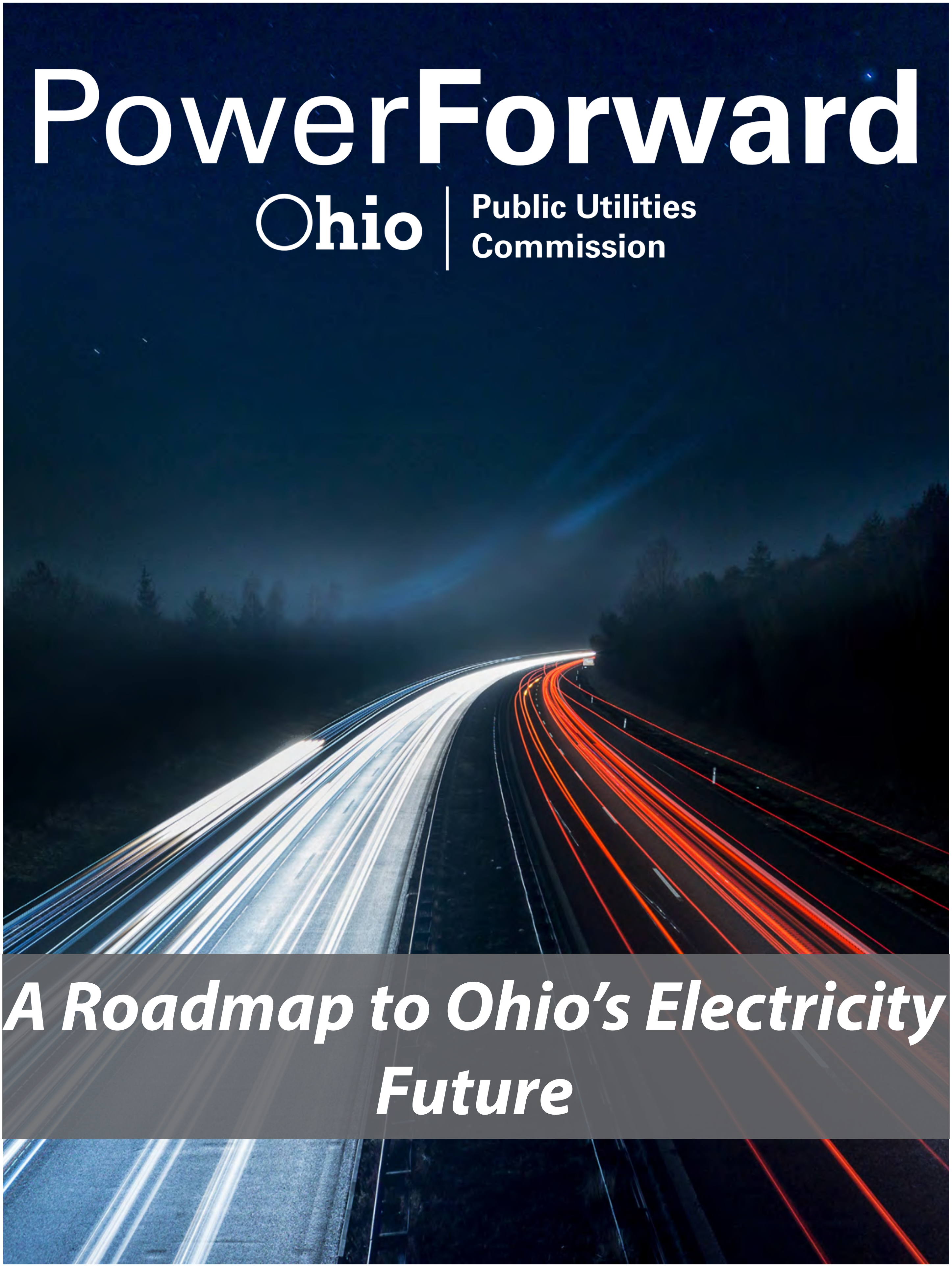
PowerForward

Ohio | Public Utilities Commission



A Roadmap to Ohio's Electricity Future

PowerForward

Ohio | Public Utilities Commission

"Ohio is known as the nation's test market, a reputation generally reserved for restaurants and grocery stores. But it's also a **proving ground for energy policy.**" COLUMBUS BUSINESS FIRST

"Still, the **open forum and welcoming of diverse, innovative ideas** puts Ohio on the leading edge of states striving to achieve the 'utility of the future.'" FORBES

"Through their work so far, the PUCO has shown the value in bringing stakeholders to the table and in establishing an end-vision for **transforming Ohio's electricity system.**"
ADVANCED ENERGY ECONOMY

PowerForward

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Executive summary and acknowlegements

Electric utility regulation in the state of Ohio has undergone a dramatic shift over the past two decades. Historically, the Public Utilities Commission of Ohio (PUCO) has been a body that regulated both electric generation and distribution service in the state. After close to two decades of transition, Ohio is a "restructured" state, and the bones of both the wholesale and retail generation markets have been formed. Each of our four electric distribution utilities (EDUs) has taken measures to divest its affiliate-owned generating units, and without future action from our General Assembly, the PUCO is, broadly speaking, out of the generation business.

The PUCO has shifted its focus to the distribution system and, specifically, how the distribution system can be improved through innovation to better the lives of Ohioans. Hence, PowerForward. PowerForward is the PUCO's grid modernization endeavor built upon the pairing of two pillars: (i) innovation; and the concept that this innovation should serve to (ii) enhance the customer electricity experience. The PUCO is not interested in innovation simply for the sake of exploring the wonderment of new things. It is interested only in innovation that will enhance the electricity experience for customers.

PowerForward consisted of three phases. Summaries of the phases are set forth in this document. These phases were designed to lead the state through a very linear discussion of the concept of grid modernization. We began with the business case for pursuing grid modernization, then conducted a deep dive into the engineering of the grid, and then went on to discuss the elements that would create the modern grid along with the ratemaking/rate design that would best accompany this evolution.

In total, the PUCO hosted **127** speakers and received approximately **100** hours of education through the three phases of PowerForward. This, in and of itself, is a victory for the PUCO and the state. Commissioners and staff were deeply engaged every hour of the three phases, and the knowledge bank that has now been developed at this agency and archived on the PUCO website for public consumption has value that is incalculable. We are forever grateful to our speakers, many of whom traveled from across the country, for their willingness to educate the Commission and staff without promise of a particular outcome. Our hope is that this document does justice to their goodwill.

This roadmap will serve not only to summarize what we learned, but it will set forth certain policy positions, outline principles and objectives, and express a vision to allow the state to pursue grid modernization responsibly.

The PowerForward Roadmap:

Creates a regulatory paradigm that will allow for innovation to reach all customers cost effectively while maintaining the delivery of safe and reliable power.

Envisions the distribution grid as a secure and open access platform that allows for customer applications to interface seamlessly with it.

Continues through the PowerForward Collaborative and associated work groups to monitor the marketplace and present recommendations to the Commission on evolving issues like electric vehicle charging stations, battery storage, distribution system planning and data access.

Informs future utility regulatory filings and proceedings in order for electric distribution utilities to advance in grid modernization initiatives.

It is important to acknowledge that our efforts thus far through PowerForward are just the start of a many decades long conversation about the future of electric distribution utility service for Ohioans. Innovation, both as a concept and in practical application, is evolutionary in nature. Very simply, we don't know what we don't know.

At the same time, there are some initial consensus investments that can be made, market parameters that can inform investment, and general guidance that can be provided to our stakeholders to make the evaluation of grid modernization applications easier. We address these topics, and many others, in this document.

It is also important to acknowledge that the Commission fully understands its role in this space. We are not trying to create, manufacture and distribute, for example, the iPhone. We are trying to create the regulatory environment that will allow for the electric grid's version of the iPhone to be deployed seamlessly and cost-effectively to customers.

This roadmap is informed by the national expertise provided to us at PowerForward, but that information was run through an Ohio filter. This document represents what we believe to be the right path for Ohio. No final decisions are made in this document;[1] and again, we understand that grid modernization will be an iterative experience. As such, the Commission's opinion on any item discussed in this document could change. This document is not binding on this Commission, or any future Commission. The Commission will consider further action in appropriate dockets. This is, however, a very well educated start. To ensure that we are evolving along with the industry, this roadmap envisions the creation of a PowerForward Collaborative along with a few specifically tailored work groups.

I would be remiss if I didn't acknowledge the work of my fellow commissioners along with the staff in advancing PowerForward. Vice-Chair Beth Trombold led our internal planning team, and PowerForward would not have been a success were it not for her diligence in ensuring that the phases were carefully planned and seamlessly executed. Commissioners Tom Johnson, Larry Friedeman, and Dan Conway are thought-leaders in this state who brought to PowerForward their varied and deep individual experiences. I am grateful for the commissioners' willingness to take this journey, and to so essentially contribute to its success.

1 The Commission issues this policy document to provide guidance to interested stakeholders regarding the future of grid modernization in this state. Although this document represents the Commission's vision for grid modernization and outlines a process for moving forward, nothing in this policy document should be construed as binding upon the Commission in any future case before the Commission. Rather, any future decisions on grid modernization will be based upon the specific facts and circumstances in each case after all interested stakeholders have had a full and fair opportunity to participate.

I promoted Krystina Schaefer, Chief of Grid Modernization and Security, into her role just a few years ago and she has exceeded every expectation. Kristin Clingan worked tirelessly to ensure PowerForward's success. Chief Analyst Howard Petricoff contributed to PowerForward, but were it not for his brilliance representing staff in our challenging case work, we would not have had the time, nor the bandwidth to launch and execute this endeavor. Many of our technical staff contributed to Howard's efforts as well, performing their day jobs with excellence so others could devote time to PowerForward. Our public affairs and media team operated exceptionally in promoting PowerForward, making it look very professional and making it accessible to our *millions* of followers. Our legal team provided thoughtful advice, our technical staff's knowledge was on display as either questioner or presenter, and our commission aides hustled from one task to the next … it was truly a team effort. I could not be more proud of them and of this agency.

And with this as our backdrop, we move the state forward—from a systematic regulatory paradigm of the past, through the challenging waters of deregulation, and now into a very bright future where we embrace innovation and change for the betterment of Ohioans. It is bold. But it is also our duty.

Very truly yours,

Chairman Asim Z. Haque
August 29, 2018

Glossary of Terms

ADMS	Advanced distribution management system
AMI	Advanced metering infrastructure
CAIDI	Customer average interruption duration index
CEUD	Customer energy usage data
CHP	Combined heat and power
CRES	Competitive retail electric service
CVR	Conservation voltage reduction
DACR	Distribution automation circuit reconfiguration
DC	Direct current
DER	Distributed energy resource
DERMS	Distributed energy resource management system
DG	Distributed generation
DR	Demand response
DRMS	Demand response management system
DWG	Data and the Modern Grid Workgroup
EDI	Electronic data interchange
EDU	Electric distribution utility
EE	Energy efficiency
ESP	Electric security plan
EV	Electric vehicle
FERC	Federal Energy Regulatory Commission
HAN	Home area network
HCA	Hosting capacity analyses
IDP	Integrated distribution planning
IDR	Interval data recorder
IT/OT	Information technology and operational technology
kWh	Kilowatt hour
MRO	Market rate offer
NARUC	National Association of Regulatory Utility Commissioners
NIST	National Institute of Standards and Technology
NSPL	Network service peak load
NWA	Non-wires alternative
OMS	Operation management system
PBR	Performance based ratemaking
PDR	Peak demand reduction
PLC	Peak load contribution
PUCO	Public Utilities Commission of Ohio
PV	Photovoltaic
PWG	Distribution System Planning Workgroup
RAP	Regulatory Assistance Project
RPC	Revenue per customer
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SCADA	Supervisory control and data acquisition
SFV	Straight fixed/variable
SSO	Standard service offer
THEO	Total hourly energy obligation
TOU	Time of use
U.S. DOE	U.S. Department of Energy
VAR	Volt-ampere reactive
VVC	Volt/VAR control
VVO	Volt/VAR optimization

Principles

Foundational tenets to guide PUCO grid modernization decisions

Do No Harm

Maintain the delivery of safe, reliable electric service at fair prices while the industry advances in grid modernization.

