

SMART GRID INITIATIVES AND TECHNOLOGIES

HEARING BEFORE THE COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

TO

EXAMINE THE PROGRESS ON SMART GRID INITIATIVES AUTHORIZED IN
THE ENERGY INDEPENDENCE AND SECURITY ACT OF 2007, AND
FUNDED IN THE STIMULUS BILL, AND TO LEARN OF OPPORTUNITIES
AND IMPEDIMENTS TO TIMELY INSTALLATION OF SMART GRID TECH-
NOLOGIES

MARCH 3, 2009



Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

48-648 PDF

WASHINGTON : 2009

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512-1800; DC area (202) 512-1800
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SMART GRID INITIATIVES AND TECHNOLOGIES

TUESDAY, MARCH 3, 2009

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The Committee met, pursuant to notice, at 10:04 a.m. in room SD-106, Dirksen Senate Office Building, Hon. Jeff Bingaman, Chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. OK, why don't we get started.

This morning's hearing is on a topic that most of us had not even heard of a few years ago, but today is widely discussed here in Washington and around the country, and that is the smart grid.

Briefly understood, this phrase refers to the digitization of the transmission and delivery systems for electricity in order to make maximum use of modern technologies. We're told that smart grid technologies can make the transmission system more efficient, reducing line loss, reducing congestion, which cause higher costs. We're also told that it can make the transmission distribution systems more reliable by allowing quicker response to failures in the event of emergencies. Further, the customers can take advantage of computerized meters and appliances to reduce demand at peak hours through shifting load to off-peak hours. This reduces the need for peak generation, reducing emissions and lowering costs.

In 2007, we initiated a number of programs to further the digitization of the grid. In the Energy Independence and Security Act that President Bush signed in December 2007, we required the Department of Energy to form a Smart Grid Task Force to track developments and advance this program. We required the National Institute of Standards and Technology, in cooperation with the Department of Energy and the Federal Energy Regulatory Commission, to head up an effort to develop an interoperability framework to establish uniform standards for these technologies.

We also authorized a grant program for demonstration projects to better understand the potential for smart grid benefits and to come to understand the problems that might attend actual installation on a commercial scale. We authorized a grant program for investments in the installation, development, and manufacture of these technologies.

In the American Recovery and Reinvestment Act, just passed 2 weeks ago, we funded these grant programs. Witnesses are here

today to report on the progress thus far in implementing these programs. Government witnesses are able to testify as to the steps taken to get the interoperability framework underway, as well as how the funding for the grant programs is being prioritized and administered. Industry witnesses can give their perspectives on these same programs. We're anxious to know whether or not we have gotten it right, as far as the structure of the programs go, and whether there are additional actions we need to take to move the country to a smart grid.

Let me call on Senator Murkowski for any comments she has.
[The prepared statement of Senator Mark Udall follows:]

PREPARED STATEMENT OF HON. MARK UDALL, U.S. SENATOR FROM COLORADO

Thank you, Mr. Chairman, for today's hearing on smart grid technology.

Smart grid technology will play a critical role in making all Americans smarter and better informed about how we use our energy. By providing up-to-the minute information about how much energy each individual is using and conveying the price at that moment for that energy, this technology allows consumers to be the ultimate decisionmakers about their energy use.

We are not there quite yet. There is much more to accomplish regarding smart grid technology as well as the regulations and policies that govern how energy information is available to consumers. But with this hearing and a growing national awareness, we are on the right track.

Specifically, I believe that if we have the right partnership of government, NGO's and businesses, we can promote and embrace current energy efficient technology, and also spur the development of new advances that will save future generations even more.

Colorado is already leading the way with such a partnership through SmartGridCity.

Xcel Energy, local government officials, and many others transformed Boulder, Colorado into a community of the future. Some Boulder residents can now program their dishwashers to start when energy prices are low from their blackberries. Or use energy stored in a hybrid car battery to wash clothes.

One important point to emphasize about the SmartGridCity is that the Federal Government has not contributed to the approximately \$100 million cost. The fact that private, profit-driven companies put so much money toward this experiment shows just how promising this technology is.

Smart grid is the future and the program in Boulder demonstrates daily how much potential this technology has. We need SmartGrid Cities in every state across the U.S. Today's hearing will help us get there. I look forward to hearing from the witnesses and would like to thank them for being here today.

**STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR
FROM ALASKA**

Senator MURKOWSKI. Thank you, Mr. Chairman. Thank you for convening this hearing. You put us in a bigger room to accommodate all those that are so interested in what we're discussing this morning: the smart grid.

Smart grid, like shovel-ready and green jobs, is what everyone's talking about nowadays. I think that that's a good thing, but I think we need to ask the question, Are we all talking about the same thing? Some appear to confuse the idea of making our electrical grid smarter with making it bigger. We know that smart grid is not the buildout of miles and miles of high-voltage transmission lines; instead, it's—what we're really talking about is a potential transformation in how we use and deliver electricity.

As you note, Mr. Chairman, we saw this potential, back in 2007, with passage of the smart grid provisions in the Energy Independence and Security Act. In that bill we recognized that our national

security efforts must include the modernization of the nation's electrical infrastructure. Senator Cantwell worked very hard on this and was a real leader in it.

The promises of a smarter grid are many. Consumers will be able to monitor in real time the amount, price, and even source of the electricity that they consume. Discussion about, you know, your dishwasher being smarter than you are, in terms of when it's going to run and how much energy it will consume. Plug-in hybrid vehicles will be able to store electricity, and a more flexible network should be better able to handle the intermittent nature of renewable resources. Utilities will be able to locate, isolate, and restore power outages more quickly.

At the same time, we recognize that a smarter grid poses some new challenges. There are several. The lack of an interoperability framework. It was just last week that Secretary of Energy Chu cited the lack of standards and protocols necessary to allow different systems to communicate with one another as the biggest roadblock in the advancement of smart grid technology.

Another issue is cyber-security. Smart grid technologies are supposed to result in a more reliable and secure grid, but if cyber-security issues are not addressed, we could be making ourselves, perhaps, more vulnerable to cyber-attacks.

Then, there's also the issue about public acceptance. Is the average consumer willing to pay the up-front costs of a new system, and then respond appropriately to the price signals? Or, you know, if people are told, or understand, that a utility may be able to reach inside their home to turn down a thermostat, is that just too much? Is that just a place where people are not ready to go?

Now, as we all know, the stimulus bill provided \$4.5 billion in funding for smart grid activities. I will tell you, Mr. Chairman, I'm concerned with our government's ability to process this unprecedented amount of money in a meaningful way. How can this funding best be allocated to advance our smart grid technologies?

Without an interoperability framework in place before these funds are expended, do we risk making investments in technology that may perhaps become obsolete?

I want to thank the witnesses on this first panel, and on the second, as well. Look forward to your testimony and getting your thoughts on the issues that I have outlined.

Thank you, Mr. Chairman.

[The prepared statement of Senator Murkowski follows:]

PREPARED STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Good morning. Thank you all for being here today. And thank you to Chairman Bingaman for convening this hearing on the timely topic of Smart Grid.

The term "Smart Grid," like "shovel ready" and "green jobs" is now part of our lexicon. Millions of people saw GE's Smart Grid commercial during the Superbowl. It seems like everyone is talking about Smart Grid these days.

But are we all talking about the same thing? Some appear to confuse the idea of making our electrical grid "smarter" with making it "bigger." Smart Grid is not the build out of miles and miles of high voltage transmission line. Instead, what we're really talking about is a potential transformation in how we use and deliver electricity.

Congress saw this potential back in 2007 with passage of the Smart Grid provisions in Title XIII of the Energy Independence and Security Act. In that bill, we recognized that our national security efforts must include the modernization of the

nation's electrical infrastructure. [I see the Senator from Washington is here today. I know this is an issue Senator Cantwell has worked very hard on and I'd like to thank her for her efforts].

