U.S. Department of Energy

Electricity Advisory Committee Meeting

NRECA Conference Center

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Summary of Meeting

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Welcome, Introductions, Developments since the March 2017 Meeting

Sue Tierney, EAC Chair, and Matthew Rosenbaum, EAC Designated Federal Officer (DFO), opened the June 2017 Meeting of the EAC. Chair Tierney expressed her gratitude for the ability to lead the EAC and asked all of the members and guests seated around the table to introduce themselves. Chair Tierney also noted that Catherine (Katie) Jereza, the new Deputy Assistant Secretary for Transmission Permitting & Technical Assistance (TPTA) for the Office of Electricity Delivery and Energy Reliability (OE), was joining the meeting for the first time and would be filling in for OE's Acting Assistant Secretary Patricia Hoffman. Following all introductions, Chair Tierney gave an overview of the meeting's agenda and commented that planned presentations would be particularly focused on pressing issues facing the grid. Chair Tierney lastly officially welcomed Katie Jereza to give remarks.

Update on the DOE New Administration Initiatives & EAC Discussion

Deputy Assistant Secretary Jereza introduced herself and provided an overview of her professional background. Ms. Jereza next reviewed the Presidential Executive Orders that affect the Department of Energy, including regulatory reduction, cybersecurity strengthening and other reviews of recent rulemaking. She also summarized the FY17 Budget, including a $24 Million increase in funding over the FY16 budget that was enacted. Ms. Jereza noted that budget increases in two areas of focus for the EAC were especially prominent: energy storage and smart grid research and development. Ms. Jereza next discussed OE's priorities, as well as how the direction of the EAC may support those priorities.

Chair Tierney called for questions that the Committee members might have for Ms. Jereza. Granger Morgan asked for insights into upcoming budget expectations. Bill Parks of OE answered that he had briefed the Senate and soon would brief the House. Mr. Parks elaborated that significant changes exist between the FY18 proposal and the FY17 actual budget, so that the final decision would remain undetermined for the time being. On the topic of cybersecurity, Chair Tierney noted

that she and Granger Morgan were participating in a National Academy of Sciences (NAS) committee looking at potential implications of a long-lived outage. DOE had asked NAS to study extended power outage implications, and Chair Tierney indicated that a report would be forthcoming to DOE soon. Mr. Parks added that Secretary Perry had identified cybersecurity as one of his top priorities. Gordon Feller added that the National Institute of Standards and Technology (NIST) has been pursuing cybersecurity-related projects. He complimented NIST for reaching out to the private sector and non-U.S. entities to expand the reach of their stakeholder engagement. He suggested bringing NIST representatives to a future EAC meeting to share findings. Mr. Parks added that interagency collaboration has been productive between DOE and NIST on both physical grid security and cybersecurity efforts. Paul Centolella noted that cybersecurity has been addressed by the Smart Grid Subcommittee. Merwin Brown asked whether any of these groups had considered "death by a thousand cuts" – situations in which cyber events resulted in many small interruptions, versus one large disruption. Chair Tierney clarified that a lot of work is ongoing in this area. Janice Lin asked whether there would be any role for the subject-matter experts within the EAC to influence the changes requested to the budget. Mr. Parks replied that a number of groups are weighing in on their respective capacities, as well as that it would be likely more appropriate for thoughts to come via those other capacities rather than through the EAC.

Grid Modernization Initiative Working Group Activities and Plans

Anjan Bose, Grid Modernization Initiative Working Group Chair, presented to the EAC a report on the DOE Grid Modernization Initiative (GMI) for approval. At the end of the last meeting, Dr. Bose indicated that the Subcommittee had received a lot of input about how to finalize the report. As a result, the Subcommittee decided to shorten the report and accelerate the timeline so that it can be readily accessible. Dr. Bose proceeded to give an overview of the report. He shared that the introduction referenced that a greater need for grid modernization exists than ever before. In short, the Working Group reiterated that new technologies require a modern grid.