Provide Net Value to Customers

Insist that EDUs spend ratepayer dollars wisely and in a manner that delivers eventual net value to the customer.

Create an Environment that Fosters Innovation

Support and develop opportunities within the stakeholder community and at the PUCO that fosters innovation in technology and regulation.

Enhance the Experience for All

Ensure that investments and the environment fostered create societal benefit and allow for an enhanced customer electricity experience accessible to all customers.

Objectives

Desired outcomes from PUCO grid modernization decisions

A Strong Grid

A distribution grid that is reliable and resilient, optimized and efficient and planned in a manner that recognizes the necessity of a changing architectural paradigm.

The Grid as a Platform

A modern grid that serves as a secure open access platform—firm in concept and as uniform across our utilities as possible—that allows for varied and constantly evolving applications to seamlessly interface with the platform.

A Robust Marketplace

A marketplace that allows for innovative products and services to arise organically and be delivered seamlessly to customers by the entities of their choosing.

The Customer's Way

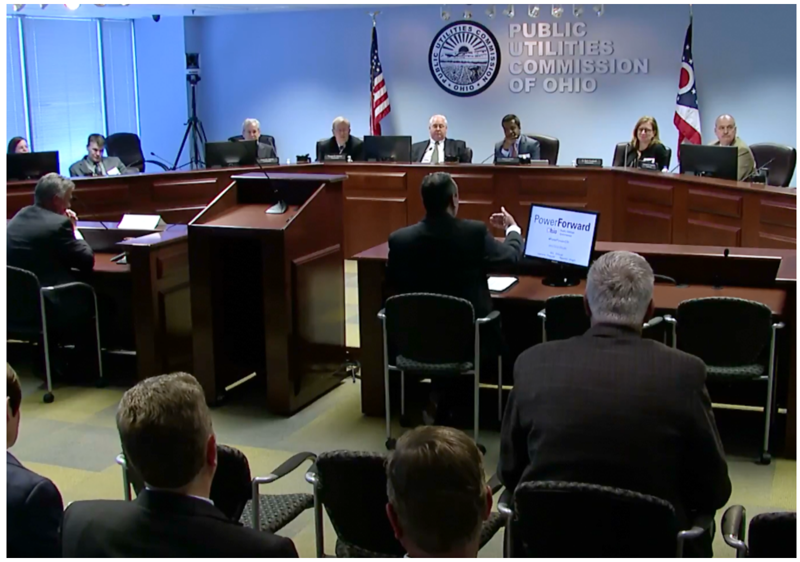
An enhanced experience of the customer's choosing on the application side, whether for reasons arising from financial, convenience, control, environmental or any other chosen consideration.

Phase Summaries[1]

PHASE 1: A GLIMPSE OF THE FUTURE

During this first phase, the Commission heard from a mix of speakers spanning the gamut of entities operating within the electric industry. These speakers developed the business case for PowerForward and modernization of the electric grid. This glimpse of the future envisions an electric grid where power and data flows both from the incumbent distribution utility to the customer, but also from the customer to the utility, yielding more transparent information about customer desires.

Early in the first phase, the Commission heard about customer segmentation and developed an understanding of the characteristics of these customer segments. There are a few distinct groupings of customers that have become readily identifiable, including those customers who are tech savvy, those customers who want status quo service, those customers who want clean energy/tech, and those customers who are savings seekers. Concurrently, we heard about naturally changing customer demographics. Customers entering the electric bill paying sphere have never experienced life without internet connectivity, and they expect a level of engagement with their service providers that is more embracing and informative than a 30-day backwards look. In this not so distant future of the electric grid, customers will demand more control over their electric bill, more instantaneous services like those provided in other sectors (e.g. mobile banking apps), and different means of communication with utilities and service providers.



The Commission also heard presentations from companies that offer products enabled by the modern grid. These included several smart technologies that can provide customers with avenues to reduce their bills as well as distributed energy resources (DERs)[2] that can be integrated into the grid. However, none of these technologies can reach their full potential without the appropriate regulatory framework. Upgrades to physical infrastructure are also needed to support the electronic network of the future. As we heard, a strong grid is necessary before Ohio can have a smart grid.

The first phase closed with presentations from Ohio stakeholders. Representatives from Ohio's EDUs provided a brief snapshot into the current state of modernization in their respective service territories. These speakers stressed the desire for utility companies to evolve the electric grid into a platform integrating limitless new technologies and services. Other local panelists identified some of these new services, many of which require the use of customer data.

Speakers opined that while some customers will be reluctant to provide data to these service providers, the incentives (e.g. possible bill reductions) will make

1 The Commission has taken into consideration all of the presentations in the three phases of PowerForward given by 127 speakers. This summary is not meant to supersede the record of web recordings and presentations available at www.PUCO.ohio.gov.

2 The National Association of Regulatory Utility Commissioners (NARUC) defines a distributed energy resource as a "resource sited close to customers that can provide all or some of their immediate electric and power needs and can also be used by the system to either reduce demand (such as energy efficiency) or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid. The resources, if providing electricity or thermal energy, are small in scale, connected to the distribution system, and close to load. Examples of different types of DERs include solar photovoltaic (PV), wind, combined heat and power (CHP), energy storage, demand response (DR), electric vehicles (EVs), microgrids, and energy efficiency (EE)." NARUC, *NARUC Manual on Distributed Energy Resources Rate Design and Compensation* (Nov. 2016) at 45, available at https://www.naruc.org/rate-design/.

customers more willing. A robust discussion was also held about the cost of grid modernization, with the Commission noting its own concerns about cost.

PHASE 2: EXPLORING TECHNOLOGIES

In the second phase of PowerForward, speakers educated the Commission about grid architecture, which is the engineering associated with the cyber-physical grid, and how this architecture must evolve to support the modern grid. Education of this kind is necessary to understand the investments required to advance the Commission's objectives articulated in this roadmap. The focus of several presentations was the benefit of defining the grid as a platform, and determining which parts of the overall electric ecosystem belong to the utility's core platform and which components are market driven add-ons.

A recurring discussion involved the importance of utilizing standards for communication systems and other components of grid architecture. New technologies responsive to changing consumer demands must communicate with and operate alongside legacy components. This becomes more difficult for products on the edge of the platform's layers. The difficulty with these products is that they are not owned by the EDUs and are therefore beyond direct utility monitoring and control. Consequently, the use of common standards for communication systems and other components of the grid is important.

Another important theme discussed in this phase is the continuing convergence of Information Technology and Operational Technology (IT/OT Convergence). These two concepts, and the personnel associated with each, have different priorities. Demands of the modern grid will require these areas to combine efforts, but a forced combination within utility operators could create culture clashes. These clashes and other dangers associated with the convergence (e.g. potential cybersecurity breaches) can be mitigated through the use of network cyber security technology, a change in management practices and employee education.

Other panels focused on specific technologies that can be used to improve reliability, reduce usage and accomplish modernization goals. These technologies include advanced metering infrastructure (AMI), distribution automation circuit reconfiguration (DACR), Volt/VAR optimization (VVO) and control (VVC), conservation voltage reduction (CVR), DERs, and storage. Investing in each of these technologies could provide meaningful benefits to customers, but speakers cautioned that investments should be made according to a single, statewide regulatory framework based on cost/benefit analyses. Many of these technologies are designed to accomplish the goal of moving toward a grid with multidirectional power flow and multidirectional communication.

PHASE 3: RATEMAKING AND REGULATION

The final, two week phase of PowerForward further discussed platform elements for the modern grid as well as traditional areas of regulation that the Commission will need to address in order to advance the modern grid. Specific topics addressed in the third phase included distribution system planning, operations and markets. It also included ratemaking, rate design, data and cybersecurity.

As to distribution system planning, the incumbent distribution utilities each expressed engineering difficulties associated with DERs operating in a system that was designed to accommodate a one-way flow of electricity from large centralized power plants. Because of their broad knowledge of the entire system, the utilities stressed the

importance of controlling the distribution planning process, but also expressed a desire to expand their businesses to include new and innovative services. Other panelists opined that potential voltage problems created by DERs integration can be solved by making the integration part of the planning process and creating a larger working group to identify new inputs during that process.

As to distribution system operations, a full day of discussion was devoted to two cutting-edge technologies that may provide both challenges and opportunities for the distribution system—electric vehicles (EVs) and energy storage. Several stakeholders presented evidence to inform the Commission that certain factors have led to an emergence of EVs. EVs could impact load requirements in a unique way. Stakeholders advocated that utilities will need to play a role in EV charging to mitigate load problems and may need to play a role in advancing the EV marketplace. A thorough discussion was also had about the benefits of energy storage. Storage has many uses including shaving peak load requirements, providing back up during outages and balancing voltage levels to maintain reliability.

As to distribution system markets, the discussion began with a review of Ohio's current market structure, monopolistic versus competitive service, and the marketplace that could be created to deploy innovation to customers. The Commission heard from Ohio stakeholders about the role that EDUs, competitive retail electric service (CRES) providers and other third parties could play in these markets. The Commission also engaged in a discussion with representatives from academia and independent think tanks about distribution level markets, and other market models that could best ensure that the full benefits of innovation are realized by customers.

The Commission further engaged in a discussion surrounding data collection, accessibility, usage and privacy. The Commission heard from speakers about Ohio's current treatment of customer data, how data is collected through the use of AMI, as well as some lessons learned from other states' handling of privacy concerns. EDUs currently house and protect all information about customer usage. This data could be used by multiple entities to provide services that will enhance the customer experience. The Commission was urged to carefully craft a means of access for these service providers in a way that respects the privacy of individual customers while still enabling new products and services in the retail market.

The Commission requested that expert panelists discuss cybersecurity and efforts our EDUs undertake to protect Ohio consumers from this ever evolving threat. As new technologies develop, new touch points are added to the grid. Each of these touch points needs to address vulnerabilities, so that potential threats can be mitigated. This is achieved by the EDUs, and those entities providing services to the grid, through education, risk management systems and certain defensive strategies. The Commission and panelists discussed what role, if any, the Commission should play in this growing challenge.

Ratemaking, especially performance based ratemaking, can be used as a framework to create incentives and disincentives for certain behaviors.

Presenters in the final days of PowerForward focused on ratemaking and rate design. Ratemaking, especially performance based ratemaking, can be used as a framework to create incentives and disincentives for certain behaviors. Several presenters stated that if the Commission would like to retool its methods of ratemaking, it should first clearly outline desired goals. From there, incentives to reach these goals can be carefully crafted to benefit customers as well as utility companies. Utilities and many other panelists urged the Commission to treat some investments made to modernize the grid as capital expenditures instead of operation and maintenance expenditures. Other speakers cautioned the Commission to draw clear lines between investments that can be made by the utilities and those that can be provided by the market.

