**Department of Energy**
**Washington, DC 20585**

June 25, 2015

**MEMORANDUM TO THE DEPARTMENT OF ENERGY**
**ELECTRICITY ADVISORY COMMITTEE**

**From:** **Patricia A. Hoffman** PH
**Assistant Secretary**
**Office of Electricity Delivery and Energy Reliability**

**Subject:** **DOE Responses to EAC Work Products**

I want to thank all members of the Department of Energy's (DOE) Electricity Advisory Committee (EAC) for your hard work during 2014.

The work products delivered by the Committee during this period are listed below. The purpose of this memo and its attachments is to provide you with the Department's responses to your analyses and recommendations in a systematic and inclusive form.

**EAC September 2014 Work Products**

1. 2014 Storage Plan Assessment Recommendations, September 2014

2. EAC Recommendations on Expanding and Modernizing the Electric Power Delivery System for the 21st Century, September 2014

3. EAC Recommendations Regarding Emerging and Alternative Regulatory Models and Modeling Tools to Assist in Analysis, September 2014

4. Status and EAC Recommendations for Electricity Delivery Workforce, September 2014

The attachments that follow summarize DOE's actions and responses to these 2014 work products.

I continue to look forward to the future efforts of the EAC and am committed to ensuring a strong and fruitful working relationship between the Committee and DOE

**Electricity Advisory Committee (EAC) Recommendations**
**2014 Storage Plan Assessment Recommendations**
**September 2014**

The Electricity Advisory Committee's (EAC) biannual Storage Plan Assessment issued in September 2014 offered several recommendations to enhance the development and deployment of energy storage technologies, policies, and programs to help ensure an effective, resilient, electric power system. OE greatly appreciates the efforts of the EAC in reviewing the activities of the DOE related to grid energy storage, and values the insights offered by the EAC members. OE has reviewed the recommendations of the EAC report and has organized responses by the four-mission areas for storage outlined in the December 2013 Department of Energy Grid Energy Storage document: 1) Cost Competitive Energy Storage Technology; 2) Validated Reliability and Safety; 3) Equitable regulatory environment, and 4) Industry Acceptance.

## (1) Cost Competitive Energy Storage Technology:

### Improved Storage Operation and Resource Assessment Tools

**Recommendation 1.1: Support the development of advanced models that can better capture the full range of system dynamics and stochastics that may affect storage operations.**

The development of advanced models that can better capture the impact of system dynamics on storage assets is an important development area. The OE Energy Storage Program is currently supporting through several projects including a joint effort with Southern California Edison (SCE) under cost share with the California Energy Commission (CEC), a project on refinement and evaluation of methods to establish optimal value streams for distribution level storage at several projects in the Pacific Northwest with utilities as well as Washington State cost shared with DOE. The SCE-led project under the CEC California Solar Initiative is aimed at integrating PV-tied energy storage models the into GridLab-D analysis tool. Through these and other efforts, we will continue to explore additional opportunities with state and regional entities to advance the development of analysis and assessment tools that can fully capture the flexibility and subsequent operational value of energy storage in resource planning.

**Recommendation 1.2: Good operational decisions that maximize value captured are needed to properly value storage assets for cost/benefit analysis and investment evaluation purposes.**

The OE Energy Storage program has multiple efforts focused on developing and expanding the analytical tools used for determining the value of energy storage systems. In FY2015, the Sandia National Laboratory (SNL) is partnering with the Hawaiian Electric Company and the California Energy Commission to develop new tools for improving the fidelity of assessing the full potential value of a proposed

energy storage deployment. Pacific Northwest National Laboratory (PNNL) is partnered with the Washington State Department of Commerce, three utilities and multiple developers to determine the cost/benefits analysis of energy storage under a wide range of utility use cases. It is the goal that these multi-party analysis efforts will lead to new decision making tools that will help capture the maximum value of storage assets. We intend to expand the scope of efforts and stakeholder engagement associated with optimal operation to achieve maximum valuation for grid services that storage can provide.

**Recommendation 1.3: DOE should continue and expand the development of resources such as the 2013 EPRI/DOE Storage Handbook and the DOE Energy Storage Database.**

The OE Energy Storage Program plans to continue to expand the development of the DOE/EPRI Storage Handbook and the DOE Energy Storage Database and maintain them as electronically accessible living documents. The database has reached 1200 entries and represents energy storage installations in 58 countries. The database includes U.S. federal and state policies on grid connected energy storage and enables energy storage developers, utilities, technology providers, regulators, and general public to access detailed product and policy information across all major markets. Now the leading free storage resource with over 850,000 page views, 90,000 sessions in 189 countries, the recent release includes a series of user-friendly features such as data visualization tools to create graphs and charts; increased social media presence and tools that enable users to share pages across Facebook, Twitter, LinkedIn, and Google+; a new search engine to query the entire data set and generate suggestions based on search criteria. Limited revision of the database is planned for FY2015; however, it is the intention to substantially expand efforts on the database in FY2016 to include an active accounting of current codes and standards related to storage.

## PHS and CAES Resource and Technology Assessments

**Recommendation 1.4: Conduct a comprehensive analysis of how much greenfield and brownfield PHS capacity exists in the United States and the cost of developing these resources.**

Due to the geographical limitations of Pumped Hydro Storage (PHS), most current storage assessments have focused on electrical storage such as batteries and flywheels that can be ubiquitously deployed. While PHS system assessments fall under the domain of the Energy Efficiency and Renewable Integration Office (EERE), and specifically the Wind and Water Technology Office (WWTO); the tools and methodologies developed under the OE Energy Storage Program may be able to add additional value in their assessment. Under WWTO support, Oak Ridge National Laboratory (ORNL) has established hydro resource estimates focused on identifying potential for increased hydropower production at existing and new sites. Additionally, they have supported Argonne National Laboratory (ANL) in the investigation of the potential operational benefits of more flexible PHS employing

advanced pump-turbine technology. The WWTO is currently undertaking a Hydro Vision development effort that will revitalize programmatic goals for their hydropower program including PHS. Moreover, OE mentioned this recommendation to EERE WWTO and was informed that they were preparing a report to Congress based on a report by ANL regarding pumped storage hydropower in the U.S. The August 2014 ANL report concludes that providing further support for the development of new pumped storage hydropower units and upgrades to existing units will contribute to grid reliability and will facilitate a larger expansion of variable renewable energy, thereby reducing power system emissions in the United States (for the full text of the report, please see- http://www.dis.anl.gov/projects/psh/PSH_RtC_TechReport_20141210.pdf)

**Recommendation 1.5: Conduct a comprehensive study of how much CAES capacity could be developed in domal salt, bedded salt, porous rock, hard rock formations, and pipelines. It would further be beneficial to use the failed development of the Norton Energy Storage project as a case study to understand what other issues (besides geology) are impediments to successful CAES development.**

Due to the limited number of planned and active deployments, there have been relatively few comprehensive analyses of Compressed Air Energy Storage (CAES) system. In 2012, SNL completed a study, funded by the OE Energy Storage Program, developing a thermal-mechanical hydraulic response model for geological formations suitable for CAES. An internal review of that analysis will be conducted to determine if models developed under this study are appropriate for the requested analysis of CAES capacity in selected geological formations. Presently, funding is not available to conduct a comprehensive study on CAES capacity in the US. Based on an extensive characterization of potential sites for CAES in the early 1980's, estimates for CAES capacity including new siting options for conventional CAES would be very expensive. Should additional resources be made available, such a study could be considered in the future. Additionally, the OE Storage Program will reach out to FirstEnergy to open discussions on the failure of the Norton CAES project.

