COMMONWEALTH OF PUERTO RICO
PUERTO RICO ENERGY COMMISSION

IN RE: ENERGY COMMISSION INVESTIGATION REGARDING THE STATE OF PUERTO RICO'S ELECTRIC SYSTEM AFTER HURRICANE MARIA

CASE NO.: CEPR-IN-2017-0002

Subject: Request for Public Comments.

Issue: Implementation of regulatory actions to facilitate the tasks of restoring electric service and encourage the deployment of new technologies.

COMMENTS OF THE GRIDWISE ALLIANCE

The GridWise Alliance (GridWise) consists of a unique cross-section of members, including: all types of electric utilities, information technology and telecommunications equipment and service providers, National Laboratories, Regional Transmission Organizations (RTOs)/Independent System Operators (ISOs), and academic institutions. GridWise has been working since 2003 to advance the modernization of the electric system. These comments generally reflect the views of our members but do not represent the views of each specific GridWise member.[1]

GridWise commends the Puerto Rico Energy Commission (PREC) for having issued its recent Resolution ("October 27 Resolution") and Order. GridWise is pleased to have the opportunity to submit these comments and will focus on the following two specific aspects of those enumerated in the Resolution and Order, as follows: 1) correcting vulnerabilities and strengthening the electric system, particularly encouraging the deployment of technologies and capabilities that will help improve the overall resilience, reliability, security, flexibility, and optimization of Puerto Rico's electric system; and, 2) helping further the development and adoption of an energy model best suited to meet Puerto Rico's energy needs, including, in addition to the factors just mentioned, ensuring affordability and economic growth in a sustainable manner. Below we share some comments that are general in nature. Following that, we respond to some of the Commission's specific questions.

I. GENERAL (MISCELLANEOUS) COMMENTS:

GridWise undertakes a holistic approach to the electric grid and the electric system, from generation to the end user, and uses this lens in making these comments.

[1] These comments also do not represent the views of our RTO/ISO and national laboratory members, and the Bonneville Power Administration, who do not participate in advocacy activities.

PREC should be commended for considering taking steps now to rebuild infrastructure in a manner that increases system resilience, reliability, and security to reduce the scale of damage and destruction and that shortens the time to restore power in the future.

- Resilience should take into account a reduction in human suffering and the total impact on the local economy along with ensuring human safety and effective operation of the electric system.

- Undertaking the immediate restoration, along with near-term and medium- and longer-term planning and rebuilding of Puerto Rico's energy system will take substantial human, technical, and financial resources.

GridWise applauds PREC's plan to evolve its regulatory model, while implementing new distributed energy resources (DERs). However, given the substantial task that Puerto Rico currently faces in restoring power and rebuilding major portions of its electric system, it might make sense to undertake some planning of the electric system, and then to revisit changes to business and/or regulatory models at a later time (particularly since the status of PREPA seems unclear at this point in time).

**GridWise has years of experience convening a range of different types of stakeholder meetings and events. For example, we organized a workshop to bring together federal, state, local, and private sector stakeholders – both GridWise members and non-members – to discuss issues and potential recommendations in the wake of Superstorm Sandy. We then developed a report that contains these recommendations (available on our website at: www.gridwise.org). In addition, we organized multiple regional workshops and a national meeting on the "Future of the Electric Grid" that examined various business and regulatory models, issues, and recommendations.

**GridWise could convene a group of stakeholder representatives and other experts that have extensive experience in a range of state policy and regulatory proceedings, as well as technical experience (e.g., Advanced Energy Economy (AEE), Brattle Group, ICF, National Electrical Manufacturers Association (NEMA)) to help PREC evolve its regulatory and/or business models, if this were to be of interest to PREC.

- GridWise understands that several entities are preparing planning documents to help Puerto Rico rebuild its electric system. GridWise is prepared to support such efforts including helping connect PREC to specific experts that can answer some of the larger and/or more specific questions, to the greatest extent feasible.

- Approximately 20 States have grid modernization proceedings at various stages of progress. These take time and PREC should consider building on the lessons learned from states with such proceedings that are more advanced and well underway, as well as drawing on experience from NARUC, NASEO, and NGA.