The final topic discussed was rate design. Specifically, speakers analyzed methods of addressing the utility throughput incentive, DERs valuation, and the importance of customers understanding rates and how to respond. Utilities prefer moving to a straight/fixed variable (SFV) method, but several presenters preferred another decoupling method that provides for greater control over customer bills for those willing to reduce consumption. Speakers recognized that it is not always easy to align innovative products with the underlying principles of cost causation, but future rates should move beyond this basic principle and empower customers to make informed choices about their energy usage. For example, the Commission heard about innovative rate designs including block and index rates, which combine the advanced purchase of a representative usage profile for a fixed cost with marginal cost pricing for incremental increases or reductions in use, and subscription rates, which provide a flexible approach for efficiently recovering utility revenue requirements in excess of marginal cost. However, the Commission was urged to be careful in making rate design decisions. It was argued by some panelists that these decisions should be unveiled through pilot programs that are thereafter analyzed, and that rate design changes will not be successful without targeted consumer education.

Components of the Modern Grid

THE PLATFORM CONCEPT

A platform can have many elements and purposes, but the concept is structural: how system elements are grouped, organized and related to each other.

A platform is a set of components or services that creates a common foundation for some set of activities. It is a stable collection of components that provide fundamental or commonly needed capabilities and services to a variable set of uses or applications through well-defined interoperable interfaces.[1] The platform is relatively stable over time, while the applications may change frequently.

Many platforms are focused on connecting and facilitating transactions between consumers and producers, and their proliferation across many sectors of our economy is easy to see. Take the web platform for a ride sharing application like Uber or Lyft, for example. Taxi companies transport passengers, but Uber, a technology company, simply connects drivers with passengers. The Uber web platform team builds the foundation for all Uber web applications and is responsible for providing a secure and reliable web ecosystem for riders and drivers (who are not employed by Uber).[2]

What does Uber's platform offer that traditional taxi cabs do not? Uber uses software and data analytics to move the provision of transport service to a new level: payment infrastructure to make transactions smoother; identity infrastructure to screen passengers and drivers; sensor infrastructure, present on smartphones, to trace the location of cars and customers in real time; and pricing infrastructure that uses dynamic pricing based on supply and demand.

In other examples, content platforms, like YouTube and Twitter, create an integrated set of tools for publishing and posting digital content. Development platforms, like Android, are designed to enable innovation. Much like personal computers, mobile devices are equipped with hardware and operating systems upon which many applications can be run. Android, the world's largest mobile operating system, is based on open source software, meaning that the software is made available with enough information to enable vendors/manufacturers to develop customized applications to run on it.

Across these examples, the foundational platform is the same for all users. An Uber or Twitter or YouTube user in Columbus will access the platforms in the same manner as a user in Pittsburgh or New York. Personal computers and cell phones come with standard hardware and an operating system that is the same as other equivalent devices sold. Therefore, a user can customize each product individually.

One of the objectives of PowerForward is to reconsider the distribution grid as a platform that creates the opportunity for entities to provide innovative products and services to customers. Additionally, a foundational component of a platform is the network that connects all the users of the platform. This reconsideration includes viewing the grid as a network that supports the platform concept. Conceptualizing the grid as a network and platform also expands its value by enabling the intergration of DERs that can be used as a grid resource.

The distribution system platform will necessarily have an underlying architecture that must be deployed to support it. The following section discusses this architecture. From there, we view the platform as having three additional interacting components: planning, operations and markets. Those components are also explored herein.

1 Jeff Taft, *Platforms for Electric Grids: Grid Architecture View* (July 25, 2017) at 8, available at https://www.puco.ohio.gov/puco/assets/File/1_Taft.pdf (emphasis added).

2 The same business model applies to other common transactional platforms like Airbnb, Etsy, eBay, and PayPal.

THE PLATFORM: GRID ARCHITECTURE

The U.S. Department of Energy (U.S. DOE) *Modern Distribution Grid Report* identifies the core components needed to establish a cyber-physical platform for the modern grid. These components include: physical infrastructure (e.g. wires, transformers, switches), advanced protection and controls, sensing and situational awareness, operational communications, and planning tools and models (e.g. DERs & load forecasting, power flow analysis).[3] According to the report, this cyber-physical platform is the foundation needed to support applications associated with an operational markets platform, which will be driven, in part, by evolving state policy objectives on grid modernization.

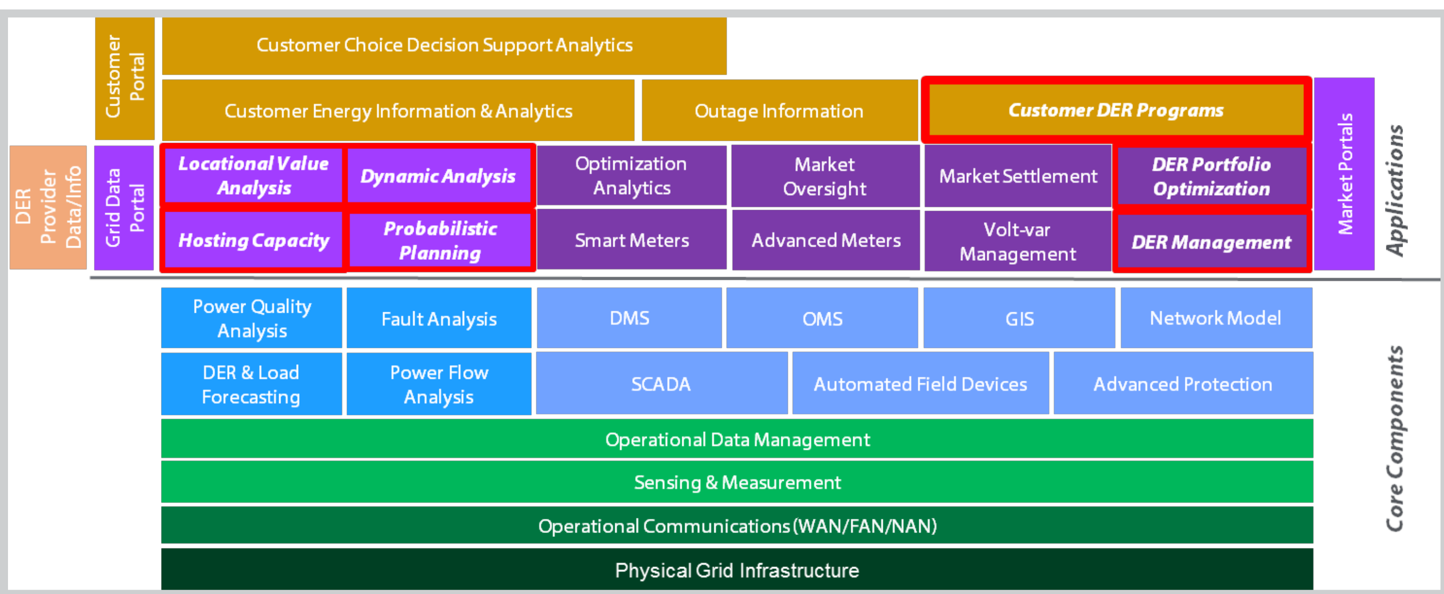
The layering of a cyber-physical platform (core components) with a markets platform and associated applications is referred to by U.S. DOE as the "logical technology stack."[4]

As part of the second phase of PowerForward, Ohio's EDUs provided an assessment of the ability of the current distribution system to support the objectives of a modern grid. Each of the EDUs are in different stages of investing in the core components associated with the cyber-physical platform. Further, because the implementation of various technologies to date has not been in response to a holistic policy on grid modernization, outcomes have not been uniformly achieved.

In order to realize the policy objectives for PowerForward, the Commission believes that each EDU should work towards developing a cyber-physical platform consisting of uniform core components, so that the foundation for customer engagement and market participation in providing innovative products and services is set in the state. The goal of a uniform platform is to enable a variety of market opportunities, regardless of service territory, and to create efficiencies that can be passed along to customers either through the proliferation of a more diverse set of retail market offerings or through cost savings associated with the different types of products and services. Further, utilities should explore whether they can share among themselves some of the investments of the cyber-physical platform, as doing so will promote certain PowerForward principles and objectives.

Figure 1: Next Generation Distribution System Platform & Applications

Objects outlined in red are future considerations



Source: U.S. DOE

3 U.S. DOE, Office of Electricity Delivery & Energy Reliability, *Modern Distribution Grid Report Volume I: Customer and State Policy Driven Functionality* (Mar. 23, 2017); *Volume II: Advanced Technology Maturity Assessment*, (Mar. 20, 2017) (*DOE Report Vol. II*); and *Volume III: Decision Guide* (June 28, 2017) (*DOE Report Vol. III*), available at https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx.

4 *DOE Report Vol. III* at 26.

The following groups of technologies will make up the core components of the platform, which were determined using the framework developed by the U.S. DOE:[5]

Field Automation: Power delivery functions can be more efficiently monitored and controlled in real time with field automation assistance … When system failures occur, automation of the distribution network enables an enhanced ability to pinpoint outage locations and causes in order to restore power swiftly, thus minimizing the frequency and duration of unplanned outages. [6]

- Distribution automation
- Volt-ampere reactive (Volt/VAR) management
- Power flow controllers

Substation Automation: optimize[s] the management of capital assets and enhance[s] operation and maintenance efficiencies with minimal human intervention. [7]

- Substation supervisory control and data acquisition (SCADA)
- Adaptive protection

Operational Communications Infrastructure: is the integration of multiple physical communication technologies—a network of networks—that may include both private infrastructure as well as telecommunication service provider infrastructure.[8]

- Wide area network
- Field area network, including neighborhood area network
- Communications network management system

Sensing and Measurement: Sufficient sensing and data collection can help to assemble an adequate view of the grid state … Sensing and measurement data is also utilized in distribution and system planning.[9]

- Advanced metering infrastructure, including advanced meters
- Production metering
- Grid asset sensors
- Environmental sensors
- Grid sensors

Operational Analytics: [O]perational analytics transform historical and real-time data for the electrical grid into actionable insights for improving operational reliability and efficiencies.[10]

- Field data management
- Electrical network connectivity model
- Distribution state estimation
- Outage management system (OMS)
- Geographic information system
- Meter data management system
- Advanced distribution management system (ADMS)
- Asset management
- Workforce management

It is further noted that, given the restructured retail electricity market in Ohio, standardized access to customer energy usage data (CEUD) for CRES providers and other third parties should be viewed as a fundamental and core component of the platform, along with the deployment of advanced customer metering.

Each EDU has agreed in its most recently approved or currently pending electric security plan (ESP) case to file grid modernization plans. Now that the Commission has a firm understanding of the essential architecture needed to advance the modern grid, it is sensible

5 *DOE Report Vol. II* at 13-14.

6 *Id.* at 36-37.

7 *Id.* at 41-42.

8 *DOE Report Vol. III* at 56, 62-63

9 *DOE Report Vol. II* at 52-54.

10 *Id.* at 56-57.

to obtain the most recent update of where each utility stands with this architecture. Each EDU would file these status updates in a new docket ending in the designation "EL-GRD."

Given the current low level of DERs deployment in Ohio, technologies associated with distributed system planning should continue to be monitored and examined by the working group described in the next section prior to including these technologies as core components in the cyber-physical platform. However, it is appropriate for the EDUs, stakeholders, and the Commission to begin this conversation to ensure that we are collectively staying ahead of the curve as adoption of DERs grows. In addition, as DERs proliferate, the following technological categories should be monitored by the same working group, and may be incorporated into the core components in the future:

- **Distributed resource management (DERMS, DRMS, microgrid interface)**
- **Optimization analytics (DERs optimization)**

After deployment of core grid components and functionality associated with investments in those components have been achieved (e.g. ease of integration of EVs, DERs), the grid should then be run as efficiently as possible utilizing all of these resources. It is anticipated that Ohio will eventually reach a point where we will need to collectively determine how to best optimize all of these demand-side resources simultaneously. This will require further study, the possibility of creating an additional work group, etc.

