U.S. Department of Energy
Electricity Advisory Committee Meeting
NRECA Conference Center
Arlington, VA
March 13, 2014

Summary of Meeting

PARTICIPANTS

EAC:

BILLY BALL
Southern Company

LINDA BLAIR
ITC Holdings

ANJAN BOSE
Washington State University

MERWIN BROWN
California Institute for Energy & Environment

PAUL CENTOLELLA
The Analysis Group

CARLOS COE
Millennium Energy Products

RICHARD COWART
Regulatory Assistance Project

ROBERT CURRY
Commissioner Emeritus, NY; Charles River Associates

CLARK GELLINGS
Electric Power Research Institute

MIKE HEYECK
The Grid Group

PAUL HUDSON
Stratus Energy Group

RALPH MASIELLO
DNV KEMA Energy & Sustainability

CLAIR MOELLER
Midcontinent Independent System Operator

CHRIS PETERS
Entergy Services, Inc.

SONNY POPOWSKY
EAC Vice Chair

WANDA REDER
S&C Electric Company; IEEE

PHYLLIS REHA
Commissioner Emeritus, Phyllis Reha Consulting

CHRIS SHELTON
AES Energy Storage

TOM SLOAN
State Representative, Kansas

DAVID TILL
Tennessee Valley Authority

GORDON VAN WELIE
ISO New England

REBECCA WAGNER
Nevada Public Utilities Commission

CARL ZICHELLA
Natural Resources Defense Council

DOE:

WILLIAM BRYAN
Department of Energy

CAITLIN CALLAGHAN
Department of Energy

IMRE GYUK
Department of Energy

HONORABLE PATRICIA HOFFMAN
Department of Energy

LARRY MANSUETI
Department of Energy

DAVID MEYER
Department of Energy

JOSEPH PALADINO
Department of Energy

MATT ROSENBAUM
Department of Energy

Speakers, Guests and Members of the Public:

ANDY BOCHMAN
Bochman Advisors LLC

CHERYL LAFLEUR
Federal Energy Regulatory Commission

DAVID OWENS
Edison Electric Institute (EEI)

JAMES PEDERSON
Federal Energy Regulatory Commission

MARY ANN RALLS
National Rural Electric Cooperative Association

RALPH LAROSSA
Public Service Electric and Gas Company

STEPHEN WHITLEY
New York ISO

ICF/Support:

SHERI LAUSIN
ICF International

CODI SHARP
ICF International

SAMIR SUCCAR
ICF International

* * * * *

Post-Sandy: Lessons for Grid Resilience Panel

Mr. Mike Heyeck and Mr. Robert Curry introduced the post-Sandy resiliency panelists: David Owens, Edison Electric Institute (EEI); Ralph LaRossa, Public Service Electric and Gas (PSEG); Stephen Whitley, New York Independent System Operator (NYISO); and Bill Bryan, U.S. Department of Energy.

The first panelist, Mr. Owens, from Edison Electric Institute (EEI), commended the evolving partnership between industry and government implemented during and after hurricane Sandy. He described his experiences working with the President of the United States, the Honorable Patricia Hoffman, Federal Emergency Management Act (FEMA) representatives, and other industry leaders. Government-industry partnerships facilitated the efficient mobilization of and amenities for work crews across state and international borders as well as enhanced logistical support and

security.

After Sandy, EEI helped develop the industry-wide National Response Event mechanism for responding to events that cause widespread power outages. Regional coordination was also improved by combining three separate Mutual Assistance Groups into the North Atlantic Regional Mutual Assistance Group. Drills have also been conducted to test these new response programs.

EEI has worked with the government to prevent cyber and physical breeches with the Electricity Subsector Coordinating Council (ESCC). The ESCC coordinates members of the government, electric sector, and external groups in response to threats. Drills for cyber and physical threat response have also been conducted.

The second panelist, Mr. LaRossa, from the Public Service Electric and Gas (PSEG) Company, gave some background about his company. He described the impacts of hurricane Sandy on the PSE&G jurisdiction's electricity switching stations and gas distribution. In order to strengthen the system for the future, PSE&G developed an Energy Strong Program, which recommends building redundancy into the grid, making the system harder by physically improving infrastructure, and deploying more advanced smart grid technologies. Mr. LaRossa commented that with low natural gas prices and available labor, the time is ripe to implement its Energy Strong Program cost effectively.

