U.S. Department of Energy
Electricity Advisory Committee Meeting
NRECA Conference Center
Arlington, VA
September 29, 2016

Summary of Meeting

PARTICIPANTS

EAC:

JOHN ADAMS
Electric Reliability Council of Texas

AKE ALMGREN
Orkas Energy Endurance Inc.

WILLIAM BALL
Southern Company

ANJAN BOSE
Washington State University

LANEY BROWN
Modern Grid Partners

MARILYN BROWN
Georgia Institute of Technology

MERWIN BROWN
California Institute for Energy & Environment

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Southwest Power Poll

PAUL CENTOLELLA
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Regulatory Assistance Project

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California Independent System Operator

PAM SILBERSTEIN
National Rural Electric Cooperative Association

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Analysis Group

DAVID TILL
Tennessee Valley Authority

REBECCA WAGNER
Nevada Public Utilities Commission

CARL ZICHELLA
Natural Resources Defense Council

DOE:

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JOYCE KIM
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ELI MASSEY
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DAVID MEYER
Department of Energy

MATT ROSENBAUM
Department of Energy

JULIE SMITH
Department of Energy

Speakers, Guests and Members of the Public:

JEREMY BEDINE
Johns Hopkins University

JASON BURWEN
Energy Storage Association

WATSON COLLINS
Eversource Energy

TOM DOUGHTY
California ISO

KIRAN KUMARASWAMY
AES

MATEO JARAMILLO
Tesla

CATHERINE JOHNSON
University of Wisconsin

JAMES OKULLO
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BENJAMIN STAFFORD
Advanced Energy Economy

LINDSAY WESTFIELD
Direct Energy

LORNA WISHAM
First Energy

ICF/Support:

RACHEL FINAN
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MAUREEN MALLOY
ICF

CHELSEA PELLECHIA
ICF

CAITLIN SMITH
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SAMIR SUCCAR
ICF

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Ms. Hoffman welcomed everyone back for the second day of the meeting and introduced the first presenter, Paul Centolella.

EAC Smart Grid Subcommittee Activities and Plans

Paul Centolella, Smart Grid Subcommittee Chair, provided an overview of the activities that the Subcommittee has been working on over the last year. This included the March panel on valuation and integration of DER, and the June panel on Transactive Energy. The Smart Grid Subcommittee has also done a series of webinars in conjunction with the Grid Modernization Initiative Working Group that further investigate the topic of valuing and integrating DER. Additionally, Mr. Centolella shared that Sascha von Meier from the University of California gave a presentation on the application of micro-synchorphasors in the distribution system.

Most of the Smart Grid Subcommittee's recent activities have been focused on valuation and integration of DER. Mr. Centolella explained that the next step for the Subcommittee is to take all of the investigation that has been done up to this point and think about topics for consideration for making recommendations to DOE about valuation and integration of DER. He provided a number of examples for areas of recommendation, such as integrating DER into distribution planning, and developing an understanding of structural regulatory barriers. Mr. Centolella also mentioned that the Subcommittee will potentially sponsor a panel on the Internet of Things at the March 2017 EAC meeting.

EAC Member Discussion of Smart Grid Subcommittee Work Products & Plans

Mr. Feller, a new EAC member, asked about what has been discussed on the Smart Grid Subcommittee around smart grid investments and key factors. He also suggested that the Subcommittee discuss business models and how utilities are reassessing how they sell, deliver, and price power, in relation to current fundamental business models. Mr. Centolella noted that the EAC produced an ARRA investments recommendation paper that is located on the DOE-EAC website. In response to Mr. Feller's question about business models, Mr. Centolella agreed that it would be a useful topic to think about going forward, but in terms of the Committee making recommendations to DOE, they will not create the models but they may be able to facilitate discussions. A member also suggested that the more examples that can be found and the more creative uses of smart grid assets that can be identified, the greater the possibility of reducing resistance to deployment.

EAC Power Delivery Subcommittee Activities and Plans

John Adams, EAC Power Delivery Subcommittee Chair, began by providing an overview of the discussions that have been held during the recent Subcommittee calls. In terms of new work products, Mr. Adams shared that the Subcommittee is looking at two topics. One is the planning process for transmission, and the other is the impact of high penetration of electric vehicles. Mr.

Brown suggested looking at the interface of the transmission and distribution system.