Following the introduction, Dr. Bose shared several observations documented by the Working Group about the grid. First, he highlighted that the grid as a system deserves more attention, rather than simply component research, and that there needs to be a focus on reliability, resilience, and security. Second, the report observed that the grid is a national infrastructure, owned by many, and thus that the resilience, reliability, and security of the grid against all attacks – cyber and physical—are public goods. As a public good, the report elaborated that these qualities are not properly economically incentivized. Thus, the burden has been left to the federal government to support needed research and development. Thirdly, since there is only a single national grid, the report mentioned the inability to do realistic physical testing, leaving simulations as the only viable alternative for systems testing. Dr. Bose listed the recommendations of the report: that greater data availability is needed, that both system and component technology ought to be studied, that the grid must be flexible to accommodate an uncertain future structure, and that nothing will work without the right policies.

Seek EAC Approval for Work Product: Review of the DOE Grid Modernization Initiative

Chair Tierney thanked Dr. Bose for shepherding the report through the writing process. Chris Shelton added that often the system analysis issue is missed, so it is especially important to call out. He noted that this trend speaks to the architecture of the system: while there have been technological changes surrounding the components, now there is need to adapt the system architecture and smarter control layers in order to accommodate future component technologies and machine learning. Mr. Shelton said that the benefit on reliability will be orders of magnitude greater. Rolf Nordstrom asked what scale of simulation yields useful system-level insights. Dr. Bose answered that the ideal simulation scale varies by idea. Mark Lauby asked whether reliability is inherent when security and efficiency are ensured. Mr. Lauby also asked how the system can be more robust and how risks to the future system will be measured with new technology incorporated. Marilyn Brown asked what the main differences between reliability, resilience, and security are. Dr. Bose answered that a main focus of this report was to underscore the need for systems research, while leaving the technical leadership to David Meyer and Kevin Lynn of DOE. Chair Tierney called for concise final comments. Merwin Brown raised a sidebar on deeper issues with simulation at the system level, particularly in modeling a cascading relay problem. Mr. Brown called for more simulation, as well as workarounds like those used to model epidemics, in order to determine which pathways were most likely to contribute to a cascading outage. Heather Sanders added that it would be helpful to talk in metrics, rather than generic "resilience." Mr. Feller suggested that the GMI report be shared with Frans Vreeswijk of the International Electrotechnical Commission (IEC) for feedback regarding metrics and standards. Mr. Shelton added that resiliency is about design, whereas reliability only has design as a single component.

Chair Tierney called for a vote to approve the Work Product. She also called out supporting the concepts of the grid as a public good and the value of system-level simulations. The EAC adopted the Work Product by a unanimous voice vote as an official recommendation of the EAC.

Update on the GMLC Program and Initiatives & EAC Discussion

Kevin Lynn, Director of Grid Integration for Energy Efficiency and Renewable Energy (EERE), and Bill Parks of OE presented a briefing for the EAC on the Grid Modernization Initiative. Mr. Parks introduced the agenda for the presentation and thanked Dr. Bose, Ms. Sanders and Mr. Adams for their work as GMI peer reviewers.

In evaluating the GMI Multi-Year Program Plan (MYPP), Mr. Parks started with attributes – defining which are critical and how they relate. Mr. Parks introduced six key focus areas, as well as how they relate to the overall systems view. Mr. Parks shared that DOE awarded three years of funding for the Grid Modernization Lab Consortium (GMLC). The majority of the findings indicated that projects are relevant and that funds ought to continue to be moved to the second tier of sponsored projects. Mr. Parks also reported that the Grid Modernization Peer Review was conducted in April 2017 in Washington D.C. Feedback from the Review included suggestions that even more engagement with presentations would be useful.

Mr. Parks shared with the EAC what reviewers determined were important design and planning tools that ought to be developed to support grid modernization. He indicated that these include: software; data requirements; connections to industry and to utilities; government involvement; and

other key considerations. The report recommended that these be used to inform the development of grid planning tools that integrate transmission and distribution, as well as address system dynamics over a variety of time and spatial scales. Mr. Parks indicated that one area of future focus will be on various utility market structures (i.e. IOU, Muni, Co-ops) to determine how standards and other initiatives can support development across multiple jurisdictions and grid structures. Mr. Parks highlighted several projects under the umbrella of the GMI. The first was the interconnection seams study. Second, Mr. Parks highlighted the system operations reviewer findings, noting that a key focus of the MYPP was on what gap areas exist in the project portfolios, as well as how existing programs should be augmented.

