHine.com steven.beeler@puc.state.oh.us stnourse@aep.com laurie.williams@sierraclub.org talexander@calfee.com tobrien@bricker.com twilliams@snhslaw.com todonnell@dickinsonwright.com William.michael@occ.ohio.gov william.wright@puc.state.oh.us

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ATTACHMENT

DM-1

DIANE MUNNS

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CAREER POSITIONS

Environmental Defense Fund 2014-present
Senior Director of External Affairs and Regulatory Policy, Clean Energy Program

- Define the overall strategy for collaborative efforts, including identifying potential partners and nurturing shared dialogue to maximize clean energy advances.
- Responsible for developing opportunities to leverage common work and implement tactical joint efforts to achieve effective collaborative alliances.
- Serve as key contact point with external partners, such as policymakers, industry allies and other non-governmental organizations in the clean energy sector
- Act as a national thought leader and expert on topics including energy efficiency, smart grid, renewables, and utility business models.

MidAmerican Energy Company 2008-2014
Vice President Regulatory Relations and Energy Efficiency

- Member of regulatory management and strategy team in Iowa, Illinois and South Dakota.
- Provide analysis and support to MidAmerican on the impact of regulatory issues.
- Represent the company and testify in regulatory forums.
- Responsible for direct management of the energy efficiency group including strategy, personnel, budget, and compliance.
- Responsible for coordination with Edison Electric Institute and representing the company at national and regional regulatory forums such as the National Association of Regulatory Utility Commissioners.

Edison Electric Institute 2007-2008
Executive Director Retail Energy Services

- Member of management team responsible for developing and directing EEI's policy positions for investor owned utility members in the states and before Congress.
- Managed business unit within EEI providing services to membership on state ratemaking, energy efficiency, supplier diversity, and National Accounts. Also directed staff of twelve on messaging to state regulators and state consumer advocates.
- Responsible for staffing and directing CEO-level committees and task forces within EEI.
- Acted as liaison between EEI and member companies.

- Spoke on energy efficiency issues to media on behalf of EEI.

Iowa Utilities Board 1983-2006
Chairman and Member (1999-2006)

- As chairman, acted as chief administrative officer responsible for budgeting, personnel, legislative and legal strategy, and media messaging for 65-member state agency.
- Gubernatorial-appointed member of a 3-member quasi-judicial board responsible for regulating gas, electric, and telecommunication companies within the State of Iowa.

General Counsel's Office (1983-1999)

- As general counsel, chief legal officer for the agency responsible for management of the office, legal advice to the Board and all filings and pleadings made in state and federal court.
- Provided legal advice to the Iowa Utilities Board.
- Drafted legal memos and Board orders.
- Defended Board orders and Board members in their official capacity in state and federal court.
- Represented the Board in matters before the Federal Energy Regulatory Commission and the Federal Communications Commission.

EDUCATION

University of Iowa
- Bachelor of Arts 1975, Phi Beta Kappa

Drake University
- Juris Doctorate 1982, Order of the Coif

ACCOMPLISHMENTS

- Established the Institute for Energy Efficiency within EEI to provide support to members on energy efficiency. Established structure, budget and hired staff. (2008)
- Served two terms as the president of the National Association of Regulatory Commissions (NARUC) and represented the association before Federal Energy Regulatory Commission, the Federal Communications Commission, Congress and the media. Testified on behalf of the organization. (2005-2006)
- First co-chair of the Department of Energy/Environmental Protection Agency's National Action Plan for Energy Efficiency. The National Action Plan for Energy Efficiency is a private-public initiative to create a sustainable, aggressive national commitment to energy efficiency through the collaborative efforts of gas and electric utilities, utility

regulators, and other partner organizations involved in energy efficiency. • Received United States Energy Association Public Service Energy Leadership Award that recognizes government officials who have motivated and advocated action to address energy efficiency. (2006) • Conceived and founded the Organization for MISO States, a regional organization supporting and representing state regulators in matters involving the Midwest Independent System Operator. (2004) • Represented 27 states in their action challenging the Federal Communication Commission's rules following the passage of the 1996 telecommunications act opening the industry to competition. The case culminated at the United States Supreme Court in *Iowa Utilities Board v. Federal Communications Commission*, the seminal case on federal state jurisdictional lines. Argued the case before the Supreme Court on behalf of the states. (1996-1998)
COMMITTEE OR BOARD PARTICIPATION
• Retail Energy Services Executive Advisory Committee – Edison Electric Institute • National Academy of Science Committee on Enhancing the Robustness and Resilience of Future Electrical Transmission and Distribution in the United States to Terrorist Attack – Terrorism and the Electric Power Delivery System • Financial Research Institute, College of Business, University of Missouri-Columbia • Institute of Electric Efficiency, Advisory Committee • Critical Consumer Issues Forum, Advisory Committee • Midwest Energy Efficiency Alliance, board of directors, executive committee, chair, policy committee • Board of Counselors – Drake Law School • Advisory Council to the Electric Power Research Institute board of directors • Participated in Harvard Electricity Project • Organization of MISO States executive committee • Energy Board of the Keystone Center or Science and Public Policy • Advisory Council of the New Mexico State University Center for Public Utilities • Chair NARUC Finance and Technology Committee