NOTE: Washington state is home to Itron, a Smart Meter manufacturer and Schweitzer Engineering Labs, which makes digital relay switching devices.

The promises of a smarter grid are many:

- consumers will be able to monitor in real time the amount, price, and even source of the electricity they consume. With two-way grid communication, the dishwasher may choose to run when electricity is less expensive or maybe the washing machine won't turn on until wind power is available;
- plug-in hybrid electric vehicles will be able to store electricity and a more flexible network should be better able to handle the intermittent nature of renewable resources; and
- utilities will be able to locate, isolate and restore power outages remotely and quickly.

At the same time, a smarter grid poses some new challenges, such as:

- The lack of an Interoperability Framework—last week, DOE Secretary Chu cited the lack of standards and protocols necessary to allow different systems to communicate with one another as the biggest roadblock to the advancement of Smart Grid technology;
- Cyber Security—Smart Grid technologies are supposed to result in a more reliable and secure grid but if cyber security issues are not addressed, we could be making ourselves more vulnerable to cyber attacks; and
- Public Acceptance—is the average consumer willing to pay the upfront costs of a new system and then respond appropriately to price signals? Or will people view a utility's ability to reach inside a home to turn down a thermostat as Orwellian?

As we all know, the Stimulus bill provided \$4.5 billion in funding for Smart Grid activities. I am concerned with the government's ability to process this unprecedented amount of money in a meaningful way. How can this funding best be allocated to advance Smart Grid technologies? Without an Interoperability Framework in place before these funds are expended, do we risk making investments in technology that may soon become obsolete?

I'd like to thank all of our witnesses for joining us today. I look forward to hearing your testimony and getting your thoughts on the issues I have outlined. Mr. Chairman, thank you again for convening this important hearing.

The CHAIRMAN. Thank you very much.

Let me just introduce our first panel. First is Honorable Suedeen Kelly, who is a commissioner with FERC. Thank you very much for being here. Patricia Hoffman is principal deputy assistant secretary in the Office of Electricity Delivery and Energy Reliability at the Department of Energy. Patrick Gallagher is here representing the National Institute of Standards and Technology.

So, why don't we just have you proceed in that order, if you could each take maybe about 6 minutes and tell us the main points we need to understand about this issue. I'm sure we'll have questions.

Thank you.

STATEMENT OF SUEDEEN G. KELLY, COMMISSIONER, FEDERAL ENERGY REGULATORY COMMISSION

Ms. KELLY. Mr. Chairman and members of the committee, thank you very much for the opportunity to speak here today.

My testimony addresses FERC's efforts to develop and implement smart grid technology. I will summarize them now, and, at the end, highlight a few issues that we see in our future.

Our Nation's electricity grid generally depends on decades-old technology and has not incorporated new digital technologies extensively. Introducing digital technology to the grid can transform it by providing benefits to the electric industry and its customers, en-

hancing the grid's efficiency, and enabling its technological advancement, while ensuring its reliability and security.

I'd like to talk about several of our roles in this effort. The first is our interoperability role.

Deployment of smart grid involves a broad range of government agencies at both the Federal and State levels. FERC's primary responsibility is to promulgate interoperability standards through a rulemaking once FERC is satisfied that NIST's work on the development of these standards has reached sufficient consensus.

Development of the interoperability framework is, indeed, a challenging task. Well-designed standards and protocols are needed to make smart grid a reality. Recent funding for NIST's efforts will help, but coordination and cooperation among government agencies and industry participants is just as important. DOE, NIST, and FERC have been working with each other for the last year, and with other Federal agencies, to ensure progress, and those efforts will continue.

Second, I'd like to talk about our collaborative efforts. A year ago, FERC and the National Association of Regulatory Utility Commissioners, the State regulatory commissioners, began a collaborative on smart grid. I and Commissioner Butler, of the New Jersey Board of Public Utilities, who will be speaking on the next panel, co-chair that collaborative. FERC and NARUC started this effort because we understood that smartening the grid will cut across traditional jurisdictional boundaries, and therefore, State and Federal regulators should work together to ensure interoperability across the boundaries, and coordination of information on smart grid technology and deployment, as well as coordination of policies.

Currently, the collaborative has begun to develop criteria that participating regulators would like to see DOE use in applying to projects seeking smart grid grants under the stimulus bill funding. The collaborative members are focusing on criteria that would help them fulfill their responsibility as to the smart grid projects they will be asked to approve.

Now, our efforts on fostering deployment of smart grid. The Energy Policy Act of 2005, Section 1223, directs FERC to encourage the deployment of advanced transmission technologies, and expressly includes technologies related to the smart grid in that section. Examples include energy storage devices, controllable load, enhanced power device monitoring, and direct system-state sensors.

FERC can use its existing authority under the Federal Power Act to help facilitate implementation of smart grid technology. For example, FERC could provide rate incentives for appropriate smart grid projects, and can provide guidance on appropriate cost recovery for these projects. Providing clear guidance on the types of smart grid costs recoverable in rates and the procedures for seeking rate recovery may eliminate a major concern for utilities that are considering making these investments.

A critical issue as smart grid is deployed is the need to ensure grid reliability and cybersecurity. The interoperability framework and the technology itself must leave no gaps in physical security or cybersecurity. Reliability and security must be built into smart grid devices and not added later. The significant benefits of smart

grid technologies must be achieved without taking reliability and security risks that could be exploited.

Another area for initial emphasis could be standards that promote common software semantics throughout the industry. These would enable realtime coordination of information from both demand and supply resources.

The next level for prioritization could include standards related to key challenges now confronting our grid, or that will soon confront our grid, including, integrating more intermittent renewables into the grid and accommodating plug-in electric vehicles. Accordingly, we might suggest a priority for development of standards permitting system operators to rely on automated demand resources, emerging electric storage technologies, and technologies such as phase or measurement units for wide area system awareness and congestion management. Another area could be standards for the charging of plug-in electric vehicles.

As to future issues, concerns about access to, and security of, smart grid control systems and data must be resolved. For example, as I mentioned earlier, consumers need realtime data on how and when their electricity usage is affected. Both demand-and supply related information.

This data could also be valuable to various business entities to enable them to better design technology that helps consumers make smarter decisions about their electricity use. This data may also be helpful to regulators seeking to better understand the cost-benefit equation of smart grid technology. In making this data available, we must take a number of things into account, including privacy concerns, authorized dissemination, and possible marketing of the data, as well as concerns about information that might enable the identification of critical energy infrastructure, something that we don't want to have occur.

A final issue involves enforcement of the smart grid interoperability standards that FERC will promulgate under the Energy Independence and Security Act. This section in the Energy Independence and Security Act is a standalone provision of law. In other words, it's not an amendment to the Federal Power Act. So, it does not provide that these standards are mandatory, and it does not provide authority or processes for enforcing them. FERC can use some existing authority in the Federal Power Act to require some, but not all, entities to comply with the standards.

In terms of ensuring compliance, FERC's ratemaking authority applies to FERC jurisdictional public utilities, but, of course, not all the public utilities in America. Our mandatory reliability authority applies to users, owners, and operators of the bulk power system, but not the rest of the electric system.

FERC's authority generally excludes local distribution facilities, and our reliability authority requires FERC to refer standards to NERC's standard-setting process before they can be mandated. If Congress intends for the smart grid standards to be mandatory beyond the scope of the Federal Power Act, then additional legislation should be considered.

Thank you, again, for the opportunity to testify today. I'd be happy to answer any questions you have.

[The prepared statement of Ms. Kelly follows:]

PREPARED STATEMENT OF SUEDEEN G. KELLY, COMMISSIONER, FEDERAL ENERGY
REGULATORY COMMISSION

INTRODUCTION AND SUMMARY

Mr. Chairman and members of the Committee, thank you for the opportunity to speak here today. My name is Suedeen Kelly, and I am a Commissioner on the Federal Energy Regulatory Commission (FERC or Commission). My testimony addresses the efforts to develop and implement a range of technologies collectively known as the "Smart Grid."

