



**U.S. Department of Energy
Electricity Advisory Committee Meeting
NRECA Conference Center
Arlington, VA
September 28, 2016**

Summary of Meeting

PARTICIPANTS

EAC:

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Electric Reliability Council of Texas

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WILLIAM BALL
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Speakers, Guests and Members of the Public:

GLEN ANDERSON
NCSL

JEREMY BEDINE
Johns Hopkins University

KURT BILAS
Midcontinent ISO

CHRISTOPHER CLACK
University of Colorado, Boulder

MEGAN CLEVELAND
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JOCELYN DURKAY
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PATRICK HUGHES
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RALPH MASIELLO
Quanta Technology

CHRIS NELDER

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JAMES OKULLO
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MICHAEL SKELLY
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Advanced Energy Economy

LINDSAY WESTFIELD
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ICF/Support:

RACHEL FINAN
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MAUREEN MALLOY
ICF International

CHELSEA PELLECHIA
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MATTHEW SCALLET
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EAC Ethics Briefing for all Members

Kate Gehringer, Office of General Counsel, DOE, provided an ethics briefing for Special Government Employees and representative members of the Electricity Advisory Committee.

Welcome, Introductions, Developments since the September 2016 Meeting

Ms. Sue Tierney, Electricity Advisory Committee (EAC or Committee) Chair welcomed the new and returning Committee members. Ms. Tierney reminded meeting attendees that a meeting transcript is being prepared and all public participants who wish to make a comment should sign-up to do so during the designated comment period at the end of the second day of the meeting. She then invited the EAC members and Department of Energy staff to introduce themselves.

Update on the DOE Office of Electricity Delivery and Energy Reliability's Programs and Initiatives

Honorable Patricia Hoffman, Assistant Secretary for Electricity Delivery and Energy Reliability, provided an update on the Department of Energy (DOE or the Department) Office of Electricity Delivery and Energy Reliability (OE) program initiatives.

Ms. Hoffman began by thanking Ms. Pam Silberstein and the NRECA for hosting the EAC meeting. She also thanked all new members for attending the meeting, and for recurring members for their continued support. Ms. Hoffman also shared her appreciation for Ms. Sue Tierney for taking over as Chair of the EAC.

Ms. Hoffman reiterated that the Committee provides a lot of value to the Department through the recommendations, which allow DOE to be able to address the challenges that the industry is facing.

Ms. Hoffman took a few minutes to talk about the timeline of what DOE started to do several years ago and where they are strategically headed. The first topic Ms. Hoffman covered was the Recovery Act. She noted that there was \$4.5 billion invested, and over 330 recovery act projects for grid modernization and investments in infrastructure. She then shared that information technologies in the electric grid is another important area that DOE has supported. They are continuing to push some of the issues that the EAC raised in 2014 on technology and operational improvements as well as the issues raised by the Smart Grid Subcommittee looking at sensors and other intelligent electronic devices. Ms. Hoffman shared that earlier in 2016 there was a synchrophasor FOA looking for tools for reliability and asset management trying to pull off of some of the recommendations, and additionally an FOA in the spring of 2016 for risk uncertainty looking at wholesale market operations, transmission planning, and demand side participation.

Ms. Hoffman shared that DOE is also looking at innovative designs for transformers and there was also an FOA out on that topic in June 2016. There was another FOA in September for sensor and modeling approaches for observability and controllability. She noted that energy storage is fundamental to allowing for flexibility in the system moving forward, and the Department has been trying to build off of the work under the Recovery Act. Ms. Hoffman shared that PNNL is continuing to invest in flow batteries and they have looked at a new additive for conventional Vanadium flow batteries, from which DOE will continue to build momentum. One of the strategic discussions Ms. Hoffman brought up was the topic of the integrated grid and EPRI's push to not only look at information technologies but also the internet of things and the integrated grid. She also noted that one valuable note to keep in mind is the establishment of the Grid Modernization Lab Consortium that is being led by Kevin Lynn and Bill Parks at DOE. Ms. Hoffman explained that she brings the topic up because it is a cross-cutting topic that involves many offices within DOE, and the Department was to continue providing value to industry.

The final areas Ms. Hoffman touched on are public-private partnerships, partnerships with National Labs, evolving regulatory structures, and national and economic security. She closed by noting that the recommendations and discussions held at the EAC meetings do help move the Department's thinking forward as well as the industry's.