ATTACHMENT
DM-2

Volt VAR Optimization at American Electric Power

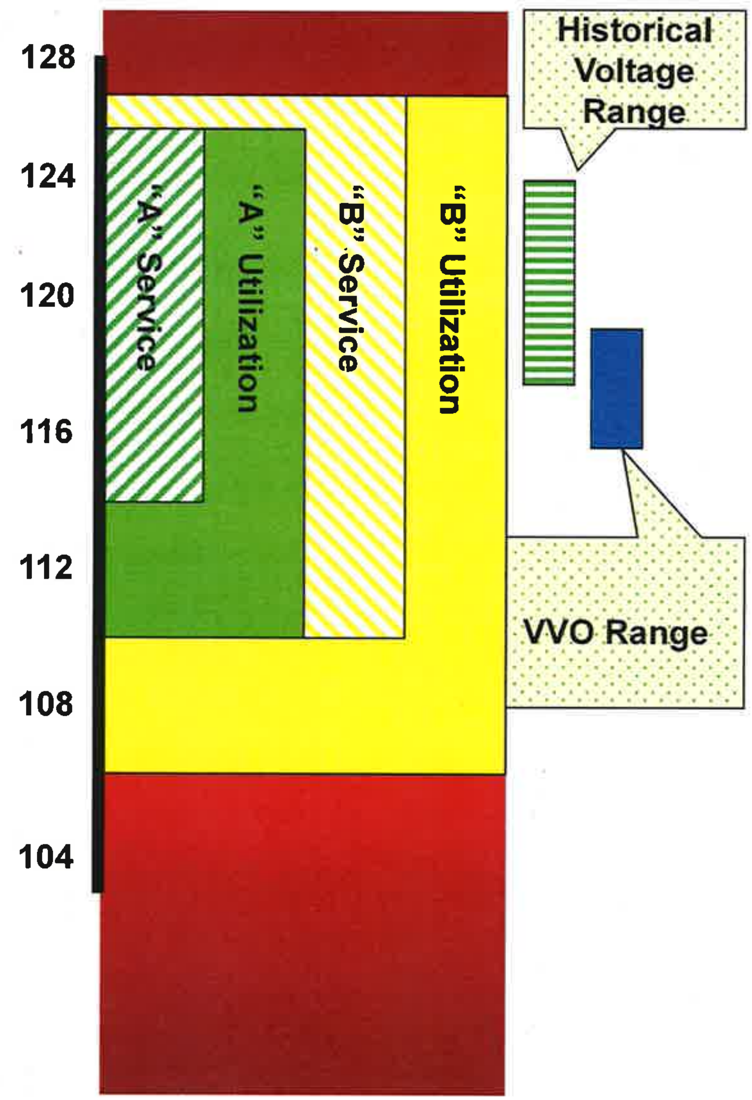
Presentation to:

National Summit on Smart Grid and Climate Change

December 3, 2014
Tom Weaver, PE

Volt VAR Optimization (VVO) Overview

- **Technology and infrastructure upgrades integrated into the electric distribution system to optimize voltage levels**
  - Utilizes communications and computerized intelligence to control voltage regulators and capacitors on the distribution grid
  - Optimizes voltage and power factor based upon selected parameters
  - Algorithm uses end of line monitoring feedback to ensure minimum required voltage maintained