Our nation's electric grid generally depends on decades-old technology, and has not incorporated new digital technologies extensively. Digital technologies have transformed other industries such as telecommunications. A similar change has not yet happened for the electric grid. As detailed below, a Smart Grid can provide a range of benefits to the electric industry and its customers, enhancing its efficiency and enabling its technological advancement while ensuring its reliability and security.

Smart Grid efforts involve a broad range of government agencies, at both the Federal and state levels. The Federal agencies include primarily the Department of Energy (DOE), the National Institute of Standards and Technology (NIST) and FERC. DOE's tasks include awarding grants for Smart Grid projects and developing a Smart Grid information clearinghouse. NIST has primary responsibility for coordinating development of an "interoperability framework" allowing Smart Grid technologies to communicate and work together. FERC is then responsible for promulgating interoperability standards, once FERC is satisfied that NIST's work has led to sufficient consensus.

Development of the interoperability framework is a challenging task. Recent funding for NIST's efforts will help, but cooperation and coordination among government agencies and industry participants is just as important. DOE, NIST and FERC have been working with each other and with other Federal agencies to ensure progress, and those efforts will continue. FERC also has been coordinating with state regulators, to address common issues and concerns.

FERC can use its existing authority to facilitate implementation of Smart Grid. For example, FERC can provide rate incentives for appropriate Smart Grid projects, and can provide guidance on cost recovery for such projects.

A critical issue as Smart Grid is deployed is the need to ensure grid reliability and cyber security. The significant benefits of Smart Grid technologies must be achieved without taking reliability and security risks that could be exploited to cause great harm to our Nation's citizens and economy.

Finally, if the intent of Congress is for the Smart Grid standards to be mandatory beyond the scope of the Federal Power Act, additional legislation should be considered.

EISA

Section 1301 of the Energy Independence and Security Act of 2007 (EISA) states that "it is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve" a number of benefits. Section 1301 specifies benefits such as: increased use of digital technology to improve the grid's reliability, security, and efficiency; "dynamic optimization of grid operations and resources, with full cyber-security;" facilitation of distributed generation, demand response, and energy efficiency resources; and integration of "smart" appliances and consumer devices, as well as advanced electricity storage and peak-shaving technologies (including plug-in hybrid electric vehicles).

Section 1305(a) of EISA gives NIST "primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems." NIST is required to solicit input from a range of others, including the GridWise Architecture Council and the National Electrical Manufacturers Association, as well as two international bodies, the Institute of Electrical and Electronics Engineers and the North American Electric Reliability Corporation (NERC). Many of the organizations working with NIST on this issue develop industry standards through extensive processes aimed at achieving consensus.

Although EISA does not define interoperability, definitions put forth by others often include many of the same elements. These include: (1) exchange of meaningful, actionable information between two or more systems across organizational boundaries; (2) a shared meaning of the exchanged information; (3) an agreed expectation for the response to the information exchange; and (4) requisite quality of service in

information exchange: reliability, accuracy, security. (See GridWise Architecture Council, "Interoperability Path Forward Whitepaper," www.gridwiseac.org)

Pursuant to EISA section 1305, once FERC is satisfied that NIST's work has led to "sufficient consensus" on interoperability standards, FERC must then "institute a rulemaking proceeding to adopt such standards and protocols as may be necessary to insure smart-grid functionality and interoperability in interstate transmission of electric power, and regional and wholesale electricity markets." Section 1305 does not specify any other prerequisites to Commission action, such as a filing by NIST with the Commission or unanimous support for individual standards or a comprehensive set of standards.

FERC's role under EISA section 1305 is consistent with its responsibility under section 1223 of the Energy Policy Act of 2005. Section 1223 directs FERC to encourage the deployment of advanced transmission technologies, and expressly includes technologies such as energy storage devices, controllable load, distributed generation, enhanced power device monitoring and direct system state sensors.

SMART GRID TASK FORCE

As required by EISA section 1303, DOE has established the Smart Grid Task Force. The Task Force includes representatives from DOE, FERC, NIST, the Environmental Protection Agency and the Departments of Homeland Security, Agriculture and Defense. The Task Force seeks to ensure awareness, coordination and integration of Federal Government activities related to Smart Grid technologies, practices, and services. The Task Force meets on a regular basis, and has helped inform the participating agencies on the Smart Grid efforts of other participants as well as the efforts outside the Federal Government.

SMART GRID COLLABORATIVE

A year ago, FERC and NARUC began the Smart Grid Collaborative. I and Commissioner Frederick F. Butler of the New Jersey Board of Public Utilities co-chair the collaborative. The collaborative was timely because state regulators were increasingly being asked to approve pilot or demonstration projects or in some cases widespread deployment in their states of advanced metering systems, one key component of a comprehensive Smart Grid system.

The Collaborative began by convening joint meetings to hear from a range of experts about the new technologies. A host of issues were explored. Key among them were the issues of interoperability, the types of technologies and communications protocols used in Smart Grid applications, the sequence and timing of Smart Grid deployments, and the type of rate structures that accompanied Smart Grid projects.

Through these meetings, Collaborative members learned of a range of Smart Grid projects already in place around the country. The Smart Grid programs in existence were varied in that they used a mix of differing technologies, communications protocols and rate designs. Collaborative members began discussing whether a Smart Grid information clearinghouse could be developed that would then allow an analysis of best practices. This information could help regulators make better decisions on proposed Smart Grid projects in their jurisdictions. As discussed below, recent legislation requires DOE to establish such a clearinghouse.

The Collaborative members have begun to look beyond the information clearinghouse to who could best analyze this information to identify best practices from Smart Grid applications. The Collaborative has met with staff from DOE to discuss possible funding for a project under the auspices of the Collaborative that could act as an analytical tool to evaluate Smart Grid pilot programs, using the information developed by the clearinghouse. This issue is still being explored.

THE STIMULUS BILL

The American Recovery and Reinvestment Act of 2009 (the "Stimulus Bill") appropriated \$4.5 billion to DOE for "Electricity Delivery and Energy Reliability." The authorized purposes for these funds include, inter alia, implementation of programs authorized under Title XIII of EISA, which addresses Smart Grid. Smart Grid grants would provide funding for up to 50 percent of a project's documented costs. In many cases, state and/or Federal regulators could be asked to approve funding for the balance of project costs. The Secretary of Energy is required to develop procedures or criteria under which applicants can receive such grants. The Stimulus Bill also states that \$10 million of the \$4.5 billion is "to implement

[EISA] section 1305," the provision giving NIST primary responsibility to coordinate the development of the interoperability framework.

The Stimulus Bill also directs the Secretary of Energy to establish a Smart Grid information clearinghouse. As a condition of receiving Smart Grid grants, recipients must provide such information to the clearinghouse as the Secretary requires.

As an additional condition, recipients must show that their projects use “open protocols and standards (including Internet-based protocols and standards) if available and appropriate.” These open protocols and standards, sometimes also referred to as “open architecture,” will facilitate interoperability by allowing multiple vendors to design and build many types of equipment and systems for the Smart Grid environment. As the GridWise Architecture Council stated, “An open architecture encourages multi-vendor competition because every vendor has the opportunity to build interchangeable hardware or software that works with other elements within the system.” (See “Introduction to Interoperability and Decision-Maker’s Checklist,” page 4, www.gridwiseac.org.)

The Collaborative has begun discussing additional criteria that regulators would like to see applied to projects seeking Smart Grid grants. The Collaborative members are focusing on criteria that could help them fulfill their legal responsibilities as to Smart Grid projects they would be asked to approve. For example, cost-effectiveness could be a key criterion and could inform regulatory decisions on rate recovery issues. Upgradeability could be another criterion. Once the Collaborative reaches consensus on the criteria, the Collaborative intends to ask the Secretary of Energy to consider its recommended criteria.