Presentation on 2016 paper sponsored by NOAA, “Future Cost-Competitive Electricity Systems and Their Impact on U.S. CO2 Emissions”

Christopher Clack presented a paper developed at the University of Colorado in Boulder in a cooperative institute with NOAA and published in Nature Climate Change. He provided a brief overview of his background and then went into explaining how the idea of the paper was formed. Dr. Clack walked through some of the results that were published in the Nature Climate Change paper as well as extensions of those results which came out in January 2016. He also explained the concept of using HVDC technology to allow the model being used to have the ability to build a national grid to pick up weather patterns. The idea is to think holistically rather than localized. He noted that large areas are better for multiple reasons. One is that there is a higher probability of finding a more valuable site, you get to resource share, and you get load diversity as well. When you coordinate planning between regions there is more efficient competition because wind or solar can sell to different markets if on HVDC highways.

EAC Discussion on NOAA Paper

Ms. Marilyn Brown asked Dr. Clack if the conclusions would change if he were to attempt to capitalize on the integration of the demand side in terms of the management of targeted spatially and temporally demand management to compliment, for instance, the intermittency of renewables. Dr. Clack noted that demand side management is in the model just not in the one shared during the meeting. When demand side management was put in the model as a means to change the load profiles one was more limited by the devices that are connected to the grid because there is only so much power that can be consumed. Dr. Clack also noted that the results that show energy efficiency are currently under review.

Mr. Lazar and Dr. Clack discussed thermal storage resource, ice storage, water storage for air conditioning, and grid integrated water heating as resources. Mr. Morris and Dr. Clack discussed the accounting for externalities in the example with hydro resources in the Northwest biological operating condition for endangered salmon. Dr. Clack noted that 2006 weather and 2006 resources for hydro and nuclear were dispatched at conservative levels at the base of what they were dispatched in those years. There are no externalities in terms of changing climates or changing habitats, but it can be added as another layer on the GIS data. Ms. Lin and Dr. Clack discussed modules within the model that include rooftop solar, and future modeling plans. Dr. Clack shared that he wants to run different scenarios with different assumptions to look at all the sensitivities that people care about from the state level upwards.

Panel: Opportunities Presented by High Voltage Direct Current Transmission

Mr. Anjan Bose introduced the HVDC Panelists including: Michael Skelly, President of Clean

Line Energy; Dale Osborn, Consulting Advisor at MISO; and Jay Caspary, Director of Research, Development & Tariff Studies at Southwest Power Pool.

Mr. Bose provided an introduction to Direct Current (DC) and explained the differences between low, mid and high voltage DC and the uses of DC in North America compared to Europe. He noted that the panel was only going to cover high voltage DC (HVDC) transmission in the US.

Mr. Bose explained the various ways to convert AC to DC and vice versa to transmit power and in which scenarios the different HVDC configurations (e.g., monopole, bipole, back-to-back, and multi-terminal DC) should be used. He explained DC transmission technology, specifically how Insulated Gate Bipolar Transistor (IGBT) brought down the cost, and why AC should be used for transmission under 400 miles and DC should be used for transmission over 400 miles.

Mr. Bose explained the applications of DC transmission, including a large amount of energy transfer, point-to-point transfer of energy from generation to the load center; interconnections across separate grids with minimal disturbance; and better control of power flow on the transmission line.

The first panelist, Dale Osborn, Consulting Advisor at MISO, explained how MISO approached transmission problems, examining the economics first and reliability second. Mr. Osborn explained how energy costs changed across the country using three different scenarios (i.e., no change, adding transmission, and adding transmission and wind generation) and how adding wind and transmission lowered the price of energy.

Mr. Osborn explained the benefits and challenges of HVDC versus AC systems (e.g., the electricity transport efficiency and distribution of benefits). He showed how building a DC transmission line from MISO north to MISO south would benefit the people at the points of supply and delivery and the generator, but not the people in the middle.