Volt VAR Impacts on Customer's Motors

EPRI EL-2036
Volume 1
Project 1419-1
Final Report
September 1981

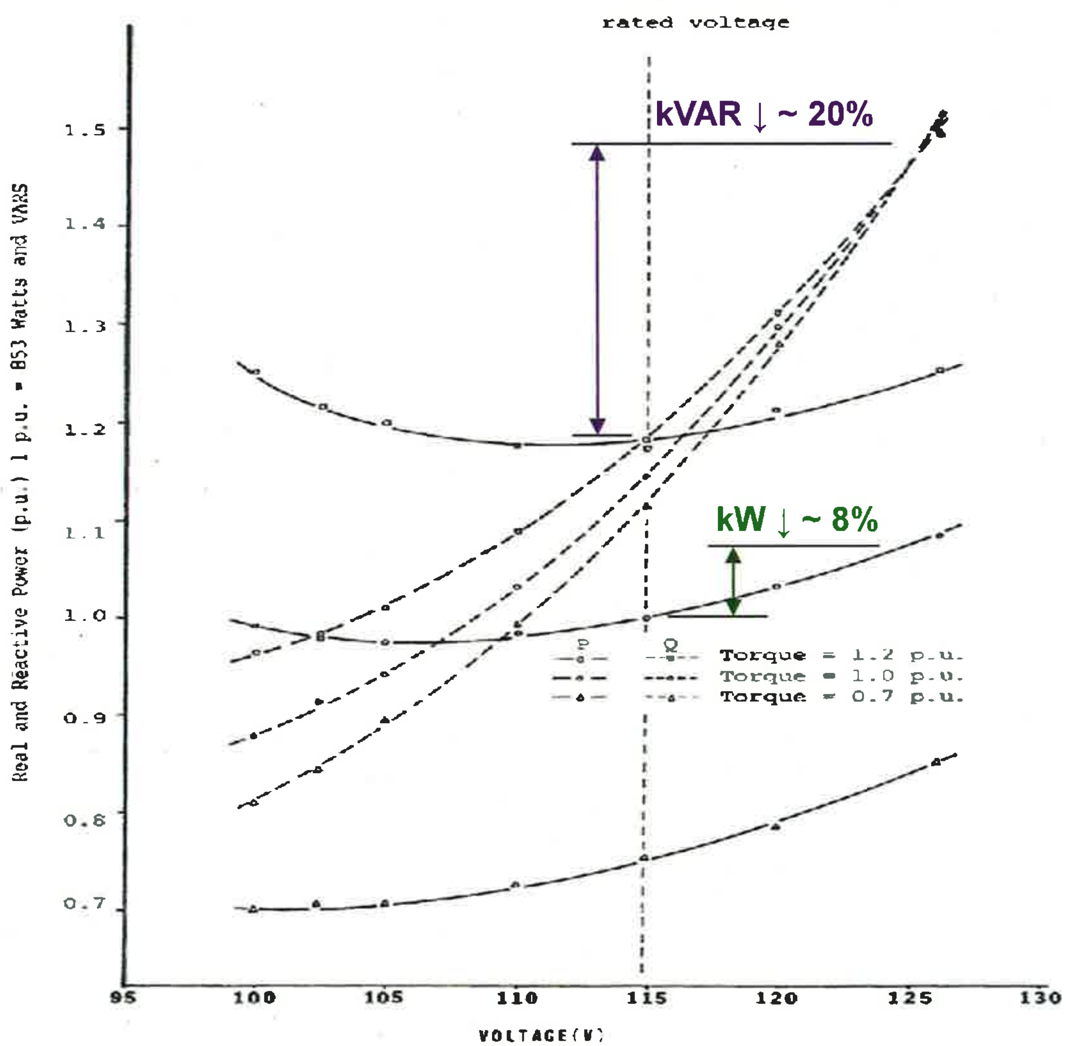
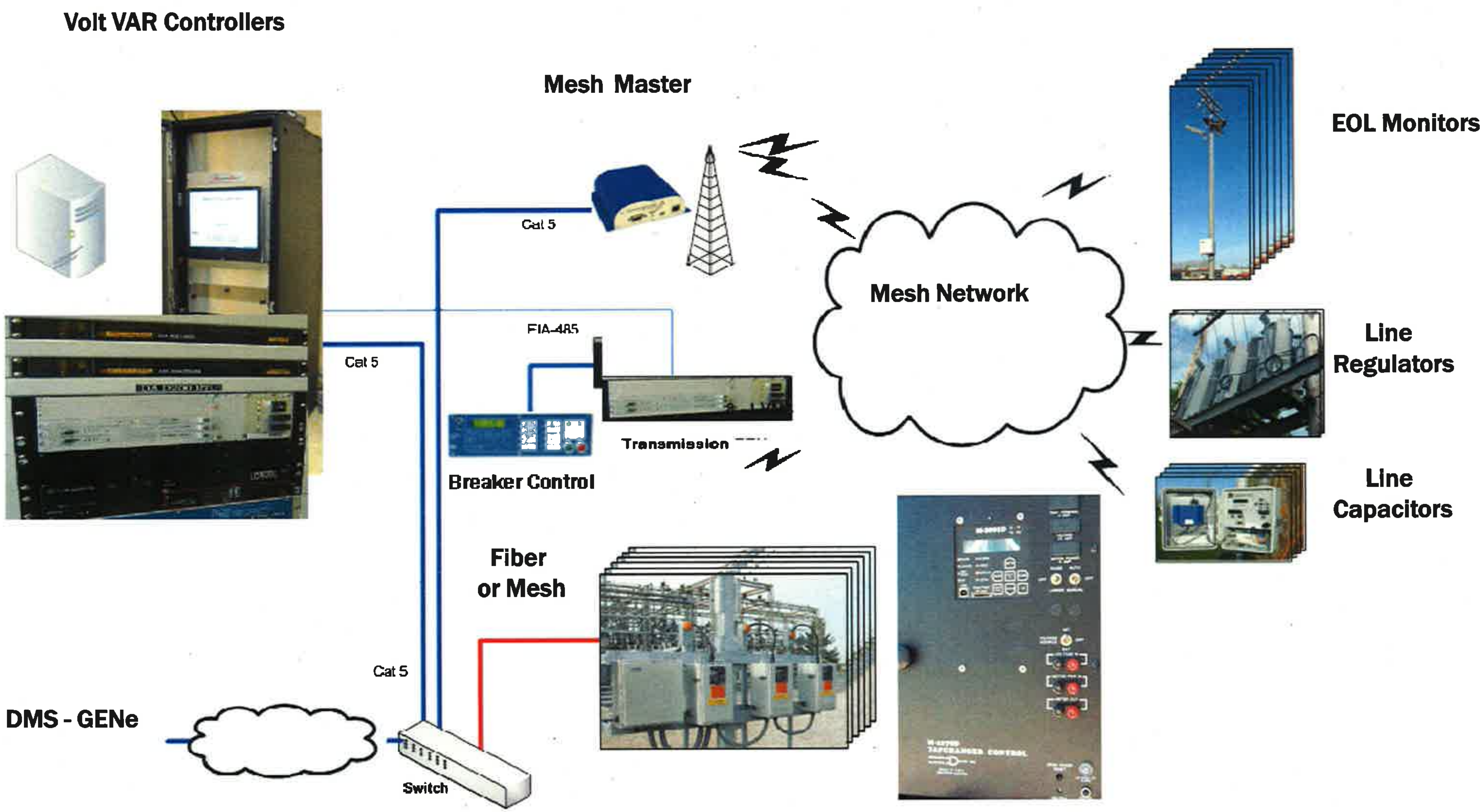