Mr. Lynn began his presentation by explaining that the GMI attempts to bring together the various investigators into grid architecture in order to standardize implementing sensing and measurement tools and other interoperability measures. Studies found that gap areas exist among sensing and measurement programs; while sensing is a subset, measurement is a crucial gap. Mr. Lynn shared that working on sensing and measurement strategies includes building out communication elements, addressing poor data quality, and considering other factors like sensor placement, development, and machine learning. He also addressed practical impacts.

Moving on to reviewer findings, Mr. Lynn shared that reviewers called out DOE for having no foundational investments in power electronics and energy storage across the department. Mr. Lynn noted that DOE struggles with piecing together disparate DOE office initiatives on related topics. He provided interoperability as an example of an area that would benefit from greater cooperative research. On the subject of security and resilience, reviewers found that more projects and a greater priority were required. This is evidenced by both a need to finish existing projects and a need to incorporate security considerations into all other projects. Mr. Lynn spotlighted infrastructure resilience in New Orleans as one example of a local utility thinking about the transactive system and microgrids, and helping the city be more resilient to major storms. Regarding institutional support, reviewers suggested that more feedback be sought from states and consumer advocates. Reviewers also advocated that the GMI make sure to capture all state-level lessons learned, including setting a context for future projects in device communication and defining a broader cybersecurity plan. Mr. Lynn closed by calling for additional questions.

EAC Member Discussion of the GMLC Program and Grid Modernization Initiatives

Ms. Sanders complimented DOE on conducting a recent GMLC review. She suggested that DOE could improve stakeholder outreach by co-locating paper review locations with other existing colloquia and conferences. Ms. Sanders also asked how the energy industry could get an evolved grid architecture adopted and implemented, and what would be the role of DOE. Mr. Parks answered that the implementation of a standard grid architecture is the focus of dialogue with the regulatory world, as evidenced by initiatives underway in 10-12 states that are evolving in real time, building on state to state communication.

Dr. Morgan asked about how cyber black-start was being studied, and specifically how individual generating units could be disentangled from a compromised system. Mr. Brown asked about access to data on system resilience to cascading events. Mr. Parks answered that data visibility and use is a critical concern, giving a recent example in which Pacific Northwest National Laboratory

(PNNL) was granted access to data gathered by the Western Electricity Coordinating Council (WECC) to support grid research. Mr. Lynn added that on the cybersecurity side, being able to act in real time is highly dependent on data quality. Mr. Centolella asked what consideration had been given to the field of power-electronics (PE) research, rather than to only the individual PE technologies. Paula Carmody reiterated the need for communication among regulators, technical staff, consumer advocates, and the high level researchers. Ms. Carmody asked how coordination among DOE, NARUC, NASEO, and others was being used – or can be used – to inform DOE research initiatives. She also asked how key takeaways from these collaborative investigations are being communicated by state member organizations to the states themselves. Mr. Parks indicated that good relationships with the National Governor's Association (NGA) and the National Center for Supercomputing Applications (NCSA) facilitated freer flow of information. Specifically, Mr. Parks referenced recent papers from the national labs addressing grid device communication, but noted that the magnitude of requests for assistance from the states has grown recently. While DOE is currently meeting requests, he noted, the Department could do so more thoroughly. Mr. Lynn echoed that communication has improved as part of the coordination process. Marilyn Brown commented that big data is exciting to both students and experts, but asked whether enough focus was being directed to data quality and accuracy, as well as data sharing. Mr. Parks replied that he did not have the answer, but that the GMLC would continue to encourage coordination among industry and universities.

Panel: Natural Gas-Electric Integration

Dr. Morgan introduced the Gas-Electric Integration Panelists, including: Sue Tierney, EAC Chair and Senior Advisor at Analysis Group; Bob Ethier, Vice President of Market Operations at ISO-New England; and Alex Rudkevich, Project Lead for Gas-Electric Co-Optimization (CECO) at ARPA-E.

Sue Tierney discussed the motivation for this panel. Dr. Tierney characterized her role as providing an overview on the gas and electric industries, and the increasing interdependence between the two. She presented a chart showing electric generating capacity additions by fuel type between 1960 and 2017, and noted that with the addition of so much gas-fired generating capacity since 2000, low natural gas prices enabled previously under-utilized gas-fired capacity to produce increasing amounts of power in recent years. She also showed that forecasts of demand for natural gas are primarily driven by use of natural gas for electricity generation. She concluded that as the electricity industry becomes more dependent on natural gas, the gas industry will equivalently depend on electricity.

