



U.S. Department of Energy
Electricity Advisory Committee Meeting
National Rural Electric Cooperative Association Conference Center
Arlington, VA
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Meeting Summary

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Welcome, Introductions, & Review of Developments since July Meeting

Michael Heyeck, Chairman of the Electricity Advisory Committee, introduced Lawrence Mansueti, EAC Designated Federal Officer (DFO), a role formerly held by Matt Rosenbaum. Mr. Mansueti called the meeting to order and provided an overview of his role as DFO as well as a summary of key legal requirements from the ethics handbook, including the financial conflict of interest policy. Mr. Mansueti thanked the EAC Members for their service on the committee.

After thanking Mr. Mansueti for his comments, Mr. Heyeck recognized Mr. Rosenbaum for his previous service as the EAC DFO. Mr. Heyeck introduced himself and welcomed the attendees, expressing gratitude for the participants' willingness to serve on this advisory committee and for the National Rural Electric Cooperative Association's hosting of the meeting. Mr. Heyeck noted that this is a public meeting and will be recorded for the purpose of preparing a detailed written summary. Mr. Heyeck explained the rules of engagement, including how members of the public could join the public comments section on the agenda for the following day. Mr. Heyeck stated that one set of written public comments had been submitted prior to the meeting.

All committee members introduced themselves with name and affiliation. After a brief overview of the agenda, Mr. Heyeck recognized Assistant Secretary for the Office of Electricity Bruce J. Walker.

Update on the Department of Energy (DOE) Office of Electricity (OE) Programs and Initiatives

Assistant Secretary Walker provided an update of recent work from the Office of Electricity. Assistant Secretary Walker first spoke about the recently formed DOE Office of Cybersecurity, Energy Security, and Emergency Response (CESER). CESER Assistant Secretary Karen S. Evans was sworn in about five weeks prior to the meeting. At the time of the meeting, CESER was fully operational and working closely with partners in the Electricity Sector Coordinating Council (ESCC) as well as the Oil and Natural Gas Coordinating Council (ONG SCC).

Assistant Secretary Walker said that after CESER was split from OE, OE refocused to its original mission. Assistant Secretary Walker said that one of the first OE initiatives was integrating the four Power Marketing Administrations (PMAs) within DOE into OE. Assistant Secretary Walker explained the PMAs as transmission companies with real market power. He stated that three of the four utilities own a significant amount of electric transmission infrastructure that transmit power from the federal hydro system owned by the Army Corp of Engineers and Bureau of Reclamations to customers that are part of the American Public Power Association, NRECA, and many Edison Electric Institute members. He also stated that OE continues to work with many of the National Labs to develop the North American Energy Resiliency Model (NAERM), a model that incorporates all the interdependencies in the energy sector, including all the energy infrastructure throughout North America, to help understand where to invest in the energy system to make it more resilient. The second phase of the project, on which OE is working with the Office of Management and Budget and congressional appropriations staff for the FY20 year, is to transition this model into a real-time model to enable situational awareness throughout North America, incorporating numerous different data points

that will also enable the next-worse-case analysis. Under this model, in the event of loss of a transmission facility, generation facility, natural gas pipeline or any other energy infrastructure, OE would be able to understand the consequences. As part of this, OE is also working with the North American Electric Reliability Corporation (NERC) and the Federal Energy Regulatory Commission (FERC) to be able to provide the best support to the industry as this model progresses. He said that they are making tremendous headway and that it is informing OE of some of the challenges and risks on the system.

Assistant Secretary Walker said that OE's primary focus is national security. He stated that everything OE focuses on is driven by understanding the implications in the energy sector regarding national security. OE has been working very closely with their partners in the National Nuclear Security Administration, which owns the nuclear weapons program, the Department of Defense, and the Department of Homeland Security to identify the most critical infrastructure in the United States from a continuity government perspective. This effort is incorporated into the NAERM to enable OE to provide the situational awareness to enable it to generate investments. Assistant Secretary Walker said OE is working very closely with the Regional Trade Organizations, NERC, and FERC to better understand the market implications,

Assistant Secretary Walker then addressed the pre-decisional leaked memo, which was not complete at the time it was leaked, that talked about trying to stave the retirement of *any* fuel secure generation in the United States. Assistant Secretary Walker stated the memo was not just focused on coal or nuclear, but rather that it was a recognition that there has been a significant change in the generation portfolio in the United States over the past two decades. Assistant Secretary Walker said that, most notably, there is a significant reliance on natural gas for electric generation, which creates a liability that did not exist two decades ago. He said this liability challenges the notion of a second contingency design on a transmission system, which was traditionally developed with an n-1-1 study. This increased reliance on natural gas pipelines and petroleum pipelines, Assistant Secretary Walker said, challenges the notion that today's system can be considered a second contingency design. Assistant Secretary Walker recognized that the n-1-1 design is 50 years old and that the system has continued to evolve. In this light, Assistant Secretary Walker said that OE's work with FERC and NERC will help provide a better perspective regarding the risks and challenges facing the system. Assistant Secretary Walker characterized DOE as part of the intelligence community and said it works closely with the other sixteen intelligence agencies to form a clearer understanding of what the threat vectors are throughout the energy sector. Assistant Secretary Walker said that OE works with the ESCC and ONG SCC to inform industry partners of risks so that they can make risk-informed, intelligence-informed decisions.

Assistant Secretary Walker said that OE would soon be issuing its proposed Critical Electric Infrastructure Information (CEII) designation rules. According to Assistant Secretary Walker, this designation would allow OE the authority to gather and protect industry information. Assistant Secretary Walker said that they do not want to disseminate critical infrastructure information unnecessarily, and that this action will pre-designate CEII information, thus exempting it from disclosure via Freedom of Information Act (FOIA) requests. He said OE would be publishing notice of the draft rules in the Federal Register in the weeks following the meeting, at which point OE will take comments and make necessary modifications. Assistant

Secretary Walker noted that one of the key underpinnings of this designation is that OE can prospectively designate things as CEII, which is different from the way the designation process has previously taken place.

Assistant Secretary Walker said that OE has been able to leverage a significant amount of work it is doing in Puerto Rico in response to Hurricane Maria. He said that OE is working with seven National Labs, the same Labs working on the NAERM, to build for Puerto Rico the most sophisticated model that exists in order to understand the impacts of future hurricanes and to identify where the best investments can be made to improve the resiliency and capability for the island to withstand another Category Five hurricane. He said a team representing OE and the National Labs would be in Puerto Rico for the two weeks following this meeting working with control and operations personnel to identify opportunities on relaying and generation investments to create resiliency in the face of the challenges of aging infrastructure that Puerto Rico faces on the system. He said that OE is also extending lessons learned from the development of the NAERM to the other areas of the United States (U.S.) that need to be rebuilt as a result of Hurricane Florence and Hurricane Michael. Assistant Secretary Walker also mentioned that he recently spoke with leaders of the Electricity Subsector Coordinating Council (ESCC) on opportunities to apply OE resources as recovery efforts continue.