Finally, complexities of both the core components and platform applications highlight the importance of the concept of interoperability. Interoperability can be defined as the capability of two or more networks, systems, devices, applications, or components to exchange and readily use information—securely, effectively, and with little or no inconvenience to the user.[11] Each EDU should demonstrate how each core component of the proposed cyber-physical platform is interoperable and developed based on, or in support of, existing open standards as part of any application for grid modernization that is filed. This will help to ensure that platform applications may be integrated as seamlessly as possible.

11 U.S. Dept. of Commerce, National Institute of Standards and Technology (NIST), *NIST Special Publication 1108: NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0* (Jan. 2010) at 19, available at https://www.nist.gov/sites/default/files/documents/public_affairs/releases/smartgrid_interoperability_final.pdf.

THE PLATFORM: DISTRIBUTION SYSTEM PLANNING

Technological innovation in the electric industry is driving a decentralization of the grid. Traditional integrated resource and distribution planning are evolving into a more detailed version of distribution system planning, or perhaps more appropriately, into integrated distribution planning (IDP) where utility distribution systems will integrate and responsibly accommodate non-utility assets. Moreover, a natural consequence of technological advancement and decentralization is the proliferation of assets, both physical and digital, which touch the distribution system.

Given the speed with which technology is developing, effective IDP must be both substantively prescriptive in order to provide an articulated action plan, yet procedurally flexible to enable timely adjustment to change. New types of subject matter analyses and increased internal coordination across utility divisions will be required to prepare for change.

> Technological innovation in the electric industry is driving a decentralization of the grid.

An essential first step in the distribution system planning process would be for each EDU to conduct a current-state assessment of their respective distribution system's present capability to integrate and accommodate the broad array of EDU and non-EDU initiatives which will likely occur, and to file this assessment with the Commission for its consideration. The current-state assessment would identify areas of strength and weakness, highlighting those areas in which the distribution system is lacking the necessary infrastructure to assure the provision of adequate and reliable service in a more decentralized environment characterized by a proliferation of DERs, as well as how much visibility the EDUs have into their own distribution systems. Specifically, these current-state assessments should, at a minimum, include the following items for the entire certified territory for each EDU:[1]

- System characteristics, including:
  - Total customers served, AMI coverage (percent of customers and percentage of delivered energy), other interval meter or interval data recorder (IDR) coverage (percent of customers and percentage of delivered energy).
  - Number of circuits and substations, number of circuits serving critical facilities, percent of substations with SCADA, and percent of substations that have been fully or partially automated to IEC 61850 or a comparable standard.
- Overview of the distribution planning process, including frequency, duration and roles/responsibilities of stakeholders involved.
- Categories of projects that result from the planning process, types of projects within each category and percent of expenditures in each category.
- Planning assumptions, including growth rates and design criteria.
- Load and DERs forecasting methods.
- Software tools used for planning, including forecasting, system modeling and mapping, power flow analysis, system protection, and hosting capacity analysis.
- Existing DERs (all types) connected to the distribution system.
- Overview of distributed generation (DG) interconnection processes, including technical screening rules for fast-tracking applications and inclusion of updates to key standards.
- Interconnection request volumes and average time to approve applications.
- Organization structure for planning and interconnection, including number of full-time equivalent employees and descriptions of roles and responsibilities.
- Descriptions of existing and planned energy efficiency and demand response

1 Curt Volkmann, *Integrated Distribution Planning: A Path Forward* (2018) at 20, available at https://gridlab.org/s/IDP-Whitepaper_GridLab.pdf.

programs, and how they are integrated into distribution planning.

- Proposed use cases, methodology and timeline for hosting capacity analyses (HCA) and other relevant analyses.
- Proposed non-wires alternatives (NWA) suitability criteria, identification of candidate capacity, and voltage or reliability projects for NWA pilots.
- Any relevant planned technology investments (e.g. AMI, ADMS) and how they will be used to support or improve distribution planning.

In addition to internal coordination across utility divisions, continuing development of technology and the increased presence of non-EDU stakeholders require collaboration between EDUs and non-EDUs. A collaborative environment is crucial to the IDP process. Ultimately, collaboration will enable new technologies to benefit the grid, and potentially result in lower implementation costs for beneficial NWAs through effective planning, asset optimization and maximization of distribution system efficiencies.

The Commission recommends that a workgroup be created called the Distribution System Planning Workgroup (PWG) to identify issues that currently exist or that may arise in the IDP process. The PWG may develop recommendations to the commission on the following:[2]

- Future scenarios for customer DERs adoption in Ohio, and how these scenarios should be incorporated into EDU forecasting and planning processes.
- Modifications to interconnection standards, including defining required functions and settings for advanced inverters.
- Development of NWA suitability criteria, processes and timeline for implementing NWA opportunities.
- Evaluation of options for procuring NWAs.
- Defining HCA use cases; identifying an appropriate HCA methodology and associated tools and data requirements to satisfy use cases; a timeline for initial HCA analysis and publication of results for each EDU.
- Development of portals for sharing information on peak load forecasts, capital plans, hosting capacity maps, heat maps reflecting locational value and other key data.

THE PLATFORM: DISTRIBUTION SYSTEM OPERATIONS

Planning in and of itself will not ensure that the modern grid operates in a manner that fulfills the PowerForward objectives. Our EDUs are the operators of the distribution system grid, and that duty does not change through PowerForward. However, there are at least two scenarios associated with modern grid operations that will require partnership with the regulator. The first is the scenario where a customer application is advancing such that it could substantially disrupt distribution system operations if not integrated appropriately. The second is the scenario where technology is deployed to better the distribution system, but it is not thought of as a traditional distribution system investment.

We will examine both of these scenarios through a discussion of two pieces of technology that the Commission will inevitably be required to evaluate in the near term—EVs and battery storage. These are but two of what will be many more pieces of technology that will likely present operational quandaries over time, both for our EDUs and the Commission. However, based upon presentations at PowerForward, they are two of the more immediate technologies that we must contend with operationally. How the Commission handles these two technologies through PowerForward, though, can be instructive for future operational issues that may arise. At the very least, the Commission intends to be constructive with EDUs and other stakeholders in determining how to operationally incorporate new technology into the grid that will advance the PowerForward objectives.

Electric Vehicles

During the third phase of PowerForward, numerous references were made to the plans of both domestic and foreign automakers to shift production from

2 Curt Volkmann, *Integrated Distribution Planning: A Path Forward* (2018) at 35, available at https://gridlab.org/s/IDP-Whitepaper_GridLab.pdf.

internal combustion engines to EVs. General Motors indicated that today there are more than 800,000 EVs on American highways and that annual sales from 2016 to 2017 grew at a rate of 26 percent.[3]

As EVs gain greater acceptance, a more substantial deployment of EV charging infrastructure will be necessary. Currently, the average range for an EV is 60 to 120 miles, with a few models reaching 200 to 300 miles per charge.[4] In the absence of additional advances in battery technology, as EVs see greater adoption by customers and take on a more significant role in Ohio's transportation system, EV charging stations must become as ubiquitous as gas stations are today.

Due to the Commission's supervisory role over the electric distribution system of the EDUs, the Commission believes that grid modernization plans developed by the EDUs must address how the existing distribution grid will adapt to meet the anticipated energy and power needs of EVs, so that the societal benefits associated with EV charging can be maximized. First, EDUs will need to assess how they will meet the demand associated with the growth of residential charging stations. Second, the EDUs must address the need for both urban and corridor travel charging stations.

The Commission is aware that home charging stations may have localized impacts on the current distribution grid, notably that an EV that charges during peak hours may put a significant strain on the local transformer or circuit. So far, EV adoption levels have been concentrated in just a few neighborhoods. Given the very low levels of EV home charging at this time, there does not seem to be an immediate need for the Commission to act on this matter in the near term, but we will continue to monitor the growth rates of EV and their impacts on the distribution system.

Based on evidence from other states, we expect to see initial adoption rates for EVs to be clustered within certain cities or neighborhoods. For example, experiences from California and other locales with heavier concentration of EVs show there could be a demand spike in the early evening as vehicle owners return home from work and plug in their cars around the same time period. To address this challenge, suggestions were made that EVs be offered time-of-use (TOU) rates so that EV owners have a price incentive to wait until off-peak hours to charge their EVs.

Because the location of EV charging infrastructure is generally located on the customer's side of the meter, the Commission believes that the EV charging stations should operate within the sphere of a competitive marketplace, especially for home and private business charging. At the same time, because the EV marketplace is in its infancy, there may be justification for limited EDU participation in the development of EV charging infrastructure as discussed herein.

3 Britta Gross, *Ohio: Power Forward EVs and Infrastructure* (Mar. 8, 2018) at 3, available at https://www.puco.ohio.gov/index.cfm?LinkServID=AB0AE6B2-5056-B562-E1E883677C120944.

4 U.S. DOE, Office of Energy Efficiency & Renewable Energy, *All-Electric Vehicles*, https://www.fueleconomy.gov/feg/evtech.shtml.

To facilitate EV adoption across the state, EV charging corridors may be an option to allow for EVs to traverse the state without concerns of running out of charge. However, corridor route charging stations present a chicken and egg conundrum. The private market will not invest in corridor charging stations until EV traffic merits the investment, yet the development of EV traffic may be suppressed until investment in corridor charging stations occurs. The investment for a direct current (DC) fast charger is a pricey endeavor.[5] Level 1 and level 2 chargers, which use single phase power and charge, can take several hours to charge a vehicle.[6] Several hours to charge is not a barrier for home or workplace charging and covers the majority of uses as EV owners can plug in overnight and be ready to go to and from work the next day. However, level 1 and level 2 charging is not suitable for someone seeking to drive long distances that go beyond the current 60 to 120 mile range of an EV charge. Fast chargers can cut the charging time down to the 30-minute range, but they require three phase electric service. Three phase service is not widely available in rural areas or outside of areas where the distribution system is designed to provide electricity for industrial or large commercial customers. To date, the staff has had discussions with Ohio EPA as part of the Volkswagen class action suit settlement, and with AEP Ohio as part of the Smart Columbus program as preliminary discussions to address EV corridor charging deployment. From those discussions, it is clear that EV corridor charging planning calls for a regional approach and must include regional planning agencies as well as other stakeholders.

The Commission is not currently in a position to determine where urban and corridor charging stations should be placed. However, the Commission hopes to be a partner with the appropriate regional or state entity that is thoughtfully charting where these urban and corridor charging stations should be placed. The Commission could be a facilitator in allowing utility involvement in foundational charging infrastructure for these corridors.

The intended storage function is to absorb energy from the grid or customer on-site generation resource, retain it for a period of time and then release the energy as needed. Storage can also be used as flexible demand that allows customers to draw and store power from the grid when it is less expensive and then use the stored energy to ride through higher price periods.

The Commission anticipates the creation of an overarching PowerForward Collaborative, and one of its tasks should be to continue monitoring state activity in this area. This monitoring should include impacts to the distribution system, rate design to incent EV charging during off-peak periods, corridor deployment and monitoring marketplace development for EV charging stations.

Energy Storage

Energy storage is emerging as an asset technology that can improve reliability and provide operational benefits across the electricity system. Energy storage applications and solutions can apply both to the bulk power and distribution systems, but in the context of the PowerForward discussion, we are exploring energy storage as a possible solution to many challenges and opportunities at the distribution level. The intended storage function is to absorb energy from the grid or customer on-site generation resource, retain it for a period of time and then release the energy as needed. Storage can also be used as flexible demand that allows customers to draw and store power from the grid when it is less expensive

5 See U.S. DOE, Office of Energy Efficiency & Renewable Energy, *Costs Associated with Non-Residential Vehicle Supply Equipment* (Nov. 2015), available at https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf.