## (2) Validated Reliability and Safety:

### Codes and Standards Development

**Recommendation 2.1: The EAC suggests that a standards process is best done from an applications viewpoint, with storage owners and operators leading the way, and with input from technology vendors. DOE can facilitate this process by continuing to convene workshops of the relevant stakeholders. DOE can also increase the adoption of codes and standards favorable to energy storage adoption by sponsoring consultants on panels, including the NEC.**

The OE Energy Storage program has recognized that there are currently significant gaps affecting development and deployment of grid energy storage both in performance and in safety. DOE has led efforts to assemble stakeholders to

accelerate the development of protocols for energy storage performance evaluation, which are now serving as the basis for industry and other stakeholders to promulgate energy storage standards through traditional standards organizations. Additionally, DOE has used its convening capacity to inaugurate stakeholder consideration of grid energy storage safety, and particularly in the underlying knowledge of how safety is validated in energy storage deployments where multiple technologies or siting arrangements could be used for a single application. Leading the community in the development of this knowledge base is a key objective of the OE Energy Storage program and the development of meaningful codes and standards for energy storage safety is an important aspect of the program. In FY2014, the OE Energy Storage program convened several workshops/webinars with key energy storage stakeholders to determine the critical needs for the safe deployment of energy storage. These efforts include:

- DOE OE Energy Storage Safety Workshop, February 2014;
- DOE OE Webinar on Energy Storage Safety, April 2014;
- DOE OE Safety Panel – ESA annual meeting and conference, June 2014;
- DOE OE Strategic Plan on Energy Storage Safety, September 2014.

Most recently, on January 14, 2015, the Energy Storage Technology Advancement Partnership (ESTAP) held a webinar on the Energy Storage Safety Strategic Plan that included a National Fire Protection Association consultant favorable to the adoption of energy storage codes and standards. In FY2015, DOE plans to continue to facilitate engagement with these stakeholders on codes and standards adoption through selected conferences, workshops, webinars, and working groups. In addition, the OE Energy Storage program is actively working with state and regional entities on the development of application specific codes, standards, regulations (CSR) templates in areas where multiple energy storage installations are planned with similar environmental and jurisdictional constraints. The ultimate goal is that these templates will facilitate and speed the adoption of energy storage technologies.

**Recommendation 2.2: DOE should continue to convene planning activities and continue to provide technical support to standards and codes bodies.**

In addition to the efforts outlined in above response, The OE Energy Storage Program has been expanding activity to address the validation of safety and the creation of CSR in a holistic fashion. In December 2014, the OE Energy Storage Program published a Strategic Plan on Energy Storage Safety (http://www.sandia.gov/ess/saf_stategicplan.html) in which the challenges and opportunities facing key stakeholders (e.g. officiating agencies, developers, first responders) in energy storage safety. The goal of the Strategic Plan on Energy Storage Safety is to provide the framework for a comprehensive effort under which the regulatory and technical underpinnings of energy storage safety can be addressed. In support of these efforts, the OE Energy Storage Program hosted webinars in April 2014

(http://www.sandia.gov/ess/docs/other/Combined_Workshop_video.mp4) and January 2015 (http://www.cesa.org/webinars/showevent/estap-webinar-doe-oe-energy-storage-safety-strategic-plan?d=2015-01-14) to disseminate the details of this plan. In addition to the CSR published documents referenced by the EAC, Sandia National Laboratory (SNL) and Pacific Northwest National Laboratory (PNNL) have presented over a dozen technical talks at conferences and stakeholder meeting on safety related issues that were addressed at the February 2014 workshop on Energy Storage Safety. Finally, in 2015 the OE Energy Storage Program have held several Energy Storage Safety Working Group Meetings to identify energy storage safety gaps and develop an action plan to be released in late May at the Energy Storage Association Conference. FY2016 plans include utilizing DOE OE's leadership in energy storage to establish a quarterly ES Safety forum. DOE will facilitate communication and collaboration amongst all ESS stakeholders in the continual process of promoting safe deployment of storage. In addition, the OE Energy Storage Program plans to establish a Stationary Energy Storage Safety and Reliability Center to coordinate the research, development, and validation of technologies required for safe and reliable energy storage systems. The Center will focus on the development of safety and reliability testing protocols and understanding the creation, propagation, and mitigation of failure modes from the primary materials/chemistry to the system level.

**Recommendation 2.3: DOE should expand their involvement in the efforts they already support and also engage in new activities as identified by the industry, particularly in code bodies.**

See response to recommendations 2.1 and 2.2. Moving forward, the OE Energy Storage program is focused on developing new validation techniques that enable the energy storage community to have a greater understanding of the materials basis for energy storage safety and mitigation of cascading failures at a systems level.

Additionally, the program will continue to focus on having national laboratory staff participating in national and international CSR activities (e.g. ESIC, IBC, IEEE and IEC TC 120). The OE Energy Storage Program is focused on using its non-partisan position to address factors related to the performance, safety and reliability of energy storage in collaboration with the entire storage community, and will utilize demonstrated technical and community leadership to facilitate the further expansion of a safe, reliable and resilient electric grid.

## (3) Equitable Regulatory Environment:

Comprehensive Study of Regulatory and Market Design and Impacts on Roles for Storage

**Recommendation 3.1: Conduct a comprehensive study, possibly in conjunction with other agencies that fund or conduct storage or energy system related research, on**

**regulatory and market designs and their effects on storage to allow for most efficient asset investment and use**.

The program is actively partnered with federal, state and municipal entities in analyzing the use of energy storage systems, the costs/benefits of energy storage, and development of tools for utilities customers and regulatory agencies for planning and implementing the deployment and use of energy storage. For Washington State, the OE Energy Storage Program is conducting a detailed use-case analysis of three independent MW scale storage installations in order to determine the value and optimal use of deployed energy storage assets. Other joint efforts between the OE Energy Storage Program are ongoing with BPA, HI, CA, VT, and OR. Performance and analysis of these systems will be disseminated nation wide and will help future adoption of storage. DOE will collaborate with regulatory organizations to ensure they are well informed and will cooperate in assessing new regulatory approaches for treatment of grid energy storage.