Assistant Secretary Walker also discussed the development of energy storage. He said that storage technology has fundamentally been driven by the desire to integrate renewable technologies into the system. According to Assistant Secretary Walker, from a national security perspective, it has become clear that there is a need for much more strategic development of storage technology with a longer duration of capability. DOE has recently issued a \$30 million funding opportunity announcement for a 100+ hour development of storage. In addition, he said OE continues to work through its Grid Modernization Lab Consortium (GMLC), which has expanded to include CESER and the Office of Fossil Energy and the Office of Nuclear Energy. In total, five DOE applied science offices comprise the GMLC, including OE. The GMLC is pooling the needs, capabilities, and challenges across those five applied science offices to drive investments. GMLC will be working toward a \$250 million investment in R&D over the next three years, a portion of which will be focused on long-term energy storage. OE is also working closely with Pacific North West National Lab on developing and capitalizing investments that they have made in their chemistry research. OE is also exploring other opportunities in long-term storage, including redox flow batteries and zinc manganese. Assistant Secretary Walker is confident that research will make significant headway in this area in the next 18 months, which aligns well with the timeline to transition the NAERM to a real-time model, which will help identify where long-term storage has the best capabilities on the system for frequency control, reactive power flow, or the needs of the system in another specific area.

OE has planned significant projects in its sensors program. Assistant Secretary Walker said OE recently received a report from across the National Labs that outlined current capabilities. Assistant Secretary Walker said this will inform how the technology can be progressed. When the real-time model is complete, Assistant Secretary Walker said OE plans to encourage the seamless integration of sensors into both the distribution and transmission systems. Assistant Secretary Walker noted that key milestones will be creating a sensor with a significant sampling rate and using modeling to inform where sensors should be installed in the system so that

artificial intelligence (AI) and machine learning can best apply that data for decision-making. Assistant Secretary Walker said that OE recently had a \$5.8 million funding opportunity announcement with regard to sensing capabilities as well as the utilization of AI to analyze data that will be gleaned by these sophisticated sensors.

In closing, Assistant Secretary Walker challenged the Committee to further explore the concept of “spinning reserve.” Assistant Secretary Walker shared a narrative about the concept, noting that about 15% of the system’s runtime does not provide any real work as defined for the normal system. Assistant Secretary Walker challenged the EAC to consider spinning reserve margins, asking if there is a possibility to use spinning reserve to do real work with the technology present today, but still have it available should the need for it occur. Assistant Secretary Walker referred to this as effectively free energy and noted that, though billions have been spent on renewable integration, the electric industry has not taken steps to examine how to harness this source of energy. He said he looks forward to a breakthrough in this area, stating that he sees chemistry offers a powerful tool for solving this issue.

Mr. Heyeck thanked Assistant Secretary Walker for his challenge. He said that, during the last meeting, one of the panels pointed out that the industry is not getting inertia out of demand. Mr. Heyeck noted that there is a demand side of that equation they can work on, suggesting the Smart Grid Subcommittee explore further.

Assistant Secretary Walker then took questions from the EAC.

Mr. Heyeck asked, on the electric side, does CEII conform to the FERC definition and is DOE developing the CEII definition for other energy infrastructure. Assistant Secretary Walker said that the CEII designation was required as a part of the Fixing America’s Surface Transportation (FAST) Act of 2015 and that OE’s CEII definition comports with the definition that was set forth in that statute. However, he said the definition is broad enough that, where there is infrastructure that impacts electricity, the infrastructure can also be utilized under the same rubric. He said that OE is having conversation with Congress to articulate that the term “electricity” can no longer refer to an independent infrastructure.

Anda Ray said that EAC has discussed the “pillars” Assistant Secretary Walker referenced in the February meeting, and asked whether Assistant Secretary Walker sees a boundary in his discussion of the transmission resiliency framework model between it and the distribution system. Assistant Secretary Walker responded that, from a national security perspective, OE is focused on a very significant subset of customers. However, as OE looks at solution sets and funds R&D projects, it considers generation, transmission, distribution, and consumer investments because each one offers opportunities. Assistant Secretary Walker said that he is hopeful about the transactive capabilities at the consumer level that have a significant impact on distribution, which then affect transmission. He said that the system is completely intertwined, and that OE does not look at anything in isolation. He added that much of OE’s current work on the NAERM is primarily focused on the transmission system but that the distribution impacts are reflected back at the bus component at the transmission/distribution substations. He noted that OE will work closely with the utilities through NERC and the ESCC to integrate that information.

Wanda Reder asked how DOE will push technologies through implementation and to execution. Assistant Secretary Walker said that about a decade ago when he sat on the EAC, one of the initiatives they undertook was meeting with the Labs from an industry perspective and having that interface. He said that DOE has started a couple of initiatives on this front and are formalizing how they are going to market much of the technology that exists in the Labs as well as how they will identify the technologies that can be utilized effectively. In the past, utilities mainly had exposure to the Labs through partnerships and only a small subset of utilities was working with the Labs to understand their capabilities. He said that DOE believes it needs to market the Labs more effectively so that utilities are aware of the types of projects they are undertaking. Assistant Secretary Walker emphasized gathering information from the utilities as to what capabilities are needed within the industry from optimization and security standpoint. He added that just before CESER's creation, OE compiled a ~40-page document of all the technologies and capabilities it has developed over the last five years and pushed that inventory out to the industry. He said that the OE leadership team is all focused on the ongoing need for this type of effort.

A Member asked if, beyond the physical infrastructure, OE has considered the underlying data and programs when talking about CEII. Assistant Secretary Walker said that those items qualify under the CEII because they are tied to the infrastructure components.

Mladen Kezunovic asked if the NAERM is cyber-physical. Assistant Secretary Walker responded that the model will have many layers, adding that the model will have a cyber-component that will incorporate different information as sensing capabilities increase across the system.

Paul Hudson commented that the potential for the 17 Labs and its technologies caught his interest. He requested Assistant Secretary Walker not forget to include the manufacturing sector in those discussions as there are many electricity-intensive manufacturers that do not have to rely on taxpayers to jumpstart technologies. Assistant Secretary Walker expressed interest and thanked Mr. Hudson for his comment.

Darlene Phillips asked whether the scope of OE's interest in spinning reserve includes or challenges the baseline need for spinning reserve, or if the scope builds on the benefits that the spinning reserves already provide. Assistant Secretary Walker said he is only beginning to challenge the need for spinning reserve, but has begun the conversation on the question with NERC. He gave examples of alternatives to spinning reserve, such as desalinating water, low-priority work coupled with battery storage, or using the power of electronics today that we didn't have thirty years ago.

Shaun Mann commented that it is concerning that OE is asking for feedback on National Lab projects from utilities, as he does not believe they have the expertise to know what technologies are truly needed. Assistant Secretary Walker expressed understanding of these concerns but said that most people do not understand the massive capabilities that the National Labs have. He said that taking utility input does not obviate the earlier stage R&D being performed.

Mr. Heyeck thanked Assistant Secretary Walker for the updates and said that EAC is pleased with the five pillars from his previous presentation as well as the challenge on spinning reserve that he provided at this meeting.

Update from the Federal Energy Regulatory Commission

Mr. Heyeck introduced the Honorable Neil Chatterjee, a FERC Commissioner nominated by President Trump in May 2017 and confirmed by the Senate in August 2017. He served as FERC Chairman from August to December 2017. Prior to joining the Commission, he was an energy policy advisor to Senate Majority Leader Mitch McConnell.

Commissioner Chatterjee thanked Mr. Heyeck for the introduction and said that he was honored to be present at the meeting. Before beginning his remarks, he stated a disclaimer that the views he expresses are his own and do not necessarily reflect the opinion of his fellow commissioners or the FERC staff. He added that the Commission's ex parte rules do not allow him to discuss any contested proceedings that are currently pending.