Figure 3-156 Input real and reactive power as a function of applied voltage for motor No.1, mfr. A, with constant torque loads.

Real Power consumption is 8% lower @ 115V than at 125V

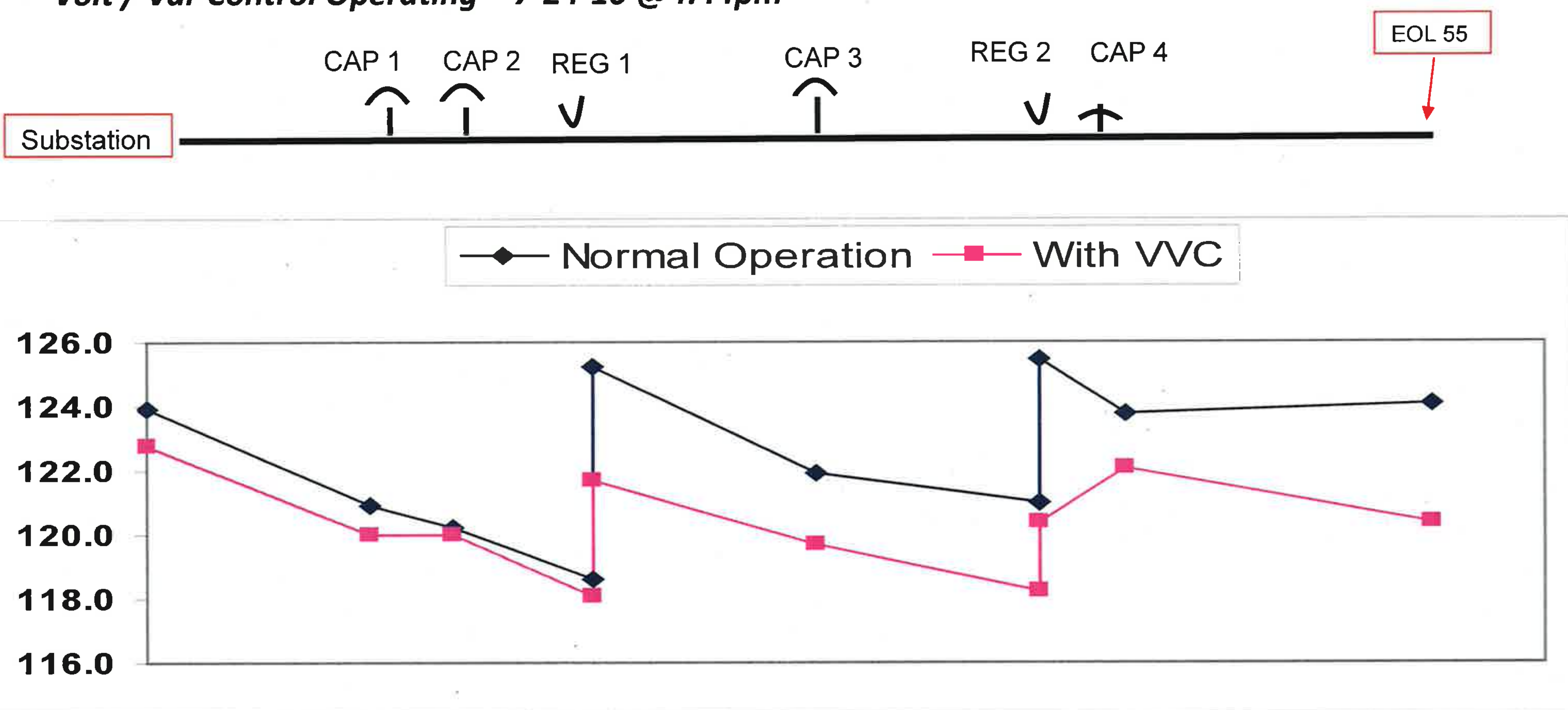
Volt VAR Optimization Architecture



AEP Ohio: East Broad – 1406 Voltage Profile

