STATEMENT OF
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BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

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Thank you Mr. Chairman and members of the Subcommittee for the opportunity to provide an update on the current status of smart grid activities at the Department of Energy as well as our future directions and priorities.

The Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (Recovery Act) expand the role of the Federal Government substantially in research, development, demonstration, and deployment of smart grid technologies, tools, and techniques. To fulfill this role, the U.S. Department of Energy (DOE) and the Office of Electricity Delivery and Energy Reliability (OE) are carrying out smart grid activities in three primary areas: (1) Smart Grid Investment Grants, (2) Smart Grid Demonstrations, and (3) Smart Grid Research and Development (R&D).

One of our top priorities is to responsibly disburse funds made available under the Recovery Act to develop and deploy smart grid technologies designed to modernize the Nation's electric system. On June 25, 2009 we released two Funding Opportunity Announcements (FOAs) – one for Smart Grid Investment Grants and the second for Smart Grid Demonstrations. We are expecting to evaluate hundreds of applications over the coming months and to make awards for projects that will show the benefits of a more modern grid that uses smart grid technologies, tools, and techniques for the betterment of electricity consumers across America. We expect this funding to spark innovation, create businesses, and provide new jobs for American workers. We believe these programs represent a "once-in-a-generation" chance for game-changing investments and we are dedicated to making sure that American taxpayers get maximum value from these investments in terms of a more reliable, secure, efficient, affordable, and clean electric system.

While these programs are about transforming the delivery and management of electric power through application of **today's** smart grid technologies, tools, and techniques (such as phasor measurement units and advanced metering infrastructure), we are simultaneously working on "next generation" systems for expanding the capacity and increasing the flexibility and functionality of electric transmission and distribution systems. Our fiscal year 2010 budget request for smart grid and related R&D is aimed at harnessing the Nation's scientific and engineering talent in electric systems and focusing it on discovery and innovation for new materials, algorithms, concepts, and prototypes for power lines, substations, transformer banks, feeder lines, storage systems, and switchgear to increase efficiency, reliability, security, resiliency, functionality, throughput, and energy density while reducing costs, footprint, and environmental impacts.

Smart Grid Performance Metrics and Trends

Section 1302 of Title XIII of the Energy Independence and Security Act of 2007 directed the Secretary of Energy to "…report to Congress concerning the status of smart grid deployments nationwide and any regulatory or government barriers to continued deployment." This week the Department of Energy released the Smart Grid Systems report. The report finds that while many smart grid capabilities are emerging, penetration levels for substation automation, smart metering, and distributed generation technologies are growing significantly.

A part of the vision of a smart grid is its ability to enable informed participation by customers, making them an integral part of the electric power system. With bi-directional flows of energy and coordination through communication mechanisms, a smart grid should help balance supply and demand and enhance reliability by modifying the manner in which customers use and purchase electricity. These modifications can be the result of consumer choices that motivate shifting patterns of behavior and consumption. These choices involve new technologies, new information regarding electricity use, and new pricing and incentive programs.

Supporting the bi-directional flow of information and energy is a foundation for enabling participation by consumer resources. Advanced metering infrastructure (AMI) is receiving the most attention in terms of planning and investment. Currently AMI comprises about 4.7% of all electric meters and their use for demand response is growing. Approximately 52 million meters are projected to be installed by 2012. As many service areas do not yet have demand response signals available, a significant number of the meters installed are estimated not being used for demand response activities. Pricing signals can provide valuable information for consumers (and the automation systems that reflect their preferences) to decide on how to react to grid conditions. A Federal Energy Regulatory Commission (FERC) study found that in 2008 slightly over 1% of all customers received a dynamic pricing tariff, with nearly the entire amount represented by time-of-use tariffs (energy price changes at fixed times of the day). Lastly, the amount of load participating based on grid conditions is beginning to show a shift from traditional interruptible demand at industrial plants toward demand-response programs that either allow an energy-service provider to perform direct load control or provide financial incentives for customer-responsive demand at homes and businesses.

Distributed energy resources and interconnection standards to accommodate generation capacity appear to be moving in positive directions. Accommodating a large number of disparate generation and storage resources requires anticipation of intermittency and unavailability, while balancing costs, reliability, and environmental emissions. Distributed generation (carbon-based and renewable) and storage deployments, although a small fraction (1.6%) of total summer peak, appear to be increasing rapidly. In addition, 31 states have interconnection standards in place, with 11 states progressing toward a standard, one state with some elements in place, and only 8 states with none.