Commissioner Chatterjee noted that the energy industry is at a pivotal point and that the decisions made by regulators and stakeholders in the near future will have lasting effects. He touched on some key conversations on-going at the Commission about bolstering grid resilience, integrating innovative technologies, developing electric infrastructure, and addressing cybersecurity. He began with resiliency, which he pointed out is a subject that Assistant Secretary Walker has demonstrated great leadership on. Commissioner Chatterjee said that Secretary Perry jumpstarted an important conversation on the resilience of the grid last fall, which Commissioner Chatterjee is a critical topic for the electricity sector to consider. In January, the Commission initiated an inquiry in the resilience of the bulk power system. In that proceeding, the Commission required regional transmission operators (RTOs) and independent system operators (ISOs) to submit information that allowed the Commission to evaluate the risks that the bulk power system faces in the changing electric market as well as possible ways to address those risks. He said the Commission also asked stakeholders for their perspectives and received hundreds of submissions, which the Commission was evaluating at the time of the EAC meeting. Commissioner Chatterjee expressed that he believes this issue was one of the most important issues currently before the Commission.

Commissioner Chatterjee expressed his concerns about the financial challenges facing the nuclear fleet, particularly because nuclear power is our single greatest source of carbon-free baseload generation. He said that it is important to note that nuclear and other baseload resources also provide valuable reliability and resiliency attributes to the grid. He stated that he believes it is imperative that the Commission continue to examine the universe of contributions that those resources offer as well as whether and how market design needs to be refined to better compensate them for their contributions. He added that he has been encouraged by the fact that several RTOs have performed or are in the process of performing fuel supply vulnerability studies in their footprints. He mentioned that the Commission has a couple of proceedings pending that touch on these issues and so could not say more about them. He then transitioned to discussing the efforts in FERC to better integrate innovative energy technologies.

Commissioner Chatterjee commented that he is particularly proud of the progress FERC had made ensuring that renewable energy resources can compete in organized markets. To illustrate this point, Commissioner Chatterjee pointed to the Commission's issuance of rules requiring all new generators, including renewables, provide essential reliability services, such as voltage support and frequency response. He said the Commission adopted revisions to the generator interconnection procedures to improve certainty for customers and to enhance the process, allowing developers to bring new generation online faster. In addition, Commissioner Chatterjee said that the Commission had approved various proposals from RTOs and ISOs to enhance integration of renewable energy into their markets, thus allowing renewables to compete on even footing with traditional generators. He emphasized that energy storage is another coming-of-age story within organized markets. He noted that it has been one of his top priorities to explore how to better allow storage to compete because of the exciting potential he believes they have to lower cost and enhance reliability for American consumers.

Commissioner Chatterjee characterized leveling the playing field for storage as a timely topic of discussion and said that there is immense interest in storage-related topics. He said that, since joining the Commission last August, FERC had taken two major steps in making a future of competitive energy storage possible by issuing Order 841 and Order 845.

- According to Commissioner Chatterjee, Order 841 required all wholesale market operators to ensure that storage can compete on a level playing field with other resources. He said that Order 841 grew out of a concern that storage technologies did not have an adequate opportunity to compete in all organized markets, as if storage did not fit into some of the other participation models that RTOs had already established. He said that both storage's energy-limited nature as well as its ability to both charge and discharge made it more complex to incorporate it into security-constrained, economic dispatch. He said that some RTOs tried to address this problem by requiring storage to utilize resource participation models already in place, such as those for demand response. However, he said that, while this approach leveraged the existing work done by RTOs, it did not necessarily let the storage resource provide all the services it was technically capable of providing. Commissioner Chatterjee characterized these limitations as textbook examples of artificial barriers to entry that not only hamper the continued development of storage, but more importantly, result in higher cost for consumers. To address this concern, he said, Order 841 sets forth three broad principles to govern storage participation in wholesale markets:
 - storage must be eligible to provide all the services that it is technically capable of providing, including energy, capacity, and ancillary services;
 - storage must be able to set the market price; and
 - the market operator must account for the unique physical characteristics of storage through bidding parameters or other means (e.g., monitoring the storage resource's state of charge)

Commissioner Chatterjee continued by saying that Order 841 adopted a minimum threshold of a 100KW for storage to participate in the market. He noted he believed that this principles-based approach strikes a balance by providing a fair and economically efficient outcome while leaving the various regions significant discretion to craft a viable proposal for their members. While he said that the Commission made significant progress in removing barriers to entry in the markets with Order 841, the interconnection process also risked imposing other significant barriers to

electric storage's full participation in electricity markets. In 2015, he said that the Commission began assessing the need for changes to its interconnection policies to address, among other things, changes that would allow integration of technologies like utility scale battery storage, leading to the issuance of Order 845 in March 2018.

- Commissioner Chatterjee said that Order 845 reformed the interconnection process for large generators. He said that Order 845 did not directly deal with storage but did make important changes that facilitated the use of electric storage and that the order included nearly a dozen discreet changes to the Commission's large generator interconnection rules. One of these changes, he said, modified the definition of "generating resource" in the Commission's interconnection policies to specifically include storage resources. He said that this change helps reduce uncertainty of how storage should be treated in the interconnection process.

Commissioner Chatterjee next discussed the Commission's future plans for storage. He said that he thought co-locating storage with renewables is an interesting trend that has benefits but that there was neither yet certainty that it will become a standard practice nor that utilities would couple energy storage with other non-renewable generation types. Commissioner Chatterjee emphasized that the answers to these questions could have major implications to storage going forward. He said that there is evidence that the cost-benefit ratio of co-locating storage is tipping in favor of adding storage. He gave an example from 2017, in which Xcel Energy held an open solicitation for new resources, receiving more than 250 offers for wind and solar resources, with median offers of \$18/MWh and \$29/MWh, respectively. He said that there were also bids for wind and solar collocated with battery storage and that these had a median offer of \$21/MWh and \$36/MWh, respectively, which are only \$3/MWh and \$7/MWh more than the conventional wind and solar, respectively. When considering market incentives, he said that collocation could be extremely beneficial in allowing renewables to avoid performance penalties and take advantage of high prices. Furthermore, he said that the Commission is looking at how to best integrate distributed energy resources and that it is making good progress. He said that the Commission held a technical conference in early 2018 to examine market design, reliability, and other challenges associated with increased DER (distributed energy resource) penetration and are currently reviewing the numerous comments submitted following that technical conference.

Commissioner Chatterjee pointed out that another area, which he believed seemed paramount to keeping up with revolutionary changes in the resource mix, is the need for new and upgraded transmission facilities. He said that after a year of collaborating with his colleagues at the Commission, working with FERC's expert staff, and meeting with stakeholders across the industry, he has a far greater appreciation for the significance of the U.S. electric transmission infrastructure, saying that it is a component of the overall energy infrastructure that deserves to be examined.