Normal Operation = 7-23-10 @4:44pm

Volt / Var Control Operating = 7-24-10 @4:44pm



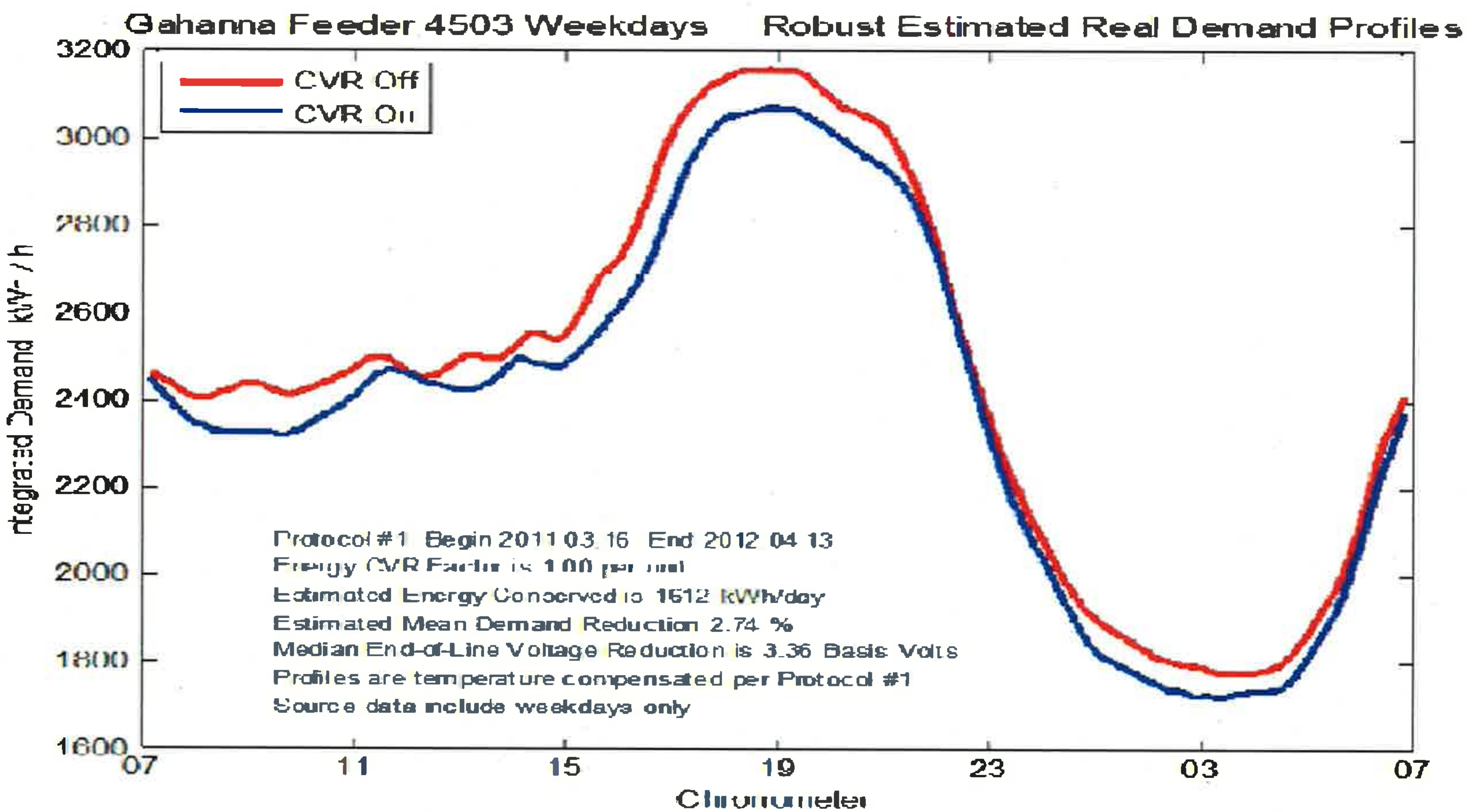
AMERICAN ELECTRIC POWER

Demand and Energy Reduction Results

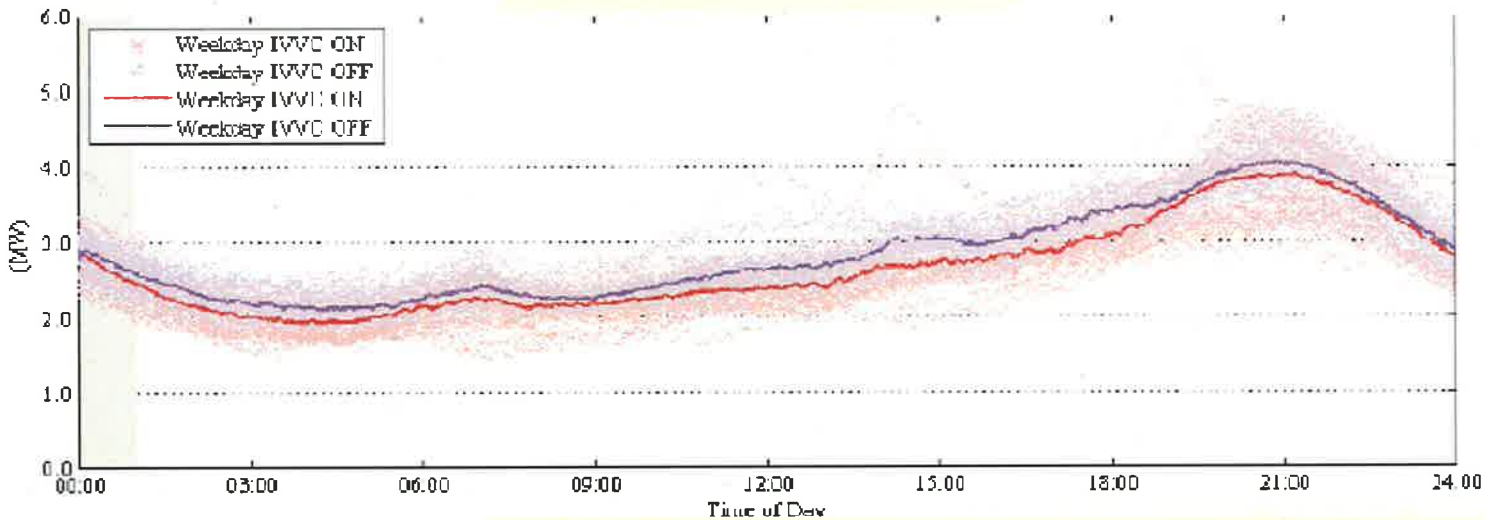
- **VVO technology works as-expected**
  - Testing demonstrates ~2-4% energy and demand reduction is achievable.