Value of a VAr White Paper – Seek EAC Approval

Mr. Adams reviewed the main recommendation areas provided in the Value of a VAr work product. He explained that the white paper has a formal set of recommendations at the end, in addition to others throughout the body of the paper. Some of the recommendations include educating and helping assess the role of the VAr in the transmission grid, and assisting policymakers in understanding which reliability services will need to be procured.

EAC Member Discussion of Power Delivery Subcommittee Work Products & Plans

EAC members discussed some of the points made in the white paper, and made suggestions to change some of the language related to expanding the definition of the word model. There was also a comment that the term 'load distribution model' is too narrow and should be broadened. Ms. Tierney moved to approve the Value of a VAr Work Product. The motion was seconded and the Value of a VAr – Perspectives on Electric Grid Voltage Support White Paper was passed unanimously.

EAC Energy Storage Subcommittee Activities and Plans

Update on Biennial Storage Assessment and 5-Year Storage Plan – Seek EAC Approval

Merwin Brown, EAC Energy Storage Subcommittee Chair, provided a report on the 2016 Storage Assessment Recommendations and Five-Year Storage Plan on behalf of Ramteen Sioshansi. Mr. Brown explained that the work products are required by federal law. The Five Year Storage Plan is due every five years, and looks at what DOE should be doing or working on. The Storage Assessment is due every two years and is an assessment of DOE's performance against the five year plan. The Work Product that is being presented, Mr. Brown explained, satisfies both of the requirements. Mr. Brown provided a brief history of the creation of the report. He added that the 2016 report maintains the same broad scope as the previous reports, but it expands to the scope of storage beyond electricity-in and electricity-out, and goes into other types of energy storage such as thermal and virtual storage techniques.

Additionally, Mr. Brown stated that a lot of the DOE background information was omitted in the 2016 report. He then went on to explain the process for the report, which was largely informed by 16 interviews conducted by the working group with representative of users, implementers, and researchers involved in the energy storage industry. In terms of the report timing, Mr. Brown noted that the deliverables were combined into one report for a couple of reasons – e.g., due to the rapidly changing environment, the working group felt that if a lot of time passed from when the interviews were conducted for the five year plan, the information would become stale. The second reason was that there is a possibility new leadership may be coming into the DOE in 2017. Mr. Brown concluded his presentation by explaining the general format of the report, and sharing the list of DOE recommendations that are offered in the report.

Mr. Lazar moved to approve the report with additional language on ice/chilled water and heating/water pumping as storage technologies, as agreed upon by the Committee. The 2016 Storage Assessment and five-Year Storage plan was passed unanimously.

Update on High Penetration of Energy Storage Work Product, Merwin Brown

Merwin Brown provided an update on the High Penetration of Energy Storage work product on behalf of Chris Shelton, EAC Energy Storage Subcommittee Vice Chair. Mr. Brown explained that the work product aims to discuss what it means for the grid if there is high penetration of energy storage. The report will provide DOE with some perspective on what they should be looking at or doing if energy storage becomes comes pervasive. Mr. Brown further discussed the purpose of the HPES work product. The white paper will look at the implications of, and examine qualitatively, high penetration of energy storage into the electricity transmission and distribution systems. Additionally, the white paper will provide a framework for identifying quantitative measures to more thoroughly characterize the vision of energy storage as an agent in the grid.

Mr. Brown shared the approach the Working Group is taking, which is a scenario planning approach. He further went on to explain the next steps for the group and timeline for the work product. The Working Group plans to submit a final product for the March 2017 EAC meeting.

EAC Member Discussion of Power Delivery Subcommittee Work Products and Plans

Patricia Hoffman shared with Mr. Brown that she came across a news article about Germany trying to build a business model around offering free electricity to customers using solar and other storage technologies. She also recommended that the Subcommittee look into other places that are on the leading edge, like Hawaii and Europe.

Panel: Grid Impacts of High Penetration of Plug-In Electric Vehicles

Ake Almgren introduced the panelists including: Chris Nelder, Manager at the Rocky Mountain Institute; Mateo Jaramillo, VP of Products and Programs at Tesla; Tom Doughty, VP of Customer and State Affairs at CAISO; and Watson Collins, Manager of Business Development at Eversource Energy.

The first panelist, Chris Nelder, Manager at the Rocky Mountain Institute, presented on how dynamic charging of electric vehicles (EV) can offer grid services. Mr. Nelder explained that his presentation largely consisted of results from a paper that was an RMI eLab collaboration with RAP, San Diego Gas & Electric.