Gross annual measures of operating efficiency have been improving slightly as energy lost in generation dropped 0.6 % to 67.7% in 2007 and transmission and distribution losses also improved slightly. The summer peak capacity factor declined slightly to 80.8% while overall annual average capacity factor is projected to increase slightly to 46.5%. Contributions to these measures include smart grid related technology, such as substation automation deployments. While transmission substations have considerable instrumentation and coordination, the value proposition for distribution-substation automation is now receiving more attention. Presently about 31% of substations have some form of automation, with the number expected to rise to 40% by 2010. The deployment of dynamic line rating technology is also expected to increase asset utilization and operating efficiency; however, implementations thus far have had very limited penetration levels.

The Smart Grid Investment Grant Program

The overall purpose of the Smart Grid Investment Grant Program (SGIG) is to accelerate the modernization of the Nation's electric transmission and distribution systems and promote investments in smart grid technologies, tools, and techniques to increase flexibility, functionality, interoperability, cyber security, situational awareness, resiliency, and operational efficiency.

The goals of the program involve accelerating progress toward a modern grid that provides the following specific characteristics that DOE believes define what a smart grid would accomplish:

- Enabling informed participation by consumers in retail and wholesale electricity markets.
- Accommodating all types of central and distributed electric generation and storage options.
- Enabling new products, services, and markets.
- Providing for power quality for a range of needs by all types of consumers.
- Optimizing asset utilization and operating efficiency of the electric power system.
- Anticipating and responding to system disturbances.
- Operating resiliently to attacks and natural disasters.

The SGIG FOA issued on June 25th calls for the submission of project applications in three phases. Phase I applications are due August 6, 2009; Phase II applications are due November 4, 2009; and Phase III applications are due March 3, 2010. We expect to make Phase I selections in September 2009.

There is approximately $3.4 billion available for this solicitation for projects in two categories:

- Smaller projects in which the Federal share would be in the range of $300,000 to $20,000,000.
- Larger projects in which the Federal cost share would be in the range of $20,000,000 to $200,000,000.

We expect about 60% of the funds will be allocated to larger projects and about 40% for smaller projects. The period of performance for awarded projects is three years, or less.

Project applications will be considered in six topic areas:

- Equipment manufacturing,
- Customer systems,
- Advanced metering infrastructure,
- Electric distribution systems,
- Electric transmission systems, and
- Integrated and/or crosscutting systems.

A technical merit review of the applications will be conducted by our own staff plus experts from colleges, universities, national laboratories, and the private sector. Reviewers will be subject to non-disclosure and conflict of interest agreements and will apply the following technical merit review criteria:

- The adequacy of the technical approach for enabling smart grid functions;
- The adequacy of the plan for project tasks, schedule, management, qualifications, and risks;
- The adequacy of the technical approach for addressing interoperability and cyber security, and
- The adequacy of the plan for data collection and analysis of project costs and benefits.

The Smart Grid Demonstration Program

The overall purpose of the Smart Grid Demonstrations Program (SGDP) is to demonstrate how a suite of existing and emerging smart grid technologies can be innovatively applied and integrated to investigate technical, operational, and business-model feasibility. The aim is to demonstrate new and more cost-effective smart grid technologies, tools, techniques, and system configurations that significantly improve upon the ones that are either in common practice today or are likely to be proposed in the Smart Grid Investment Grant Program.

The SGDP FOA was also released on June 25th and calls for applications to be submitted by August 26, 2009 in two areas of interest:

- Regional demonstrations, and
- Grid-scale energy storage demonstrations.

The regional demonstration area covers projects involving electric system coordination areas, distributed energy resources, transmission and distribution infrastructure, and information networks and finance. The grid-scale energy storage demonstration area covers battery storage for load shifting or wind farm diurnal operations, frequency regulation ancillary services, distributed energy storage for grid support, compressed air energy storage, and demonstration of promising energy storage technologies and advanced concepts.

Approximately $615 million is available for awards with 8-12 regional demonstration projects and 12-19 energy storage projects expected. The period of performance for awards is three to five years.