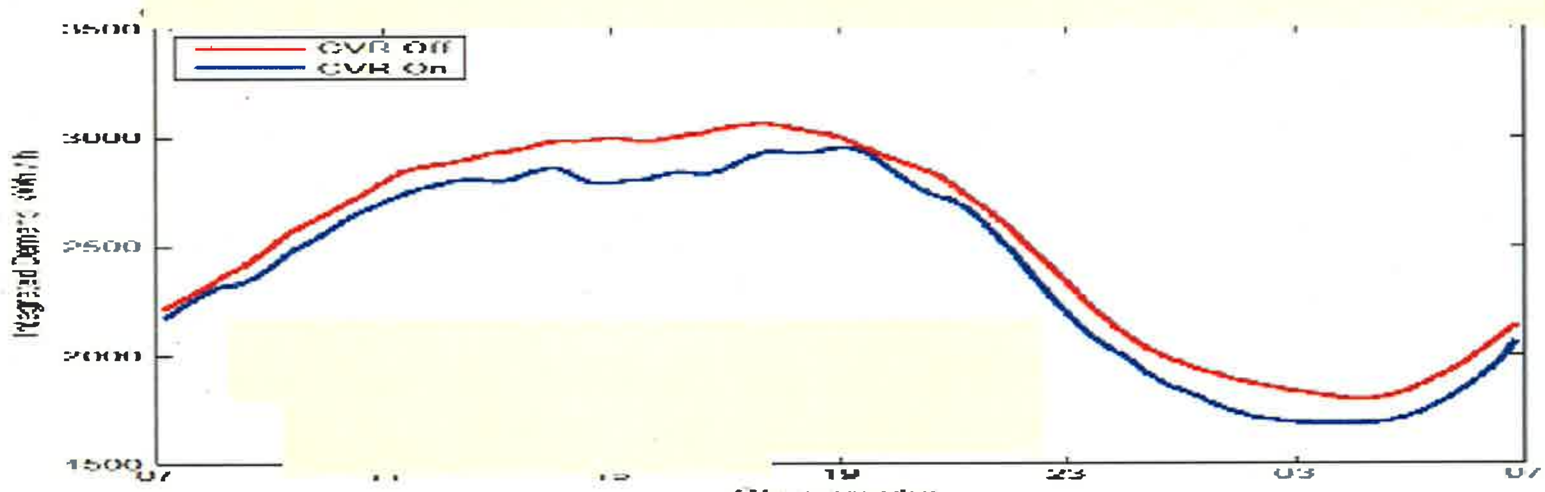
Circuit Level Results Averaged Across 11 Circuits	Industry Experience	Battelle Projections AEP Ohio Project	Initial Results AEP Ohio Project
Customer Energy Reduction	2.0%	3.3%	2.9%
Customer Peak Demand Reduction	2.0%	3.0%	2 - 3 %