Dr. Tierney commented on similarities across the electric and gas industries. Both have separated the delivery function from commodity supply and have established state-regulated local distribution companies. Both allow for market-based prices for commodity supply with regulated cost-of-service for delivery functions (whether regulated by FERC or by states). In discussing differences between the industries, Dr. Tierney highlighted how developments in the physical footprints of the gas and electric systems create implications for regulation: The first key difference she highlighted is the network quality of the electricity distribution system, whereas pipeline systems are more like laterals. Electricity delivery is highly interconnected, while gas companies

own individual systems and do not have a mesh network configuration. She also highlighted a difference in storage capability: With gas, regional storage allows for seasonal draw-down. With electricity, current storage technologies typically allow for only minutes to hours of storage capability. A third difference relates to commodity markets: While the gas production system is unregulated both upstream and midstream, with market-based commodity prices, interstate and local gas delivery is regulated; by contrast, the electric supply system in organized power markets (and in bilateral wholesale transactions) has market-based prices subject to regulatory oversight. Addressing a series of other differences, Dr. Tierney elaborated that variations in service responsibility, demand outlook, and industry reliability organizations and standards all contribute to market design, operational scheduling and coordination issues that can cause misalignments between the operations of the two industries with the potential to disrupt gas-electric integration. To date, the industries have evolved and adapted to changing conditions, but Dr. Tierney raised concerns about the continuing need to stay ahead of changing conditions in the two industries, especially as they become increasingly interdependent.

The second panelist, Bob Ethier, discussed the role of ISO-New England (and the New England electric system as a region) as being at the forefront of gas-electric integration. Reliability, Dr. Ethier relayed, is at the core of ISO-NE's mission. Due in large part to New England's relative geographical distance from fuel supplies and its reliance on long-distance fuel-delivery systems and a challenging regulatory environment for infrastructure development, supply constraints have frequently presented operational challenges for the region's electric system. The capability of the natural gas delivery system, Dr. Ethier indicated, is not keeping up with gas demand. With constrained gas-delivery capacity into the region, supply is naturally limited. The pipelines that have historically been -built to serve the region were focused on building capacity to serve space-heating demand in buildings during winter months – not power generation – and now run either at or near their maximum capacity during the winter.

Dr. Ethier described how New England has shifted from coal- and oil-fired generation in cold weather to increasing dependence on natural gas, and that coal and oil assets have been retiring and will continue to retire in the coming years. ISO-NE, he stated, needs to solve the problem of optimizing operations in a future when the region does not have coal or oil to lean on for the handful of peak winter-demand days. Observations from recent winter have yielded operational lessons, however. Dr. Ethier communicated his view that New England needs LNG to meet peak winter loads. In addition, he described ISO-NE efforts to mitigate the fuel-security risks and the need for energy market changes that strengthen resource performance, including hourly settlement of the market and increased prevalence of scarcity pricing. He described how pay-for-performance enhancements in the forward-capacity market have been designed to lead to systematic improvements in reliability. Lastly, Dr. Ethier shared that ISO-NE is conducting a study of fuel-security challenges, in order to gather additional recommendations for how to improve the functioning and efficiency of both gas and electricity markets.

The third panelist, Alex Rudkevich, presented an overview and findings from the GECO study, which has been designed to simulate the interactions of the electric and gas systems operations. He touched upon the proposed timing of the gas-balancing market, including clarifying that prices are formed day ahead. In terms of market outcomes, granular pricing signals were determined to be at work. In electricity markets, hourly gas trade values drove pricing. In the gas market, relief

of pipeline constraints eased locational gas markets, which are highly dependent on pipeline utilization and capacity. Dr. Rudkevich described GECO as bringing forward pipeline modeling and optimization capabilities into an integrated gas-electric future. This analysis has included economic optimization of pipeline operation through a conceptual formulation that includes two-sided auctions with buyers and sellers, as well as an auctioneer who controls pipeline direction. The case study assumed a 1600+ mile pipeline network with pipeline operation and market clearing both subject to optimization. The case study also set out to determine efficient locational trade values. Given GECO's novel technology, Dr. Rudkevich expressed optimism that the capability to think through optimization would allow both grid and pipeline operators to use the findings to implement more innovative solutions to typical issues in locational pricing and gas scheduling. He provided several examples of recent innovation related to these issues.