**Recommendation 3.2: Host a collaborative discussion of regulatory models that could address the roles and economic opportunities for storage in conjunction with FERC, NARUC, and NCSL. Topics to be covered in the discussion could include using distributed storage to provide ancillary services to the grid as well as more traditional micro-grid and renewable-integration services.**

In the past, the OE Energy Storage Program has actively engaged NARUC and FERC in helping establish and understand the value proposition. An analysis effort on the use of flywheels for frequency regulation was one of the primary influences supporting FERC order 755. However, as identified by the EAC, substantially more can be done to examine regulatory models affecting storage. Currently, the analytic models that have been developed are being disseminated to stakeholders in an effort to identify the value streams for storage – including storage in distributed energy resources. Further information and active discussions with the regulatory agencies will be important for the future adoption of energy storage. In FY2016, the OE Energy Storage Programs plans to initiate collaborative development of regulatory models with FERC, NARUC, and NCSL that could address the roles and economic opportunities for energy storage services. FY2015-16 plans also include increased engagements with state utilities and regulatory commissions that, to date, have had little or no experience energy storage will help accelerate the deployment of energy storage as seen in New York, Alaska and Oregon. The OE Energy Storage program has partnered in FY2014 with federal, state and municipal entities to conduct the critical analyses defining the cost benefits of energy storage systems and the development of tools for utilities customers and regulatory agencies for planning and implementing the deployment and use of energy storage. Examples include the Washington State Utilities and Transportation Commissions, Vermont Public Service Commission, and the California Energy Commission.

## Regulatory Design to Capture Renewable-Integration Benefits of Storage

**Recommendation 3.3: The importance of renewable integration as a major value proposition for storage development calls for comprehensive study of implications of different market and regulatory mechanisms on efficiently signaling the value of these services. This research can be carried out solely by the DOE or in concert with other agencies. DOE should make that research available to the ISO and RTO communities, state regulators, and FERC.**

The OE Energy Storage program is actively focused on understanding institutional and regulatory hurdles for implementation of energy storage and developing the needed analyses and analytic tools to enable storage to contribute, at an equitable level, with other grid resources. As mentioned previously, the program is actively partnered with federal, state and municipal entities in analyzing the use of energy storage systems, the costs/benefits of energy storage, and development of tools for utilities customers and regulatory agencies for planning and implementing the deployment and use of energy storage. OE Energy Storage Program efforts with Green Mountain Power in VT are aimed at demonstrating combined energy storage and renewables to understanding the impact and value of distributed energy storage with PV. While the outcomes of this research are widely disseminated to the energy storage community at large, a greater emphasis will be placed on presenting this work to system regulators, state regulators, and FERC.

## (4) Industry and Stakeholder Acceptance

**Recommendation 4.1: Continue funding demonstration projects from both public and private sources**.

The OE Energy Storage Program plans to continue to support demonstration projects in collaboration with public and private partners. The program is further supporting the development, deployment and operation of grid energy storage through controlled testing of prototype commercial storage technologies at the SNL Energy Storage Test Facility and by providing commissioning support, monitoring, and reporting of field demonstrations including the DOE funded ARRA storage projects. Another example is co-funding projects from both public and private sources such as Helix Power which received a $2.6M grant from the New York State Energy Research and Development Authority (NYSERDA) for a project to spin and demonstrate a novel 1MW-90 second flywheel. This project is leveraged by a $200k grant from the OE Energy Storage Program for a feasibility analysis of the technology. The study revealed that there are very sizable markets for fast systems capable of banking energy for a 90 sec period, and able to deliver one to two million full depth discharges over a 20 year life time. The initial application selected for the NYSERDA proposal concerns recycling of braking energy in metropolitan train applications. The proposal was backed by New York City Transit and by ConEd. This project is representative of a number of other projects, leveraging private and public resources to advance energy storage.

**Recommendation 4.2: DOE conducts a parametric cost benefit analysis of the ARRA demonstration projects in order to enhance the value derived from these investments.**

Industry acceptance hinges on the ability to design storage systems and demonstrate the value, performance and reliability of these systems in both controlled and fielded deployments. Industrial acceptance crosscuts other topic areas in that a cost competitive energy storage technology with validated safety and reliability in an equitable regulatory environment will naturally lead to greater acceptance by the industry. The OE Energy Storage Program has been actively working with the ARRA demonstration projects to evaluate their progress and challenges but the scope of such evaluation is constrained by ARRA contractual requirements and companies will not freely provide their actual cost data to a third party. The OE Energy Storage Program will prepare a summary of lessons learned of ARRA funded projects and provide as much cost benefit information that can be derived.

**Recommendation 4.3: EAC recommends that any existing inter-agency coordination around energy storage be made more transparent and that such coordination be augmented and strengthened in order to provide more coherent priorities around storage research, development, demonstration, and deployment and in order to better inform the development of national targets for energy storage on an ongoing basis.**

Improving coordination between the federal agencies actively developing energy storage is important in order to assure minimal overlap in research objectives and activities, and in order to facilitate the transfer of technologies as they evolve from early stage, fundamental science, to applied systems. Within DOE, there have been several efforts to develop an overall Department strategy on storage and coordinate activities. The 2013 DOE Energy Storage Strategy was developed with representatives of OE, ARPA-e, EERE, and Office of Science to outline the principle drivers for increased use of energy storage. Since the inception of ARPA-e, the OE and ARPA-e storage programs have held joint peer review meetings to facilitate coordination of efforts and exchange of technical information. The OE program is also involved in several DOD deployments of energy storage including the Base Camp Integration Lab (BCIL) where SNL is testing energy storage systems for inclusion in a microgrid configured Forward Operating Base. Opportunities to collaborate more fully among DOE Offices and with other Federal Agencies will be explored.