Mr. Osborn explained the HVDC Network Concept that would link the west and east coast of the U.S. to deliver controlled wind and solar energy at a lower cost. He explained why the HVDC transmission system could be built today and the benefits of building the line (e.g., different uses of gas systems, the ability to change U.S. generation patterns, and how to decrease the loss of energy from system diversity). The system terminals could collect generation from solar and wind and the increased transmission capacity could deliver twice the MW of energy, which would save billions of dollars. The system could also be built incrementally and would lower the cost of future transmission.

The second panelist, Jay Caspary, Director of Research, Development & Tariff Studies at Southwest Power Pool (SPP), presented on the DOE funded Grid Modernization Study. The SPP footprint had grown over the past 10 years into the Dakotas, Minnesota, and Montana where they are building transmission. The SPP system has outdated back-to-back HVDC ties at the western edge of the grid that presented an opportunity to replace those assets in order to optimize them in the future. However, additional studies are needed in order to build confidence in how to replace them, which was an effort being led by NREL, PNNL, and other national labs.

Mr. Caspary explained the Grid Modernization Study timeline and the biggest challenges they faced (e.g., harmonizing the western and eastern grid models). He provided a high-level view of the study and explained the 2024 baseline scenarios used and the most extreme scenarios considered. He explained how network seams presented the biggest opportunity and the challenges associated with cross-network connections. The Grid Modernization Study is facilitating discussions between eastern and western regional planners and utilities about current grid efforts and needs for model harmonization. Mr. Caspary explained the next steps for the project, including the DOE-funded Pan-Canadian Wind Integration Study, and noted the next project meeting would be held on October 4th. He concluded his presentation by showing a NREL graph that displayed time synchronized generation, transmission, transfers, and load data across North America.

The third panelist, Michael Skelly, President of Clean Line Energy, presented on his project Plains and Eastern Clean Line (PECL). The PECL came about because transmission poses the biggest challenge to the grid and it was clear that no one else was going to build a project to address it. Mr. Skelly explained some of the problems he identified in 2009 when this project began (e.g., utilities inability do decade-long projects and the lack of pressure from FERC or RTOs for interregional planning to connect generation resources to load).

Mr. Skelly explained why Clean Line chose the projects they did, including the reasons (e.g., economic, regulatory requirements, etc.) behind their decisions on: the level of state involvement, location of wind generation, and the size of DC lines. He explained the status, objectives, business model, and challenges for some of the five projects (i.e. Rock Island, Grain Belt Express, Plains and Eastern, Western Spirit, and Centennial West). Some challenges included utility board citing processes and legislation changes.

Mr. Skelly explained the current status of the PECL, including the recent signed participation agreement with DOE that occurred after a three and a half year process. The agreement let Mr. Skelly talk to landowners with confidence about where a DC line would go and has resulted in facilitating the right-of-way process. Mr. Skelly was also in discussions about entering an agreement with wind generators, participation options with utilities in the southeast, and identifying and announcing who their HVDC equipment supplier will be. Mr. Skelly explained how the DOE participation agreement worked, specifically the requirements the PECL needed to meet before DOE could step in a claim right-of-way, and Clean Line's outreach efforts to provide landowners with plenty of time and information to make decisions. The outreach efforts are the most important aspect of the PECL project preparation and aim to help people understand why the project is an important part of the country's infrastructure and opens up the avenues for communication. Mr. Skelly concluded by recognizing the project will not be without opposition but they are doing everything possible to include stakeholders and benefit the local communities that the projects are in.

EAC Discussion of HVDC Panel

Ms. Tierney and Mr. Skelly discussed the implications of the Clean Power Plan on the PECL project.

Mr. Zichella commended Mr. Skelly on his efforts to get wind and solar generation onto the electric

grid and conduct stakeholder outreach, and DOE for producing the early application process.

Mr. Lazar noted the 2000/2001 California power crisis that created the economic incentive to flow power from the east to west coast and he, Mr. Caspary, and Mr. Osborn discussed the level of arbitrage that occurred with back-to-back DC connections on a routine basis.

Mr. Feller and Mr. Skelly discussed the role of carbon pricing and the potential opportunities to connect to Canada in terms of Mr. Skelly's business model and project assumptions. Mr. Skelly explained how some utilities were thinking in terms of the Clean Power Plan, why he did not anticipate his project connecting to Canada, and how the European interconnections for renewables had very different driving forces than in the U.S.