Commissioner Chatterjee then highlighted challenges facing the transmission grid. First and most importantly, he said, is that the transmission infrastructure is antiquated with most of the system more than 40 years old and based on 1950s-era technology. Second, he said that the expectations for the transmission system are and continue to grow. Commissioner Chatterjee said that past grid design struck a balance principally between cost and system dependability, and while those objectives will remain important, that he felt it was clear that demands from the transmission architecture will grow in the coming years. As the third challenge, he said that the

current transmission system is increasingly unable to keep up with rapid, market-driving innovations and policies. Technological advancements in the energy sector are happening at a rapid rate, he said, and the transmission system must improve to accommodate those advancements or risk impediment caused by this lack of transmission capacity to meet future demand. Commissioner Chatterjee said that significant issues arise when vast quantities of cheaper generation resources are located great distance from load centers. Shifting locations and scaling resources, he said, will require upgrades to the transmission facilities. He noted that the challenge for FERC and other regulators is to create a regulatory environment that will incentivize the investments in the transmission system that North America needs in the next century. He added that he believes the Commission should provide the right financial incentives for transmission investments and leverage competition to find more cost effective and innovative solutions to transmission needs.

He said that the Commission appreciates the enormous risks that come with building transmission infrastructure, noting that interstate transmission projects are often billion-dollar projects. He said that the magnitude of those risks reveals why it is imperative that the Commission seeks to ensure that investment returns are sufficiently attractive so that they will continue to pursue these projects. He added that he has heard from numerous stakeholders that the Commission needs to devote more resources to these efforts, noting that he found their arguments compelling.

Commissioner Chatterjee highlighted two specific areas of FERC's concern. First, he said that the Commission issued an order the night prior to the meeting addressing the DC Circuit's decision in *Emera Maine v. FERC* to remand FERC's methodology for determining return on equity for transmission-related projects. He said that many stakeholders have been outspoken on this issue, warning that the uncertainty surrounding the path forward in relation to this case chills investment in transmission infrastructure. Therefore, Commissioner Chatterjee said that the Commission's action should help ensure more clarity moving forward. As the second area of concern, he stated that many stakeholders believed that the commission's incentives policy set forth in Order 679 needed to be reviewed to ensure it is applicable in current times, with stakeholders noting that the policy was crafted in a pre-Order 1000 world. Since Order 679 was issued in 2006, he said, its implementation has been affected by legal challenges. In light of *Emera Maine*, Commissioner Chatterjee said, uncertainty regarding the Commission's approach to transmission projects' returns on equity has underscored the importance of the investment incentives, as described by Order 679, to developing the compensation package necessary to convince capital to support transmission investments. The consequences of the Commission's efforts in addressing those and other stakeholder concerns regarding the adequacy of investor returns on transmission investment are immense, he said, with potentially hundreds of billions of dollars in transmission investments depending on the Commission's action in response to the stakeholder concerns. He said that, for this reason, it is a personal priority of his to expeditiously consider how FERC will address the concerns regarding adequacy of returns on transmission infrastructure investment.

Lastly, before ending his discussion, Commissioner Chatterjee touched on cybersecurity, calling it important across both the gas and electric spheres. He said that technological advancements driving society cannot be examined without discussing the increasingly threatening cyber

vulnerabilities with which the private and the public sectors contend. He stated that it is imperative to proactively defend against cyber-attacks, adding that he has been vocal about his concerns surrounding cyber threats targeting the electric system and pipelines, both of which directly affect the Nation's security and prosperity. Commissioner Chatterjee emphasized that it is essential to comprehensively address emerging threats by foreign adversaries, and our Nation's ability to withstand and recover quickly from extreme events. The ability to withstand cyber-attacks, he said, is a vital part of the conversation around grid resilience. He noted that throughout this process, the Commission should work to address the critical question, what threats should the grid be designed to withstand? Given the nation's increasing reliance on electricity as well as the increase of threats to the grid, he said it is critical we evaluate whether the historic norms of planning the grid are enough or if additional steps should be taken. According to Commissioner Chatterjee, this would mean asking ourselves, could the grid hold up against a cyber-attack that disables an entire substation? He added that he has joined his colleague, Commissioner Rich Glick, to bring attention to their concerns that, despite the U.S. grid operators' requirement to comply with many mandatory standards overseen by FERC, they currently have no comparable set of standards for a network of pipelines. He said that FERC has the authority to issue certificates for new interstate gas pipelines and to set their rates but not to regulate their security, as this charge falls to the Transportation Security Administration (TSA), which oversees 851 million aviation passengers per year, 131,000 miles of railroad track, and 4 million miles of highway. Commissioner Chatterjee said that, in May of 2017, TSA confirmed that it had just six full-time employees overseeing more than 2.7 million miles of natural gas, oil, and hazardous liquid pipelines traversing the entire country. He said that these are important topics to examine but that it still may not be possible or cost effective to design the grid to withstand every cyber-attack. He said that steps need to be taken to reduce the size of disruption and enhance the grid's resiliency. He said that he is committed to working with his colleagues at the Commission as well as government partners and industry leaders to help ensure they are doing all they can to protect against future threats. He then concluded his remarks and thanked everyone for their time.

After Commissioner Chatterjee's presentation, the Committee recessed until the 2:30 panel.

Panel: Perspectives on Grid Resilience

Sheri Givens introduced the panel, which focused on the policy perspectives of resilience, explored how different stakeholders consider the issue, and provided insights from the regulator, consumer advocate, utility, and state legislative perspectives. Ms. Givens introduced Bryan Olnick of Florida Power & Light (FPL) who gave the first presentation on the utility perspective of resilience investments.

Mr. Olnick's presentation focused on grid resilience, particularly with regards to weather impacts. Mr. Olnick introduced his company, FPL, a subsidiary of NextEra Energy that serves a significant part of Florida where most of customers live about 20 miles from the coast. He said that FPL works to ensure the grid is resilient against all vulnerabilities. He said that since 2004, Floridians have experienced numerous storms, which have set the foundation for FPL's resilience measures. He gave the example of Hurricane Wilma, which caused significant damage in 2005 and following which required over 18 days for FPL to completely restore power. Mr.

Olnick said that in 2006, Florida state commissioners issued several regulatory orders to build grid resilience in the state. The first initiative, he said, was for all regulated utilities to conduct pole inspections. He said that the state commissioners also implemented new vegetation requirements and instructed utilities to develop infrastructure-hardening initiatives, leaving it to the utilities to define what those standards would be. In 2006, he said FPL looked at putting together a toolkit to strengthen Florida's system, not only in the context of reliability but also in resiliency. An example he gave was the distribution pole-hardening toolkit FPL implemented, which provided engineering solutions for improving pole resilience. He said this was also an approach that was holistic, including hardening of the transmission system.

Mr. Olnick said that FPL's resilience roadmap was formed under the Commission's 2006 orders, focusing particularly on wind-loading strategies and designs. In working with all 35 counties that FPL serves, he said FPL regularly meets with emergency management professionals to understand how they define their most critical facilities, prioritized in FPL's resilience strategies. He said that these facilities could be 911 call centers, local jails, or important community centers, such as large shopping centers. He said that critical road crossings were also prioritized. FPL also included a provision that incentivized undergrounding, Mr. Olnick said.

According to Mr. Olnick, the State of Florida did much work to change building codes, and so FPL anchored their strategy on those codes. These standards defined wind-loading for Florida, he said, and that as a result of Hurricane Wilma, FPL decided to follow the extreme wind-load (EWL) standard for their structures. Mr. Olnick said that FPL's key strategy is to prevent, mitigate and restore by examining each of those pieces individually and that FPL hopes to complete its feeder-hardening plan by 2024. He pointed to the many lessons learned since the beginning of this project. He gave the example of an incident during Hurricane Wilma where 12,000 poles went down, requiring FPL five days to restore its substations to service. He also gave the example of Hurricane Irma, which impacted 4.4 million customers but caused a lot less pole damage than Wilma. By the time Irma made landfall, he said FPL was almost done hardening its transmission system, and so hardly lost a single transmission line on the west coast of Florida. When comparing the impacts of Wilma and Irma, he felt it was clear that the three billion dollars spent on hardening was worth the investment. He pointed to FPL's exceptional underground system performance as another lesson learned from Irma. Because of this, he said that FPL is now looking at undergrounding instead of just hardening overhead, particularly as these costs reach parity. Moving forward, he said FPL is also prioritizing customer initiatives. He said that FPL's plans for the grid include more hardening and more smart grid technology.