Mr. Nelder explained some of the grid benefits that proactive EV charging could produce, including providing ancillary services, increasing renewable penetration, and reducing transportation and electricity costs. He explained how load reshaping could be achieved through two mechanisms (e.g., using time-of-use rates to incentivize charging when cost is low or direct control of charging stations from utilities) and how idealized charging could flatten the Duck Curve. Mr. Nelder explained how controlled charging of EVs could provide advanced utility

services, such as demand response (e.g., turnoff charging at peak load), power quality (e.g., providing ancillary services), and mobility as a service. EVs could also reduce emissions and, according to a recent NREL report, can reduce net emissions with coal powered electricity when compared to current vehicles if optimal charging is involved. Additionally, smart charging of EVs can increase renewable penetration by absorbing extra wind and solar generation or by curtailing generation, further lowering emissions.

Mr. Nelder explained some of the lessons learned that came from California's ambitious EV projects, including the effectiveness of time-of-use rates at shifting off-peak hours and the ancillary services provided by smart EV charging. He noted two projects in particular; the PG&E pilot project with BMW that bid EV and stationary storage into the demand response market as a useful model that might be applicable at a larger scale and the SDG&E pilot that will post hourly dynamic prices a day ahead so drivers can set their EV charging limits or rate responses. Mr. Nelder concluded his presentation by summarizing the benefits to the grid that could occur if EVs are integrated in a proactive and intelligent manner and how poor EV integration could negatively impact the grid.

The second panelist, Mateo Jaramillo, VP of Products and Programs at Tesla, presented on EVs from the consumer point of view. Mr. Jaramillo explained that Tesla's mission was to transition the globe to sustainable energy and he provided a brief history of the company's EV activities.

The latest EVs Tesla produced use their complete powertrain system and Mr. Jaramillo explained how their EV work informed their grid work (i.e., EVs are essentially stationary batteries if their motors are removed). Charging is when EVs interface with the grid. People usually charge at home overnight, which the distribution system would need to support. However, people are interested in driving their EVs long distances and Mr. Jaramillo described Tesla's Superchargers effort that is building a larger network of high-power DC charging stations along highways that would charge cars in 20 minutes. Tesla has already built 400 charging stations in the U.S. that are heavily used, especially at peak times, and allow people to drive their EVs long distances.

Mr. Jaramillo explained how Tesla had deployed 10 GWh of rated battery capacity through connected fleet vehicles, the million car thought process, and why it is important to pay attention to the developing tariffs and rates in potentially high-impact scenarios with relatively small penetration. EVs can be connected and are controllable, which make them a potential grid asset. Tesla was looking at how to control charging systems so as to engage EVs with the grid but Mr. Jaramillo explained the questions that needed to be addressed before that could occur.

Mr. Jaramillo explained what he expected to see with high penetration of EVs, including: an increase in energy literacy; convergence of distributed energy devices; and high penetration of behind-the-meter distributed energy resources. The potential suite of distributed energy technologies (e.g., solar, batteries, EVs, etc.) participating in the grid could either be the best or worst thing to happen to the grid, depending on how the system tariffs will take those assets into account. Mr. Jaramillo cautioned against violating some of the basic tariff principles and explained some of the better options for simple EV tariffs. He concluded by explaining Tesla's vision for the future, which included a lot of behind-the-meter distributed resources that are connected and interacting with the grid via a suite of technologies. The interest in EVs was great and Mr. Jaramillo

expected that they will very much be a part of the distributed energy future.

The third panelist, Tom Doughty, VP of Customer and State Affairs at CAISO, presented on the possibility of EVs addressing California's issues and helping meet their renewable generation goals. EVs are one of several components that defines the new generation of power supply as energy goals shift toward a carbon-free economy and society. Mr. Doughty provided an overview of some of the big changes in California as they transitioned to a lower carbon emissions system. The transition is largely being driven by high electric rates and is being complemented by rapidly rising consumer-owned power (e.g., rooftop solar).