EAC Discussion of Gas-Electric Integration Panel

Dr. Morgan thanked the panelists and solicited final comments from the panelists. Dr. Ethier noted that one of the things ISO-NE talks about is not only the real-time and day-ahead market, but also the need to develop a two-day-ahead or a three-day-ahead market that could help to address the chicken-and-egg problem of interconnected gas and electricity pricing. Dr. Tierney also commented about the increasing number of protests against FERC's willingness to site and approve natural gas pipelines, which is especially prevalent in New England.

Mr. Zichella thanked the panelists, before asking Dr. Ethier when the new electric-transmission line to carry electricity produced by Canadian hydropower generation would be approved and potentially in service. Dr. Ethier answered that the New England Clean Power Link (NECPL) had been approved by the Department of State. Mr. Zichella followed up by asking Dr. Rudkevich to expand on who would run his hypothetical gas market, which was introduced by GECO.

Mr. Brown asked Dr. Ethier whether a situation could arise where physically gas would not get delivered, given the pressure reaction problem of very-quick-operating combustion systems. Dr. Ethier replied that Canadian hydropower could be helpful, but that some conditions could make it unlikely that the connection would have a big enough impact. That said, he said that if Canada were willing to sell capacity all winter, and not just when a surplus exists, then that type of arrangement could be more attractive to New England. Dr. Rudkevich added that such a market exists in Victoria, Australia. This type of setup requires hourly data for transparency and valuation, but, with a better idea of the value, one can more accurately determine whether an asset is worth the investment. Dr. Brown asked a follow-up question regarding the impacts of when gas plants suddenly shut off. Dr. Ethier responded that this could hypothetically happen, but that pipelines are capable of shutting off their valves to power plants. Lastly, Dr. Brown asked whether there has been much discussion on pipe re-lining in order to allow for the system pressure of a pipeline to be raised. This question (and potential response) was deferred.

Rep. Morris shared that the Pacific states' renewable portfolio standards and electric-performance standards have forced the utilities to operate on a peaker-load model. The Northwest Gas Association (NWGA) has worked on a micro-LNG study, looking for where subscriber capacity for small amounts of gas could be negotiated. Rep. Morris asked the panelists whether their organizations had examined capital-expenditure tradeoffs. Dr. Ethier replied that ISO-NE had

looked at cap-ex tradeoffs. He explained that Analysis Group is currently looking at micro-LNG and methane solutions and running the numbers regarding firm contracts with LNG facilities. In general, the pipelines appear to be accepting immediate draws as long as the LNG facilities are back-feeding the pipes from another location. Mr. Adams followed up by asking if the vision is to be able to trade gas on pipelines both in future hours and current hours. Dr. Rudkevich affirmed. Dr. Tierney commented regarding the economics of different ways to solve the problem, i.e. satellite LNG, versus pipeline additions, versus dual fuel, etc. She gave a real life example as well: in Massachusetts, a gas-fired peaker with dual-fuel capability had been proposed, and intervenors in the state energy-facility-siting case had not wanted oil-fired dual-fuel supply and there had been a discussion of on-site LNG satellite storage as an alternative, without regard to the potential difficulty of siting such satellite LNG facilities.

Mr. Lauby shared that NERC is quite interested in single-point disruptions, such as when gas supply ends up not being available. He pointed to the loss of Aliso Canyon as an example. As further explanation, Mr. Lauby shared that NERC requires firms to have planned protocols to address situations where there could be pipeline failures. He asked the panelists for their reactions to the idea that dual-fuel capability is a silver bullet for generators. Dr. Rudkevich acknowledged that NIMBY issues arise for any onsite oil storage. Ms. Lin asked whether efficiency gains could be made by running generation units more constantly – rather than constantly starting up and shutting down – but using energy storage solutions to meet the load. Dr. Ethier replied that siting is still difficult, especially since the "system" doesn't well represent the "slightly-better" tradeoffs, i.e., replacing heavy oil combustion with light oil. He asserted that New England is just generally against oil. Regarding gas shortages, renewables help, especially since anything that displaces gas use within an operating day helps ride through a gas-delivery shortage situation. Dr. Rudkevich said that gas is a storable and compressible medium, so the storage missing on the consumption side can be made up in the form of "storage by displacement." In addition, improvements in planning can allow consumers to demand less on the inter-day system.