INITIAL DEPLOYMENTS ARE STILL IN PROGRESS

Initial efforts to use Smart Grid technologies are still being implemented and analyzed. Even comprehensive pilot projects such as Xcel’s project in Boulder, Colorado (which includes smart meters, in-home programmable control devices, smart substations and integration of distributed generation), are in the early stages of development and data gathering. Thus, it is too early to assess the “lessons learned” from such efforts.

A particularly interesting project, however, is under development by Pepco Holdings, Inc. (PHI). At the transmission level, Smart Grid can be equated with widespread deployment of advanced sensors and controls and the high-speed communications and IT infrastructure needed to fully use the additional data and control options to improve the electric system’s reliability and efficiency. PHI’s proposal follows this model. In a filing with FERC seeking approval of incentive rates, PHI committed to promote interoperability through insistence “upon open architecture, open protocols and ‘interoperability’” when dealing with potential vendors, and to adhere to “available standards which have been finalized, proven, and have achieved some levels of broad industry acceptance” as much as possible for its Smart Grid deployments. Furthermore, PHI committed to “provide a method of upgrading systems and firmware remotely (through the data network as opposed to local/site upgrades) and ensure that unforeseen problems or changes can be quickly and easily made by PHI engineers and system operators on short notice.” Adherence to such principles, along with adequate consideration of cyber security concerns, is essential at this early stage of Smart Grid development. The Commission granted incentive rates for this project, and construction is expected to start in 2009.

NEXT STEPS

As Congress recognized in enacting EISA, the development of an interoperability framework can accelerate the deployment of Smart Grid technologies. The process of developing such a framework may take significant time. NIST has primary responsibility for this task, and must coordinate the efforts and views of many others. As a non-regulatory agency, NIST is used to serving as a neutral mediator to build consensus toward standards. Achieving consensus among the many, diverse entities involved in Smart Grid may be difficult. Coordinated leadership is needed to help minimize conflicting agendas and unnecessary delay. The Stimulus Bill’s funding will help NIST’s efforts, but may not guarantee quick achievement of the goals. In the meantime, the Commission may be able to take steps to help hasten development and implementation of Smart Grid technology. For example, the Commission’s day-to-day knowledge of the electric industry may allow it to suggest aspects of the interoperability framework that should be prioritized ahead of others. This prioritization may facilitate progress on the Smart Grid technologies that will provide the largest benefits for a broad group of participants.

An overarching approach for prioritization could focus initially on the fundamental standards needed to enable all of the functions and characteristics envisioned for the Smart Grid. This may include, for example, standards for cyber security, since the electric grid and all devices connected to it must be fully protected.

This approach also may include standards that promote common software semantics throughout the industry, which would enable real-time coordination of information from both demand and supply resources.

The next set of targets for prioritization could be standards needed to enable key Smart Grid functionalities identified by relevant authorities including FERC. For example, challenges associated with integrating variable renewable resources into the generation mix and reliably accommodating any new electric vehicle fleets could be addressed, at least in part, through certain capabilities envisioned for the Smart Grid. Accordingly, priority could be placed on the development of: (1) standards permitting system operators to rely on automated demand response resources to offset an unplanned loss of variable generation such as wind turbines or to shift load into off-peak hours with over-generation situations; (2) standards permitting system operators to rely on emerging electric storage technologies for similar purposes; (3) standards permitting transmission operators to rely on technologies such as phasor measurement units for wide-area system awareness and congestion management; and, (4) standards permitting some appropriate control over the charging of plug-in hybrid electric vehicles, particularly encouraging such charging to occur during off-peak hours.

Even before NIST's work has led to sufficient consensus, the Commission could provide rate incentives to jurisdictional public utilities for early implementation of certain Smart Grid technologies, if adequate steps are taken to ensure reliability and cyber security while minimizing the risk of rapid obsolescence and "stranded costs." The Commission also may be able to use its ratemaking authority, apart from incentives, to encourage expansion of Smart Grid technologies. Providing clear guidance on the types of Smart Grid costs recoverable in rates, and on the procedures for seeking rate recovery, may eliminate a major concern for utilities considering such investments.

While FERC, by itself, may be able to take steps such as these to foster Smart Grid technologies, achieving the full benefits of a Smart Grid will require coordination among a broad group of entities, particularly DOE, NIST, FERC and state regulators. For example, DOE's authority to support up to 50 percent of the cost of a Smart Grid project may elicit little interest from utilities if they are uncertain of their ability to recover the rest of their costs. Similarly, Congress itself recognized, in EISA section 1305(a)(1), the need for NIST to seek input from FERC, the Smart Grid Task Force established by DOE and "other relevant Federal and state agencies." Also, the concurrent jurisdiction of FERC and state commissions over many utilities will require regulators to adopt complementary policies or risk sending conflicting regulatory "signals." More fundamentally, a Smart Grid will require substantial coordination between wholesale and retail markets and between the Federal and state rules governing those markets. Similarly, Smart Grid standards may require changes to business practice standards already used in the industry, such as those developed through NAEBS, and the industry and government agencies should support the work needed to evaluate and develop those changes.

Concerns about access to, and security of, Smart Grid control systems and/or data also must be resolved. For example, data on how and when individual customers use electricity could be valuable to various commercial entities, but customers may have privacy concerns about unauthorized dissemination or marketing of this data. Similarly, generation owners and operators may be concerned about cyber access to control systems that operate their facilities. Access to information enabling the identification of critical energy infrastructure must also be limited. Issues about who owns Smart Grid-generated data and the security of some of its products are unresolved.

An additional issue involves enforcement of Smart Grid standards promulgated by the Commission under EISA section 1305. This section, which is a stand-alone provision instead of an amendment to the Federal Power Act (FPA), requires FERC to promulgate standards, but does not provide that the standards are mandatory or provide any authority and procedures for enforcing such standards. If FERC were to seek to use the full scope of its existing FPA authority to require compliance with Smart Grid standards, this authority applies only to certain entities (i.e., public utilities under its ratemaking authority in Sections 205 and 206, or users, owners and operators of the bulk power system under its reliability authority in Section 215). FERC also has asserted jurisdiction in certain circumstances over demand response programs involving both wholesale and eligible retail customers. However, FERC's authority under the FPA excludes local distribution facilities unless specifically provided, its authority under sections 205 and 206 applies only to public utilities, and its section 215 authority does not authorize it to mandate standards but rather only to refer a matter to NERC's standard-setting process. If the intent of Congress is

for the Smart Grid standards to be mandatory beyond the scope of the Federal Power Act, additional legislation should be considered.

Finally, in developing and implementing Smart Grid technologies, the electric industry and vendors must meet the critical need, recognized by Congress in EISA section 1301, for grid reliability and "full cyber-security." An entity subject to FERC-approved reliability standards under FPA section 215 must maintain compliance with those standards during and after the installation of Smart Grid technologies. Also, the interoperability framework and the technology itself must leave no gaps in physical security or cyber security. Reliability and security must be built into Smart Grid devices, and not added later, to avoid making the grid more vulnerable and to avoid costly replacement of equipment that cannot be upgraded. The significant benefits of Smart Grid technologies must be achieved without taking reliability and security risks that could be exploited to cause great harm to our Nation's citizens and economy.

CONCLUSION

A properly coordinated and timely deployment of Smart Grid can provide many positive benefits to the Nation's electric industry and its customers, if we are careful to maintain and enhance grid security and reliability at the same time. Indeed, I would expect Smart Grid to evolve in many unanticipated but beneficial ways. Well-designed standards and protocols are needed to make Smart Grid a reality. They will eliminate concerns about technology obsolescence, allow system upgrades through software applications, and ultimately permit plug-and-play devices, regardless of vendor. FERC is committed to working closely with DOE, NIST and others to facilitate rapid deployment of innovative, secure Smart Grid technologies.

Thank you again for the opportunity to testify today. I would be happy to answer any questions you may have.

The CHAIRMAN. Thank you very much.

Ms. Hoffman, go right ahead.