Regardless of the points just made, Puerto Rico Energy Commission (PREC) should identify its goals and objectives in modernizing its electric system (or "new energy model") at (or very near) the outset of this process, which will help achieve results and avoid unintended consequences.

The following features should be part of a modern grid and need to be considered during the planning process:

(1) Dynamic optimization of grid operations and resources, with full cyber-security, to facilitate system reliability, resilience, and robustness;
(2) Deployment and integration of distributed resources and generation, including renewable resources, to help improve system performance, power flow control, and reliability;
(3) Development and incorporation of demand response, demand-side resources, and energy-efficiency resources;
(4) Deployment of ''smart'' technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation;
(5) Deployment and integration of advanced electricity storage and peak-shaving technologies;
(6) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services;
(7) Near real-time situational awareness of the electric system;
(8) Advanced monitoring and control of the modernized electric grid; and,
(9) Enhanced certainty for private investment in the electric system.

Electric System Planning:

Consideration should be given to repairing and/or rebuilding in the short- and longer-term in a more resilient, "smarter" manner – where it makes sense to do so.

- **DERs will fundamentally change the load factors and variability patterns on the bulk power grid and local distribution grids, and will therefore change the requirements for central generation and for localized control of grid service quality.**

- **A holistic systems planning approach is needed**. Planning at least can be started in parallel with immediate restoration of power, at least to major portions of populations in Puerto Rico and the U.S. Virgin Islands.

- Planning should account for the fact that Distributed Energy Resources (DERs) will not **eliminate** the need for the grid.
  - Planning for, and implementing, some near-term solutions that could be more resilient and "smarter" can be performed along with planning for what likely will be a

longer-term, *phased approach* toward developing and re-building a more resilient, sustainable electric system, which will take time to completely rebuild.
    - System planning can be iterative and can be updated along the way.
    - Different approaches might be appropriate for different parts of the islands.
    - Cost-effectiveness should be ensured over the long term or project lifetime.
    - Public-private partnerships should be leveraged for the recovery effort, where appropriate.

- **Focusing on the desired outcomes or objectives is important:** i.e., to create a resilient, reliable, and secure system design. Planners and engineers should aim to design a system that meets resiliency, cost, and other metrics and, in doing so, utilize the best mix of technologies and capabilities for the intended outcomes. Options for technologies and capabilities that are available to achieve such outcomes include but are not limited to: outage detection and management systems (e.g., smart meters), those that enable "islanding" of portions of the grid, microgrids, distributed energy resources, and energy storage (e.g., flywheels, batteries), and digital and flood-resistant substations, among others.

- Many critical infrastructure systems and sectors have interdependencies, so there is a need to look holistically at systems and across critical infrastructure sectors. For instance, planners should consider coordinating, including co-locating (or optimizing other synergies), between and among multiple infrastructures/sectors, e.g., telecommunications, electricity, and water infrastructure.

Assistance – Electricity Subsector Coordinating Council:

GridWise is involved in the Support Group (SEWG) to the Electricity Subsector Coordinating Council (ESCC), which consists of the main trade associations of the electric sector and several governmental agencies and others. The ESCC has worked hard over the past several years to foster a strong public-private partnership effort to enhance cyber and physical security and, more recently, preparation and responses to natural disasters. In the future, GridWise encourages Puerto Rico to request and use mutual assistance at as early a stage as possible. Some of the lessons from Hurricanes Harvey and Irma, both with respect to pre-positioning crews, as well as from hardening infrastructure, and deploying technological solutions are highlighted in Appendix I to this document.

Rates/Regulatory Models:

Because DERs will fundamentally change the load factors and variability patterns on the bulk power grid and local distribution grids, and will therefore change the requirements for central generation and for localized control of grid service quality, dynamic rates need to be just that: dynamic where they can respond to changes in the supply mix (e.g., California "Duck Curve") and localized distribution system conditions. With respect to time-of-use rates, these actually might become counter-productive if not sufficiently flexible as to be able to accommodate changes in demand and supply that will be introduced with DERs. It is essential to balance load and reduce peak capacity requirements.