6 Level 1 charging provides 2 to 5 miles of range per 1 hour of charging, while Level 2 charging provides 10 to 20 miles of range per 1 hour of charging. U.S. DOE, Office of Energy Efficiency & Renewable Energy, *Developing Infrastructure to Charge Plug-In Electric Vehicles*, https://www.afdc.energy.gov/fuels/electricity_infrastructure.html.

and then use the stored energy to ride through higher price periods. It can also serve as a backstop for intermittent renewable energy resources.

Traditionally, energy storage has been viewed as a grid service to the bulk electric system, such as an ancillary service in the PJM market that supports the reliable delivery of electricity. The Federal Energy Regulatory Commission (FERC) defines ancillary services broadly as "those services necessary to support the transmission of electric power from seller to purchaser … to maintain reliable operations of the interconnected transmission system. Ancillary services supplied with generation include load following, reactive power-voltage regulation, system protective services, loss compensation service, system control, load dispatch services, and energy imbalance services."[7] Energy storage can do many of these things. In restructured areas of the U.S., generation, capacity and ancillary services are traded on wholesale electricity markets.

Energy storage also provides customer benefits by enabling a customer to engage in arbitrage through avoidance of higher cost electricity prices, minimizing demand charges, and in certain contexts, maintaining service during a black out.

As we know, power systems are evolving to include multiple sources of volatility—DERs, responsive and controllable loads, time-varying loads, etc. We know that the electric grid does not have buffering capabilities to deal with that volatility, especially at the distribution level. This lack of buffering, or ability to smooth out variable loads, is a vulnerability of the power system that makes it unique compared to most complex systems. Energy storage (a shock absorber) can provide buffering capabilities that may ultimately be considered a standard, necessary tool in addressing operational issues on the distribution grid.

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 cyber-physical platform discussed above. Ohio EDUs are encouraged to consider energy storage as an alternative solution to problems typically addressed by traditional wires investments.

The Commission believes that for addressing distribution system issues, a standardized cost-benefit methodology to compare energy storage proposals with traditional technologies should be developed. The details associated with each specific integrated solution proposal, including wholesale market participation and cost recovery, can be decided within those proposals on a case by case basis.

Further, the Commission encourages the PWG to determine a process for identifying where it would be beneficial to deploy storage solutions, and the PowerForward Collaborative is encouraged to develop a process whereby these proposals can be submitted to the Commission and decided without extended delay.

The proliferation of energy storage solutions across the world is at an exciting point with many different types of cost effective energy storage technologies emerging, and many interesting use cases. As we heard in PowerForward: "People aren't buying batteries, they're buying solutions. They have a particular problem they're trying to solve."[8] The Commission encourages Ohio's EDUs to actively pursue the potential benefits energy storage can provide to the distribution grid and Ohio ratepayers.

7 FERC, *Glossary*, https://www.ferc.gov/market-oversight/guide/glossary.asp.

8 Tim Ash, Fluence, Remarks at PowerForward Phase 3: Ratemaking and Regulation (Mar. 7, 2018).

THE PLATFORM: DISTRIBUTION SYSTEM MARKETS

As discussed during the third phase of PowerForward, Ohio is a restructured state with a competitive retail marketplace. Arguably, this construct lends itself much better to the creation of a new open marketplace than a vertically integrated utility construct. Ohio's current retail market is comprised of two primary players that directly serve customers with generation service—EDUs who provide default service, and CRES providers who provide retail generation service (and other products/services).

A generally accepted line of demarcation that exists within this marketplace is at the customer's meter. "Behind" the meter is generally perceived to be in a customer's home or place of business. CRES providers are able to operate behind the meter, providing both the commodity and other products/services to customers. "In front" of the meter is generally perceived to be part of the distribution system operated by the EDUs. During PowerForward, the Commission heard from speakers who opined that these designations of in front and behind the meter are becoming antiquated. However, the meter still acts as a line of demarcation for the marketplace that exists in Ohio, and it provides an initial framework that we can utilize to launch the grid modernization marketplace.

Arguably, the pursuit of an enhanced customer experience through innovation is more likely to succeed in the competitive marketplace than in a regulated environment. Assuming utility deployment of foundational assets through an architectural construct that provides access to non-utilities, innovative products and services can then be introduced. The introduction of non-regulated capital investment would mitigate the need for economic regulation and recovery, and more equitably allocate costs to those consumers who find net value in the product or service offered. If barriers to market entry are minimized, ample incentive should exist to attract non-EDU participants into the market.

Behind the Meter

Therefore, for behind the meter grid modernization customer applications, it is recommended that the current retail marketplace structure should prevail. Assigning the opportunity for behind the meter customer applications to competitive forces, whether CRES providers, third-party technology or other trusted customer advisors, is consistent with traditional behind the meter limitations on regulatory jurisdiction. These competitors could include EDU affiliates with appropriate corporate separation safeguards to eliminate the possibility of competitive advantage.

Markets will develop where opportunities exist. However, without the safety net of regulated recovery mechanisms to reduce investment risk, markets will develop at different paces dictated by the scope of opportunity for return on investment and economic margin. It is possible that social policy may dictate a faster pace, a jump start, or assisted development in what would otherwise be an underserved customer segment. In these circumstances, where market development is slower than the pace desired by implementation of a desired social policy, it may be advisable to permit EDU market participation behind the meter for a limited period, with as minimal a scale possible to advance that social policy.

There should be two such social policy justifications that would allow an EDU to participate in providing behind the meter customer applications: (i) in circumstances where there is social inequity in the deployment of customer applications; and (ii) in circumstances where the application is deemed crucial to advance the state, but the marketplace has not developed to allow for that application to be deployed competitively to customers—a necessity and timing nexus must exist for this second justification. Further, the Commission would provide due consideration, in very limited circumstances, to a request by an EDU to deploy for residential customers only, a behind the meter application of minimal invasion and cost that is deemed essential for residential customers to realize the benefits of grid architecture investments.

The Commission believes this backstop should exist to promote the PowerForward principle **Enhance the Experience for All**. The state has already seen an example of how market forces may delay the extension of essential technology to all Ohioans in the context of broadband services. The Commission hopes to provide a backstop to avoid this situation in the electricity context. If such a social policy justification is triggered, the Commission encourages EDUs to partner with CRES providers or other third parties that could serve to both deploy the application efficiently and reduce the public cost burden of deployment.

In Front of the Meter

As the Commission has expressed a principle of **Do No Harm** and a grid objective of maintaining a **Strong Grid**, the Commission believes that EDUs should maintain their role regarding access to the distribution system for applications in front of the meter. Whether access

is intended to implement a distribution system improvement or a customer-specific application, the EDU owns and must be the caretaker of the distribution system in order to advance the PowerForward principles and objectives.

When considering a distribution system improvement, the EDU is encouraged to consider the use of NWAs as an option to defer or avoid more expensive distribution system investments. As previously discussed, the PWG should work to determine how an EDU can identify where it would be beneficial to deploy a NWA solution. The PowerForward Collaborative should work to create a process whereby these proposals can be submitted to the Commission and decided without extended delay.

It is possible that an intended customer-specific application could occur in front of the meter that is either divorced from, or co-mingled with system betterment. For a purely customer intended application without system betterment, the customer should be able to choose the entity who provides that application. EDUs should endeavor to provide reasonable access to a CRES provider or other third party that is installing such a customer application, and can require that certain system requirements be met upon installation as our EDUs are ultimately responsible for system reliability.

Applications that are intended to benefit individual customers may also be used to provide system benefits. Because system asset optimization is an articulated PowerForward objective, non-EDU investments, regardless of whether they are located in front of or behind the meter, may be used to provide more cost-effective solutions to distribution system problems. Partnerships of this nature, between the EDU and third party/customer, would serve to promote an expanded role for non-utilities while reducing the cost to implement distribution system solutions.

This is an initial framework for the grid modernization marketplace. It mostly mirrors the current marketplace that exists in our restructured paradigm, with a few additional policy considerations. These parameters could surely change as the marketplace evolves. The PowerForward Collaborative should observe the marketplace to ensure that it is fulfilling the PowerForward principles and objectives, and should refer disputes to the Commission as the marketplace develops.

It should be noted that the Commission is interested in the concept of distribution level markets as advanced by former Commissioner Paul Centolella and Dr. Paul Sotkiewicz.[1] However, the concept is more advanced than these initial steps we are taking, and quite possibly could require legislative changes to implement. The Commission will keep this market concept in mind as we advance further into our grid modernization endeavors over the years.

1 See Paul Centolella, *Design of Distribution System Markets: Platform Markets and Practical Considerations* (Mar. 8, 2018), available at https://www.puco.ohio.gov/index.cfm?LinkServID=1279B206-5056-B562-E18AF1F0AB0779D4; Paul Sotkiewicz, *Distribution Market Design: Leverage Wholesale Market Design and Operations Knowledge* (Mar. 8, 2018), available at https://www.puco.ohio.gov/index.cfm?LinkServID=4829A3DF-5056-B562-E1C4A404D34A3EAA.

RATEMAKING

The PUCO establishes distribution service rates for the EDUs through several mechanisms. Base distribution rates are established through traditional base rate cases conducted in accordance with the requirements of R.C. Chapter 4909. In addition, during proceedings to establish standard service offer (SSO) generation rates as part of an ESP under R.C. 4928.141 and 4928.143, an EDU may also request the PUCO to include a variety of provisions regarding its distribution services. R.C. 4928.143(B)(2)(h), for example, authorizes riders that implement single-issue ratemaking, incentive ratemaking mechanisms including revenue decoupling, and provisions regarding distribution infrastructure and modernization incentives. A nexus to distribution system reliability and alignment with customers' expectations is necessary attributes of such provisions.

Below, Table 1 displays for each EDU the date of the EDU's most recent base distribution rate case order and the ESP-approved riders available for the EDU to recover the costs of specific distribution system investment programs. The table also lists the latest dockets where each EDU has or is expected to file grid modernization plans.

Table 1

	Most Recent Distribution Rate Case	**Distribution System Capital Investment Riders**	**Current Grid Modernization Plan Dockets**
AEP Ohio	11-351-EL-AIR December 2011	Distribution Investment Rider	13-1939-EL-RDR (gridSMART Phase 2) 14-1693-EL-RDR (Grid Mod Report)
		gridSMART Phase 2 Rider	
		Smart City Rider	
		PowerForward Rider	
Dayton Power and Light	15-1830-EL-AIR Hearing July 2018 91-414-EL-AIR January 1992	Distribution Investment Rider	TBD
		Smart Grid Rider	
Duke Energy Ohio	17-32-EL-AIR Hearing July 2018 12-1682-EL-AIR May 2013	Distribution Capital Investment Rider	TBD
		Distribution-Reliability Infrastructure Modernization Rider *(Proposed to be eliminated)*	
		Proposed PowerForward Rider	
FirstEnergy	07-551-EL-AIR January 2009	Distribution Capital Recovery Rider	16-481-EL-UNC (Grid Mod Plan) 17-2436-EL-UNC (Distribution Platform Modernization)
		Advanced Metering Infrastructure/ Modern Grid Rider	

Again, each EDU has already filed, or is expected to file a grid modernization plan due to previously issued Commission orders or an executed stipulation. In both evaluating and implementing these plans, the Commission expresses a desire herein to implement **performance based ratemaking (PBR)**.

Requiring utilities to adhere to performance metrics is not a new concept. The Commission has consistently utilized industry wide metrics to determine whether the EDUs are maintaining a reliable distribution system (CAIDI, SAIDI and SAIFI reliability metrics). Failure to adhere to these metrics could result in a discretionary Commission fine. However, with grid modernization investment, the Commission will need to deploy PBR that has greater weight.

Requiring utilities to adhere to performance metrics is not a new concept.