STATEMENT OF PATRICIA HOFFMAN, ACTING ASSISTANT SECRETARY FOR ELECTRICITY DELIVERY AND ENERGY RELIABILITY, DEPARTMENT OF ENERGY

Ms. HOFFMAN. Mr. Chairman and members of the committee, thank you for this opportunity to testify before you on the Department's progress in advancing smart grid projects and activities under title 13 of the Energy Independence and Security Act and the American Recovery and Reinvestment Act.

A smart grid uses information technology to improve the reliability, availability, and efficiency of electric systems from large generation, including renewables, through the delivery system to electricity consumers, and eventually to individual end uses or appliances.

There are several guiding principles to the Department's smart grid efforts. First is the need to establish quantitative metrics for guiding the implementation of a smart grid. In June 2008, the Department sponsored a Smart Grid Implementation Workshop, which brought together stakeholders from across the country to discuss smart grid definitions, metrics, and analysis. The Department envisions these metrics may become key indicators for understanding progress toward implementing a smart grid.

A second guiding principle is transparency. It is the Department's intent to use every means at its disposal to keep the public informed of, and involved in, the progress of smart grid developments. There are several avenues for effective communication and coordination to occur.

For example, the Federal Smart Grid Task Force, as required by EISA, Section 1303, has met every month since March 2008 to coordinate Federal activities. This coordination and involvement in-

cluded the Federal Energy Regulatory Commission, the National Institute of Standards and Technology, the Environmental Protection Agency, the Department of Homeland Security, the United States Department of Agriculture, and the Department of Defense.

Additionally, the Department is contributing to the efforts of a NARUC-FERC smart grid collaborative by supporting the development of a Web-based information clearinghouse to share what is known about smart grid projects and foster a better information exchange.

The Department is committed to moving smart grid standards through the development processes and getting to them—getting them to the point of adjudication by Federal and State regulatory agencies as rapidly as possible by implementing EISA Section 1305. The Department is working closely with NIST, who has the primary responsibility to coordinate the development of a framework for interoperability standards.

The cornerstone of a smart grid is the ability of multiple agents—for example, devices—to interact with one another via a communications network. The interaction of multiple devices, and the benefit that that brings to the electric power system, is what differentiates a smart grid from the existing system. If not properly protected, the smart grid could be vulnerable in areas including a breach of availability, a breach of data integrity, or a breach of confidentiality.

Over the last 8 months, DOE has been working collaboratively with the Utilities Communication Architectures User Group to develop cyber-security requirements for advanced metering infrastructure, AMI, a key application for the smart grid. This work will help accelerate the development of cyber-security requirements and other smart grid technologies.

Additionally, the Department is currently developing EISA Section 1309, a study of the security attributes for a smart grid system, for delivery to Congress by the end of the fiscal year.

The Department envisions an electric system—generation, delivery, and use—with the capability to measure and understand performance on a realtime basis, to model and analyze policy and regulatory objectives, and improve resiliency. The Department's highest priorities are to implement the recovery plan and accelerate the development of interoperable open standards.

With respect to the Recovery Act, the Department is poised to release two notices of intent in order to implement the Smart Grid Investment Grant Program and the regional demonstration projects, followed by a subsequent release of formal solicitations for proposals.

This concludes my statement, Mr. Chairman, and I look forward to answering any questions you may have.

[The prepared statement of Ms. Hoffman follows:]

PREPARED STATEMENT OF PATRICIA HOFFMAN, ACTING ASSISTANT SECRETARY FOR
ELECTRICITY DELIVERY AND ENERGY RELIABILITY, DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Committee, thank you for this opportunity to testify before you on the Department's progress in advancing smart grid projects and activities under Title XIII of the Energy Independence and Security Act of 2007 and the American Recovery and Reinvestment Act of 2009 (Recovery Act). Creating

smart grid is critical to meeting future demand growth while maintaining a reliable electric system.

A smart grid uses information technology to improve the reliability, availability and efficiency of the electric system: from large generation through the delivery system to electricity consumers and eventually to individual end-uses or appliances. The information networks that are transforming our economy in other areas are also being applied to grid applications for dynamic optimization of electric systems operations, maintenance, and planning.

There are several guiding principles to the Department's smart grid efforts. First is the need to establish quantitative metrics for guiding the implementation of smart grid activities. Efforts to develop smart grid metrics have been underway for some time. For example, in June 2008, the Office of Electricity Delivery and Energy Reliability (OE) sponsored a "Smart Grid Implementation Workshop" which brought together stakeholders from across the country to discuss smart grid definitions, metrics, and analysis and the data and methodologies that will be needed for the effective application of those metrics. The Department envisions these metrics may become key indicators for understanding progress toward implementing a smart grid.

POTENTIAL SMART GRID METRICS

- Dynamic Pricing:—fraction of customers and total load served by Real Time Pricing (RTP), Critical Peak Pricing (CPP), and Time of Use (TOU) tariffs
- Realtime System Operations Data Sharing:—Total Supervisory Control and Data Acquisition (SCADA) points shared and fraction of phasor measurement points shared.
- Distributed-Resource Interconnection Policy:—percentage of utilities with standard distributed-resource interconnection policies and commonality of such policies across utilities.
- Policy/Regulatory Progress:—weighted-average percentage of smart grid investment recovered through rates (respondents' input weighted based on total customer share).
- Load Participation Based on Grid Conditions:—fraction of load served by interruptible tariffs, direct load control, and consumer load control with incentives.
- Load Served by Microgrids:—the percentage total grid summer capacity.
- Grid-Connected Distributed Generation (renewable and non-renewable) and Storage:—percentage of distributed generation and storage.
- Electric Vehicles (EVs) and Plug-InHybrid Electric Vehicles (PHEVs):—percentage shares of on-road. For example, light-duty vehicles of comprising EVs and PHEVs.
- Grid-Responsive Non-Generating Demand-Side Equipment:—total load served by smart, grid-responsive equipment.
- Transmission & Distribution (T&D) System Reliability:—utilizing the Institute of Electrical and Electronics Engineers, Inc (IEEE) indices that measure distribution system reliability.
- T&D Automations:—percentage of substations using automation.
- Advanced Meters:—percentage of total demand served by advanced metered customers
- Advanced System Measurement:—percentage of substations possessing advanced measurement technology.
- Capacity Factors:—yearly average and peak-generation capacity factor.
- Generation and T&D Efficiencies:—percentage of energy consumed to generate electricity that is not lost.
- Dynamic Line Ratings:—percentage miles of transmission circuits being operated under dynamic line ratings.
- Power Quality:—percentage of customer complaints related to power quality issues, excluding outages.
- Cyber Security:—percent of total generation capacity under companies in compliance with the North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection standards.
- Open Architecture/Standards:—Interoperability Maturity Level—the weighted average maturity level of interoperability realized among electricity system stakeholders
- Venture Capital:—total annual venture-capital funding of smart grid startups located in the U.S.

A second guiding principle is transparency. It is the Department's intent to use every means at its disposal to keep the public informed of and involved in the

progress of the smart grid developments. There are several avenues for effective communication to occur. These include, for example:

- Bi-annual reports to Congress, as required by the Energy Independence and Security Act of 2007 (EISA) Section 1302, on the status of smart grid implementation nationwide. The first such report is undergoing the concurrence process and should be available shortly.
- The Smart Grid Subcommittee of the Electricity Advisory Committee, as required by EISA Section 1303, which has produced a report, "Smart Grid: Enabler of the New Energy Economy," with recommendation for how OE proceeds with its smart grid activities. This report can be downloaded from our website (<http://oe.energy.gov/DocumentsandMedia/final-smart-grid-report.pdf>).
- The Federal Smart Grid Task Force, as required by EISA Section 1303, has met every month since March 2008 to coordinate Federal activities, and includes involvement from Federal Energy Regulatory Commission (FERC), National Institute of Standards and Technology (NIST), Environmental Protection Agency, Department of Homeland Security, United States Department of Agriculture, and the Department of Defense.
- The offering of "Smart Grid E Forums" to provide information on key topics of interest through web-based seminars in collaboration with utilities, state regulators, consumer groups, equipment manufacturers, and national laboratories and universities from across the country. Last week OE sponsored its 4th such E Forum which provided information on the potential role for the smart grid to enable clean energy development and covered topics such as wind integration and electric and hybrid electric vehicles.
- The establishment of a Smart Grid Clearinghouse to serve as a central repository for smart grid project information, applications, requirements, performance, costs and benefits, standards, etc.