Ms. Laney Brown and Ms. Lin asked for specifics around supply shortages. Ms. Brown also asked Dr. Rudkevich how the value of GECO could be articulated to regulators and asked Dr. Tierney whether she could envision regulatory interest to the extent of what was seen following the 2003 blackout, regarding overhauling gas-system regulation. Chris Shelton asked what the daily use of imported electricity during peak times is. Dr. Ethier replied that the answer is highly dependent on the weather in Canada. Mr. Shelton followed up by asking whether resources could be dispatched uneconomically at any point, so that gas may be conserved to be used later. Dr. Ethier responded "no," initially, but that he wasn't sure. Dr. Morgan asked whether there would be repercussions if an electricity outage were to be caused by the gas industry. Dr. Tierney replied that there are different attitudes about the sense of urgency to address these issues across the two industries. In addition, uncertainty exists regarding how polarized politics in Congress surrounding fuel use could respond to that type of incident.

EAC Smart Grid Subcommittee Activities and Plans

Paul Centolella, Smart Grid Subcommittee Chair, introduced the Smart Grid Subcommittee and gave an overview both of the Subcommittee's establishment under EISA 2007 and of recent focus

areas for the Subcommittee.

Mr. Centolella reviewed for the group that at the March 2016 EAC Meeting, the Smart Grid Subcommittee invited a panel to evaluate DER value and the distribution level markets, beginning the process of evaluating DER valuation and integration. At that meeting, Bill Kallock of Integral Analytics gave an overview of how granular analysis is needed to capture the full utility benefits of DER at the grid edge. Professor Michael Caramanis of Boston University had expanded on the idea, looking at the distributed market clearing mechanism when DER is either tractable or not. On the topic of Distributed Control Systems, Professor Deepak Divan from the Georgia Tech Strategic Energy Institute recommended that using distributed control (instead of the current centralized control model) could flatten the demand profile and more efficiently use DG to support voltage control.

Mr. Centolella continued by providing context on more recent work by the subcommittee in preparation for the development of the work product regarding DER valuation and integration. He shared that the Smart Grid Subcommittee evaluated the significant and growing role of distributed resources on the grid. The main finding was that DOE should develop tools to support efficient wholesale markets that provide increasingly granular price signals to help integrate DERs, as well as that DOE should coordinate with FERC and state regulators. Overall, the group concluded that DER value is highly dependent both on location and on time of use, though the valuation by markets and regulators has not developed sufficiently to reflect the full opportunities presented by DERs. Mr. Centolella shared the Subcommittee's view that these tools and methods will support increasingly granular market models.

A second finding presented in the report is with regard to the methods and tools that DOE can support development of that can support planning and operations. Specifically, the Subcommittee asserted that DOE has an essential role to play in the development of frameworks, methods and tools needed for DER valuation and integration. Mr. Centolella explained that the work product recommends that DOE continue research and development programs focused on tools, including computational models, to support DER integration as well as other cross-cutting applications. The work product concluded that DOE provides essential leadership both in basic research conducted through the Office of Science, and forward-looking, applied research and development support critical for modernizing the grid and addressing DER integration challenges.

Finally, Mr. Centolella communicated that the Smart Grid Subcommittee urges DOE to take advantage of its unique positon to convene the diverse entities involved in grid operations and control, to facilitate stakeholder dialogue and to provide scientifically supported technical assistance. Specifically, the subcommittee recommended not only that DOE collect and harmonize the various frameworks already under development in leading states, but also that DOE approach integration and valuation concerns from both a customer and an operator perspective.

Mr. Centolella closed by giving a brief overview of ongoing and planned work for the second half of 2017 for the Subcommittee. These topics include greater focus on challenges and opportunities presented by the Internet of Things, as well as possible examination of how infrastructure investment in the grid can be both optimized – with economically efficient investments – and can be a means by which to support continued U.S. leadership in the development of grid technologies.