Ms. Givens asked if the incentives for communities for undergrounding are on a cost-share basis or if it is a regulatory requirement. For storm hardening filings, she asked if there is a cost recovery that is regulatory or included in rate cases. Mr. Olnick responded that these storm-hardening programs are rate-based, and that FPL does justification for each agreement it makes. He said that, for undergrounding, when FPL conducted an analysis on the time reduction in restoring them versus overhead structures, they found that there was a 25% improvement in performance in cases in which they undergrounded as opposed to hardening overhead. It is a regulatory mechanism, he said, but is prescriptive because communities had to be of a certain size. He said that they have undergrounded over 40,000 residences.

Ms. Givens then introduced the other panelists: Richard Mroz, former Commissioner of the New Jersey Board of Public Utilities; Elin Swanson Katz, President of the National Association of State Utility Consumer Advocates and Consumer Counsel of the Connecticut Office of Consumer Council; and Charlotte Lane, Member of the West Virginia House of Delegates.

Mr. Mroz began the panel by introducing a list of resiliency issues that state-level officials are concerned about, including fuel redundancy, generation nexus and retail, asset hardening, system management, and DERs. He said that there is still integrated resource planning in some areas, but many states have abandoned that function. State policymakers are concerned about that with regards to transmission and distribution hardening and upgrades, he said, with special focus at the distribution level. He said these policymakers are also concerned with many DER issues, such as integration, islanding, black start capabilities, and cybersecurity. In addition to energy systems, he said state policymakers are concerned with the nexus of critical infrastructure, including water, wastewater systems, and telecommunications. Some state regulators have statutory authority and are looking for ways to invest in integrating new technologies, Mr. Mroz said. He gave an example where, when advanced metering infrastructure (AMI) was deployed, there were limits in communication as many states did not have an established distribution automation backbone.

Mr. Mroz then provided insight on New Jersey, which is heavily populated, has a large amount of critical infrastructure, and has seen several infrastructure-related incidences, such as pipeline explosions. Thus, he said the state has an all-hazards approach when dealing with any particular event. He shared that, in the 2000s, the state began instructing its public utilities to conduct upgrades to their aging infrastructure. Superstorm Sandy led many in the state to focus on improving resiliency, Mr. Mroz said, with millions of dollars spent on hardening as well as developing new platforms, such as a web-based outage map. He said the state also supported the development of microgrids in thirteen different locations and that there is a project currently underway to develop a dedicated power system for the northern part of the New Jersey transit system for use in its continued operation in the event of a larger grid outage. Mr. Mroz stated this project will be a combination of distributed generation and baseload sources. He said that New Jersey also issued several pipeline orders to ensure there was redundant pipeline capacity.

Mr. Mroz said that ongoing concerns within the industry in New Jersey included the costs of resilience measures, valuation methods, and rate structures. He said state regulators are grappling with questions on costs and how to account for them, with several initiatives proposed to examine this issue, including studies conducted by the National Association of Regulatory Utility Commissioners (NARUC), the National Academy of Sciences, and the Electric Power Research Institute. Mr. Mroz said that there have recently been discussions on possible collaboration between states and federal agencies on this issue.

Next, Ms. Swanson Katz presented on how grid resiliency can affect consumers, including affecting the consumer experience and consumer costs. Her comments focused on distribution-level resilience, examining some of its common issues, including generation mix as affected by resilience initiatives, differences between vertically integrated and restructured states (e.g., natural gas constraints in restructured states), regional transmission constraints, and cybersecurity. She expressed the importance of a dialogue among commissioners, advocates, and

utilities on these issues.

Ms. Swanson Katz continued by examining the definitions of reliability and resiliency. She defined reliability as keeping the service on at all times, replacing equipment as necessary, and ensuring ongoing maintenance. She defined resiliency as the ability to absorb, respond to, and recover from catastrophic events. She also defined grid modernization as upgrading the electrical grid to integrate new technology. She gave the example of considering whether fixing a pole would fall under reliability, resiliency, or grid modernization, noting that it is important to assure consumers they are not paying for a single asset more than once.

Ms. Swanson Katz provided perspectives on her experience with resilience improvements in Connecticut. Between 2011 and 2012, she noted that Connecticut experienced three storms that caused the largest outages in the state's history. She said this taught the State's utilities the importance of tree trimming for improving resilience, but noted there remains public opposition to the practice. Another lesson learned she shared was that from the lack of coordination between the utility and the regulators, between the utility and the towns, and among utilities themselves. She said that since these outages, there has been progress in improving communication in the State. She said these outages also taught utilities lessons about preparation and technical integration. Following the three storms, she said that Connecticut's two investor-owned utilities faced approximately \$450 million in storm-related costs. She said that Florida appropriated \$300 million for hardening efforts and are undertaking a grid modernization docket that is expected to be completed by the end of 2018. She also briefly discussed the challenge of making informed modernization decisions in the face of public pressure to restore power as quickly as possible.

Ms. Swanson Katz then spoke to how to determine how much resilience is actually needed, explaining that location is one of the key factors. She said that state energy and climate policies also tend to affect this determination. There has been work on developing microgrids in Connecticut, which she says creates an issue distributing that cost. She gave an example of a military base that wanted a microgrid, which was established as a cooperative effort between the state, utility, and military through a cost-sharing arrangement. In the future, she said that useful measures should include a more uniform resilience analytical framework, prioritization of customer needs, careful consideration of who pays and how they pay, continued dialogue among stakeholders, continued training and collaboration on policy development, and more educational opportunities for industry.

Ms. Lane then continued the resilience conversation by providing perspectives from West Virginia. Ms. Lane started with an introduction to West Virginia, which has 1.8 million people and two major electric utilities – American Electric Power, serving the southern part of the State, and FirstEnergy, serving the northern and central areas. Both utilities, she said, have only coal-fired facilities in West Virginia. Ms. Lane said that, when she was chair of West Virginia's public service commission in 1996-2000, West Virginia had the seventh lowest electric rates in the country, which lead the legislator to largely ignore these rates. However, as the State's rates increased over the past 10-15 years, she said the West Virginia legislature has become more concerned about the cost of electricity. She said that this increase in rates can be largely attributed to the cost of upgrading facilities. She said this has led her to examine the topic of improving resilience regarding embracing resilience improvements without fully understanding

the issue or an agreed upon definition of resilience.