Ms. Conklin explained that Secretary Hoffman asked that she mention a rule making about transmission DOE recently completed. Last week DOE announced the finalization of the Integrated Interagency Pre-application Process (IPP), which was implemented under section 216(h) of the Federal Power Act. The purpose of the rule is to encourage transmission developers to collaborate more with stakeholders during project planning, before they apply for a permit, so the steps further along in the project process are easier (e.g., EIS). She added that DOE had already piloted this concept with a few presidential permit applications. The rule was published in Federal Register and information on the rule was published to DOE's website.

Representative Morris noted AEP's new lines that aim to get electricity over longer lines and higher capacity. He and Mr. Caspary discussed the tradeoffs of using those overhead lines, including land use, capacity, and grid resiliency.

Ms. Lin and the panelists discussed the extent to which energy storage had been considered as a means to improve utilization of existing or new transmission. Panelists explained that solar aggregation, like wind, over a large enough footprint lowered the variability and smoothed the curve enough to make it a predictable and reasonable generation resource without storage. Once the transmission is built, it greatly lowers the cost of building solar and wind in unexpected areas because those resources can be used more efficiently. However, there are storage applications to complement renewables in the long-term and there is a threshold of renewable penetration where storage becomes important but that price point has not been reached yet in many systems.

Ms. Lin and Mr. Caspary discussed distributed energy resources and local renewables as an alternative to transmission and Mr. Caspary explained the need for more data and understanding of load resources down the road.

Mr. Almgren and Mr. Skelly discussed the value of a big system but the difficulties and complexities of projects that cross multiple states or countries and how to ensure benefits in the middle states.

Mr. Almgren and Mr. Skelly discussed the progress of cable technology and the drop in cable price. Mr. Skelly explained why interconnections through cables is easier in Europe than in most of the electric power markets in the U.S. Mr. Osborn and Mr. Skelly explained that the price was such that cables replaced lines in New England but it would take a long time before it could do the

same in the rest of the U.S.

Ms. Silberstein asked what needed to be fixed with transmission and Mr. Skelly explained his thought that the fundamental flaw with interregional panning was the reliance on RTOs to evaluate transmission lines instead of giving other authorities the ability to evaluate a project driven process.

Presentation on National Academy of Sciences report “The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies”

Mr. Centolella and Mr. Gellings participated on a National Academy panel whose report was recently published, called “The Power of Change: Innovation for the Development and Deployment of Increasingly Clean Electric Power Technologies.” Mr. Centolella explained what the panel was tasked to do. He shared that they were tasked with determining how policy could accelerate the market adoption of advanced energy efficient and lower non-carbon polluting technologies. Mr. Centolella provided two overarching recommendations. The first was that the government should significantly increase their emphasis on supporting innovation for increasingly clean electric power generation technologies, which was an underlying theme of the report. The second recommendation was that Congress should consider an appropriate price for pollution, both greenhouse gases and other pollutants that are not internalized in a market-based system to create a level playing field, create market pull, and expand research, development, and commercialization. Mr. Centolella then walked through the details and the steps that were taken to come to the conclusions and recommendations. He also shared that the report looks at the innovation process as a whole, and recognized significant barriers at the technology and at the commercialization level.

Mr. Gellings then presented on efficiency and technology readiness. He provided details and supporting information and also noted the recommendations. The first recommendation Mr. Gellings shared was that there should be some effort made on understanding what the behavioral issues are and potentially coming up with solutions that point to activities and programs that reduce the uncertainty of people actually adopting the more efficient technologies. Mr. Gellings discussed other recommendations including on building standards, government in the private sector, and increased investments in innovative efficient technologies. Mr. Gellings final comment was regarding technology readiness levels, and how TRLs are a way to measure the stages of development of a technology, which are all provided in the paper.

EAC Discussion on the NAS Report

Mr. Merwin Brown shared that another dimension of research that needs to be added at the federal level is adaption to climate change. Ms. Hoffman provided her thoughts on chapter six on the electric grid, which provided a huge emphasis on the regulatory issues and business models. She focused in on a comment about a customer role for the distribution system as a customer energy service provider or a distribution system operator. Mr. Lazar added that the report does not discuss the field switching of currently fossil fueled loads, primarily space and water heating, and electrifying those loads. Ms. Marilyn Brown asked about the social cost of carbon.