Interoperability and Cyber Security

A key aspect for the implementation of smart grid technologies, tools, and techniques nationwide is the need to address interoperability and cyber security. Development of industry-based standards for governing how the many different devices involved in smart grid can communicate and interoperate with each other in a seamless, efficient, and secure manner is one of the top priorities for OE and other Federal and state agencies. Since the smart grid vision involves the two-way flow of both information and electric power, and for higher degrees of automation and control than exist in today's electric transmission and distribution system, it is necessary for there to be standards that guide manufacturers and smart grid developers, foster innovation, and provide for a platform that enables a wide range of offerings to come to market and have the opportunity to compete. As occurred with telecommunications and the evolution of the Internet, effective standards form the basis upon which entrepreneurs can bring innovations to the marketplace, build new businesses, and create job opportunities.

At the same time, it is paramount that smart grid devices and interoperability standards include protections against cyber intrusions and have systems that are designed from the start (not patches added on) that prevent hackers from disrupting grid operations from gaining entry through the millions of new portals created by the deployment of smart grid technologies, tools, and techniques.

Through the Federal Smart Grid Task Force, we are collaborating with the National Institute of Standards and Technology (NIST) and other agencies and organizations in the development of a framework and roadmap for interoperability standards, as called for in EISA Section 1305. Cyber security is a critical element of these efforts. Our collaboration with NIST includes financial assistance involving $10 million of Recovery Act funding that was designated to support the development and implementation of interoperability standards.

As a demonstration that the DOE is working to eliminate cyber security risks, the following language is part of the smart grid FOAs:

Cyber security should be addressed in every phase of the engineering lifecycle of the project, including design and procurement, installation and commissioning, and the ability to provide ongoing maintenance and support. Cyber security solutions should be comprehensive and capable of being extended or upgraded in response to changes to the threat or technological environment. The technical approach to cyber security should include:

- A summary of the cyber security risks and how they will be mitigated at each stage of the lifecycle (focusing on vulnerabilities and impact).

- A summary of the cyber security criteria utilized for vendor and device selection.

- A summary of the relevant cyber security standards and/or best practices that will be followed.

- A summary of how the project will support emerging smart grid cyber security standards.

DOE intends to work with those selected for award but may decide not to make an award to an otherwise meritorious application if that applicant cannot provide reasonable assurance that their cyber security will provide protection against broad-based systemic failures in the electric grid in the event of a cyber security breach.

The following technical merit review criteria will be used in the evaluation of applications and in the determination of the SGIG project awards. The relative importance of the four criteria is provided in percentages in parentheses.

1. Adequacy of the Technical Approach for Enabling Smart Grid Functions (40%)

2. Adequacy of the Plan for Project Tasks, Schedule, Management, Qualifications, and Risks (25%)

3. Adequacy of the Technical Approach for Addressing Interoperability and Cyber Security (20%)

4. Adequacy of the Plan for Data Collection and Analysis of Project Costs and Benefits (15%)

Smart Grid Research and Development

OE's fiscal year 2010 budget request contains a new line item to support a suite of activities to develop the next generation of smart grid technologies, tools, and techniques. While the FOAs are intended to accelerate existing systems, the R&D activities are aimed at new inventions, discoveries, and technology advances. We view grid modernization as a multi-decade process based on private sector investments and business innovations across a variety of markets and applications. This will be a highly dynamic process and will require agility and flexibility in the way OE manages its activities. There is direct linkage between the FOAs and the R&D, as lessons learned during implementation will generate use cases, best practices, and experience that will guide R&D directions and priorities.

Smart grid R&D priorities for fiscal year 2010 include:

- Integrated communications,
- Advanced components,
- Advanced control methods,
- Sensing and measurement,

- Improved interfaces and decision support, and
- Grid materials research.

Integrated communications involves projects to create an open architecture and support interoperability for a “plug&play” smart grid environment. Advanced components include projects to develop power electronics devices for high-voltage energy conversion and flow control. Advanced control methods includes projects to provide operating and control solutions for integrating renewable and distributed energy systems into the electric transmission and distribution system, including plug-in electric vehicles. Sensing and measurement includes projects for advanced devices to evaluate system conditions and feed back such information to both grid operators and consumers for optimized operations and controls. Improved interfaces and decision support includes projects to develop tools for grid operators and consumers to use information streams from smart grid devices for real-time decision making and diagnostics. Grid materials research includes projects to explore advanced materials for conductors, insulators, power electronics devices, and other equipment that involve materials that change shape or functionality in response to external conditions where new qualities and performance features will be needed when those devices operate in a smart grid environment.