**Electricity Advisory Committee (EAC) Recommendations**
**Expanding and Modernizing the Electric Power Delivery System for the 21st Century**
**September 2014**

1. **Work with the industry to define the architecture of the next generation EMS and DMS and create standards that drive the implementation of an 'open systems architecture.'**

   DOE's Office of Energy Policy and Systems Analysis (EPSA), as part of its preparatory work for the QER, sponsored path-breaking work at PNNL on grid architecture questions, and other offices have participated actively in the review of successive drafts of PNNL's basic document. It is important to understand that PNNL is not trying to develop a prescriptive blueprint for the grid (or sections of it) – rather PNNL's work demonstrates a *method* for thinking systematically and rigorously about grid architecture questions, and for coping with the complexity of grid architecture as a subject. It has great potential value as a neutral mechanism for focusing discussions of grid architecture among diverse groups of stakeholders. EPSA, OE, EERE, and PNNL will collaborate in FY2015 to refine, extend, and apply PNNL's concepts through workshops and dialogues with utilities, regulators, and others.

2. **Fund a demonstration project that illustrates the efficiency gains from deployment of advanced power flow control technologies.**

   The Department recognizes the value that advanced power flow control technologies can provide to the grid through increased power transfer capabilities, improved voltage stability, and enhanced system stability. Currently, there are demonstrations with advanced power flow control technologies through ARPA-E's Green Electricity Network Integration (GENI) program to evaluate benefits. A project involving Smart Wire Grid (SWG) and their distributed flexible AC transmission system (FACTS) technology is on-going with the Tennessee Valley Authority (TVA). Another project is partnering with the Bonneville Power Administration (BPA) to demonstrate a magnetic amplifier concept that was developed by the Oak Ridge National Laboratories (ORNL).

   In its FY2016 budget request, DOE asked the Congress to appropriate funds for additional demonstration projects.

3. **Research and report on strategies to harden and make more resilient grid assets in response to credible potential threats, both natural and man-made. Work with other federal agencies to inventory and characterize vulnerabilities and lessons learned from microgrid development projects such as those being established by the Department of Defense.**

Re hardening grid assets and making them more resilient:

- After the Metcalf incident in California, DOE in cooperation with the utility as well as DHS and the FBI visited eight cities in the U.S. and two in Canada to make electricity companies aware of the possible threat and to inform them in classified briefings of what actually happened. Two "roadshow" sessions were held in Canadian cities.

- DOE is leading the development of a broad strategy on transformers for the White House and has met with utilities, utility trade groups, transformer manufacturers, and other federal agencies to develop an approach to enhance the security and resiliency of especially large transformers. The effort is led by Assistant Secretary Hoffman in close collaboration with other agencies including DHS, DOD, and FERC.

Re "work with other federal agencies to inventory and characterize vulnerabilities and lessons learned from microgrid development projects":

- OE has been working in a collaborative partnership with the Department of Defense (and others—National laboratories, DHS, and the private sector) to demonstrate and document lessons learned in the development and deployment of microgrids. Specifically the Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) program will demonstrate secure microgrid architecture with the ability to maintain operational surety through trusted, reliable, and resilient electric power generation and distribution at three distinct sites. An additional key element of SPIDERS is the standardization of microgrids to support future applications.

  The SPIDERS program includes a formal Transition Team whose primary function is to document and disseminate the results of the program. Products of the Transition Team include a Technology Transition Plan for each of the three sites which includes documentation of the process, lessons learned, etc. and will allow similar microgrids to be deployed at DOD facilities and in the private sector. It may also identify gaps in technologies and policies that can be addressed in joint initiatives/activities in the future. A Utility Assessment Report from each phase also documents results from each facility. In addition to documentation after each phase, an open industry day is held to disseminate results in a live forum.

4. **Identify and assess other strategies to assure the continued provision of critical social services when grid power is disrupted.**

The Energy System Predictive Capability subprogram of OE's Modeling and Analysis Division (EIMA) is funding a National Laboratory to examine the fragility risk of infrastructure to high impact, low frequency (i.e. extreme) events to system infrastructure. Current quantitative analysis methods focus on a top down approach for modeling and simulating risks to the system; the approach is to model the risk of each element of the system to the threat and determine the reliability of the connected system based upon the reliability of the system elements. The results from this work are expected sometime during Q3 of 2015.

DHS/FEMA is currently developing a Power Outage Incident Annex (POIA). The POIA is being developed by planners from FEMA's Response and Recovery Directorates in partnership with DOE as the Sector Specific Agency, and other Federal departments and agencies and will describe the processes and organizational constructs that the Federal government uses to respond to and recover from a major disruption in the nation's power system.

**5. A. Continue to prioritize and provide funding for research and development on variable resource integration and energy storage applications.**

**B. Collaborate with industry and university research efforts to identify, evaluate and promote the development of technology advancements and operational enhancements needed to lead toward the Integrated Grid.**

A. Integrating the unique characteristics of various distributed energy resources enables greater system flexibility and resiliency as more variable renewable resources are added to the system. A 2012 PNNL report[1] investigated the balancing services required to accommodate the increased system variability under a 2020 nationwide 20% renewables penetration scenario. Under this scenario, an additional 18 GW of intra-hour balancing capacity is required where the balancing capacity is provided by storage or other DER assets. Current OE efforts with California Energy Commission (CEC) and Southern California Electric (SCE) under the California Solar Initiative are focused on integrating storage into distribution systems having high solar PV penetration using GridLAB-D to evaluate integrated solutions in grid planning and analysis. In collaboration with WA State, the OE program is analyzing (3) MW scale energy storage systems under selected use cases including distribution level load shaping and Volt-VAR support. Under this collaboration, the OE storage program will develop an evaluation tool in which storage usage and value is co-optimized for various transmission, distribution, and microgrid applications. A project sponsored by BPA, PNNL, Energy Northwest and Powin Energy, field tested a Li-ion storage system sited at a wind farm, at a distribution substation, and at a solar PV facility, exploring the functional benefits of storage for a range of use cases. Furthermore, SNL is performing an analysis of the benefits of energy storage in the Hawaii Electric Company (HECO) grid to enable increased renewable generation, as well as improved grid reliability. Part of this analysis includes an assessment of different technologies for potential

deployment in HECO. In addition, SNL is collaborating with a number of organizations such as Natural Energy Laboratory of Hawaii Authority (NELHA), Los Alamos County, CEC, and Texas Tech University's (TTU) Scaled Wind Farm Technology (SWIFT) facility to provide optimization methodologies in technology selection, siting, and operation. Due to funding constraints in FY2015, plans for many similar energy storage application efforts have been deferred until FY2016.

[1]National Assessment of Energy Storage for Grid Balancing and Arbitrage, Phase II: WECC, ERCOT, EIC Volume 1: Technical Analysis

B. Much of the research done or planned by OE, and a substantial portion of the electricity-related research done by other DOE offices, is aimed at the "development of technology enhancements and operational enhancements needed to lead toward the Integrated Grid." (Note that DOE assumes its concept of Grid Modernization and EPRI's Integrated Grid concept are largely consistent, though not necessarily equivalent.) In addition, OE and EPSA have significant efforts under way to support the evolution of innovative policy and regulatory concepts needed to facilitate the development of a 21st century grid.