The third panelist, Mr. Whitley, from the New York Independent System Operator (NYISO), discussed hurricane Sandy from the bulk system level. At the bulk system level, they analyze the whole system to try and prevent cascading outages. He described the interconnection status of the most impacted areas in New York City and New Jersey, and the impact on electric load and operations during the storm. New York City's overhead transmission was maintained, even though all connections outside the City were lost, which emphasizes the value of diversity of transmission lines. Diversity prevented even bigger problems and expedited restoration of power after the storm.

In addition to storm resiliency, Mr. Whitley briefly addressed challenges in meeting record peak demands during recent winters and summers. The NYISO has many lessons to learn, but Mr. Whitley lauded the communication and coordination between Independent System Operators (ISOs) thus far.

The final panelist, Mr. Bryan, from the U.S. Department of Energy, described his involvement in the response efforts on the ground after hurricane Sandy. He listed the four main issues that needed to be addressed on the ground: 1) coordination between states and regions; 2) mobilization of goods and work crews and evaluation of assets; 3) access across boarders; and 4) equipment hardening.

Moving forward, DOE will employ the Incident Management Council to better respond to all types of emergency events. The budget request for 2015 may provide

added resources for streamlining communications between industry utilities, government, and communities. If funding allows, an Energy Resiliency and Operations Center will be built to accommodate all stake holders.

EAC Discussion of Storm Panel Topics

Mr. Clair Moeller asked why resiliency lessons were not implemented after hurricane Katrina.

Mr. LaRossa responded that Katrina required less regional coordination because it was seen as a Louisiana event. In contrast, the 2003 black out required national coordination, and industry responded excellently.

Mr. Whitley responded that lessons learned during hurricane Katrina should have been better maintained by conducting frequent drills.

Mr. Bryan commented that the federal government must wait for states to ask for assistance because states have to absorb 25% of the cost. He also commented that FEMA overhauled its processes for coordinating with states over the last 5-6 years in response to lessons learned during hurricane Katrina.

Mr. Ralph Masiello commented on his experiences waiting for power to be restored after Sandy. There was insufficient interoperability, and the crews clearing trees were not always appropriately informed or equipped.

Mr. LaRossa commented that there were no worker fatalities during response efforts. However, more testing equipment should be available to crews, and we must strive for interoperability and redundancy.

Mr. Bryan added that the ability for interoperability exists, but it interferes with privacy because people would be tracked.

Mr. Tom Sloan asked Mr. LaRossa if there were plans to do necessary upgrades while restoring service during the restoration process.

Mr. LaRossa responded that the priority was just restoring service. They updated cross arms and insulators, but every scenario is too unique to make individual upgrade plans.

EAC Transmission Subcommittee Activities and Plans

Discussion of Grid Resiliency and Aging Transmission Assets Paper

Mr. Heyeck gave an overview of the *Recommendations on U.S. Electric Grid Resiliency* paper and thanked Mr. David Till and Mr. Clark Gellings in particular for their contributions. He described that the paper followed up recommendations in the

2011 Grid Security paper.

Hon. Hoffman asked if the EAC recommends that DOE change the logic of its current resiliency structure. Mr. Heyeck responded that although there are various ways the infrastructure could be breached, hopefully DOE can use a similar set of responses.

Mr. Centolella commented that the electricity system connects with other infrastructure, so gas, water, and communications systems must all be protected to keep electricity resilient. He mentioned recent cyber-attacks.

Mr. Anjan Bose commented that shifts toward a smarter grid create concern that the electric grid cannot run without computers.

Mr. Heyeck reiterated that redundancy of stations is more important than additional reinforcement of current stations.

Ms. Wanda Reder commented that the electric grid needs to develop and practice resiliency plans to avoid chaos during emergency events. She suggested that technology should be employed as much as possible, especially in coastal areas where hurricanes and storms will be worst, and there are dense loads. Ms. Reder suggested investment in submersible technologies.

Mr. Heyeck commented that companies have considered elevating substations, but this was unpopular in Long Island. The Electric Power Research Institute (EPRI) is also testing coatings to resist salt water spray; however these would not stand up to inundation.

Mr. Curry commented that as the former commissioner for New York, the cost of replacing existing assets is inhibitive. He also commented that new substations can be made to look like row houses, as ComEd did.

Ms. Reder moved to approve the paper. The motion was seconded.

Members unanimously approved the *Recommendations on U.S. Electric Grid Resiliency* with no changes.

Discussion of Proposed Technology R&D Roadmap for the 21st Century Electric Grid Paper

Mr. Heyeck gave an overview of the potential work product about the Technology R&D Roadmap for the 21st Century Electric Grid. This work product would respond to the six pillars developed by the Grid Tech Team (GTT) to modernize the grid. Mr. Clark Gellings has already initiated an R&D piece under the Smart Grid Subcommittee, so the R&D roadmap will be a joint effort between the Smart Grid and Transmission Subcommittees.