Mr. Doughty explained the renewable penetration in California's electric systems and explained how the current practice of curtailing excess renewable generation was not sustainable. He explained how those curtailments were expected to increase over the next five years and proposed EVs as a solution for excess renewable generation. Mr. Doughty explained the synergies between EVs and renewable integration and how EVs could address some of the issues posed to the electric grid from renewable penetration. Empowering EVs as a grid resource requires three aspects: the technology that links EVs to the grid, the market design and rates, and ease-of-use or customer preferences. There has been a tremendous amount of development work on technology pilots, market pilots, regulatory and legislative developments to determine the grid needs, the opportunities EVs present to meet those needs, and the challenges that need to be overcome. CAISO is excited about the ability for EVs to provide services back to the grid to make grids more resilient, stronger, and cost effective and CAISO is committed to increasing EV use in the near future.

The fourth panelist, Watson Collins, Manager of Business Development at Eversource Energy, presented on EVs from the utility perspective. He noted that utilities were excited about being part of the EV conversation because EVs are a cleaner resource, in terms of emissions, have a lower fuel cost, and have a lot of flexibility regarding how they are integrated into the grid.

Mr. Collins provided an overview of Eversource and explained their efforts to determine the impact of EVs on the distribution grid, including reviewing studies, conducting pilot projects, and education and outreach efforts through their website (plugmyride.org). They found that EVs and grid integration did not pose a bulk supply system issue, there was a lot of time to charge EVs (about 23 hours), and there were numerous ways and speeds to charge EVs. Mr. Collins explained the six areas topic areas Eversource was planning to look into regarding EVs, including EV and grid integration for residential charging, open vehicle-grid integration platform, workplace charging and fleets, multi-unit dwelling infrastructure, DC fast chagrining, and enhancing EV and grid interoperability.

Mr. Collins explained the results from the ISO New England and National Lab 2013 study that examined the impacts of EV charging demand on the grid. The graph compared the load over the course of the day to the hypothetical EV charging patterns at various levels of penetration.

Mr. Collins explained Sacramento Municipal Utility District's study on the grid impacts from EV charging that determined the different annual distribution grid upgrade costs required to accommodate varying degrees of EV penetrations and types of charging mechanisms. The upgrade

costs trended more around capacity charging so the utility was trying to manage capacity charging on the grid to minimize those effects. Mr. Collins explained how costumers in California were responding to time-of-use rates once they were participating but the challenge was engaging customers in the first place so an easier mechanism of customer engagement would be a better option. Additionally, California's electric inclining block rates did not make EVs competitive with gas vehicles, which is a policy issue that would need to be addressed for EVs to take off. Mr. Collins concluded by presenting a list of questions regarding EV and grid integration goals, challenges, and solutions.

EAC Discussion of Grid Impacts of High Penetration of Plug-In Electric Vehicles

Ms. Tierney and Mr. Jaramillo discussed how the majority of people with rooftop solar are locked into long-term third-party contracts but how the dramatic market changes expected over the next few years will change rates, the number of loan products people own, and third-party contractors' incentives and contract terms. Mr. Collins explained why he thought standards would move towards requiring an aggregator and how public policy objectives will determine how electricity will be priced to customers. He and Mr. Doughty discussed how consumer preferences would shape the EV and grid integration relationship and how customers needed a simple interface in order to make smart EV charging feasible.

Mr. Ball and Mr. Nelder discussed how optimal EV charging times are going to be different in every place. Mr. Nelder explained how the charging problem needed to be worked backwards, beginning with identification of places with high power and low prices and the stakeholders involvement and activities that need to take place to make this all work together, which he described as daunting but achievable.

Ms. Currie, Mr. Collins, and Mr. Jaramillo discussed issues surrounding EV charging stations (e.g., planning and permitting issues, management of workplace charging stations, and the high cost of charging stations in residential neighborhoods) and how some of those challenges have been overcome (e.g., the change of charging station costs, locations, and how it interfaces with the grid).

Mr. Centolella asked how close EVs were to being able to incorporate driving patterns and rate changes into automated charging and what interoperability standards and technology gaps remain before EVs reach that point. Mr. Collins and Mr. Jaramillo explained the competing ideas of where smart charging controls could reside (e.g., in charging stations, in vehicles, or with the utility) and why the smart charging hub should be in the vehicles and not with utilities, which could negatively impact reliability.

Ms. Laney Brown and Mr. Doughty discussed the available data that could be used to inform investment and infrastructure decisions regarding charging stations, including the EV fleet case study conducted on an Airforce base. Mr. Nelder explained the questions surrounding who should own and manage charging structures (e.g., utilities or third parties) and the useful projects in California that test the different ways to approach these questions (e.g., rate-based infrastructure or ownership by one provider).