Another R&D priority for 2010, and one that is closely related to and coordinated with our work in smart grid R&D, involves Clean Energy Transmission and Reliability and projects involving the deployment of Phasor Measurement Units (PMUs). OE leadership has been instrumental in the development and deployment of this technology and in the formation of the North American SyncroPhasor Initiative (NASPI), which involves OE collaboration with the Nation’s leading electric utilities, power transmission companies, independent system operators, universities, national laboratories, and the North American Electric Reliability Corporation. The NASPI mission is to improve power system reliability and visibility through wide area measurement and control. Synchrophasors are precise grid measurements now available from monitors called phasor measurement units (PMUs). PMU measurements are taken at high speed (typically 30 observations per second – compared to one every 4 seconds using conventional technology). Each measurement is time-stamped according to a common time reference. Time stamping allows synchrophasors from different utilities to be time-aligned (or “synchronized”) and combined together providing a precise and comprehensive view of the entire interconnection. Synchrophasors are providing greater insight into system operating conditions and hold the promise to enable a better indication of grid stress. An important goal is the use of PMU-derived information to trigger corrective actions that maintains reliable system operation.

A map of PMU installations shows growing numbers across North America including the Eastern Interconnection, Western Interconnection, and the ERCOT Interconnection (which comprises most of Texas). Devices called phasor data concentrators aggregate PMU data for use by system operators for wide area visibility and measurements. There are significant computational challenges in organizing and analyzing phasor data and in developing models and analysis tools for grid operators and visualization and decision making support. Such models and tools are essential for making key system-level improvements, including:

- Wide-area, real-time interconnection monitoring, visualization, and situational awareness of precursors of grid stress e.g., phase angles, damping,
- Monitoring of key metrics and compliance with reliability standards,
- Translation of data and metrics into information dashboards for operator action,
- Model validation (e.g., dynamic models, load models),
- Event analysis of root causes and forensics,
- Small signal stability monitoring and oscillation detection,
- Automated control actions – smart switchable networks,
- Definition of "edge" and reliability margins for real-time dynamic system management, and
- Computation of sensitivities and analysis of contingencies

OE priorities in this area for fiscal year 2010 include development of prototype small signal monitoring tools for damping of characteristic grid oscillations, development of dynamics analysis capabilities for PMU-based networks, development of advanced visualization and decision making tools, assess possible PMU installations to monitor dynamics from wind and other variable sources of renewable generation, research in new algorithms and computational methods for solving complex power system problems, and assessments of human factors requirements for grid operators using operational simulations and scenario-based assessments.

Conclusion

OE's smart grid activities are among our top priorities and crosscut virtually everything we do in electricity delivery and energy reliability. Our immediate attention is on the successful implementation of the two Recovery Act programs in smart grid investment grants and demonstrations. At the same time we are moving forward on smart grid R&D to accelerate development of the next generation of smart grid technologies, tools, and techniques. All of these efforts are aimed at modernizing the North American electric grid. We believe that grid modernization is paramount for achieving national energy, environmental, and economic goals for reductions in oil consumption and carbon emissions, as well as creation of new businesses and jobs for American workers.

This concludes my statement, Mr. Chairman. Thank you for the opportunity to testify. I look forward to answering any questions you and your colleagues may have.

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Patricia Hoffman is the Principal Deputy Assistant Secretary for the Office of Electricity Delivery and Energy Reliability at the U.S. Department of Energy. The Office of Electricity Delivery and Energy Reliability leads the Department of Energy's (DOE) efforts to modernize the electric grid through the development and implementation of national policy pertaining to electric grid reliability and the management of research, development, and demonstration activities for "next generation" electric grid infrastructure technologies.

Hoffman is responsible for developing and implementing a long-term research strategy for modernizing and improving the resiliency of the electric grid. Hoffman directs research on visualization and controls, energy storage and power electronics, high temperature superconductivity and renewable/distributed systems integration. She also oversees the business management of the office including human resources, budget development, financial execution, and performance management. Before joining the Office of Electricity Delivery and Energy Reliability, Hoffman was the Program Director for the Federal Energy Management Program which implements efficiency measures in the federal sector and the Program Manager for the Distributed Energy Program that developed advanced natural gas power generation and combined heat and power systems. She also managed the Advanced Turbine System program resulting in a high-efficiency industrial gas turbine product. Hoffman holds a Bachelor of Science and a Master of Science in Ceramic Science and Engineering from Penn State University.