Seek EAC Approval for Work Product: DER Valuation and Integration

Ms. Currie commented that the work product was well-written, and she lauded the focus on how to continue to improve research and development, as well as commended the recommendation that customer-focused integration challenges be addressed. Mr. Roberti asked whether the traditional DSO would be trying to calculate the hosting capacity of DER, or whether the distribution operator would be developing a transactive platform. He noted that the Subcommittee followed some examples in Europe where peer to peer markets developed.

Rep. Morris commented that the Washington State House struggles with the issue of when values should be propagated out to system markets, or remain behind the meter in the case of centralized markets. Mr. Centolella replied that regardless of where the industry goes, research into the balance between centralized markets, local markets, and faster-acting markets is necessary. Once more data become available, then the difference between the costs and benefits of each path can be modeled. Ms. Laney Brown validated the GMLC report conclusion that there is an increased need for support from DOE to the states. Dr. Marilyn Brown asked whether the EAC should look into the tie-in between internet access and access to demand response programs. She noted that even in the U.S. different network capabilities or upgrades might be necessary to support new services, like demand response. Dr. Morgan expressed worry that promoting innovation in the DER space by relaxing regulatory oversight could lead to private-sector disruption that causes problems. He suggested a change to the wording of Recommendation #5, which was agreed to.

The Work Product was approved unanimously by a voice vote of EAC members.

EAC Energy Storage Subcommittee Activities and Plans

Mr. Brown, Energy Storage Subcommittee Chair, began by noting two typos in the High Penetration of Energy Storage (HPES) Work Product to be corrected before the Committee votes to officially adopt the Work Product as Recommendations. He then introduced Ramteen Sioshansi as the new Vice Chair of the Energy Storage Subcommittee. He also introduced Mr. Shelton, who would discuss the HPES Work Product, while also noting that several new work products were also underway. Mr. Brown noted that these were focused on opportunities and challenges in thermal storage; rate and tariff design for energy storage systems; and the potential use of energy storage for grid reliability and resilience. Mr. Brown then turned over the podium to Mr. Shelton.

Mr. Shelton noted that this panel had been inspired by realization of the state of the industry, with storage showing up in many different flavors and forms, which prompted discussions about what storage at serious scale would mean for the industry. Mr. Shelton credited Mr. Brown with the idea to use scenarios, which would allow different points of view across which Members could still engage on the topic. Mr. Shelton gave a brief overview of each of the four HPES scenarios for the entire EAC. He also indicated that a shortened version of the recommendations was provided up front, but that longer and more thorough recommendations are available in the appendix. Dr. Morgan asked a question about page 5 under the "policymakers and regulators" heading, regarding

"conflict resolution." He wanted to make sure that the section referring to "consumers vs. defectors" was referring to the erosion of social equity and the access to electricity. Mr. Shelton suggested an edit could be made related to the national objective of access. Ms. Lin clarified the assumption of grid defection. Heather Sanders asked whether there was a follow-on piece of work that evaluates the goodness or badness of certain paths that got the country to each (negative) future, as well as what are the signposts and what should be done to mitigate or avoid these. Mr. Shelton replied that it is not usually the role of the EAC to make value judgments, but that DOE can do it and can engage stakeholders. Mr. Lauby commented that the work product was a good way to look at future scenarios and outcomes. He added that he thought the group would see more storage facilities on the system in the future, especially as gas use increases. He suggested that the EAC consider developing a road map for how to get to these outcomes as a future Work Product. Mr. Feller commented that the EAC would have more time in the future to debate among the scenarios. He suggested discussing what comes next once the Members approve this Work Product, namely that states and utilities might appreciate some tool, like a report card, that could measure progress to X scenario based on taking Y and Z actions. Mr. Feller concluded that a road map would help define some of the steps, but that a scorecard could be more specific. Mr. Shelton suggested that a key challenge is that there is a jurisdictional issue across federal-state issues, as well as those that cut federal to federal and state to state. Mr. Zichella added that the EAC should consider thinking about a recommendation to do trend-tracking of various scenarios, in order to figure out which of these scenarios is actually approaching, similar to how solar or other distributed generation scaled up. Mr. Zichella stated that he had found similar trend-tracking helpful in trying to make judgments about what the future electric system would look like.