Mr. Centolella and Mr. Gellings provided comments in response to the questions from Committee members. Regarding Mr. Merwin Brown's comment, Mr. Centolella noted that adaptation to climate change was not in the scope of the study. In response to Ms. Marilyn Brown, Mr. Centolella noted that carbon value for most technologies is relatively small. They continued to discuss some of the underlying factors of the recommendation in the report. To conclude, Mr. Centolella commented on Ms. Hoffman's question. He noted that an area of continued need and focus is where technologies will integrate in a way that is efficient, cost-effective, and reliable.

Open Discussion on Industry Topics Relevant to DOE

Ms. Tierney opened up the meeting to EAC members for them to share their ideas about topic areas the DOE should look at.

Ms. Lin identified the barrier to utility storage projects, including the lack of system planning and operation tools that would indicate the value of storage and suggested the DOE fund storage modeling projects that would tap into existing commercially available tools and break the expensive barrier of having pilot projects that exhibit the value of storage.

Mr. Feller suggested an effort to reach out to startups, that include potentially disruptive technologies and who are largely invisible to big organizations, who could potentially solve problems in a more efficient and fast way. Ms. Laney Brown identified the gap of a translator or educator in the space around innovation and new projects and suggested DOE explore developing tools for translation and communication that supports innovation.

Ms. Sanders suggested the DOE build or support the creation of a portfolio comparison tool that could allow the user to look at all the available options for solving a problem before making a decision. She also suggested a new standard that promotes a new way of designing the distribution system so there is a way to explain why the level and timing of grid modernization technology was being deployed.

Mr. Lazar explained the preliminary results of his paper on the role of grid integrated water heating in helping storage and scheduling needs to integrate variable renewables. He explained the ability and benefits of curtailing a considerable amount of renewable generation by controlling a fraction of system water heaters.

Mr. Brown explained that the focus of the GMI effort has been on data analysis, which is important, but there is a need to identify, obtain, and determine how to use the data required to run the modern grid and DOE could focus on that need.

Ms. Tierney explained the need for system operators and balancing authorities to have more visibility into behind-the-meter resources that was currently being inhibited by privacy issues.

Mr. Ball explained the need for the physical smart grid technology and cyber security to develop at the same rate to reduce the conflicts between deploying new smart technology onto the grid and increasing cyber security threats. He suggested DOE work on the physical and cyber security

issues from the beginning of projects but recognized how challenging that was.

Ms. Currie explained the need to examine how new technology changes the revenue model and how to communicate those potential changes so stakeholders can begin to think about how to change the utility financial model to adapt to their changing system. Mr. Gellings, Ms. Wagner, Ms. Marilyn Brown, and Ms. Sanders discussed the changes that need to occur with grid changes and modernization, including the level of preservation of the current electric grid that should occur, the evolution in the regulatory model as the technology changes, the changes in future electricity consumption, and the role of intermediaries in transforming the grid.

Mr. Centolella explained how the government will never be fast enough and utilities will never know enough to address cyber security issues and suggested DOE help convene regulators and industry to discuss what regulations are needed to address cyber security. He also explained the need to integrate transmission system marketing and engineering and the potential ambiguity of who should fill the transmission system dispatch role despite the fact that it will still be a necessary role to fill.

Mr. Zichella suggested DOE facilitate conversations on the intersection of the utility markets and regulations that discuss all the necessary considerations (e.g., threats identified by utilities, projected distribution system dynamics, and the appropriate future role of utilities) so as to come to conclusions about the best avenue for the future of the industry.

Mr. Almgren noted the impact future grid changes will have on resiliency and the importance of addressing those issues.

Wrap-up and Adjourn Day One of September 2016 Meeting of the EAC

Ms. Tierney, EAC Chair, thanked everyone for their participation and reminded them about the no-host dinner subcommittee members were welcomed to join. She reviewed the agenda for the second day of the meeting and invited new members to sign-up for at least one of the EAC subcommittees before adjourning Day 1 of the meeting.

Respectfully Submitted and Certified as Accurate,



Susan Tierney
Analysis Group
Chair
DOE Electricity Advisory Committee

12/06/2016

Date



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

12/06/2016

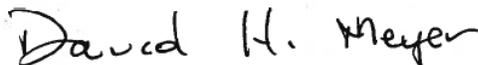
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