Foundational technologies and investments:

While many technologies are being used or will be used to varying degrees in Puerto Rico, GWA encourages PREC to work with the relevant stakeholder(s) to facilitate the deployment of many of the most critical functionalities (e.g., network monitoring and control) – including the necessary foundational investments – of this critical functionality in a timely manner (see Appendix II herein, as well).

Advanced Metering Functionality (AMF)/Advanced Metering Infrastructure (AMI):

AMF has evolved to consist of multi-purpose sensors on the network supplying information that supports system operations and enables customer choice and active participation. AMF networks can position the grid as a platform for the integration of DERs. It provides greater visibility into what is occurring at the edge of the grid – providing grid operators with situational awareness of DER. When grid operators are able to better understand the nature and intermittency of DER, they are able to manage their systems more efficiently and effectively. Further, AMF networks can also leverage Distribution Automation (DA), including capacitor bank controllers in addition to direct or customer-activated load control. With more DERs, including microgrids, coming "on line," the need for visibility and control at the "edges" of the grid becomes increasingly important.

II. GRIDWISE'S COMMENTS ON SOME OF THE COMMISSION'S SPECIFIC QUESTIONS – APPENDIX I TO THIS "RESOLUTION AND ORDER" ISSUANCE/REQUEST FOR PUBLIC COMMENTS:

Microgrids:

- Microgrids have the potential to greatly increase reliability and resilience during extreme weather events in addition to protecting "anchor" loads (as referred to by PREC) or, critical infrastructure, loads from cyber and physical attack as well as other grid disturbances. New rules and procedures specifically affecting the development and deployment of microgrids should be addressed by the Commission.

- Microgrids have myriad benefits, particularly during natural and human-caused disasters, including, but not limited to, being able to direct power to priority or critical infrastructure customers in such emergency situations, as well as being able to help "segment" the grid and thereby likely mitigating the effects of cyber or other hazards.

1. **Microgrid Organization:**

   Questions 1.1, 1.2, and 1.3 – touches on Section 3 questions, too – ownership/competitiveness issues:

   - New rules and procedures pertaining to the implementation of microgrids should be developed and considered by the PREC (as also reflected in New York's "Track I" Straw Proposal on its "Reforming the Energy Vision" (REV)).[2]

   - GridWise believes the PREC should encourage the use of open, consensus-based standards and protocols that support interoperability and competitive participation by third party providers.

   - That said, flexibility is essential to enable participation of all kinds of DERs, including microgrids, in a safe, secure, and transparent manner and to accommodate different types of DERs at different times, locations, and under varying conditions.

   - Distributed Energy Resources (DERs) should be available to consumers, utilities, and third-party providers to achieve the highest value to all customers over the life cycle of the resources.

   - Private generation owners should be fairly compensated for excess electricity, while ensuring they still pay for the services, like reliability and power quality, provided by the grid. Regulators should consider new rate designs, including access fees, fixed charges, and demand charges, to relate the price paid by electricity customers to the value that they receive.

   - For grid transformation to be successful, utilities must maintain a safe and secure risk profile that allows them to access capital for grid investments at a reasonable rate. While future incentives to invest in advanced technologies are appropriate, they should not change the utility's fundamental risk structure. Any proposed business model changes or alternative regulatory structures should demonstrate that they would not increase the risk of investing in a utility and result in an increase in a utility's cost of capital and the associated increased cost to customers. Business models also should be adapted so utilities who decide to invest in less capital-intensive, advanced technologies obtain a return on their investments (ROI) and/or receive a sustainable revenue stream(s) from these sources.

[2] New York Public Service Commission's (NY PSC) "Reforming the Energy Vision" (REV) Track I Straw Proposal at 59.