Discussion of Subcommittee Renaming and Possible Merger with Smart Grid Subcommittee

Mr. Heyeck described the history of the Transmission Subcommittee. Currently there are gaps in the EAC's coverage of electricity distribution and in other areas the Smart Grid and Transmission Subcommittees overlap. The proposal is to rename and redefine the Transmission Subcommittee as the "Power Delivery" Subcommittee, and it would cover top-down transmission and distribution. The Smart Grid Subcommittee would cover the customer aspects, microgrids, etc.

Mr. Heyeck added that the EAC's focus thus far has been on needs of the Office of Electricity Delivery and Energy Reliability (OE). The redefined Subcommittee would make more of an effort to support the Office of Energy Efficiency and Renewable Energy (EERE) as well. Mr. Heyeck proposed a dialogue with Mr. Cowart about repurposing the two Subcommittees going forward.

Mr. Cowart explained that the leadership team decided to rename the Subcommittees to clarify their purposes. The Power Delivery Subcommittee will henceforth focus on top down transmission, including interconnection of renewables at the grid scale, and the Smart Grid Subcommittee will focus on bottom up issues, including customers, smart grids, load management, and distributed generation.

Mr. Chris Shelton commented about potential gaps in interconnection standards. He heard that the Institute of Electrical and Electronics Engineers (IEEE) is not interested in filling these gaps.

Mr. Gellings mentioned that a revision has been proposed, IEEE1547A, but state commissions must adopt the revision before it has an effect. He asked what the EAC can do to influence the adoption of this revision. The issue involves both the Smart Grid and Power Delivery Subcommittees as they have been redefined.

Mr. Cowart responded that he will ask DOE about what the EAC can do regarding the adoption of this revision. He will also work with DOE to change the Transmission Subcommittee name to "Power Delivery," but the operation of the Subcommittees will remain largely the same.

Mr. Heyeck commented that gaps will still exist between the Subcommittees, for example, grid security will also have micro gaps. These will be addressed as they arise.

DOE Energy Storage Program Update

Dr. Imre Gyuk, Energy Storage Program Manager at DOE presented about the Department's Energy Storage Program. Since energy storage is becoming more of a reality, much of the Department's Program is geared toward commercialization of energy storage technologies. The Program is leveraging American Recovery and Reinvestment Act (ARRA) stimulus funding toward storage demonstration projects.

Mr. Gyuk described key energy storage demonstration projects in which the Department is involved.

Several projects use frequency regulation, which was the basis for the Federal Energy Regulatory Commission (FERC) to establish "Pay for Performance," and which is now commercially implemented in many regions.

Dr. Gyuk described projects implementing various types of flow batteries such as zinc-halogen and iron-chromium flow batteries. The Department is also researching new battery technologies including: mixed acid electrolyte for V/V and V/Fe flow batteries, lead carbon batteries, and aqueous hybrid ion (AHI) batteries.

In addition to batteries, the Department is researching compressed air and isothermal energy storage technologies.

Next Dr. Gyuk discussed the role of energy storage in grid resiliency. One possible solution is to create microgrids that could provide services for an extended time during emergencies. The microgrids could provide demand management during non-emergency times.

Dr. Gyuk discussed energy storage safety. In February 2014, DOE held a workshop with Sandia, the Pacific Northwest National Laboratory (PNNL), and other stakeholders. The workshop covered dangers of energy storage and how to improve safety measures. The OE Energy Storage Program has a new Energy Storage Safety Initiative. As part of this Initiative, they accepted an industry mandate to develop a National Energy Storage Safety Strategic Plan.

The Department is also developing a protocol for how to measure and report performance of energy storage technologies, which will be the basis for a new IEEE standard. DOE will also develop the Energy Storage Handbook in tandem with the National Rural Electric Cooperative Association (NRECA) and EPRI.

Finally, Mr. Gyuk described the Department's International Energy Storage Database, which records grid-connected energy storage projects across the world.

EAC Discussion of the DOE Energy Storage Program

Mr. Gordon van Welie asked about liquid metal batteries, as developed at the Massachusetts Institute of Technology (MIT).

Mr. Gyuk responded that liquid metal batteries require large scale storage units. The Department will monitor the new technology as MIT continues to test it.

Mr. Paul Centolella asked about how the Department facilitates progress between developing advanced battery technologies and funding commercial projects. He asked

if there are additional opportunities—possibly internationally—to implement advanced technologies such as simulation modeling and regional innovation institutes.