Ms. Lane said that she believed focusing on technical feasible investments in resilience without considering cost and benefits might create unrealistic resiliency goals and uneconomic investments. She said that it is important to invest in measures that are commercially available and technically feasible, but also affordable. Ms. Lane said the cost versus benefits approach must be carefully and holistically studied, but that the necessary analytical tools for this task do not currently exist. She emphasized the need for these tools to focus on societal costs of corrective measures and that, while many utilities report outage data from the meter level, this data still provides little information on the classes of customers affected or the value of electricity to those customers. She believes this information can be useful but that, while rapid recovery from outages is important, the cost of different levels of rapidity must be compared to the cost of customers of less rapid recovery from outage events. Ms. Lane recognized that DOE's OE has funded the development of several projects that focus on this topic. She gave the example of Lawrence Berkeley Laboratory's Interruption Cost Estimate Calculator, a flexible and user-friendly web-based application that can provide cost estimates of outages in different states. However, she observed that this tool is not designed for resiliency cost modeling for long-term sustained outages because of its limited outage duration range, pointing to a statement from Lawrence Berkeley Laboratory that the estimates from this tool are not appropriate for resiliency planning due to the nature of cost change and spillover effects over longer power interruptions. She pointed to the need for a tool with cost-benefit analysis capabilities as a precursor to resiliency planning.

On this same topic, Ms. Lane expressed concern for what she saw as an unwillingness to break down resiliency planning into manageable and affordable bites. She gave the example of DOE's request to FERC to implement rules to ensure the continuity of generation units with secure fuel supplies. Ms. Lane considered this measure to be meritorious, but expressed dissatisfaction that FERC declined to address this fuel security with a short-term ruling, instead opting to open a separate proceeding that is likely to last many years. She believed that a short-term ruling could have made costly resilience improvements more affordable in the near-term. She expressed hope that the Administration's and Senate's efforts to inquire further about the fuel security issue in the near-term would provide more forthcoming solutions.

Ms. Lane explained that vegetation management is also important in West Virginia in terms of tree trimming along electric lines. She said that when the State public service commission investigated power line outages after severe weather events in 2009 and 2010, it issued a ruling that required expanded duration and frequency outage reporting on a circuit-by-circuit basis, targets for improved performances, and a requirement for remedial action on the worst-performing circuits. She said that, in 2012, when West Virginia's electric service was significantly affected by a derecho and Superstorm Sandy, the commission conducted another investigation and determined that fallen trees along power lines caused significant damage, creating difficulties for utility crews to assess and repair damage. She stated that, as a result, the commission required West Virginian utilities to implement aggressive right-of-way clearing over a five-year period, following continuous five-year cycles afterwards. Since then, she says it appears that the frequency and duration of outages as well as costs have been reduced.

Ms. Lane said she hopes that microgrids are adequately investigated and that, during weather events, microgrids should be large enough to accommodate key facilities such as hospitals, transportation fueling stations, food storage, and distribution facilities. Ms. Lane believes that such expansive microgrids cannot be served solely by intermittent resources, such as wind or solar. She also noted that there is little evidence of any issues associated with living in close proximity to nuclear facilities, which can provide important benefits in terms of resiliency. Ms. Lane says small modular reactors should be considered for providing important baseload generation to serve reasonably sized microgrids. The Tennessee Valley Authority is working on some demonstrations, but she believes this process should be expedited.

In conclusion, Ms. Lane noted potential smart grid and cybersecurity threats. Ms. Lane was concerned that smart grids could lead to new problems and that systems that are highly beneficial to utilities will become more susceptible to cyber threats. She worried that systems that allow for direction communication with customers to identify line outages and remote control of substations could become targets for adversaries looking to disrupt the grid. In these scenarios, she believes multiple firewalls and protective interfaces will serve as little more than nuisances to well-funded cyber terrorists. Until the control functions built into the systems can be completely separated from the internet, private networks, and wireless interfaces, Ms. Lane believes smart grids should be viewed as vulnerable to cyber-attacks.

Ms. Givens noted that while each of the four panelists brought different perspectives, there were also commonalities among their presentations, such as cybersecurity as a concern. Ms. Givens also expressed her appreciation for DOE's and the National Labs' ongoing work in this area. She also noted the theme of overlap among in the topics of reliability, resilience, and grid modernization and whether there should be a uniform definition for each of them. Another key takeaway she noted is the important of conducting a cost-benefit analysis to ensure costs are prudent.

Ms. Givens alluded to the discussion on the Interruption Cost Estimator (ICE) calculator and other analytical tools and raised a question on whether there is a need for national standards for analytical frameworks or if this should be examined on a state-by-state or case-by-case basis. Ms. Givens asked the panelists if there is an analytical framework that they have found helpful and if they are looking to DOE to ensure that framework exists. Additionally, she asked what the panelists would find helpful when looking at resiliency proposals.

Ms. Lane said she is looking for direction from DOE on a universal model that all states can use and modify for themselves. Ms. Swanson Katz said that the framework should not be federally standardized, but recognizes the importance of the availability of these frameworks and the urgency to address their dearth. She also believed states can benefit from continued leadership by DOE in this area, but that they should make these different paradigms available rather than imposed. Mr. Mroz agreed, citing that there are different needs, perspectives, and legal foundations in each state. He also noted that resilience is considered differently among generation, transmission, and distribution assets. One of the concerns on cybersecurity is the lack of standards for the deployment of cyber measures at the distribution level, Mr. Olnick said, adding that there are differences even within states, which he based on FPL's experiences in Florida. Ms. Swanson Katz added that cyber threats are so large that they cannot be addressed on

a state-by-state basis, requiring national-level support.

The panel then took questions.

Clay Koplin asked Mr. Olnick whether FPL has fully assessed all value streams from undergrounding, such as power factor correction, voltage support, improved system reliability, property value, physical security, customer satisfaction, and longer asset life, and employee, public, and wildlife safety and whether they have communicated those value streams with Florida regulators. Mr. Olnick said they have not examined most of those and that when FPL proposed a lateral hardening project earlier this year, they focused only on the resiliency aspect of the hardening, but did recognize and informally discuss some of these ancillary benefits. Ms. Swanson Katz added that though demand for undergrounding is high, it is also very expensive and only considered when it is essential to a reliability need. She said that her company is instead looking at volt Volt-Ampere Reactive Optimization as a more cost-effective means to benefit reliability.

Ms. Ray mentioned positioning cybersecurity not only defensively, but also proactively as we add cyber capabilities to the grid (i.e. not solely relying on retrofits). She then posed a question on resiliency and customer engagement and how the panelists focus on the customer perspective and customer adaptability. She asked the panel if focusing on the customer perspective changes how they approach resiliency efforts. Mr. Olnick noted the dependence on communications nowadays, particularly during extreme weather events. Given that communication infrastructure is important, he said that FPL changed some of its restoration strategies to more closely integrate with communication providers. Ms. Swanson Katz concurred that communications has become more critical. She also noted growing complaints about lack of resilience from consumers, observing that more consumers are less adaptable and more impatient during interruptions, but noted that blaming the consumer is not a viable substitute for these other efforts.

Ms. Reder asked the panelists what DOE can do to help, mentioning the societal cost aspect of resiliency efforts and the need to weigh that into investment decisions. However, she noted these facts are not currently part of the formula for existing analytical tools. She then asked how process can adapt to keep infrastructure in line with rapidly changing design standards. Ms. Reder concluded by asking about best practices for model circuits. Mr. Olnick began by expressing confidence in the work of the National Labs from a technological perspective. In terms of designing common standards, he said there is much diversity in standards throughout the country and that a collaboration with DOE would be helpful for inventorying different utility models. Mr. Mroz said he was not aware of the ICE calculator, pointing to this as an example of why information-sharing throughout the industry is important, especially for state regulators. He also said that the issue of establishing a valuation framework is something that calls for collaboration amongst DOE, FERC, NARUC, and other industry organizations. Ms. Swanson Katz that DOE can help through research and convening, and provide resources, recommending that DOE continue to convene dialogue and communicate to state-level entities. She also highlighted DOE's ability to set standards. Ms. Lane said her biggest concern is cybersecurity, which she said requires DOE support. Ms. Givens added that, as many organizations have very little in-house expertise and few resources to hire outside experts, DOE cybersecurity resources are essential.