6. **As previously recommended by the DOE EAC the Department should to continue to work with regional and interconnection-wide planning and reliability entities such as RTOs, the Western Electricity Coordinating Council, Peak Reliability, and the Eastern Interconnection Planning Collaborative to take advantage of DOE research and development products as these entities develop planning tools and methods needed to reliably expand and modernize the 21st century grid.**

Eastern Interconnection:

- Both the Eastern Interconnection Planning collaborative (EIPC) and the Eastern Interconnection States Planning Council (EISPC) are using some of their remaining ARRA grants to study issues related to the growing linkages and interdependencies between the gas and electric infrastructures. EISPC's work products on this subject are now available, and EIPC's are emerging. EISPC has also issued recently several high-value papers prepared using ARRA funds, including a transmission planning primer and a study on resource adequacy requirements, and they are planning a study on probabilistic risk assessment in the electricity sector. EIPC has agreed to help make timely data available to DOE for its annual *Transmission Data Review* and its triennial congestion studies.

- EIPC's members have already decided to continue to fund the organization after the ARRA funds are fully spent, and EISPC is actively exploring options for long-term funding.

ERCOT:

- ERCOT recently produced its second Long Term System Assessment (December 2014). This plan featured a new stakeholder process that was created using the final portion of its ARRA grant. ERCOT plans to continue using the tools and techniques established under the interconnection wide planning process to produce an annual six year transmission plan and a biannual fifteen year long term system assessment.

- In addition, ERCOT and DOE have been working on a number of additional ways to improve specific elements of ERCOT's analytical capability. These are being funded through OE's state technical assistance program.

Western Interconnection:

- The Western Electricity Coordinating Council (WECC) has incorporated increases to their non-DOE budget to accommodate efforts started under the DOE ARRA interconnection grant, now that their DOE funding has ended. DOE will continue, on a case-by-case basis, post-ARRA interconnection-wide grant, to provide support to WECC on specific projects when requested. For example, DOE is funding a national lab to assist WECC with its own-funded assessment of impacts that could occur from additional shutdowns of western coal generation as a result of WECC's request for access to that lab's unique tools not available from the private sector.

- The Western Governors Association's (WGA) DOE interconnection-wide planning grant ended in April 2015. The funds were used both by the WGA, and by its subsidiary body, the Western Interstate Energy Board's State-Provincial Steering Committee (SPSC), so a two-part answer is provided below.

    - The last major WGA project under the DOE ARRA grant, a "RAPID" tool kit for transmission and other energy infrastructure siting, was released in August 2014. WGA itself did not ask for additional DOE support when its DOE grant when its DOE grant expired in April 2015. However, as it did prior to the ARRA, DOE will consider any future requests for funding support.

    - For the SPSC, post-ARRA grant funding will come from two sources:

      1) About 75% of its work is electricity reliability-related, and thus eligible for funding under a FERC-approved tariff that the Western Interstate

Energy Board's Western Interconnection Regional Advisory Body (WIRAB) retains;

2) The remaining roughly 25% of the SPSC's workload is not reliability-related, and funds for it may be sought on a case-by-case basis as was done prior to the DOE ARRA grant, either directly from DOE or through a DOE-funded contractor. DOE expects to continue providing support for selected SPSC projects, subject to future appropriations levels.

7. **Coordinate with abovementioned entities, ERCOT and FERC regional planning entities to ensure that emergent technology, grid coordination, and operational advancements are included in their regional and interregional planning efforts as required under FERC Order 1000 non-wires alternatives analysis and consideration.**

Obtaining full value from the planning processes established under Order 1000 is an important objective, but it will be a long-term undertaking. It appears that in reviewing the materials filed in response to Order 1000, the FERC staff have focused most on whether the planning processes were transparent and open to would-be participants, and how they dealt with cost allocation, both of which are high-priority concerns for FERC. Presumably the staff will address other aspects of the filings in due course.

After coordination with FERC staff, DOE intends to review and draw upon the filed materials as source documents for DOE's triennial national congestion studies; the next study will be initiated in 2015.

If its resources permit, DOE will undertake a broader review of the filings in response to Order 1000, again in coordination with FERC.

8. **Work with industry to support the development of guidelines and Interconnection standards (macro and micro level), both communications and full grid interaction ability of any device connected to the grid.**

OE is actively participating on an activity informally labeled "Grid 3.0" with NIST, FERC, EPRI and SGIP. The forum is developing a prioritized list of architecture, interoperability, standards and other actions that have the potential to accelerate and improve grid modernization activities. OE is also participating in the Smart Grid Interoperability Panel, both at the board level and in the cyber security and Open FMB efforts to improve communications and device connectivity. This aligns with the Quadrennial Energy Review regarding communications and interoperability.

9. **As the modernized grid will be needed to support greater integration of renewable generation, and national, environmental and economic goals, DOE should study the means to improve efficiency and reliability through strategic electrification of end uses, including thermal and transportation uses.**

DOE's Office of Vehicle Technologies (within the Office of Energy Efficiency and Renewable Energy) is working on several challenges related to the electrification of transportation, such as battery cost, performance, and working life; hybrid vehicle systems; power electronics for advanced electric drive vehicles; and advanced materials for vehicles. OE's collaboration with the Vehicle Technologies included successfully completing the development of smart grid-capable electric vehicle charging stations at home and at commercial facilities, which allow management of electric vehicle charging depending on electricity price signals and grid conditions.

The Department recognizes, however, that there are many other opportunities across the economy for strategic electrification. For example, OE also worked with experts representing the DOE's Office of Building Technologies (within the Office of Energy Efficiency and Renewable Energy) to complete a DC microgrid scoping study. The study identified a few advantageous applications for DC microgrids, including one for buildings with significant amounts of native DC loads and DC energy resources. In addition, DOE looks forward to pursuing strategic electrification as an important element in future collaborations with states and cities on integrated approaches to grid modernization. We will pursue it as opportunities arise in conversations with state and local officials.

## Electricity Advisory Committee (EAC) Recommendations
## Emerging and Alternative Regulatory Models and Modeling Tools to Assist in Analysis
## September 2014

This paper addresses the recommendations put forward by the Electricity Advisory Committee (EAC) on emerging and alternative regulatory models and modeling tools to assist in the analysis. The Department agrees that recent trends, such as the availability of digital technology, federal and state policies driving a shift to renewable and distributed energy resources, and the emergence of new market entrants (e.g., prosumers), are necessitating a need for information and tools that can help policymakers make prudent decisions regarding future grid designs and infrastructure investments.