Example of Energy Savings on Circuit 4503 using Utilidata AdaptiVolt System



Circuit Performance





Customer Demand and Energy Savings

1,056 KW
607,600 kwh

1,034 KW
595,448 kwh

Volt VAR Optimization will reduce customer peak demand and energy consumption

VVO for Energy Efficiency / Capacity Reduction

- **Energy Efficiency (24/7 Operation)**
  - Help meet state Energy Efficiency targets
  - Receive incentives / participate in DR markets
  - TRCs 2 to 3 – better than many current programs
  - Reduce Energy Consumption by Customers
  - Not limited by "participation rates"
  - Reduce Emissions
  - Relieve Transmission Congestion

Levelized cost of VVO is in the low part of the Energy Efficiency range due to low initial capital cost and no on-going fuel cost

- **Capacity (Demand Reduction Only)**
  - Reduce amount of capacity required at peak / critical times
  - Short payback period if generation charges are based on peak demand
  - Defer investment in capacity replacement or upgrades
  - Engage in DR Market
  - Relieve Transmission Congestion

Future Application of VVO

- Meet Energy Efficiency Targets
- Evaluate as an energy resource in the IRP
- Evaluate as a Demand Reduction Resource
- Help meet EPA 111D reductions
- Increase ability to host renewable energy resources

gridSMART®

From AEP AMERICAN ELECTRIC POWER®

Questions?

tfweaver@aep.com

ATTACHMENT
DM-3

FirstEnergy Services Corporation

Smart Grid Modernization Initiative

Scope of Work

FirstEnergy Services Corporation's (FirstEnergy's) Smart Grid Modernization Initiative (SGMI) involved deployment of advanced metering infrastructure (AMI), distribution automation (DA), volt/VAR optimization (VVO), time-based rate programs, direct load control (DLC) devices, and customer systems in parts of New Jersey, Ohio, and Pennsylvania. SGMI's Ohio footprint covered a 400-square-mile area southeast of Cleveland. Smart meters were piloted in Ohio, and a statistically rigorous study assessed load impacts and customer acceptance of time-based rate programs. DA equipment deployed in New Jersey, Ohio, and Pennsylvania included reclosers, capacitor banks and grid sensing devices. VVO equipment, deployed in Ohio and Pennsylvania, included capacitor banks and load tap changer regulator controls. Advanced load control devices were deployed in New Jersey and Pennsylvania.

Objectives

FirstEnergy aimed to enable customers' informed participation in electricity consumption management, improve power quality and operational monitoring capabilities, optimize asset utilization and operating efficiencies, evaluate wireless network technologies, and better predict and respond to abnormal system conditions.

Deployed Smart Grid Technologies

- **Communications infrastructure:** FirstEnergy deployed various network infrastructures to create a communications system within each deployment location. Each system consists of public code division multiple accesses (CDMA) technology, fiber optics, public and private spectrum networks, and radio frequency (RF) mesh network technology with pole-mounted concentrators. The various systems facilitate communications between centralized software systems and a wide range of AMI, DA, and DLC field devices.
- **Advanced metering infrastructure:** FirstEnergy deployed 34,309 smart meters for residential and commercial customers, enabling two-way communication between the utility, meters, and in-home technologies that provide customers with energy usage information. The smart meters provide FirstEnergy with data used for more detailed load profile analysis and demand forecasting.