Mr. Heyeck opened his question by noting that each state has different ways to determine cost-of-service, giving the example of depreciation. He asked if depreciation can be spread over a longer life when a resilient system is being built and if the cost of service should factor in resilience improvements. Ms. Swanson Katz said there is not enough conversation about reducing cost. Mr. Olnick said this is a big challenge in the industry, recognizing that customers do not want to see bill impact. He said that FPL has tried to balance cost by driving down operation and management costs to make up the bill impact. He said this has also said costs have been driven down by implementing efficiency initiatives. He stated that regulators will typically not accept multimillion-dollar resiliency efforts if there is significant bill impact.

Flora Flygt asked about cybersecurity concerns around plug-and-play devices and whether they would increase vulnerability to cyber threats. She also noted an instance of an organization taking the precaution of assuming they were going to get hacked in order to determine how they could mitigate such damage. Ms. Flygt also asked Mr. Olnick if there were lessons learned from the decision-making process in Florida to implement resiliency efforts and how these lessons could help others create their own frameworks for evaluation. Ms. Flygt opened this question up to the other panelists as well. Mr. Olnick said FPL made decisions on how much hardening is needed by identifying assets in areas most prone to damage. He said they also considered critical infrastructure functions and asked communities what they considered to be most critical, which he said taught them the importance of the community approach and ensuring customers are aware of the efforts. Mr. Mroz said he has concerns that there are no standards for the manufacture of the devices that are integrated into the grid. He believes it is incumbent on industry to better understand this so there is a certain confidence level on the capability of those devices. In terms of decision-making on resiliency improvements, he believes there should be clarity on the priorities during restoration. Ms. Swanson Katz listed tree trimming, local engagement, and priority setting as useful practices to prepare for an incident, but highlighted hardening internal communication systems and improving interoperability as two actions that have made a significant difference in restoration response. However, she noted the importance of recognizing that certain intense events cannot be prevented from happening, meaning that utilities should not take resources from developing their response plans either. Mr. Olnick added that the main focus of resiliency was not so much on prevention, but on mitigation and restoration, and that he agreed with Ms. Swanson Katz that it is important to set those expectations of resiliency and communicate their limits to consumers upfront. Ms. Lane said that West Virginia's utilities have been good at communicating with legislators on these issues and legislators can also communicate with their constituents to supplement utility communications.

Tom Bialek asked about resilience dividends and whether the concept is accepted across the public utility commissions (PUCs). Mr. Mroz answered no, but that he has examined it in his tenure, adding that there should be more discussion about it so that people are aware of the value of these investments.

Dr. Bialek then asked the panelists how increasing electrification, such as electric vehicles and fuel switching, impact their view of grid resilience. Finally, he noted that the life of power electronics is much shorter, noting that a situation where there is increasing electrification as well as more devices may lead to the need for a more frequent refresh of resilience efforts. Ms.

Swanson Katz said that consumers do care about prices. In the example of cable, she said more consumers are finding alternative options. She noted that while the situation is different for electricity, DERs are becoming increasingly more popular. Mr. Olnick said that utilities will need to become more comfortable with an increase in refresh rates.

Jeff Morris stated that there have been many resilience exercises in his state and that having a repository of these and others' best practices would be very helpful. He also asked Mr. Olnick if there has been talk about resiliency as a service (i.e. temporary power sources for short-term outages that can be demanded by customers outside of normal rates). Mr. Olnick responded that FPL considers other business models, such as a microgrid, that might make more sense than hardening. He said that FPL has roughly four alternative projects that test other models, including microgrids. Mr. Mroz added that it is difficult to have different resiliency measures for different customers due to regulations in price discrimination, but that it is still an option worth exploring.

Dr. Kezunovic said that though DOE has many resources in terms of Labs and funding, he found it worrisome that resiliency is not defined well. He then asked the panelists if the lack of these definitions and metrics hinders their ability to perform their roles regarding resiliency. He also asked how they conduct their state or local proceedings without a precise definition. Mr. Olnick said there are likely many missing components that are needed. Mr. Mroz said there will always be a divide between the federal and state jurisdictions and that different metrics should be divided in terms of the issues that they address. Ms. Swanson Katz said that because it will be difficult to agree on any singular definition, the industry should instead focus on developing best practices with respect to resiliency. Mr. Mroz concluded by saying that there is often a call for national policy on many of these issues and that DOE should be leading the conversation on national policy direction.

Presentation: Reflections on the Grid Modernization Initiative Peer Review

Gil Bindewald, Director of Grid Communications and Control in OE's Advanced Grid R&D Division at DOE, provided an overview and current status of the Department's Grid Modernization Initiative (GMI), the Grid Modernization Laboratory Consortium (GMLC), and the Grid Modernization multi-year program plan. He also provided an update on the 2018 GMI peer review and thanked the EAC members who were present there for providing meaningful insights and helping to make the meeting successful.

Mr. Bindewald began by giving a brief introduction about GMI, which started about three years ago with the initial focus within both the Office of Electricity and the Office of Energy Efficiency and Renewable Energy. He noted that in the FY19 appropriations, the Senate report highlighted GMI and encouraged them to make sure that all the other applied programs were engaged. The report also pointed out the role of the GMLC and the multi-year program plan. Furthermore, the report highlighted some technical areas, which included national grid resilience modeling, improved grid cyber resilience, advanced sensors, energy storage, advanced control paradigms, and field validation. Over the past year, GMI has expanded to include all applied energy programs to ensure broad energy system resilience and modernization.

GMI began as an effort to improve internal coordination, to look for ways to coordinate and cooperate with variety of stakeholders, to help reduce the likelihood of duplication between programs, to improve efficiencies, and to drive towards results effectively. Mr. Bindewald noted that, for the overall external awareness of the program, there needed to be a more cohesive interface so that stakeholders would not have to navigate through the various offices and activities throughout the department. Creating a more consolidated and cohesive activity, he said, would allow them to better engage and gain exposure and access to the other relevant areas. He explained that GMI started as a grid modernization strategy for the Department of Energy to align the existing base programs. Mr. Bindewald also said that there is an integrated multi-year program plan that came out recently that is currently being revised. In addition, he said that GMI looks across the National Laboratories' resources to identify core scientific abilities that may contribute to future success, both for the industry as well as the broader range of DOE programs. He said that GMLC is a subset of GMI comprised of fourteen Labs. Mr. Bindewald said that one of the objectives of GMI is to make these resources more beneficial to those who want to pursue research and partnership with DOE.

Within the GMI, he explained that there are six focus areas, which include design and planning tools, system control and power flow, sensing and measurements, devices and integrated testing, security and emergency response, and institutional support. Mr. Bindewald went over the organizational chart, mentioning that GMI is looking to fill the vacant Security and Resiliency position. He said that the multi-year program plan is currently being updated to achieve broader attributes of resiliency, affordability, security, reliability, sustainability, and flexibility and to use these six thematic areas to identify goals and objectives that the programs collectively can aim towards.