Seek EAC Approval for Work Product: High Penetration of Energy Storage Future

A motion to approve the Work Product – including modifications—was offered. The motion was seconded. The Work Product was approved with modifications. Mr. Brown wrapped up discussion. Ms. Sanders pointed out that many of the recommendations that were included in the final Work Product were robust, applying across multiple scenarios. She commented that stakeholders do not need to know which scenario will be the ultimate outcome before taking actions that could mitigate issues across the board. Ms. Sanders also commented that the Energy Storage Subcommittee looked for outcomes that might only develop in a single scenario, but that could have a severe, adverse impact. She reiterated that the Subcommittee could do further work into picking a future scenario structure, but that it was outside of the scope of this Work Product, which was designed not to involve a value judgment. Mr. Brown concluded that Day 2 of the meeting would focus on examining how the role of energy storage in reliability, resilience and security would evolve and he thanked Ms. Lin in advance for her contributions.

EAC Power Delivery Subcommittee Activities and Plans

John Adams, Power Delivery Subcommittee Chair, introduced Heather Sanders as Subcommittee Vice Chair, and as the person who is spearheading the Transmission-Distribution Interface Work Product. Mr. Adams shared the Subcommittee is working on the transmission distribution interface, especially its increasing importance given a high penetration of distributed energy resources. Mr. Adams posed the question as: given that this resource is showing up on the

distribution system, there is a need for greater visibility into the distribution system. He commented that from his perspective as an engineer at ERCOT, there are no control capabilities on distribution resources to the extent required for a more flexible grid. Mr. Adams suggested the Subcommittee's Work Product was focused on addressing the triplicate questions of: What is going to happen? Does the interface need to evolve? Do we need to develop more communications? In order to answer these questions, Mr. Adams notes that the interfaces are potentially different around the country, between ERCOT and PJM and California or Southern Company. He added that another focus of the Work Product would be how the evolution of the interface would differ in different business and regulatory situations across the country. Mr. Adams noted that the Subcommittee had met immediately prior to the full EAC Meeting and had concluded that it may be useful to develop "best practice" ideas that could be applied across the country. A key component of identifying these best practices would be identifying research gaps, industry players, and the location of the seams between the transmission and distribution systems. In addition, identifying useful policy tools and federal-state interactions would be focuses of the Work Product.

In discussing immediate next-steps, Mr. Adams shared that the Subcommittee was in the process of assembling a team and gathering reference materials. He noted that the Energy Storage Subcommittee had successfully made use of the interview structure and that the Power Delivery Subcommittee would be following a similar format while conducting outreach to experts across the country. At the time of the meeting, Mr. Adams noted that the Subcommittee had developed a paper outline and was planning to schedule and perform interviews. Following interviews, a draft of the Work Product would be developed, including both findings and recommendations. He lastly noted that the Subcommittee thought it prudent to consult with the Department of Energy on how the Work Product fits within the scope of the Department's work. Given that some of this consultation will be ongoing, Mr. Adams shared that the Subcommittee had targeted the June 2018 Meeting for presentation of the Work Product to the full EAC for a vote and approval as formal recommendations.

Wrap-up and Adjourn Day One of June 2017 Meeting of the EAC

Sue Tierney, EAC Chair, thanked John Adams for his presentation. She also thanked Deputy Assistant Secretary Jereza for her time. Paul Centolella extended an open invitation to any EAC Members who want to join the Smart Grid Subcommittee are welcome to attend breakfast at 7:00 am in the restaurant at the Westin.

Chair Tierney concluded by reminding the EAC Members that there is also an open dinner at 6:00pm immediately following the day's meeting. Chair Tierney adjourned Day 1 of the EAC Meeting.

Respectfully Submitted and Certified as Accurate,

Susan Tierney
Analysis Group
Chair
DOE Electricity Advisory Committee

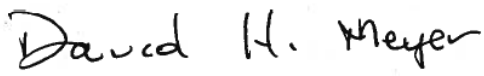
11/22/2017
Date

Carl Zichella
Natural Resources Defense Council
Vice-Chair
DOE Electricity Advisory Committee

11/22/2017
Date

Matthew Rosenbaum
Office of Electricity
Designated Federal Official
DOE Electricity Advisory Committee

11/22/2017
Date



David Meyer
Office of Electricity
DOE Electricity Advisory Committee

11/22/2017
Date