Generally, regulators and utilities have become comfortable with the current cost of service paradigm. The Commission authorizes a revenue requirement for utilities, guaranteeing utilities an opportunity to recover the prudently incurred costs of providing utility service, including a reasonable return on investment. For traditional distribution service, this will continue to be the paradigm that both the Commission and the EDUs have grown accustomed to and that is statutorily mandated. However, if the Commission is willing to allow the EDUs to explore different avenues of investment for the betterment of customers, then both the Commission as well as the EDUs must embrace a new normal. This new normal will require greater use of PBR along with cost containment measures, and EDUs will have to bear some risk for their failure to either hit performance benchmarks or contain costs within approved levels.

The Commission must determine the actual metrics to be utilized for each grid modernization plan/investment on a case by case basis within the various grid modernization dockets for each EDU. Our goal is to achieve uniformity in the metrics utilized for utility investments. As a guidepost, the Regulatory Assistance Project (RAP) prepared a paper that describes certain PBR opportunities for the Commission based upon Ohio's statutory and regulatory regime.[1]

Furthermore, in requests for grid modernization investment, it only makes sense that an EDU include a **cost/benefit analysis** with the application. This way, the Commission and stakeholders can transparently evaluate whether a grid modernization investment should be made in the first place. Applications for investment should demonstrate that benefits generated by the project will exceed costs on a net present value basis. If there are significant reductions in operating expenses associated with the project, then the cost recovery mechanisms should be offset by those reductions until the savings are trued up in base rates.

Further, the Commission believes that **audits** should be conducted at timeframes agreed to between the staff and EDUs. There should be both a **financial audit** as well as a **managerial audit**. The financial audit would simply ensure there is accounting alignment. The managerial audit would:

- evaluate whether the capital deployed resulted in grid functionality that is in accordance with the company's grid modernization plan and PowerForward principles/objectives.
- evaluate whether PBR metrics are being achieved.
- include a prudency review to determine whether there has been any improper expenditures.

The results of these audits could impact recovery by the EDUs.

The Commission will also encourage the implementation of **cost caps** for each EDU grid modernization plan. As we have said repeatedly, the Commission's expression of governmental will to allow the EDUs to invest in grid modernization for the betterment of customers is not a blank check. Performance will be evaluated and tied in some circumstances to recovery on a case by case basis, and there will also need to be an absolute ceiling that each class of retail customer

1 See The Regulatory Assistance Project, *Recommendations for Ohio's Power Forward Inquiry* (Feb. 2018), available at https://www.raponline.org/knowledge-center/recommendations-ohios-power-forward-inquiry/.

can be charged on a month to month basis. The cost cap would apply to capital expenditures. There should be no opportunity for carrying charges, and deferrals (deferring collection until a later date) should be discouraged.

In addition, the Commission should be open to considering proposals that remove possible biases that inefficiently favor capital, instead of operating expenditures by, for example, allowing expenditures on software as a service to be **treated as a capital expenditure** or otherwise permitting margins to be earned on those expenditures when such a treatment results in lower overall costs to customers. This would be determined on a case by case basis.

Finally, in order to assist the staff's evaluation of the costs and benefits of an EDU's filings as well as perform necessary financial and managerial audits, the Commission may need to consider hiring an outside consultant. This is only being smart. The Commission was being placed in a position to evaluate applications for grid modernization investment even prior to launching PowerForward. This new world of investment requires a certain level of engineering expertise that is quite specialized. As we all get used to the new normal, the Commission may employ the assistance of experts to help with individual EDU applications. As PUCO staff becomes more and more adept, and as the Commission continues to grow its Grid Modernization and Security division, the necessity to utilize consultants may be reduced.

RATE DESIGN

Addressing the Throughput Incentive

Through the passage of Senate Bill 221 (SB 221) in 2008, a renewable portfolio standard was established in Ohio that requires a certain percentage of electricity sales from EDUs and CRES providers to come from renewable energy resources, including a carve out for solar resources.[2] It also requires EDUs to achieve annual energy reduction benchmarks through the implementation of energy efficiency and peak demand reduction programs.[3] More generally, state policy encourages the implementation of DG through review and update of rules surrounding essential issues associated with the deployment of DG, including: interconnection standards, standby charges, and net metering.[4] The regular review of these rules (and enabling statute) should ensure that new opportunities (e.g. community solar) are considered.

Under traditional rate design, there is an inherent tension between policies that encourage DERs, namely DG and energy efficiency, and the ability of the EDU to earn its revenue requirement. This is because the technologies and programs associated with DERs have the potential to decrease an EDU's sales below the amount included in the test year that was used to establish the revenue requirement. The motivation for utilities to increase sales (or to discourage measures that may negatively impact sales) is generally referred to as the throughput incentive. This incentive is exacerbated when large portions of a utility's fixed costs are recovered through volumetric charges to the end-use customer (i.e. dollar per kWh charges).

In recognition of the throughput incentive, SB 221 included specific provisions for revenue decoupling mechanisms.[5]

Decoupling is a comprehensive term used to refer to the methods available for disconnecting a utility's profits from its sales, which in theory, removes the throughput incentive and makes the utility neutral to policies that may reduce usage and thus sales. One form of decoupling is a SFV rate design, which is based upon the principle that fixed costs should be recovered through fixed charges ($/customer) and variable costs should be recovered through volumetric charges ($/kWh). Another form of decoupling includes specific mechanisms for revenue per customer (RPC) decoupling, which uses a decoupling rider to true up the actual revenue per customer with the authorized revenue per customer approved in the last distribution rate case. In addition to SFV rate design and RPC decoupling, lost revenue adjustment mechanisms can be used to compensate the utility for revenue lost through the

2 Am. Sub. S.B. 221, 127th Gen. Assem. (2008); Ohio Revised Code 4928.64.

3 Ohio Revised Code 4928.66.

4 Ohio Revised Code 4928.02(K).

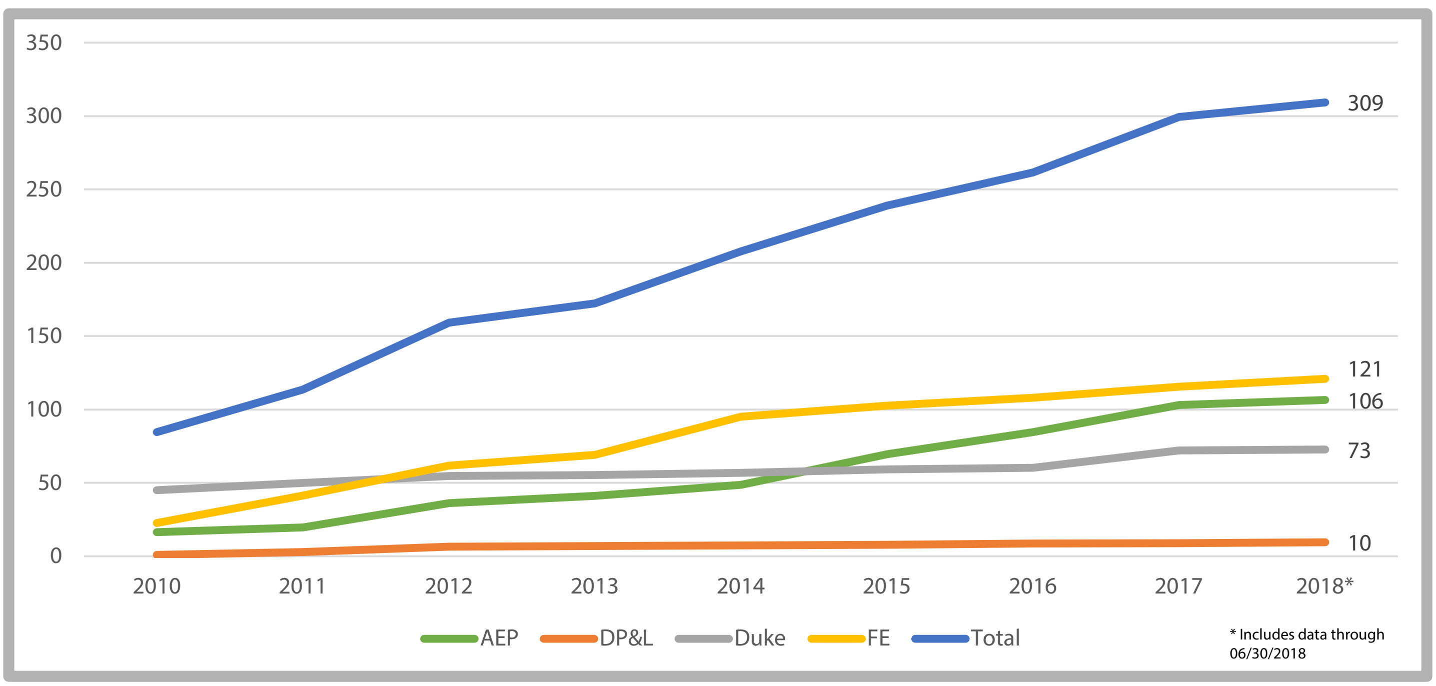
5 Ohio Revised Code 4928.143(B)(2)(h) and 4928.66(D).

implementation of energy efficiency programs based on the estimated energy savings and corresponding reduction in sales, though these are not usually included in the category of decoupling mechanisms.

The Commission has previously encouraged the EDUs to utilize the SFV rate design in the development of distribution rates.[6] However, through PowerForward, the Commission provided an opportunity for further discussion on issues surrounding the throughput incentive. Specifically, as part of PowerForward: Ratemaking and Regulation, the throughput incentive was further examined by a number of stakeholders in response to the following question included in the speaker solicitation: "How can energy prices be structured to remove disincentives for investments in energy efficiency and other DERs while still allowing utilities to recover authorized revenue requirements?"

When it came to discussion of the various decoupling mechanisms, a variety of viewpoints and perspectives were expressed. Some panelists said that SFV is appropriate as long as the costs are aligned with the cost of service. Other panelists said that SFV rate design sends the wrong price signal and disincentivizes energy efficiency investments that could reduce the cost of service over time. Some believe the classification and inclusion of fixed costs in the SFV customer charge is overstated, since most costs are variable in the long run (i.e. there may not be consensus on the extent to which costs should be considered fixed vs.variable).

Figure 2: Ohio Distributed Generation Capacity (MW)



Data reported by EDUs pursuant to Ohio Adm.Code 4901:1-25-02.

6 *In re Aligning Elec. Distrib. Util. Rate Structure*, Case No. 10-3126-EL-UNC, Finding and Order (Aug. 21, 2013) at 19-20.

It is often said that rate design is more art than science. While there may be some application of creativity and imagination in the rate design process, the complexity is more likely linked to the many and varied interpretations and conclusions drawn from the same set of agreed upon ratemaking principles. As detailed in Principles of Public Utility Rates:

> *[R]ate-structure problems are far more complex than problems of fair return even though the latter are by no means elementary; and they are even less amenable to solution by reference to definite principles of rate making … it is due to the necessity, faced alike by public utility managements and by regulating agencies, of taking into account numerous conflicting standards of fairness and functional efficiency in the choice of rate structure.*[7]

The Commission has recently, through its decisions, taken a more deliberative approach regarding EDUs' movement toward a SFV rate design. Based on discussions at PowerForward and given the current levels of DG in the state (see Figure 2 above), the Commission is inclined to further examine the range of possible decoupling mechanisms. The Commission does believe, however, that each EDU should address the throughput incentive using the full range of mechanisms available under the Ohio Revised Code. This may include both a SFV rate design and RPC decoupling to some degree. It also may include gradualism in implementing SFV rates, changes in methods of classifying costs as fixed rather than variable, other rate design approaches that may become feasible for the residential and small commercial classes as AMI is deployed, and a combination of these mechanisms.