Mr. Gellings explained the benefits of EVs as a part of a portfolio of electric technology that can be used to lower carbon emissions and underscored the societal benefits of some electric technology. Mr. Lazar and Mr. Almgren discussed how rate design was the biggest challenge to workplace charging.

Mr. Nelder explained why and how aggregators had an important role in smart charging, how a plug can collect information for smart charging and does not require customers to know anything about capacity, and why he thought it was important to disseminate information on the potential effects of EVs on the grid (i.e., to avoid the potential short-term overload of the distribution grid from EVs). Mr. Centolella suggested that DOE play a role in developing EV and grid interoperability standards.

Ms. Lin noted a few opportunities for DOE to help support EVs, including the tiered tariffs that don't financially incentivize people to charge during optimal times and the lack of knowledge about charging tariffs among the diverse group of EV stakeholders (e.g., EV dealers, rooftop solar participants, aggregators, utilities, car manufacturers, etc.). She suggested DOE work with stakeholders to develop a rate design around EVs that accelerates and simplifies tariffs for end-users (e.g., outreach efforts that clarify how tax credits work).

Ms. Lin and Mr. Doughty discussed the need for EV data (e.g., charging locations, power level, and times) to be more accessible to stakeholders (e.g., system operators, utilities, innovators, aggregators, and technology companies) so they are aware of what is happening from a geographic perspective and the current efforts to achieve that data dissemination.

Ms. Marilyn Brown, Mr. Nelder, and Mr. Collins discussed the issue of equity around EVs (e.g., little participation from low-income people). Mr. Nelder and Mr. Collins explained the current efforts to prevent those equity issues around EVs and discussed the net societal benefits associated with moving towards high EV penetration quickly (e.g., lower carbon and pollution emissions), which will be felt by lower income communities even though they may not be involved in the burgeoning EV market.

Mr. Almgren concluded the discussions by thanking the panel for their excellent contributions.

Update on Grid Modernization Initiative Working Group Activities and Plans

Anjan Bose, EAC Member, provided an update on the Grid Modernization Initiative Working Group activities and future plans. He began by summarizing the sequence of events over the last couple of years and why the working group was created. Mr. Bose explained that with the grid modernization chapter in the QER, and material on grid modernization in the QTR, the Grid Modernization Initiative (GMI) was created by the Department of Energy. The first thing that came out of the GMI was the Multi-Year Program Plan (MYPP), and the call for proposals to all of the labs which was called the Grid Modernization Lab Consortium (GMLC).

Mr. Bose shared that as part of the EAC's GMI Working Group activities, six foundational projects were presented to the group by the project PI's and a number of observations were made. He

explained that the Working Group's plan is to develop a report for the March 2017 meeting. The target date is set mainly to coincide with the new administration starting and the need to stress the importance of grid modernization issues and the complexity of these issues. Mr. Bose noted that the report will cover recommendations about where the GMI stands today, gaps in the existing GMLC projects, and the connection between policy and technology.

Update on the Clean Power Plan Working Group Activities and Plans

Mr. Zichella provided an update on the Clean Power Plan Working Group's activities and future plans. Although the CPP has been tied up in litigation, the Working Group is moving forward with its activities. Mr. Zichella and Caitlin Callaghan, DOE, have been working together to structure a series of webinars. They have planned to hold two webinars, one that looks at public agencies and the other looking at private institutions and NGOs that are working on Clean Power Plan compliance approaches. The webinars will be held in a panel format, and will be open to all EAC members.

Public Comments

Jeremy Bedine provided a public comment on behalf of the academic work he is working on at Johns Hopkins University in the Energy Policy and Climate Program. Jeremy participates in a group within that program that is drafting an energy plan for the next president, and he is focused on grid modernization and extension.

Wrap-up and Adjourn September 2016 Meeting of the EAC

Sue Tierney, EAC Chair, and Mr. Zichella, EAC Vice Chair, thanked everyone for their comments and adjourned the September 2016 meeting.

Respectfully Submitted and Certified as Accurate,

Susan Tierney
Analysis Group
Chair
DOE Electricity Advisory Committee

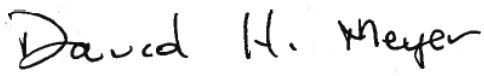
12/06/2016
Date

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

12/06/2016
Date

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

12/06/2016
Date



David Meyer
Office of Electricity
DOE Electricity Advisory Committee

12/06/2016
Date