At-A-Glance

Recipient: FirstEnergy Services Corporation

State: New Jersey, Ohio, and Pennsylvania

NERC Region: ReliabilityFirst Council

Total Project Cost: $114,940,274

Total Federal Share: $57,470,137

Key Partners: Cleveland Electric Illuminating Company, Jersey Central Power & Light Company, Metropolitan Edison Company

Project Type: Advanced Metering Infrastructure
Customer Systems
Electric Distribution Systems

Equipment

- 34,309 Smart Meters
- AMI Communications Systems (RF Mesh)
- Backhaul Network (Fiber and Cellular)
- Home Area Networks
- 720 In-Home Displays
- 535 Programmable Communicating Thermostats
- 37,721 Direct Load Control Devices
- Upgrades to 64 Distribution Automation Circuits
  - 172 Automated Distribution Circuit Reclosers
- Upgrades to 46 VVO Circuits
  - 187 Automated Capacitors
  - 4 Automated Voltage Regulators
  - 236 Equipment Condition Monitors
- Distribution Automation Communications Network
- SCADA Communications Network

Time-Based Rate Programs (a pilot study)

- Peak-Time Rebate
- Critical Peak Pricing (opt-in)

Key Benefits

- Reduced Operating and Maintenance Costs
- Improved Electric Service Reliability and Power Quality
- Reduced Distribution Line Losses

- **Distribution automation and volt/VAR optimization systems:** FirstEnergy implemented a centralized software tool for DA system control of automated feeder devices for 64 distribution circuits. Technology upgrades included supervisory control and data acquisition (SCADA) displays for substation breakers and field devices. The tool enables integrated voltage control and reactive power from capacitor controllers, line capacitor switches, load tap changers, and regulators for 46 circuits and facilitates optimization of distribution circuit voltages, increasing efficiency and improving power quality.
- **Time-based rate programs:** Project partner Cleveland Electric Illuminating Company (CEI) offered peak-time rebates and opt-in critical peak pricing in conjunction with the AMI deployment. Peak-time rebates offer a financial incentive for electricity customers to lower their peak demand, while critical peak pricing provides a higher on-peak price signal to induce demand reductions. Both options involve day-ahead notifications of higher on-peak prices/rebate opportunities.
- **Advanced electricity service options:** CEI customers participating in the consumer behavior study were provided with in-home displays, programmable communicating thermostats, and direct load control devices (see Consumer Behavior Study below). These technologies facilitate two-way information exchange and enable customers to better manage their electricity use and bills.
- **Direct load control devices:** FirstEnergy installed almost 38,000 units and supporting communications infrastructure throughout Jersey Central Power & Light Company's (JCP&L's) and Metropolitan Edison Company's (Met-Ed's) service territories, allowing the utilities to control air conditioner settings remotely. Participating customers received financial incentives in exchange for allowing the utility to raise thermostat set points by either six degrees or nine degrees.

Consumer Behavior Study

This study involves more than 34,000 CEI customers. Various rate and enabling technology combinations were tested to assess load impacts and customer acceptance in a randomized control design with treatment and control groups. Rate programs were two opt-out peak-time rebate options and an opt-in critical peak pricing option. FirstEnergy deployed enabling technologies to support the study: power switches, in-home displays, and programmable thermostats (either utility-controlled or customer-controlled, depending on customer preference). Customer energy usage information is available through a web portal. Notification methods included e-mail, phone, and text messaging. Deployment for the study is complete, but the project is still conducting results analysis.

Benefits Realized

- **Improved distribution system reliability:** The distribution automation capabilities include remote restoration, which reduces the number of customer minutes interrupted. The interaction between the energy management system (EMS), automated reclosers, and grid sensors enables the EMS to model grid status and evaluate potential power restoration options. The EMS can automatically select and execute the optimal restoration plan to improve distribution system reliability and decrease outage duration.
- **Improved power quality:** The distribution management system coordinates the operation of automated capacitor banks and voltage regulators to optimize power quality and to reduce energy losses in the distribution system.
- **Lowered peak demand:** Pennsylvania and New Jersey have lowered peak time power usage with direct load control devices adpoted by their customer through their voluntary integrated distributed energy resource (IDER)/direct load control program. During forecasted peak demand times, the load control devices cycle appliances that are heavy energy users, such as air conditioners.

- **Increased customer engagement:** Direct load control and a pilot time-based rate program provided service options to customers, providing information they could use to assess their energy usage and associated costs.

Lessons Learned

Through the grant-funded deployment, FirstEnergy identified many best practices and opportunities for improved implementation experience in the future. Examples include:

- Test alternative baseline calculations.
- Employ a smoothing strategy to reduce snapback on company-controlled devices.
- Test network communications design rigorously before equipment installation.
- Collaborate with vendors to modify design and operations.
- Be prepared for integration of real-time solutions (e.g., integrating DA and volt/VAR control systems onto the existing EMS system), as this effort is often more complex than initially anticipated.

Future Plans

FirstEnergy will continue its smart grid efforts through the following:

- Substantiate operating impacts, including maintenance cost reductions, improved reliability, and reduced carbon emissions.
- Complete analysis of pilot network communications technologies (DA, VVO, AMI, and IDER), and assess them for potential cross-cutting applications.
- Evaluate scalability of all tested smart grid technologies to larger customer populations.
- Rank order capital projects to modernize the utility distribution system.
- Continue assessing cyber security risks and developing suitable mitigation plans in accordance with industry standards.

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