Stakeholders should have the opportunity to review and address how specific applications of decoupling comply with fundamental rate design principles as well as the principles and objectives set forth in PowerForward. Finally, any decoupling mechanism established to address the throughput incentive within the context of a distribution rate case or rider mechanism should take into account any lost revenue adjustment mechanisms being recovered through energy efficiency riders, to ensure that no double recovery occurs.

Time-of-Use Rates for SSO Customers

R.C. 4928.141 states that, each EDU "shall provide consumers, on a comparable and nondiscriminatory basis within its certified territory, a standard service offer of all competitive retail electric services necessary to maintain essential electric service to consumers, including a firm supply of electric generation service." The SSO, or default generation service, may take the form of either an ESP or a market rate offer (MRO). The ESP allows for broader discretion than the MRO, in that it establishes the supply and pricing of electric generation service but also allows for recovery of costs associated with certain infrastructure modernization investments and economic development activities.

Through the ESP process, each EDU has developed a competitive bidding process, utilizing a descending clock auction, for the procurement of competitive retail electric generation service for the full requirements of serving SSO customers, including energy and capacity.

The Commission believes that the benefits associated with competitively bid SSO rates can be expanded through the implementation of SSO time-of-use rates that utilize advanced meter data. TOU rates should be designed or modified to incent customers to reduce consumption during peak periods and to engage customers in making informed decisions about their energy usage, regardless of whether customers are shopping for their electric supply or on the SSO rate.

For instance, as referenced earlier, as the deployment of EV charging infrastructure grows, TOU rates should incent off-peak charging for customers with an EV. In addition, TOU rates may provide a benchmark for more dynamic products and services in the retail market as they develop.

The Rocky Mountain Institute identifies five key design choices that impact the effectiveness of TOU rates: the on-peak/off-peak price ratio, peak period duration and frequency, financial mechanism (charge or rebate), enrollment method, and enabling technology.[8] In developing a proposal for a TOU rate, each EDU may incorporate the lessons learned

7 James C. Bonbright, *Principles of Public Utility Rates*, 288-289 (Columbia University Press 1961).

8 Rocky Mountain Institute, *A Review of Alternative Rate Designs: Industry Experience with Time-Based and Demand Charge Rates for Mass-Market Customers* (May 2016) at 6, available at https://rmi.org/insight/review-alternative-rate-designs.

from the historical implementation of TOU rates, along with lessons learned from the industry in other jurisdictions. The proposal may also detail how the rate design furthers the objectives of PowerForward.

The Commission encourages, in parallel with advanced meter deployment, that each EDU propose or amend an existing TOU rate design for SSO customers, which may include: real time pricing, block and index pricing, TOU pricing, variable peak pricing, critical peak pricing, and/or critical peak rebates. Further, the on-peak/off-peak ratio should be sufficient to provide a response from participating customers and the peak period duration and frequency should reasonably allow for participation from customers on the rate. The proposal may also include a rebate program for enabling technologies (e.g. smart thermostats) which can be paired with TOU rates offered through the SSO or through CRES provider offerings that utilize time-based pricing.

The Commission envisions that each EDU proposal would include plans for marketing and education of the TOU rate design to customers, along with options for informing customers of available TOU offerings through the PUCO's Energy Choice Ohio website. Assuming approval and implementation of the TOU rates, it is recommended that each EDU provide annual updates reporting on the success of each of the TOU offerings. Based on those updates, the PowerForward Collaborative may discuss opportunities, and make recommendations to the Commission, to improve the TOU offerings available to SSO customers.

USING DATA TO ENHANCE RETAIL OFFERINGS

It is the policy of the state of Ohio to "[e]ncourage innovation and market access for cost-effective supply- and demand-side retail electric service including, but not limited to, demand-side management, time-differentiated pricing, waste energy recovery systems, smart grid programs, and implementation of advanced metering infrastructure."[9] As foundational grid architecture investments are planned, designed and implemented, the data generated needs to be used to better enable customer choice and to inform customers of their energy consumption and costs so they can manage their energy usage, adopt technologies that provide benefits and drive systemic benefits for the grid. This means that both shopping and SSO customers should have access to more and better data.

While there has been some level of AMI deployment in the state, the initial investments made with the American Recovery and Reinvestment Act funding were primarily focused on obtaining operational benefits for the utility (reduced meter reading expenses, remote meter diagnostics, outage detection and verification) and were not as focused on the sustained development of innovative products and services for customers. The Commission has identified AMI, including advanced meters, as a core component of the platform and believes that CEUD needs to be better utilized by the EDUs as well as made available to third parties in a way that will lead to an enhanced customer experience.

The data generated needs to be used to better enable customer choice and to inform customers of their energy consumption and costs so they can manage their energy usage, adopt technologies that provide benefits and drive systemic benefits for the grid.

For shopping customers, the implementation of grid modernization technologies should remove barriers between the wholesale and retail markets. The deployment of AMI, including smart and advanced meters enables the provision of the type and granularity of data needed to align retail charges with the wholesale market costs for generation. However, there are also barriers associated with the settlement of the data by the load serving entity and the current methods, or lack thereof,

9 Ohio Revised Code 4928.02(D).

for accessing the data by market participants.

Going forward, CEUD should be made available in a way that allows for the monetization of changes in an individual customer's energy and usage, including the potential to provide services through the installation of DERs as market opportunities continue to develop. In the short term, the Commission believes that the EDUs should calculate and settle the following values on an individual basis for all customers with smart meters: total hourly energy obligation (THEO), peak load contribution (PLC) and network service peak load (NSPL).[10]

As the asset owners of the core components associated with the distribution system platform, including AMI and smart or advanced meters, the EDUs are the data stewards for energy data associated with the modern grid. In an effort to create a uniform platform, the Commission envisions the creation of an additional workgroup called the Data and the Modern Grid Workgroup (DWG) to address data access issues associated with grid modernization. The Commission encourages that, at a minimum, the DWG accomplish the following tasks:

- Create protocol for data privacy protections.
- Allow customers to obtain real-time, or near real-time, access to CEUD through the connection of qualified home area network (HAN) devices to the customer's smart meter.
- Prescribe a uniform methodology across the EDUs for third parties to obtain CEUD. This should include a method for CRES providers to obtain the THEO, PLC and NSPL values referenced above.

The DWG would work in tandem with the PUCO's existing Electronic Data Interchange (EDI) Working Group. The work of the EDI Working Group will continue to be important as the objectives of PowerForward are accomplished.

CYBERSECURITY

Customers, utilities and third party providers will enjoy many benefits from a modernized electric grid. However, the nature and characteristics of its architecture, facilities and technology may increase cybersecurity risks. For example, with the increasing use of internet based management systems and the proliferation of customer and third-party access to those systems, those who have the desire and the ability to negatively affect the electric system will have increasing numbers of entry points. Therefore, the risk of cybersecurity breaches will need to be addressed in order to protect customer information, utility systems and the reliable operation of the electric grid.

While the modern grid presents new cybersecurity challenges, the Commission has had discussions with our EDUs about cyber threats and vulnerabilities informally for many years now. Through these discussions, along with very engaging panels at PowerForward, we believe the Commission should not approve the substantive cybersecurity policies and procedures of the EDUs. First, in refraining from developing and approving cybersecurity requirements for the distribution system, it eliminates the risk of those policies and procedures being publicly disclosed. Second, this is an area where threats change by the minute, and waiting

10 THEO, PLC, and NSPL parameters are values calculated by the EDUs within PJM's territory and used for a variety of purposes by PJM. *See PJM, THEO, PLC & NSPL Methodology Inventory,* http://www.pjm.com/markets-and-operations/billing-settlements-and-credit/theo-plc-and-nspl.aspx.

for government approvals to react appropriately could be detrimental to our EDUs and customers.

While the Commission will not prescribe specific measures to protect EDU systems from cyberattacks, the Commission does believe it is appropriate to require the EDUs to confirm that they in fact have a plan to sufficiently address cybersecurity concerns that is consistent with industry best practices, similar to the requirements for emergency plans and coordination for restoration of electric service contained in Ohio Adm.Code 4901:1-10-08.

The Commission encourages each EDU to make an annual filing to confirm that adequate cybersecurity planning is being implemented, including how relevant national standards are being met. The Commission envisions opening a stand alone docket, centered entirely on cybersecurity, and for each EDU to work with staff to determine content for these annual filings. The filings should not include confidential or sensitive information, the inadvertent disclosure of which would create a vulnerability for the grid.

As it relates to PowerForward specifically, each Ohio utility should include in any PowerForward related filing the associated measures to protect grid modernization investments from cybersecurity risks for the Commission's consideration.

By limiting the Commission's oversight to review of each utilities' annual report and PowerForward filings, the Commission intends to satisfy its regulatory goals while eliminating the inherent risks that could arise if the Commission reviewed each EDU's cyber policies and procedures.

Roadmap Summary

Table 2

The Platform: Architecture	EDUs should develop a cyber-physical platform consistent with guidance set forth herein that consists of as close to uniform core components across the territories as possible. EDUs should work to develop standardized access to CEUD across the four territories for third parties. EDUs should ensure core architectural components are deployed with existing interoperability standards in mind so that applications may be integrated seamlessly. EDUs should file brief updates discussing where each utility is with deploying grid architecture for Commission consideration.
The Platform: Planning	Commission should create Distribution System Planning Workgroup (PWG) to be run by the staff or facilitator. EDUs should file a current state planning assessment in PWG docket for Commission consideration.
The Platform: Operations	Commission should create PowerForward Collaborative to be run by the staff. PowerForward Collaborative should monitor EV marketplace and should study impacts to the distribution system, rate design to incent EV charging during off-peak periods, corridor deployment and the development of the marketplace for EV charging stations. PWG should work to determine where on the distribution system it would be beneficial to deploy a storage or other NWA solution. PowerForward Collaborative should determine process whereby proposals for NWAs can be submitted to the Commission and decided without extended delay.
The Platform: Markets	Behind the meter applications should be deployed competitively, although social justification could exist that would allow for EDUs to deploy behind the meter applications through regulated paradigm. In front of the meter, EDUs should still be the owners and caretakers of the distribution system; EDUs are encouraged to explore NWAs if they would more cost-effectively displace traditional distribution system improvements; EDUs should provide reasonable access to third parties seeking to provide a customer application, and are also encouraged to explore partnerships with third parties to utilize these applications for grid optimization purposes. PowerForward Collaborative should observe marketplace development to ensure that the market is fulfilling the PowerForward principles and objectives, and should refer disputes to the Commission.

Rate Design	Commission and stakeholders should continue to evaluate throughput incentives, and EDUs should address the throughput incentive using the full range of mechanisms available under the Ohio Revised Code. EDUs should propose a TOU rate design for SSO customers, including plans for marketing and education of the TOU rate design; EDUs to make annual filings for Commission consideration addressing success of the TOU rate design.
Using Data to Enhance Retail Offerings	Commission should create Data and the Modern Grid Workgroup (DWG) to be run by the staff or facilitator. EDUs should be the data stewards for energy data associated with the modern grid. The DWG, at a minimum, should address the following tasks: (i) create protocol for data privacy protections; (ii) drive toward real-time or near real-time data becoming available; (iii) prescribe methodology for CRES providers and other third parties to obtain CEUD including a method for CRES providers to obtain the THEO, PLC and NSPL values.
Cybersecurity	EDUs should make an annual filing confirming that they have a cybersecurity plan. EDUs should explain, in any PowerForward filing, measures to be taken to protect grid modernization investments from cybersecurity threats.