Mr. Bindewald then summarized the 2016 Grid Modernization Lab Call, which included thirteen National Labs and more than 150 partners from academia, industry, and states discussing over 88 projects. He mentioned that a key part of this call was understanding the regional impact and relevance of the technologies. Eleven key regional projects were undertaken to further understanding of how these technologies, techniques, and tools could be integrated in effective ways while reflecting regional differences across the country.

Mr. Bindewald provided an overview of the 2018 peer review that took place September 4-7 in Pentagon City, VA. The activities of this peer review included review of DOE's grid modernization portfolio, industry leader panel discussions on the future of the grid, presentations from leadership at the National Laboratories, a reflection on the updated Grid Modernization Multi-Year Program Plan, and engagement with other GMI projects in the portfolio during the poster session. He said that, from a high-level perspective, most of the feedback on the peer review was positive, with attendees strongly acknowledging both the teams and their projects. Key takeaway actions included:

- communicating project results more broadly;
- involving industry early and often in project to ensure maximum transfer of technology from the Labs to industry, which Mr. Bindewald characterized as critical in terms of project success and ensuring the appropriate goals and objectives are targeted;
- encouraging convergence in areas where it is absolutely necessary (e.g. interoperability, system controls);

- making project results nationally accessible;
- communicating success stories; and
- identifying success metrics and linking them to GMLC pillar goals in order to articulate the transformative story and specific project contributions more readily.

Mr. Bindewald also covered priorities outlined in the peer review’s panel of Assistant Secretaries from DOE’s applied offices, which included:

- emphasizing the importance of resilience and the need to identify and address challenges to the power system in real-time through situational awareness;
- understanding the role and importance of baseload generation; while the current national portfolio focuses on the intra-operation of distributed devices, load, and DER, it assumes base load generation is fairly static, which could be misleading;
- highlighting the value of affordability, reliability, and sustainability as attributes of the power system;
- understanding the role of small, modular generation sources in the grid of the future;
- realizing a fully integrated vision of the electricity system, from generation to load, and better understanding fuel availability; and
- exploring interdependencies between the power system and other infrastructure.

Mr. Bindewald reiterated that the multi-year program plan is currently being revised. He then moved on to highlight the six areas of GMI:

- *Devices and integrated testing*, which consists of developing new devices to increase grid services and utilization and validate high levels of DER at multiple scales by looking at interconnection standards and test procedures.
- *Sensing and measurements*, which applies sensing technologies to load, transmission, and distribution. The ability to understand signatures within the data has been a part of the base program, which has expanded to include the role of machine learning and artificial intelligence in data analytics.
- *System control and power flow*, which includes the design and implementation of a new grid architecture that coordinates and controls millions of devices and integrates with energy management systems. Mr. Bindewald added that there is a role for the computational mathematical advancements of the universities and laboratories side that will help further this program.
- *Design and planning tools*, which consists of creating grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales. The focus of this program is on the uncertainty around the variability of generation.
- *Grid security and resilience*, which involves developing resilient and advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems. One of the focuses of this program has been finding a way to embed security and resiliency in the underlying design and integrate it through the rest of the system.
- *Institutional support*.

Mr. Bindewald then outlined emerging themes, which include the following:

- *Generation (including fuel interdependencies)*
- *North American Resilience Modeling*

- *Physical Security and Cybersecurity*
- *Advanced Sensors*
- *Energy Storage*
- *Institutional Support and Analysis (including metrics and valuation)*

John Adams asked whether he can still refer to the 2015 GMI portfolio for information about grid modernization and if the update will be providing a few details or rather be a major rewrite. He also asked when the new portfolio will be posted. Mr. Bindewald responded that much of the fundamental work in the 2015 portfolio, such as mathematics, computation, and modeling, was still relevant. The update will focus on generation and the details on the system, risk, cyber security, and physical security, which were not as dominant in the 2015 portfolio. He said that they are still going to capture the overall balance, but much of the key technical topics will still be relevant. The new portfolio will recognize the distinction between security and resiliency. Mr. Bindewald said he hopes to publish the new portfolio by early 2019 but that this is contingent upon the review process.

Dr. Bialek commented that, in the context of institutional support analysis around metrics, particularly regarding the need for tools to conduct analysis and value reliability and resiliency, he thinks that the large value placed on reliability and resiliency can never be justified. He asked why there is such disparity and what is being done to have a proactive outreach to validate assumptions behind it. Mr. Bindewald responded that one of their challenges is defining reliability and resiliency, which they have been undertaking. He said that there is an on-going activity within the GMI portfolio under the resilient distribution system that is trying to understand how community resilience and utility reliability can couple together. The results thus far has been posted on their website.

Bob Cummings complimented the 2018 peer review, saying it was informative. He proposed three ideas for new projects: large data analysis of the Western phasor measurement units (PMUs), skid generation, and development of an integrated new set of tools for analyzing system dynamics, controls, and power flow. Mr. Bindewald thanked him for his comments.

Mr. Hudson commented that in his organization, there are large manufacturing companies that are members, many of whom have self-generation. He asked what considerations, if any, the DER resource of spinning reserve played into GMI's evaluation. Mr. Bindewald responded that they have focused on its interconnection and interoperability but have not wholly defined specific manufacturing resources. They have a few active projects concerning industrial microgrids, which focus on how those resources could support the asset owner and the system attributes.

Mr. Mroz asked Mr. Bindewald if he could confirm the scope of the efforts on the advanced sensors program and whether he is working with the traditional electric industry and/or device manufacturers as they evolve. Mr. Bindewald responded that they are working with all of them in some ways. They have been working as a Department in the synchrophasors area at the transmission level and with micro PMUs for a couple of decades, trying to understand the tools and capabilities of the data analytics behind them. He mentioned that two years ago, they solicited a funding opportunity announcement to examine low-cost sensors and understand both

how those sensors provide visibility and insights into the distribution systems and increase reliability. He noted that one of the challenges they have is not the amount of data but the accuracy and the redundancy within the data and they are trying to understand how that data plays into the robustness of the decision-making process.

Mr. Heyeck commented that they have much data available but that it is fragmented and chaotic. He said that he is looking forward to the data analytics panel, which would take place during the March in-person EAC meeting.

Wrap-up and Adjourn Day One of October 2018 Meeting of the EAC

Mr. Heyeck thanked everyone for attending the EAC meeting. He said that there will be a Dutch dinner at restaurant Pinzimini in the Westin Hotel for EAC members. He said that the meeting would resume the next day at 8:00 AM at the same location and end at noon. He announced there would be a 2.5-hour panel on Grid Scale Storage followed by the two subcommittee reports. He added that there would also be a mandatory ethics training for the committee. He said leadership would meet again at noon that day, followed by the Energy Storage Subcommittee meeting at 12:30pm. There were no closing comments. The meeting adjourned.

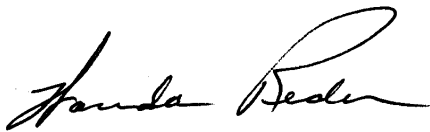
Respectfully Submitted and Certified as Accurate,



Michael Heyeck
The Grid Group, LLC
Chair
DOE Electricity Advisory Committee

02/15/2019

Date



Wanda Reder
Grid-X Partners, LLC
Vice-Chair
DOE Electricity Advisory Committee

02/15/2019

Date



Lawrence Mansueti
Office of Electricity
Designated Federal Official
DOE Electricity Advisory Committee

02/15/2019

Date