The Department is currently undertaking many efforts that correlate with many of the EAC's recommendations and they are described in this response. However, the Department also recognizes that much work has yet to be accomplished to develop the requisite planning and analysis tools and underlying data. Future efforts will involve an inventory of current models, tools and information with an examination of how DOE might improve their availability. In addition, the Department will work with utilities, state and local governments, industry associations, and other stakeholders to identify gaps and determine how to best move forward.

The remainder of this paper provides a summary of DOE activities with respect to the various recommendations with comments on how the Department might best address them at this time.

**Recommendations 1, 3, 7, and 10: Provide technical assistance in the form of white papers, methods and tools to help regulators, policymakers and utilities examine emerging requirements and better evaluate distribution investments.**

> The DOE Office of Electricity Delivery and Energy Reliability (DOE OE) has traditionally provided technical assistance to regulators and other state officials in matters involving resource planning and regulation at the distribution and transmission system levels, although additional work is required to address new requirements. For example, in FY2014 and FY2015, Lawrence Berkeley National Laboratory (LBNL) and its subcontractors (e.g., the Regulatory Assistance Project) have provided technical assistance to seven state utility commissions (CA, HI, IL, MI, MN, NY, VT), four state energy offices or governors' offices (CT, MI, NH, RI), one regional energy organization (Western Interstate Energy Board) and two national stakeholder organizations (the National Governors Association and the National Association of State Consumer Advocates) in the areas of regulatory and retail market reforms, grid modernization, rate design, and financial modeling. This technical assistance has taken the form of presentations and briefings to policymakers and stakeholders, direct engagement with Commissions and their staff, as well as in-depth review of materials (e.g., orders, memos and

whitepapers) developed by these different organizations for their stakeholders. DOE OE plans to continue providing technical assistance in the coming fiscal year.

In FY2014, DOE OE also funded a multi-year project entitled "Future of Electric Utility Regulation" managed by LBNL, which has formed a Future Electric Utility Regulation Advisory Group comprised of state regulators, utility executives, key stakeholders and technical experts to provide guidance on a series of "concept papers" on alternative regulatory models that are targeted at policymakers, state regulators, the electric utility industry, customer groups and other key stakeholders. The objectives of the project are to advance the discussion on the future of cost-of-service regulation, explore and analyze incremental and more fundamental changes to utility regulation, and examine proposals for new utility business models, particularly in the face of increasing levels of distributed energy resources including energy efficiency, distributed generation, demand response and energy storage. These concept papers will be used by DOE OE as part of a targeted outreach effort including webinars and industry conferences and could also serve as background material for DOE-sponsored workshops to convene regional stakeholders to discuss actionable items and transition strategies.[1]

In addition, DOE's Office of Energy Policy and Systems Analysis (EPSA) commissioned a study in late-2014 with the Pacific Northwest National Laboratory (PNNL) to begin a process to develop organized views and insights about the existing U.S. grid as a means of identifying structural constraints to grid modernization. The process involves the application of grid architecture to enable planners to undertake a systems approach for examining relationships within and among the various structures, e.g., the business, market, regulatory, control, and coordination structures that make up the grid planning and operations framework. Applying a systems approach should provide insights on constraints and unintended consequences when considering new market and business structures associated with the integration of distributed energy resources that may be owned by consumers or third-party merchants. DOE OE is now working with the NY Public Services Commission to apply grid architecture to support the NY Reforming the Energy Vision (REV) discussion where new market and business models are being considered. DOE OE is also planning a series of regional workshops in 2015 to more fully vet architectural schemes that may better support the development of alternative regulatory models. The results of these efforts will be the development of tools and information to assist both utilities and regulators in designing advanced grids.

**Recommendation 2: Evaluation of EIA data.**

[1] In 1999, the DOE commissioned a technical review of electricity reliability under industry restructuring comprised of a series of white papers. See: http://certs.lbl.gov/pdf/certs-gotf-summary.pdf

In 2013, DOE OE worked closely with the Energy Information Administration (EIA) to revise the EIA Form 861 to better determine the extent to which smart grid technologies (e.g., smart meters and distribution automation technology) and practices (e.g., the application of time-varying rates) were being deployed within distribution circuits. In addition, DOE OE worked closely with LBNL to revise the EIA Form 861 to obtain a more consistent reporting of reliability indices (such as SAIDI and SAIFI). The results from the revised Form 861 survey was made available on February 27, 2015 and they are available on the EIA website[2]. DOE OE intends to report this information in the next version of the biennial Smart Grid Systems Report due in December 2016; however, the Department will consider preparing a whitepaper, including supporting independent analysis to describe the available data and options for its use by utilities and regulators. The options for a white paper may include an examination of trends in reliability performance over time to identify underlying drivers and, in particular, the effects of regulatory policies and utility investments/practices in seeking to improve reliability performance, as well as the adoption rates of smart grid technologies and practices.

**Recommendation 3: Development of distribution planning models and tools, performance and cost data and methodologies.**

DOE understands that new tools or enhancement to current tools, including the development of economic valuation and financial models, will be necessary for utilities, regulators and other stakeholders to develop investment plans that effectively account for the costs and benefits of the emerging digital technologies and distributed energy resources.

For several years, DOE has supported the development of tools to support grid planning and will continue to do so. For example, GridLAB-D™ is an open-source, simulation and analysis tool developed by PNNL to enable grid designers to understand and compare the effect of new technologies on distribution grid operations and to evaluate their potential benefits. PNNL continually incorporates new features and capabilities into the tool based upon input from the GridLAB-D user community. The System Advisor Model (SAM) developed at the National Renewable Energy Laboratory, Sandia National Laboratory, the University of Wisconsin and other organizations is a performance and financial model designed to facilitate decision making for people interested assessing renewable energy projects. The Financial Impacts of Distributed Energy Resources (FINDER) model developed at LBNL is a pro-forma financial tool which evaluates the impacts on utility costs, revenue, and profitability from increasing penetrations of a variety of different demand-side resource options under a variety of different utility business models and operating conditions. This tool has been directly used in technical assistance activities with several states (e.g., AZ, KS, MA, NV) over the

[2] See EIA website: http://www.eia.gov/electricity/data/eia861/index.html

past few years, while the research it enabled has been used to provide technical assistance in a variety of other situations (e.g., with the California Public Utilities Commission and the National Governors' Association).