It is the Department's intent to build on these activities and work closely with key stakeholders so that the Nation is working in a consistent direction and not at cross purposes. There is neither the time nor the resources to spend dealing with problems that could be addressed through effective stakeholder engagement and Federal coordination.

For example, the Department is contributing to the efforts of the National Association of Regulatory Utility Commissioners (NARUC)-FERC Smart Grid Collaborative by supporting the development of a web-based information clearinghouse to share what is known about smart grid projects and foster better information exchange. The Department is also working with the Smart Grid Stakeholders Roundtable and EPA to assist public and private sector group to develop a common understanding of smart grid challenges and opportunities.

Interoperability Standards:—The Department recognizes that one of the major barriers to commercial success is the lack of industry-based standards for governing how the many different devices involved in smart grid, and their ability to communicate with each other in an efficient and secure manner, can become more interoperable than they are today.

The Department has learned hard lessons over the years about the amount of time and effort it takes to get standards of this type developed, implemented, and accepted. For example, after more than 10 years of development, there are still activities underway for full implementation of uniform and consistent grid interconnection standards for distributed energy resources. The Department understands that there are standards development organizations such as the Institute of Electrical and Electronics Engineers, International Electrotechnical Commission, American National Standards Institute, International Organization for Standardization, and the International Telecommunications Union who need to be involved in the process and that these organizations rely primarily on volunteers and contributions from their members to work on the standards development effort.

The Department is committed to moving the standards through the development process and getting them to the point for adjudication by Federal and state regulatory agencies as rapidly as possible by implementing EISA Section 1305. The Department is working closely with NIST which has primary responsibility to coordinate development of a framework for interoperability standards, as called for in EISA Section 1305. The Department has provided technical and financial assistance to NIST to support their efforts.

Cyber Security:—The cornerstone of a smart grid is the ability of multiple agents, i.e. devices, to interact with one another via a communications network. The interaction of multiple devices, and the benefit that this brings to the electric power system, is what differentiates the smart grid from the existing system. If not properly protected, the smart grid could be vulnerable including:

- **Breach of Availability.**—Smart grid technology will include an immense communications network to manage the distribution infrastructure. One of the key reliability promises of the smart grid is enhanced management of the grid under emergency conditions. However, without proper planning, a natural-or man-made event could disable the communications infrastructure, rendering the smart grid ineffective at coping with the emergency situation.
- **Breach of Integrity.**—A basic service for the smart grid is the ability to measure the use of electricity and transmit that information to the utility for billing purposes. A cyber intruder could compromise the data and send false information to the utility and either lower or increase the billing, depending upon the motivation.
- **Breach of Confidentiality.**—If a perpetrator is able to access and view data being transmitted between the utility and smart meters at customer premises, they could potentially use that information for unauthorized or illicit purposes.

Over the last 8 months, DOE has been working collaboratively with the Utilities Communications Architecture Users Group (utilities, vendors, et al) to develop cyber security requirements (including vulnerability testing through the DOE Smart Grid Test Bed) for advanced metering infrastructure (AMI), a key application for the smart grid. This work will help accelerate the development of cyber security requirements for other smart grid technologies. Additionally, the Department is currently developing the EISA Section 130—Study of the Security Attributes of a Smart Grid System for delivery to Congress by the end of the fiscal year.

Success Stories:—Wide Area Measurement Systems (WAMS) technology is based on obtaining high-resolution power system measurements (e.g., voltage) from sensors that are dispersed over wide areas of the grid. The data is synchronized with timing signals from Global Positioning System (GPS) satellites. The real-time information available from WAMS allows operators to detect and mitigate a disturbance before it can spread and enables greater utilization of the grid by operating it closer to its limits while maintaining reliability. When Hurricane Gustav came ashore in Louisiana in September 2008, an electrical island was formed in an area of Entergy's service territory. Entergy used the phasor measurement system to detect this island, and the phasor measurement units (PMU) in the island to balance generation and load for some 33 hours before surrounding power was restored.

The Department has also been actively involved in supporting early demonstration and testing of smart grid applications through National Laboratories and Power Marketing Administrations. For example, Pacific Northwest National Laboratory and the Bonneville Power Administration conducted a demonstration of "Smart" white appliances and dynamic pricing on the Olympic Peninsula and elsewhere in the Northwest. The results of that demonstration have been studied nationally and internationally. Building on this type of Department success is a priority in moving the smart grid along.

End Goal:—The Department envisions an electric system (generation, delivery and use) with the capability to 1) measure and understand system performance on a real-time (time and location) basis; 2) model and analyze policy and regulatory objectives and 3) improve resiliency (faster response times and ability to withstand cyber attacks without loss of critical services).

The Department's highest priorities are to implement the Recovery Plan and accelerate the development of interoperable, open standards. With respect to the Recovery Act, the Department is focused on releasing two notices of intent (NOIs) in order to implement the Smart Grid Investment Grant program and the Regional Demonstration Projects, followed by a subsequent release of formal solicitations for proposals. The NOIs will provide instructions regarding what types of projects qualify, who is eligible to be receive funding, and how proposals will be evaluated. The Recovery Act requires issuance of NOIs for the Investment Program within 60 days of enactment and within 30 days for the Regional Demonstration Projects. The Department is currently on track to complete both NOIs prior to the respective deadlines.

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

The CHAIRMAN. Thank you very much.
Dr. GALLAGHER.

STATEMENT OF PATRICK D. GALLAGHER, PH.D, DEPUTY DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, DEPARTMENT OF COMMERCE

Mr. GALLAGHER. Chairman Bingaman, Ranking Member Murkowski, members of the committee, I want to thank you for the opportunity to appear before you today to discuss the role of the National Institute of Standards and Technology to enable interoperability of smart grid devices and systems.

NIST is the nation's measurement science and standards agency. For over 100 years, NIST's world-class science has provided the foundation for American innovation by providing technical leadership, cutting-edge measurement technologies, and by promoting effective standards in the marketplace.

As part of the Department of Commerce, NIST's mission is uniquely focused on U.S. industry. These characteristics make NIST well suited and ready to support the national effort on smart grid technology.

Smart grid presents an exciting and yet complex challenge. It is fundamentally the marriage of two complex systems: the Nation's electrical transmission grid with modern digital information technology. The capability that results from this marriage will provide the measurements and controls to enable greater reliability of electrical power, and it will enable a host of new technologies, from distributed power generation from renewable sources to smart appliances that can adjust to market conditions. The President has repeatedly emphasized the importance of smart grid to achieving both of these goals.

What is the NIST role in smart grid? Under the Energy Independence and Security Act, NIST has primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems.

Interoperability refers to the ability of a system to work with other systems without any special effort on the part of the consumer. An interoperable smart grid will allow utilities and customers to purchase equipment that works smoothly, reliably, and securely with other smart grid systems.

Manufacturers of smart grid equipment need assurance that their products will be interoperable on the smart grid network. Achieving interoperability requires effective standards and tests to measure and validate that the performance conforms with the standards. This is a classic NIST role.

The Nation's present electrical grid is already a complex engineering marvel. There is a universe of standards on which the present infrastructure is based, and NIST and many other organizations are now assessing the applicability of these standards to smart grid and to identify what new standards need to be developed.