- **GridWise wishes to draw PREC's attention to a White Paper it recently published on battery storage in front of the meter. This Paper acknowledges that storage is unique in that it does not neatly fit into traditional generation, transmission, or distribution categorizations or definitions. As such, depending on the structure of a utility (i.e., vertically integrated or restructured), this ***could*** affect the ownership ability and models, as well as competitive issues, with respect to such resources. GridWise calls attention to these issues as PREC considers issues pertaining to microgrids, which could be similar. GridWise's White Paper has been used in a grid modernization proceeding that currently is underway in Maryland ("PC-44") and helped spark a discussion in the Storage Work Group pertaining to such definitional and related ownership and competition-related issues, which are quite complex. (*GridWise has attached its Storage White Paper to this Submission as an additional resource.*)

- GridWise wishes to note, in particular, that multi-customer microgrids, if deployed, likely would introduce some particular challenges in designing the rules to ensure customer choice and control, while accommodating the physics with respect to the ways in which these microgrids will work.

- Thought also should be given to the implications for the utilities' obligations to serve and the microgrid owners' obligations to serve their customers. It also must be recognized that some level of coordination between the grid operator and non-participating customers will be needed to understand what is transpiring at the grid edge.

2. Microgrid Placement and Availability:

Questions 2.1 through 2.4:

GridWise understands the desire and need to restore power to Puerto Rico's customers as quickly as possible. However, GridWise does not believe that microgrids and/or solar and/or storage can be deployed <u>everywhere</u> in San Juan or in Puerto Rico, more broadly. As we have noted in our general comments above, ***planning*** is needed to ensure that electricity supply/"generation" resources of all types – whether distributed or centralized – are located in a way that ensures the resilience, reliability, and optimization of the system. If resources are installed randomly, that could create significant reliability problems in the near or longer term. We believe that a diverse mix of resources (e.g., solar, wind, storage, microgrids, and/or natural gas or other resources) is appropriate to address Puerto Rico's needs going forward and to help ensure continued resilience and reliability for its system.

As is also noted below, GridWise believes that co-locating some resources near loads, especially critical loads, such as hospitals, is important. Having generation all in one place can be problematic, as has been witnessed with Hurricane Maria, unfortunately.

4. Microgrid Generation Technology and
5. Restoring Operations Using Combined Heat and Power (CHP) Systems:

GridWise wishes to note that combined heat and power (CHP) can be used in a microgrid context. For instance, Princeton University (in New Jersey) had a combined heat and power microgrid that helped retain power during Superstorm Sandy. Since that time, other parts of New Jersey have been considering deploying microgrids in a range of applications.

III. GRIDWISE'S COMMENTS ON SOME OF THE COMMISSION'S SPECIFIC QUESTIONS – APPENDIX II TO THIS "RESOLUTION AND ORDER" ISSUANCE/REQUEST FOR PUBLIC COMMENTS:

Distributed Resources to Augment Northern Supply:

In addition to the transmission and distribution lines, the generation in Puerto Rico is (or was) vulnerable, because it is situated near the coast to take advantage of cooling water. Thus, as noted in the microgrids section and elsewhere in this document, GridWise encourages resources to be located closer to loads, generally speaking, particularly in the case of some critical loads, such as hospitals, schools, and water/wastewater treatment infrastructure.

As also noted previously, DERs are extremely valuable and present a unique opportunity to help Puerto Rico restore power relatively quickly in some instances, and to help P. Rico rebuild in the near and long term in a more resilient and sustainable manner. However, DERs will not work in all instances nor everywhere in San Juan or Puerto Rico more broadly, as we also have noted herein.

GridWise appreciates the opportunity to submit these comments and offers to continue to serve as an ongoing resource to the PREC. For questions about this Submission, please contact me at shauser@gridwise.org or (720) 254-8020 or Ladeene Freimuth, Policy Director of the GridWise Alliance, at: lfreimuth@gridwise.org or (202) 550-2306.

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Appendix 1: Examples of, and Recent Lessons Learned from, Rebuilding in a More Resilient Manner

Examples of Rebuilding in a More Resilient, "Smarter" Manner:

- Wooden poles could be replaced with concrete or steel ones, where appropriate.