Mr. Gyuk responded that ARPA and OE encourage the development of technologies to near-commercial readiness, but money is not often available. In the international arena, the Korean project is DOE's biggest project, but there are several additional projects such as a battery licensed in India, another Korean project for a high temperature sodium system, and a project in Germany with a wind plant. OE is very aware of the international scene.

Mr. Gyuk also commented that OE has conducted fairly extensive simulation modeling for energy storage based on a flow battery model from the DOE innovation hubs that is being used by Argonne National Labs.

Mr. Centolella asked what recommendations the EAC can make to expand DOE's institutional reach. For example, should DOE try to partner with states or countries?

Mr. Gyuk responded that DOE needs additional funding for the implementation of advanced storage all the way to commercial-readiness and deployment.

Mr. Masiello commented that many of these energy storage issues are outside DOE's jurisdiction and within FERC or state jurisdictions, as reported in the 2012 Energy Storage Report. California is developing the first mandate to plan for storage, and DOE is working with the California energy commission.

Mr. Gyuk agreed that it is no mistake that a majority of DOE's projects are in California, where there is funding.

Mr. Shelton added that Ohio and West Virginia have also been critical in energy storage progress with the largest battery projects in the US. These projects have informed progress in California.

Mr. Shelton also commented that the EAC should participate in safety forums. He clarified that there are different safety concerns for industrial versus customer-side energy storage projects. For example, Mr. Shelton's company, American Energy Storage (AES), already follows safety requirements mandated by Superfund and local regulations to engage fire professionals, etc. Thus the Department's safety initiative should distinguish between the industrial and customer side, and it should avoid creating uncertainty about regulatory obligations in the future.

Mr. Gyuk commented that the Department is aware of the balance between requiring regulation and hindering the system. Many existing safety regulations fail to address energy storage, so the Department plans to suggest best procedures within applicable regulations. He welcomed AES to join this discussion.

Mr. Merwin Brown asked how much fundamental physics and chemistry research the

Department is conducting to develop new storage technologies.

Mr. Gyuk answered that a lot of research is underway to develop new systems. However, research must stay within the boundaries of the eventual application including cost and space.

Mr. Brown asked about the Department's distinction between utility- and distributed-scale energy storage.

Mr. Gyuk responded that the Department does not make a clear distinction. Many of its applications are in the 1 MW range, and these are generally distributed at the substation level. The Department is not interested in strictly domestic use, which seems impractical. However, batteries could be scaled up and deployed on the transmission side. Mr. Gyuk described that energy storage implementation is currently a series of small battles to win over each state. At this point, the Department is not concerned about the distinction between utility- and distributed-scale energy storage.

Mr. Carl Zichella mentioned that procurement mandates in California encourage innovation. Now that the market space exists, is DOE collating ideas for future development?

Mr. Gyuk responded that he attends conferences and hears proposals for many emerging energy storage technologies. As he talks with people, he offers advice and sometimes DOE support for new ideas.

EAC Storage Subcommittee Activities and Plans

Mr. Masiello explained that Mr. Brown will take over as the Chair of the Energy Storage Subcommittee after the March EAC meeting.

Mr. Masiello mentioned that the *National Grid Energy Storage Strategy* paper was approved in January and submitted to the Department.

Discussion of the Storage Safety and Testing Paper

Mr. Masiello presented the preliminary outline for the Distributed Energy Storage Testing and Safety work product. However, he asked whether this paper is still relevant when DOE is simultaneously developing a National Strategy for Energy Storage Testing that will be in place by June 2014.

Ms. Reder suggested that it may be more valuable to have the committee available as a sounding board while the National Strategy is developed.

Mr. Gyuk responded that the expertise and knowledge of the EAC would be welcome throughout the development of the National Strategy.

Mr. Masiello commented that the EAC could still provide new insight about materials science development for intrinsically safe storage technologies, as suggested Mr. Carlos Coe.

Mr. Gyuk explained that the Department will hold a workshop later this year, to follow up the February workshop, for battery degradation and associated material topics.

Mr. Coe commented on the importance of improving the intrinsic safety of energy storage technologies. Thus far the focus has been on system-level safety, but the Department should also research material-level safety.

Mr. Masiello suggested that the EAC should submit a recommendation to endorse the safety initiative that the DOE has already started instead of duplicating the effort.

Mr. Shelton commented that the EAC could still provide discussion about industrial versus load side safety issues. The EAC could catalogue what safety measures are already required for industry by existing regulations and find if gaps exist.

Members discussed potential energy storage safety hazards and the anticipated public perception.