The addition of information technology will greatly increase the complexity of this system. Many of the devices and appliances that will be part of the smart grid do not presently exist, but will be developed to meet future utility and customer demands. Due to its inherent complexity, there can be no single standard for smart grid devices and systems; rather, suites of standards need to be devel-

oped, and these standards will not be static, but they need to evolve to ensure that the system interoperability is maintained even as new technology is brought onto the grid.

Another challenge in the effort to develop smart grid is the diversity of the participants in its development, use, and regulation. Developing the smart grid involves Federal agencies, State and local governments, utilities, manufacturers, standards development organizations, and consumer groups.

Engaging all of these stakeholders is an essential ingredient to develop effective smart grid standards if they are to be adopted and used. The Energy Independence and Security Act specifically called for NIST to solicit input from a wide variety of private and public entities, for this very reason.

Knowledge of the standards development process is a unique strength of NIST. We are viewed as an impartial and technically knowledgeable partner. We have a long history of working collaboratively with industry, standards organizations, and government agencies. Over the past year, NIST has formed stakeholder groups, called Domain Expert Working Groups, many of whom have not previously worked in close coordination, to promote the information-sharing necessary for the development of effective smart grid standards. We are using their expertise to identify where interoperability barriers exist, where relevant standards current exist, and where standards exist but are not interoperable, and, at times where the gaps exists, where new standards need to be developed.

With appropriations from the American Recovery and Reinvestment Act, NIST will expand the public-private coordination framework and move more rapidly to make the needed progress in smart grid standards. We are working closely at the interagency level to develop the detailed action plans that will support this expanded effort.

This coordination framework will allow us to establish standards development priorities—a key step—support standards assessments, and accelerate key standards development or harmonization efforts where they are needed.

I would like to note that the process of agreeing upon comprehensive and effective suites of standards is hard work. To be effective, standards must be agreed upon, and, if necessary, developed with broad representation and buy-in from all stakeholders. While it can take time to develop the consensus needed for success, NIST's framework will provide the broad-based and expert input through an open and transparent process. In the long term, we believe this will save time.

We believe that we can also maintain the aggressive schedule needed to meet smart grid goals. While some of the work can be done immediately, other aspects of this problem will be more of a challenge. NIST has the means and capability to meet it.

Standards alone do not guarantee interoperability. They must be supported by conformity assessment testing to ensure that smart grid devices and systems that are developed based on the standards are truly interoperable. NIST laboratories will be focused on supporting this effort.

NIST is proud to have been given an opportunity and to have this role in the Energy Independence and Security Act Legislation

and under the American Recovery and Reinvestment Act. I want to thank you for the opportunity to testify today on our work. I would be happy to answer any questions the committee may have. [The prepared statement of Mr. Gallagher follows:]

PREPARED STATEMENT OF PATRICK D. GALLAGHER, PH.D. DEPUTY DIRECTOR,
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, DEPARTMENT OF COMMERCE

Chairman Bingaman, Ranking Member Murkowski and Members of the Committee, thank you for the opportunity to appear before you today to discuss the National Institute of Standards and Technology's (NIST's) role to enable a resilient Smart Grid composed of secure and interoperable devices and systems. NIST carries out this work in coordination with the Department of Energy (DOE) and the Federal Energy Regulatory Commission (FERC), both represented here today.

The availability of clean, reliable and affordable energy is essential to the economic welfare and security of our Nation. We can improve our energy supply through increased use of new renewable and distributed energy sources provided that we can make them widely accessible to industry, businesses and consumers through the Nation's electric power grid. This, however, is not an easy task given the current state of the electric power grid.

As stated by President Obama, we need to "update the way we get our electricity by starting to build a new Smart Grid that will save us money, protect our power sources from blackout or attack, and deliver clean, alternative forms of energy to every corner of our nation."¹

For this vision to succeed, utilities and others who are implementing the Smart Grid need to be able to purchase equipment in the marketplace and readily incorporate it into the Smart Grid so that it works seamlessly and interoperates with all other systems.

Interoperability refers to the ability of a system or a product to work with other systems or products without special effort on the part of the customer. Achieving interoperability requires reliable standards and validated performance—that is the challenge for NIST.

Under the Energy Independence and Security Act (EISA) of 2007 (Title XIII, Section 1305), NIST has "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems" The American Recovery and Reinvestment Act provided \$10 million for NIST for this purpose.

NIST is well-suited for this role. The agency has a reputation as an impartial, technically knowledgeable third party with a long history of working collaboratively with industry and other government agencies, including DOE and now the Federal Energy Regulatory Commission (FERC). NIST also has provided measurement technology and assistance to utilities, equipment manufacturers, and other power-system stakeholders. Only through collaborative efforts with all stakeholders will Smart Grid solutions to the complex and layered problems of interoperability be adopted by the many participants—power generators, Independent System Operators (ISOs), Regional Transmission Operators (RTOs), electric service providers, consumers, vendors, etc

The present electric power grid infrastructure is based on numerous standards, and many organizations are now assessing their applicability to the Smart Grid and determining what new standards need to be developed. NIST is working with these organizations to "tie it all together" so that unnecessary redundancy, conflicts, and gaps among the standards can be avoided and resolved. For there to be true interoperability, new Smart Grid devices also require testing to show that they conform with the standards.

The nation's electrical grid has been called "the greatest engineering achievement of the 20th century" and "largest interconnected machine on Earth." Due to the complexity of the grid, we and many others believe that there can be no single standard for Smart Grid devices and systems. Rather, we expect suites of standards to be developed for different aspects, including distributed energy resources (DER), demand response (DR) devices/appliances, electric vehicles, wide area measurement systems (WAMS), and other parts of the Smart Grid vision. The Smart Grid also needs to be evolutionary—beginning with the existing energy infrastructure and evolving as new innovations arise and the energy infrastructure and consumer needs and be-

¹Gross, Grant. "Obama Includes Broadband, Smart Grids in Stimulus Package." Stimulus Speech. January 8, 2009. IDG News Service. www.itworld.com/government.

havior change. This means that standards, conformance tests and other efforts to ensure interoperability must also continue to evolve.

NIST has begun the coordinating of the interoperability framework by bringing together the many stakeholders. Working in close cooperation with the DOE and its Grid Wise Architecture Council (GWAC), domain expert working groups have been established that cover key areas of the Smart Grid, including transmission & distribution, and commercial, industrial, and residential buildings. Additional groups and task forces to address higher-level and crosscutting issues—in business and policy, cyber security, and smart grid framework/architecture, to name a few—have been initiated.

Our goal is to bring these experts together, many of whom have not worked in close coordination before, to promote the information sharing necessary for the development of effective Smart Grid standards. We are using their expertise to support the framework development by identifying where the barriers to interoperability exist. In addition, we are identifying where relevant standards currently exist, where standards exist but are not interoperable, and where gaps exist that will need to be filled by new standards.

With appropriations from the recent enactment of the American Recovery and Reinvestment Act (ARRA), NIST will make significant headway working with its team comprising of NIST staff, contractors, and staff from the Department of Energy (DOE), the Federal Energy Regulatory Commission (FERC), the Grid Wise Architecture Council (GWAC) and many other industry and standards developing organizations to more rapidly make progress in the following ways:

- Interoperability Framework/Architecture.—An initial version of the interoperability framework will be developed—one that will have the flexibility to evolve as the Smart Grid develops.
- Smart Grid Standards Gap Analysis and Roadmap.—We will develop a smart grid standards gap analysis and road map to identify critical areas and guide interoperable standards development.
- Publicly Accessible Interoperability Knowledge Base.—NIST plans to create a publicly accessible interoperability knowledge base that will be the repository of the information necessary to perform standards assessments.
- Accelerate Standards Development. With the clear picture of the standards landscape and roadmap established, NIST will work effectively with standards development organizations (SDOs), contractors, and industry experts and other stakeholders to accelerate the development of scalable, compatible and interoperable standards.

I would like to caution, however, that the process of creating good consensus-based standards is not easy. To develop robust standards and ensure their use, the standards developing groups should have broad representation from all key stakeholders. Achieving consensus agreement among such a diverse group of stakeholders can take significant time, particularly if the resulting standards need to be applicable domestically and internationally.