- A transmission line, or portion of a line, could be repaired to help restore power. Then, the line could be made more resilient, e.g., by creating redundancies or hardening. After these steps occur, the original line could be replaced or upgraded, if necessary.

- A variety of resources, such as solar, batteries, microgrids, and/or diesel could be used to help restore power in certain parts of the island and/or to critical facilities relatively quickly. These systems could later be upgraded to provide more permanent grid support.

- Given the current location of generation sources, some type of reliable generation with adequate "fuel supply" near critical loads, such as hospitals, likely should be part of the overall resiliency planning considerations.

Information about Restoration in the Wake of Hurricanes Harvey and Irma:

CenterPoint Energy:

- Hurricane Harvey made landfall on Friday, Aug. 25.
- Of CenterPoint's 2.4 million customers, approximately 1.3 million lost their power,[3] or roughly 50 percent, "compared to 2.1 million when Hurricane Ike hit Houston in 2008. For comparison's sake, CenterPoint had 2.2 million customers at that time."[4]
- "Fewer than 40,000 were still without power by late Thursday"[5] – i.e., within one week – and all of these outages were restored "in under 10 days."[6]
- The utility's investments in grid modernization capabilities and technologies, including a mobile substation that provided "power for more than 9,000 customers"[7] enabled them to reduce power outages and to restore power much more quickly where outages did occur.

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[3] Mercado, Kenny, Senior Vice President, Electric Operations, CenterPoint Energy, "Kenny Mercado's [Prepared] Remarks for [Texas] Senate Business & Commerce Committee," page 1, November 1, 2017 (Mercado prepared remarks).

[4] Handy, Ryan Maye, "CenterPoint Energy continues to restore power to most Houston-area customers," Updated September 1, 2017, Houston Chronicle, chron.com, available at: http://www.chron.com/business/energy/article/Outages-dwindling-across-Texas-but-many-still-12165137.php.

[5] Ibid.

[6] Mercado prepared remarks, page 1.

[7] Mercado prepared remarks, pages 1-2.

- They avoided "almost 41 million outage minutes."[8]
- "The Smart Grid, including distribution automation devices such as intelligent grid switches, allowed [CenterPoint] to quickly isolate problems on [the] grid and restore service to 140,000 customers through those devices."[9]

FPL:

- Hurricane Irma "impacted all 35 counties and 27,000 square miles of FPL service territory, causing more than 4.4 million customers [(i.e., 90 percent of the company's customers)] to lose power."[10]
- To prepare, "FPL assembled and pre-positioned the largest restoration workforce in U.S. history, which grew to approximately 28,000 at its peak."[11]
- "This preparation and coordinated response, combined with [$3 billion in] hardening and automation investments that FPL has made since 2006 to build a stronger, smarter and more storm-resilient energy grid, enabled the company to restore service to over ***2 million customers in 1 day***" – i.e., to restore nearly 50 percent of the outages.[12] (Emphasis added) This is an "80% improvement compared to [Hurricane] Wilma restoration efforts."[13]
- "Within three days, 75 percent of FPL customers were restored and within five days, 90 percent of customers were back on."[14] The "full restoration was completed 10 days after Hurricane Irma left FPL's service territory."[15]
- FPL "completed the fastest storm restoration of the largest number of customers by any one utility in U.S. history."[16]
- "Hurricane Irma had an approximately 50% higher damage potential than Hurricane Wilma" and 15% more of the population (90% in Irma versus 75% in Wilma) lost power during Irma.[17] Yet, "there was an approximately 80% reduction to pole damage and an