Mr. Cowart commented that the EAC should be proactive regarding safety standards to avoid misplaced public opposition to energy storage installations.

Discussion of the 2014 Biennial Storage Program Review

Mr. Masiello described the Subcommittee's plan for the 2014 Biennial Storage Program Review. The EAC Charter requires the Subcommittee conduct a review of the Department's Energy Storage Program every two years. The 2012 Energy Storage Report was distributed during meeting registration. First, the Subcommittee will need to gather a team to work on this report.

Mr. Brown referenced the two requirements for the Energy Storage Subcommittee: a review every two years and a more thorough assessment with recommendations every five years.

Mr. Brown explained that the Subcommittee will present a near-final draft by the September 2014 EAC meeting. He asked Energy Storage Subcommittee members to help draft this report. Mr. Brown also asked Mr. Gyuk to give the Subcommittee insight about the type of feedback that would be most helpful for the Department.

Discussion of the Distributed Energy Storage Paper

Mr. Brown described the proposed white paper on Distributed Energy Storage, which would be a joint effort of Smart Grid and Energy Storage Subcommittees. The paper would have parallels to the *National Strategy for Energy Storage* that the Energy

Storage Subcommittee passed in January 2014. However, this paper would focus on distributed-scale instead of utility-scale storage. Mr. Brown added that the paper may need to be reframed, since Mr. Gyuk just commented that the Department does not currently distinguish between distributed and utility scales.

Mr. Brown described the proposed scope of the paper. Distributed storage is a subject of interest because the energy storage input from customers may not be accounted for by utilities, but it will increasingly impact the grid.

Mr. Brown explained that the work group plans to complete the paper by the end of 2014 and present the paper for EAC approval at the 2015 spring meeting.

Mr. Brown predicted that many barriers to the widespread adoption of technology will be institutional. The technologies will probably look similar, but the purpose and who is deploying them will differ.

Mr. Brown asked to what extent EAC resources will be committed to reviewing the Quadrennial Energy Review (QER). He explained that if EAC efforts are needed for the QER, the Distributed Energy Storage paper can be postponed. However, the Subcommittee cannot postpone the Biennial Storage Report, which is a statutory requirement for 2014.

Mr. Gellings asked to see a more developed outline of the proposed paper before giving approval to move forward. He explained there is great concern among utilities about demand from grid-related services, and distributed storage would affect this demand. However, distributed storage could be defined very broadly (for example, it could include appliances and electric vehicles), which would make it impossible to capture all of the sources.

Mr. Brown explained that a working group did develop a draft outline, which was included in March meeting materials. Mr. Brown agreed that the work group would need to define and limit the scope. Mr. Brown also suggested a future distributed energy storage panel with industry members who could speak about challenges and needs for distributed energy storage.

Mr. Heyeck commented that the work group should move forward and develop a detailed outline for the June meeting. Mr. Masiello agreed that effort should move forward. He referenced comments from panelists Mr. Clyde Loutan and Mr. Whitely to emphasize the relevance of the topic.

Hon. Hoffman commented that part of the DOE 2015 budget will be allotted to investigation of small DC systems.

Mr. Sloan requested that the work group distribute a detailed outline electronically before the June meeting, so the Committee can have a productive discussion in June.

Mr. Cowart agreed that this method would be appropriate. The work group can email the updated outline, and the Committee will engage in electronic dialogue in the meantime.

Mr. Zichella asked DOE to identify what topics would be most useful to DOE, regardless of whether they are included in the current outline.

Hon. Hoffman responded that DOE is not currently looking at distributed energy storage, so this work product may inform future work. She mentioned DC microgrids and how to integrate loads at a growing enterprise.

Mr. Zichella commented that distributed storage is very location-based and mentioned zoning of distributed storage in California.

Mr. Brown commented that the work group will distribute a refined outline before the June meeting for review. Moving forward, this work product may be reframed as a survey paper or situational awareness paper instead of a "National Strategy."

Mr. Cowart thanked Mr. Heyeck and Mr. Masiello, who are term limited in August 2014, for proactively reaching out to new leadership on their respective Subcommittees. He reminded the Committee that Mr. Brown will be taking over as Chair of the Storage Subcommittee and Mr. David Till and Mr. Zichella will be taking over as Chair and Vice Chair of the Transmission Subcommittee.

Public Comments

Mr. Samir Succar spoke on behalf of Katherine Hamilton from the Energy Storage Association (EAS). He read an excerpt of the full comment that EAS submitted. This comment is available with the March meeting materials on the EAC website.

The March 2014 EAC Meeting was adjourned.