The following is a more procedural extrapolation of the ratemaking section that ascribes recommended steps to evaluating grid modernization applications requesting recovery:

1. In requests for recovery, EDUs are encouraged to include a **detailed cost/benefit analysis**. That cost/benefit analysis should show how net present value will be provided to customers, demonstrate the prudency of proposed investments, and how capital expenditures that result in operational savings will be offset through the rider recovery mechanism.

2. The EDUs are encouraged to work with staff in order to propose **PBR** metrics in their requests. Collectively, we should attempt to achieve uniformity for metrics across the four EDUs.

3. The Commission believes that hiring a **consultant** to assist in evaluation of the applications is sensible.

4. The Commission believes that **audits** should be conducted at timeframes agreed to between the staff and EDUs. There should be both a **financial audit** as well as a **managerial audit**. The financial audit would simply ensure there is accounting alignment. The managerial audit would evaluate (i) whether the capital deployed resulted in grid functionality in accordance with the plan/request and PowerForward principles/objectives/recommendations found in this document; (ii) whether PBR metrics are being achieved; and (iii) a prudency review. The results of these audits could impact recovery by the EDUs.

5. The Commission encourages that either a monthly or annual cost cap be set in place for an EDU's full package of grid modernization investments. Grid modernization spend should be gradual and manageable. The **cost cap** should be devised for each class of retail customer on capital expenditures. There should be no opportunity for carrying charges and deferrals should be discouraged.

Recommended Next Steps

Next steps, with recommended timeframes, would proceed as follows:

Commission Anticipates Creation of PowerForward Collaborative and Workgroups
By January 1, 2019, the commission anticipates that it will establish separate dockets for the PowerForward Collaborative and its spinoff workgroups, the Distribution System Planning Workgroup (PWG) and the Data and Modern Grid Workgroup (DWG). The PowerForward Collaborative would be led by staff. The PWG and DWG may be led by a facilitator of staff's choosing. Participants would include the EDUs and others who are interested in advancing the goals established in this document or subsequent order for the Collaborative, DWG and PWG.

EDUs Would File Grid Architecture Status Reports
By April 1, 2019, each EDU would file a brief report discussing where it stands with the deployment of grid architecture as described in the section entitled The Platform: Grid Architecture, in a new docket ending in the designation "EL-GRD" that the Commission will consider. Any applications for future investment should include at the onset all infrastructure required to support anticipated future functionality (i.e. the investments should be reasonably scalable and interoperable to support future grid modernization applications).

EDUs May File Applications for Investment
It is contemplated that via the authority granted to EDUs in their existing ESPs, and subject to the recommended parameters for applications discussed in this roadmap, EDUs can apply for investment in this core grid architecture within these GRD dockets that the Commission would consider. Further, the Commission encourages, in parallel with advanced meter deployment, that each EDU propose or amend an existing TOU rate design for SSO customers.

EDUs Would File Current State Distribution System Planning Assessment
By April 1, 2019, each EDU would file a current state planning assessment as detailed in The Platform: Distribution System Planning section within the docket created for the PWG that the Commission would consider.

Collaborative and Workgroups Anticipated to File Reports At Least Annually
A proposed timeline for the near term launch of the PowerForward Collaborative as well as the PWG and DWG are set forth below. The Commission envisions that a status report would be filed by the PowerForward Collaborative on an annual basis for the Commission's review, and the PWG and DWG would file reports discussing activity and resolution of prescribed goals as they occur, but reporting for both workgroups would at least occur annually. These reports would include recommendations for consideration by the Commission.

EDUs Would File Cybersecurity Plans
By January 1, 2019, the Commission anticipates establishing a separate docket focused on cybersecurity. The EDUs and staff would work to achieve consensus on the annual filing requirements, and the first cybersecurity filing would be made by each EDU separately in that docket by December 31, 2019. The Commission envisions that it would acknowledge these filings via order.

Commission Envisions Customer Education Efforts
In order to educate Ohioans about the benefits of grid modernization and the expanding role of the customer, the Commission envisions that the PowerForward Collaborative will work with stakeholders to advance certain educational endeavors for the benefit of Ohio customers.

Figure 3: Timeline of Next Steps

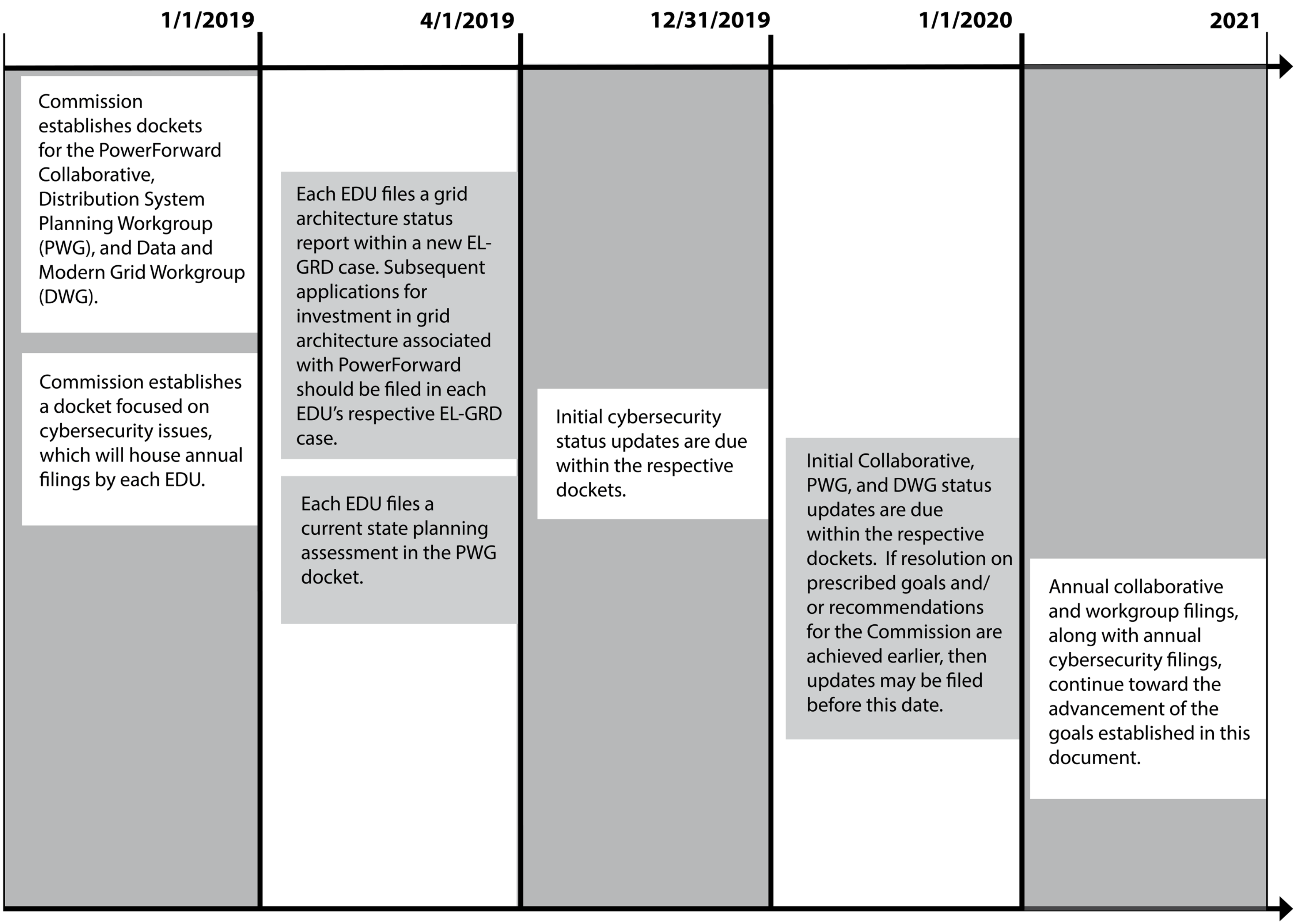


Figure 4: Collaborative and Working Groups

	PowerForward Collaborative								
	Grid improvements for EV charging and related costs	Urban and corridor charging station development; EV policies in other states	Measures to ensure that EV stations use open, interoperable access and payment protocols	Competitive nature of charging; evaluate Commission approved programs and lessons learned	Effective rate design for EV customers and site hosts, including applicability of TOU rates and demand charges	Development of performance metrics as new technologies are integrated into the grid	Develop process and timeline for implementing NWA opportunities	Ohio market development including web-based marketplaces and the ability of customers to access products and services	Educational efforts to inform Ohioans of grid modernization benefits
Subgroups									
Planning Work Group (PWG)	EDUs file "current state" assessment on IDP	Work through issues that currently exist or may arise in IDP	Future scenarios for DERs (including EV) adoption, how to incorporate these scenarios into EDU forecasting and planning	Determine process for identifying where it is beneficial to deploy a storage solution; locational value	Modifications to interconnection standards; including defining functions, requirements and settings for advanced inverters	Develop NWA suitability criteria and options for procurement	Define hosting capacity analysis use cases, identify appropriate HCA methodology and associated data requirements, timeline	Develop portals for sharing info on peak load forecasts, capital plans, HCA maps, heat maps	
Data Work Group (DWG)	Create protocol for data privacy protections	Drive toward real-time or near real-time data being available thru HAN device to the customer's smart meter	Prescribe uniform methodology for third parties to obtain CEUD	Prescribe uniform methodology for CRES providers to obtain THEO, PLC, NSPL values					

PowerForward Speakers

We would like to thank the following participants for their expert testimony as a part of the three phases of PowerForward. This list does not include the countless others who have spoken to the Commissioners and staff about a variety of issues in the days leading up to and following the phases. Thank you to all of you as well.

Sonia Aggarwal, Energy Innovation
Julio Aguero, Quanata Technology
Wassim Akhdar, Varentec
Paul Alvarez, Wired Group
Tim Ash, Fluence – A Siemens and AES Company
Thomas Ashley, Greenlots
Jeff Bailey, Duke Energy
Pablo Barrague, AES Energy Storage
Mike Beirne, AMP
Joe Bentley, AES US Utilities
Ed Beroset, EPRI
Jim Boch, IPKeys Technologies, LLC
Barb Bossart, PUCO
Brian Bowen, First Fuel
Dan Bowermaster, EPRI
Mark Burke, Ericsson, Inc.
Becky Campbell, First Solar
Richard Caperton, Oracle Utilities
Paul Centolella, Paul Centolella & Associates, LLC
Hisham Choueiki, Public Utilities Commission of Ohio
Michael Coddington, National Renewable Energy Laboratory
Alan Cooke, Pacific Northwest National Laboratory
Paul DeMartini, Newport Consulting Group
Larry Dickerman, Landis+Gyr
Mike DiNucci, Chargepoint, Inc.
Phil Dion, AEP
Patty Durand, Smart Grid Consumer Collaborative
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Sonny Fanelli, FirstEnergy
Russell Feingold, Black & Veatch Management Consulting, LLC
Dan Francis, AEP
Jeff Fuller, AES
Stacey Gabbard, AEP
Britta Gross, General Motors
Katie Guerry, EnerNOC
Kevin Hall, AES US Utilities
Joe Halso, Sierra Club
Don Harrod, Village of Minster
Ryan Harty, American Honda Motor Co., Inc.
Thomas Hawes, Direct Energy/Centrica
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Scott Hipkins, FirstEnergy
Doug Houseman, EnerNex
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Jennifer Kefer, Alliance for Industrial Efficiency
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Deborah Merril, Just Energy Group
Eileen Mikkelsen, FirstEnergy
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Jonathon Monken, PJM Interconnection
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Todd Ryan, Smart Wires
Ram Sastry, AEP
Krystina Schaefer, Public Utilities Commission of Ohio
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Doug Scott, Great Plains Institute
Jamie Scripps, 5 Lakes Energy
James Sherwood, Rocky Mountain Institute
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