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[8] Mercado prepared remarks, page 2.
[9] Ibid.
[10] Edited Transcript of NextEra Energy, Inc. earnings conference call or presentation, text version of transcript, October 26, 2017 (1:00 p.m. GMT), available at: https://finance.yahoo.com/news/edited-transcript-nee-earnings-conference-122613065.html?.tsrc=applewf.
[11] NextEra Energy, Inc. and NextEra Energy Partners, LP, Third Quarter 2017 Release, October 26, 2017, available at: http://www.investor.nexteraenergy.com/phoenix.zhtml?c=88486&p=EarningsRelease.
[12] Edited Transcript of NextEra Energy, Inc. earnings conference call or presentation, text version of transcript, October 26, 2017 (1:00 p.m. GMT), available at: https://finance.yahoo.com/news/edited-transcript-nee-earnings-conference-122613065.html?.tsrc=applewf.
[13] Edited Transcript of NextEra Energy, Inc. earnings conference call or presentation, text version of transcript, October 26, 2017 (1:00 p.m. GMT), available at: https://finance.yahoo.com/news/edited-transcript-nee-earnings-conference-122613065.html?.tsrc=applewf.
[14] Von Ancken, Erik, "FPL shares lessons learned after Hurricane Irma knocked out power statewide," Orlando.com, October 17, 2017, available at: https://www.clickorlando.com/news/lessons-learned-for-fpl-after-irma.
[15] NextEra Energy, Inc. and NextEra Energy Partners, LP, Third Quarter 2017 Release, October 26, 2017, available at: http://www.investor.nexteraenergy.com/phoenix.zhtml?c=88486&p=EarningsRelease.
[16] NextEra Energy, Inc. and NextEra Energy Partners, LP, Third Quarter 2017 Release, October 26, 2017, available at: http://www.investor.nexteraenergy.com/phoenix.zhtml?c=88486&p=EarningsRelease.
[17] Edited Transcript of NextEra Energy, Inc. earnings conference call or presentation, text version of transcript, October 26, 2017 (1:00 p.m. GMT), available at: https://finance.yahoo.com/news/edited-transcript-nee-earnings-conference-122613065.html?.tsrc=applewf.

80% improvement in the time to energize all substations following the storm when compared to Hurricane Wilma." Moreover, "while the average customer outage from Hurricane Wilma lasted for over 5 days, the average outage for customers affected by Hurricane Irma was roughly 2 days, a 60% improvement."[18]

- "The total GDP within [FPL's] service territory averages over $1 billion per day. By reducing the average customer outage by more than 3 days when compared to Wilma," the "avoided economic loss to the state has more than paid for the $3 billion in hardening investments . . . made since 2006."[19]
- Final storm costs are preliminarily estimated to be "approximately $1.3 billion."[20]

[18] Ibid.
[19] Ibid.
[20] Ibid.

Appendix 2: "No Regrets" Measures

The table below highlights some of GWA's recommended near-to-medium-term measures and their rationales. Such measures could include but are not limited to the following. We shared these measures with New York's Public Service Commission during their "Reforming the Energy Vision" (REV) process and with the U.S. Department of Energy (DOE) during their Quadrennial Energy Review (QER) process.

Measure or Technology	Driver	Comments
Getting the grid ready………		
Upgrade Geographic Information System (GIS) Data Models	Must have the right data to drive the models. The data needed for the advanced modeling of the distribution system exceed the data that have been needed to drive Outage Management Systems (OMS) and load flow analyses that have been utilized to date.	Utilities that have undertaken new Advanced Distribution Management Systems (ADMS) have found that they need additional data to drive their models.
Distribution Supervisory Control And Data Assess (DSCADA)	Must have visibility and control to key components on the distribution grid.	Many utilities do not have DSCADA systems deployed, or have only limited capabilities with the systems deployed today. These systems must be upgraded to give the utilities the visibility and control not only to the feeder breakers, but to key distributed automation on their feeders.
Advanced Distribution Management Systems (ADMS)	Must be able to model the distribution feeders in near real time and on a continual basis, with feedback control points to validate the model.	To enable two-way power flows on the distribution grid, the grid operator will need this advanced modeling capability. Additional modules or systems will be needed to perform functions such as Volt/VAR Optimization (VVO) and Distributed Energy Resource Management (DERM). As increasing levels of DERs are added to the system, these additional capabilities will be required to effectively manage system stability and reliability.
Distributed Energy Resource Management (DERM)	DERM systems will be needed when penetration levels of DERs reach a level at which they are affecting system reliability and stability.	State policies and objectives that incent consumers and third parties to install DERs will have significant impacts on the speed of adoption within a given state. Consideration should be given to how this DERM functionality will be incorporated during the