DOE will continue to undertake its own efforts, as well as partner with other organizations, e.g., the Electric Power Research Institute (EPRI) and the National Rural Electric Cooperatives Association (NRECA), to support the development and dissemination of simulation models and tools. EPRI has developed the OpenDSS simulation tool which supports distribution system analysis. The Cooperative Research Network of NRECA is developing the Open Modeling Framework (OMF) that offers various DOE-developed tools and common data models with the goal of making advanced power systems models usable in the electric cooperative community.

**Recommendation 4: With industry, develop and make available additional data on the cost of outages and power quality events to customers, and update the ICE Calculator.**

In late FY2014, DOE OE tasked LBNL to work with the developer of the publicly available Interruption Cost Estimate (ICE) Calculator to update the tool through the addition of new utility-led value of loss load surveys not included in the original release. DOE understands that more representative and updated survey data developed by utilities is needed and will continue to work with the private sector to address this issue. Nevertheless, utilities are beginning to use the ICE Calculator and its underlying database to support their reliability planning efforts and its application has been reported in utility filings with regulatory commissions.

DOE OE intends to advance the concept of incorporating avoided customer and societal costs into reliability and resilience planning (value-based reliability planning) by working with these and other utilities that are interested applying such methods to determine strategies that can best allocate funding across investment options (e.g., hardening, smart grid deployments, the integration of distributed energy resources and microgrids) to achieve specific reliability and resilience objectives given constrained resources. As recommended by the National Research Council[3] and mandated by Executive Order 13653, DOE OE also intends to develop and make available data, information and tools that can support this type of decision-making within a risk-based framework.

In addition, the Department, in FY2015, has tasked LBNL to explore two options for addressing an important current limitation of the ICE Calculator, namely, the inability to provide reliable cost estimates for widespread and longer duration interruptions. The costs to customers and their communities that are imposed by

[3] See "Disaster Resilience – A National Perspective", The National Academy Press, Washington, DC, 2012

these interruptions cannot be addressed through utility surveys, alone. With respect to the first option, DOE OE is gathering perspectives and data from the insurance industry. Insurers have very explicit ways of defining outage-related events, and monetizing the impacts on their customers. The second option involves a review of the macroeconomic modeling literature. Here, the focus is on delineating the cost concepts that appear in the literature and their interrelations, and discussing how they are applied in different estimation approaches. Both scoping studies will be completed before summer 2015.

**Recommendation 5: Prepare an analysis of how to best remove market failures and barriers to enable efficient responses from smart devices.**

DOE has undertaken several efforts to examine mechanisms that would enable efficient, value-based interactions of smart devices with grid operations. For example, DOE OE has supported technical and policy-related research and technical assistance in the area of demand response, including making recommendations for achieving demand response benefits (e.g., see the 2006 Report to Congress[4]), examining customer-enabling technologies that facilitate responsive loads, conducting research and development on smart devices, supporting the development of smart grid interoperability standards, and supporting regional demand response collaboratives (e.g., with the Mid-Atlantic Distributed Resources Initiative and the Pacific Northwest Demand Response Project) that seek to identify and help mitigate barriers to demand response, as well as provide benefit-cost data and associated frameworks.[5]

In the Recovery Act funded projects, DOE OE examined and reported on the impact of in-home displays and programmable communicating thermostats to enable customers to better respond to variable rates. With respect to the application of customer data, the Green Button Initiative has been responsible for the adoption of a voluntary data standard to enable and incentivize software developers and entrepreneurial organizations to build applications, products and services that can help consumers better manage their electricity use.

In addition, work conducted by PNNL and Battelle Memorial Institute funded under the Recovery Act and in prior efforts has demonstrated the efficacy of applying incentive-signaling approaches to continuously coordinate the responses

[4] Report to Congress – "Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them", U.S. Department of Energy, February 2006, http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_Benefits_of_Demand_Response_in_Electricity_Markets_and_Recommendations_for_Achieving_Them_Report_to_Congress.pdf

[5] In 2009, the Pacific Northwest Demand Response Project developed "Guidelines for Cost-Effectiveness Valuation Framework for Demand Response Resources in the Pacific Northwest" which were submitted by the Northwest Power Planning Council in their regional power plan.

of smart grid assets to meet a wide range of operational objectives. Further work is needed in theory, modeling and simulation to assure the robustness of these approaches at scale along with deployments at scale. DOE OE proposed work in the FY2016 Congressional Budget Request to examine the coupling of market-based control signals involving the participation of customers and third-parties with electric distribution operations, generally known as transactive energy. The proposed effort includes developing simulation tools and test cases, including validating tools using the initial test cases that were developed under the Recovery Act projects. DOE OE will continue to inform decision-makers about this effort and similar efforts involving the valuation of distributed technologies and grid services through its technical assistance efforts with State programs.

Also, the GridWise® Architecture Council has created a "Transactive Energy Framework[6]" to establish common language and understanding of transactive systems. This work is helping to drive consideration of requirements for standards, for example by the Smart Grid Interoperability Panel, and is also being extended to help regulators, policy makers and executives through development of a "Transactive Energy Decision Maker's Checklist."

Regarding common approaches for communicating with smart devices, the DOE EERE Buildings Technology Program is undertaking an effort, working with industry, to develop a voluntary standard for characterizing the energy flexibility capabilities and performance of "connected" (smart) equipment in buildings. This will provide a uniform basis for manufacturers to validate the capabilities of such equipment to utilities, building owners, and consumers. It is intended to support the development of the market for such equipment and appliances by allowing, for example, utilities to offer rebates or coupons to consumers to offset marginal costs of purchasing equipment that is more capable of offering grid services. A related Buildings Technology activity is developing industry alignment on approaches to advance interoperability of connected equipment and building automation systems so that these technology investments can be integrated more simply and reliably. The results aim to improve overall buildings performance for their owners and occupants, as well as to offer energy consumption flexibility for the mutual benefit of grid and building operations.

Furthermore, the time and effort to achieve interoperability today is a key barrier to the utilization of smart devices of all sorts. The high costs of specialized integration and testing, the plethora of interfaces and information technology approaches, and the inability of products from different solution providers to easily work together spoil the business propositions that encourage viable markets and paths for deployment. To address this, DOE continues its support of the smart grid interoperability mission of the Smart Grid Interoperability Panel (SGIP).

[6] See: http://www.gridwiseac.org/pdfs/te_framework_report_pnnl-22946.pdf

Working with NIST, DOE, and industry partners, the SGIP has been instrumental in standards and testing advances that contributed to the Green Button, OpenADR, and SEP2.0 standards, to name a few. More effort is underway to bring cybersecurity tools and best practices into the deployment culture of electricity service and technology providers. A recently launched effort, the Open Field Message Bus (OpenFMB) project, is bringing utilities together around modern information and communication technologies, standards, and best practices related to messaging, information modeling, and business processes that will support their ability to more readily integrate distribution automation equipment and distributed energy resources (including distributed generation, storage, and flexible load).