		design phase of ADMS. This functionality could be provided as an add-on module to the ADMS, or could be a stand-alone system that is integrated for operational purposes. Timing to install DERM will depend on the penetration levels of DERs.
Volt/VAR Optimization (VVO)	To improve grid efficiency and ensure power quality, as new complex resources are integrated into the grid.	VVO could be a module of the ADMS or a stand-alone system but, at a minimum, will need to be integrated for operational purposes to ADMS.
Distribution Feeder Balancing Program	To better manage and leverage voltage management capabilities to maintain power quality on the grid.	To reduce losses and better manage the voltage and VARs on the distribution grid, the distribution feeders will need to be balanced as far out on the feeders as is economically and practically feasible. This may require increasing conductor size or pulling in additional conductor phases in some areas. As part of the design and analysis phases of the ADMS and VVO, utilities should consider how much feeder balancing would be needed.
Advanced Sensing Capabilities on Distribution Feeders	To increase situational awareness of grid conditions.	To support the ADMS models and enable the optimization of grid operations, additional sensing components will be needed. Advanced meters could comprise one component of this sensor network, particularly when looking at VVO functionality.
Asset Management Systems (AMS)	To track and enable more condition-based maintenance on the distribution grid.	Given the increase in sophisticated assets on the distribution grid, tracking and understanding the condition of these assets will become increasingly important to control maintenance costs and ensure the reliability of the system and its assets.
Getting the exchange and settlement infrastructure in place:		
Meter Data Management Systems (MDMS)	To establish the foundation for managing consumer usage data. Enables the utility to gain a better understanding of the ways in which consumers are using electricity.	An MDMS will allow the utility to gather and analyze their consumers' usage data, giving them a deeper understanding of how consumers are currently using electricity. An MDMS is a critical component of any advanced metering system. By establishing an MDMS in advance of an advanced meter deployment, the utility will be positioned to more quickly leverage data/information from advanced

		meters, and to offer immediate value to the consumer, once the deployment has occurred. In addition, by leveraging MDMS with current metering information, the utility can perform additional analytics on this usage information. This analysis will be useful in developing new programs for consumers as well as providing insights they can use in planning an advance meter deployment. These data or information also will provide the utility with an understanding of the impacts of DERs as they are installed on the system.
Advanced Metering Infrastructure (AMI) *(Adopting a Phased Approach from Targeted Through Complete Deployment)*	Positions utilities and consumers to have the ability to purchase or supply services to the grid, in association with the implementation of DERs. This is a critical component need to establish the platform for transaction management, including the buying and selling of services as well as measurement and verification of transactions for settlement purposes.	AMI capabilities will be needed for consumers who wish to participate in a DER market to sell and receive new services. This same infrastructure can provide numerous operational benefits as well as serve as sensors on the network to enhance situational awareness and allow the grid operator to optimize network operations. All of the value streams should be considered in the planning for and deployment of these systems to maximize their value, including by state regulators.
Infrastructure that supports both:		
Communications Infrastructure	Foundational in nature. Planning should incorporate all new requirements for managing the grid as well as enabling the AMI that will be required to support the robust buying and selling of services via the grid as the "enabling platform."	Communications infrastructure varies in size, etc., and lacks uniformity of structure. Taking into account a given utility's topology and the availability of public telecommunications infrastructure, an optimal design then can be developed. Communications infrastructure that overlays the electric grid infrastructure is the foundational capability that enables situational awareness and remote management. It should not be planned for in a "siloed" manner but, rather, should be done holistically. Planning for this infrastructure needs to incorporate all communications requirements, both immediate or emergency,

		and planned, and should remain flexible and agile to accommodate emerging requirements as much as possible.
Data Analytics	Turning data into "actionable" information will require a focus on developing and deploying data analytics capabilities.	By their very nature, the modernization of the distribution grid and the deployment of AMI will result in utilities having more data, i.e., "big data." Data analytics are required to turn these data into "actionable" information and to ensure these data are leveraged for their maximum value to consumers and utility operations.