**Recommendation 6: Facilitate improved evaluation of volt-var optimization to unleash predicted benefits from full-scale deployment.**

Utilities are increasingly deploying voltage/VAR optimization (VVO) technology, including for conservation voltage reduction (CVR) purposes, however, DOE OE agrees that additional information and tools are required to gain greater adoption of the practice of VVO (and CVR) throughout the industry. Standard methods are needed that enable effective evaluation of VVO/CVR by regulators and regulatory mechanisms and incentives that can address cost and revenue recovery issues should be elucidated. DOE is completing a study that has examined forty-one projects where VVO has been implemented. The study effort has involved the development of a database and reports on VVO performance, factors that influenced VVO implementation, and institutional barriers. It has also resulted in the formation of an ad-hoc industry group.

Much of the knowledge on the application of VVO/CVR, its performance and the institutional factors required to permit full-scale deployment resides with the many utilities which have tested and deployed the technology. Given this, DOE plans to work with industry associations that can more effectively support the needed information exchange among utilities to address the matters of cost/benefit data and tools for measurement and verification and planning. Potential industry associations include the Institute of Electrical and Electronics Engineers (IEEE) and the Electric Power Research Institute (EPRI).

**Recommendation 8: Make available objective information on social costs to support the evaluation of performance metrics and alternative regulatory or business models.**

As indicated above, DOE OE is developing data and information to support reliability and resilience planning that applies the avoided societal costs in the calculation of benefits. Specifically, DOE OE is gathering additional data on what customers would pay to avoid an outage (or their estimated costs from outages) from surveys conducted by utilities, as well as documenting case studies on how

utilities have applied this information to support their investments for improving reliability and resilience. This information, including methodology and tools (such as the ICE Calculator), will be made available on a DOE website.

Also, DOE OE has recently undertaken an effort to develop a tool to be made freely available on the web that will enable users (e.g., utilities, public service commissions, and stakeholders) to prospectively estimate the environmental benefits of a wide range of smart grid projects. The effort will leverage power plant emissions data on a region-by-region basis. A heuristic set of questions will prompt the user to provide key parameters describing their project's scope in terms of magnitude, location, and technology type. A standardized method for converting these parameters into engineering impacts such as changed load shapes and reduced truck rolls will be provided. The changed load shape data will then be combined with the power plant dispatch and emissions profiles to produce the power plant impacts. Simple assumptions about fuel efficiencies for trucks associated with outage restoration and for vehicles used for meter reading and service connections/disconnections will also be included.

**Recommendation 9: Prepare a whitepaper on options for advancing energy innovation, including through state and regionally based institutions**

Currently, DOE advances technology and capabilities for the electric industry through funds provided to the national laboratories, industry and academia, including supporting innovative product development via the Advanced Research Projects Agency – Energy (ARPA-E). DOE also collaborates with such organizations as EPRI, NRECA and the National Association of Regulatory Utility Commissioners (NARUC) to advance technology, information and evaluation methodologies. We appreciate the recommendation and will consider developing a whitepaper for advancing energy innovation as funding allows.

## Electricity Advisory Committee (EAC) Recommendations
## Status and EAC Recommendations for Electricity Delivery Workforce
## September 2014

**DOE create a response to the October 2012 paper and the October 2013 memo providing an update on the recommendations.**

This paper shall serve as a response to the October 2012 and October 2013 memo.

1. **OE should take the lead to coordinate power and energy workforce activity across federal departments including, though not limited to DOE, NSF, Department of Education, and Department of Labor.**

   OE understands the need to coordinate power and energy workforce activities across the Federal agencies. Currently, OE does not have the authority to acquire such a role, but will continue to coordinate and leverage resources within the Department to increase leadership and participation in the power and energy workforce activities internally and across Federal agencies. OE continues to have strong engagement with the Department of Energy's newly formed Job Strategy Council, which is focused on accelerating job growth in the energy sector, increasing key partnerships, and strengthening the energy workforce. This Job Strategy Council works with both industry and federal partners.

2. **Provide resources for OE to take a lead workforce coordinating role.**

   OE is currently exploring opportunities to expand leadership in the workforce subject area. Particularly, OE is working with the newly formed DOE Jobs Strategy Council to not only identify opportunities for job growth in the energy sector but to also identify more pathways for skilled individuals to be matched with potential career opportunities. Additionally the Job Strategy Council has partnered with the Joining Forces White House Initiative to support and strengthen engagement with veterans in the energy sector OE's involvement in the Jobs Strategy Council has led to the formation of the Utility Industry Workforce Council in March 2015. Participants include both industry and federal partners. OE is also continuing to coordinate with internal DOE program offices to develop combined workforce materials where appropriate.

3. **Inventory existing programs across federal agencies that provide material and resources for the private power and energy industry sector.**

   OE continues to investigate opportunities to enhance visibility of the power and energy sector workforce across federal agencies. OE is currently investigating opportunities to post appropriate workforce curriculum on the existing repositories of our federal partners so as to ensure the presence of power industry materials amongst other federal sponsored educational materials.

4. **Define and create a portal to be used as a repository for workforce materials across federal agencies that includes content and curriculum from the ARRA workforce training grants.**

   OE will encourage grantees to submit their workforce materials so that they can be publically posted on smartgrid.gov. Additionally, OE is investigating other strategic opportunities and platforms to build upon the workforce materials submitted by recipients. OE is currently working with internal DOE program offices to compile and raise the visibility of workforce programs across DOE including OE's ARRA funded projects.

5. **Develop a division of responsibility that clarifies ownership and accountability across federal agencies for various aspects of workforce development programs to address power and energy needs. This is needed to coordinate activity and make goals and objectives actionable.**

   OE will engage with the Interagency Working Group on Undergraduate STEM Education to ensure that smart grid workforce is an area that is being addressed across federal agencies. This working group group consists of: Department of Agriculture, Department of Commerce, Department of Defense, Department of Education, Department of Energy, Department of Health and Human Services, Department of the Interior, Department of Transportation, Environmental Protection Agency (EPA), National Space and Aeronautics Association (NASA), and the Smithsonian Institution.

6. **DOE OE completes the final report assembling information and findings from ARRA Smart Grid Workforce Training Grants and makes it generally available.**

   OE is currently compiling the final report from the finding on the ARRA Smart Grid Workforce Training Grants. The final report is anticipated to be posted on the DOE-OE website as well as on SmartGrid.gov by September 2015. As of January 2015, more than 38,000 people have been trained through the SGIG investment grants.