Having good standards alone does not guarantee interoperability. Conformity assessment testing is necessary to ensure that the Smart Grid devices and systems developed based on the standards are truly interoperable. The NIST laboratories have long supported the development of the reference implementations of the standards for emerging technologies and the tests that will validate their interoperability.

NIST has been providing technical support for the development of Smart Grid devices for several years now. These include the Phasor Measurement Units, devices that will enable operators to get the information about grid conditions that they need to limit the effects of disruptions and instabilities in the grid and avoid large scale blackouts as occurred in the Northeast in August 2003. They also include high-megawatt power converters that will provide the flexibility to readily and reliably connect alternative and renewable resources to the grid.

Under the EISA, once sufficient consensus has been achieved, FERC will begin the rulemaking process for adopting standards and protocols. NIST's goal is to support this action by working closely with stakeholders to identify and develop the standards as quickly as possible based on broad participation and expert input. NIST believes that the most effective standards will be developed through broad input from experts, including industry and other stakeholders. The proposed approach will provide expert input through a voluntary consensus standards development process, while pursuing the aggressive schedule needed to develop the Smart Grid.

Finally, NIST has the important responsibility to develop Federal Cyber Security standards. Interoperability across the electric power grid infrastructure will do us no good if the grid is disabled by a cyber attack enabled by access through the

Smart Grid system. Security must be integrated into the interoperability framework in order to ensure the integrity and availability of the infrastructure and the privacy of Smart Grid users. The cyber security strategy for the Smart Grid must account for both domain-specific and common risks when developing interoperability solutions. Collaborative efforts will enable the development of the standards needed to reach our vision for Smart Grid interoperability.

The following is a preliminary list of cross cutting security requirements for the Smart Grid that have been identified and will be addressed by NIST and its team:

- Identification and authentication to provide unambiguous reference to system entities.
- Access control to protect critical information. Integrity to ensure that the modification of data or commands is detected.
- Confidentiality to protect sensitive information, including personally identifiable information (PII) and business identifiable information (BII).
- Availability to ensure that intentional attacks, unintentional events, and natural disasters do not disrupt the entire Smart Grid or result in cascading effects.
- Security architecture to ensure that there is no single point of failure.
- Conformity Assessment Procedures for Smart Grid devices and certification criteria for the personnel and processes.
- Strategies for isolating and repairing compromised components of the Smart Grid.
- Auditing to monitor changes to the Smart Grid.
- Supply chain security to ensure that products and services are not compromised at any point in the life cycle. This is a defense-in-breadth strategy.

NIST is proud to have been given such an important role in the EISA legislation. We have received enthusiastic support from DOE, GWAC, and many industry and other stakeholders. We believe that with the continued cooperation and collective expertise of the industry in this effort, we will be able to establish the interoperability and standards frameworks that will enable the Smart Grid vision to become a reality.

Thank you for the opportunity to testify today on NIST's work on Smart Grid interoperability. I would be happy to answer any questions the committee may have.

The CHAIRMAN. Thank you. Thank all of you for your testimony.

I'll start with a couple of questions. I guess one question, maybe to you, Dr. Gallagher—I'm not clear as to what kind of timeframe you're looking at here. I think you referred to developing this framework, as I understand it, in order to meet the schedule for deployment of the smart grid. I believe, something to that effect. What is the schedule for deployment of the smart grid? Are there time limits on development of these suites of standards that you've referred to here? What can we expect?

Mr. GALLAGHER. I think the question of timing is front and center for everybody right now, and we are all changing gears rapidly to address a much quicker pace on this program. I think that there are no defined timeframe standards, at least from the Federal interagency process, but we do know of some very powerful drivers on the standards development process, including the fact that the grants program, that DOE will be managing, will be investing heavily in smart grid devices and technology, and that these investments make more sense when there is a standards framework involved.

What NIST is focused on doing is basically accelerating the process by which the standards development can occur. In other words, the convening and the priority-setting. The actual standards development work is going to be a process that takes place largely in the private sector, with standards development organizations, with utilities, with all the stakeholders. The duration of those processes will depend on the complexity of the specific problem. In some

cases, it will occur very quickly—months—and in other cases, if it's technically very challenging, it may take considerably longer.

But right now what's desperately needed is a overall roadmap; in other words, a coordination effort by which we can establish which standards in this complex suite of issues are the most important to address right away, which ones affect regulatory concerns or technical challenge, and to basically provide that coordination to the community.

The CHAIRMAN. Do you have an idea—if what is needed is this roadmap, when will the roadmap be completed?

Mr. GALLAGHER. The roadmap is under development now. We were beginning that work even before the Recovery Act funding. We hope to have an initial draft of the roadmap by this summer, working with the community.

The CHAIRMAN. OK. So, initial drafts and—when would it be sufficiently final that, say, FERC could—as I understand it, you've got to complete this roadmap, so-called “framework,” and then FERC and other agencies have to then move and adopt—do a rulemaking to adopt standards. When would the roadmap be sufficiently finalized that FERC could go ahead and begin to adopt a standard?

Mr. GALLAGHER. I don't want to answer for FERC, but it's my understanding that what FERC would need in rulemaking is basically, what makes it powerful to them is a standard that's widely adopted and used in the community. In other words, it's the level of consensus surrounding a given standard that makes it appealing, that it is useful in the rulemaking process for regulations, because it basically allows their rulemaking not to address the formation of a specific standard.

So, I don't believe that this roadmap is directly tied to the progress FERC needs to make. What the roadmap is really designed to do is—the smart grid itself is so complex; we have transmission and distribution, we have devices, we have demand response, we have all of these various subsystems in the smart grid that there's a bit of a jam right now, in terms of which specific standards are most urgent to move forward. The roadmap basically provides that coordination. The timeframe that FERC needs to look at is the actual specific standards in their regulatory area that are out there and have reached a level of maturity where they believe it's suitable for rulemaking. At least that would be my understanding.

The CHAIRMAN. Commissioner Kelly, did you have a different—a thought on that?

Ms. KELLY. Yes, thank you, Mr. Chairman.

Dr. Gallagher is correct—we believe that the first step is to come up with a roadmap, and that means prioritizing the development of the standards. NIST is in charge of putting together the standards development organizations and attempting to get as much consensus around proposed standards as possible. We believe that that process really has to be driven and managed so that it doesn't just meander. We are very optimistic that, with the stimulus bill's funding of \$10 million for NIST, that they will now have sufficient resources to be able to do that. We are working with them, and will continue to work with them, to provide input on how the standards development process should be prioritized, and also to help give

them information, based on our day-to-day understanding of the electric industry, about how to move forward. But, we are anxious that it move forward with some urgency, and we do believe that NIST agrees with us.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you.

I mentioned Dr. Chu's comments about the lack of standards being the greatest bottleneck, and he suggested that we lock people up in a room and tell them to come out with a standard in a few weeks. Based on what you've just told us, Dr. Gallagher, and confirmed by you, Commissioner Kelly, you're probably not going to be able to come up with standards in a week or so, even if you were to be locked in a room.

But, it does certainly present the question. There is a great deal of funding—Federal funding out there now for NIST for implementation of the smart grid. Should disbursement of these stimulus funds be contingent on development of the standards and protocols? I mean—what I'm concerned about is obsolescence. We go ahead and we direct hundreds of millions, perhaps even billions, of dollars, but if we don't have the standards and protocols in place, we spend it, but we don't have the systems, the interoperability, that we had hoped for, and now the money that we have spent is on obsolete systems, and, to a certain extent, we're starting all over again. Is there some prioritization of this funding that we might be considering?

Commissioner KELLY.

Ms. KELLY. Thank you, Senator.

We believe that there are some safeguards that can and should be put into place by DOE, in acting on these applications, that would ensure or minimize to a great extent the risk of obsolescence. That's basically that the applications deal with the open architecture issue.

Short of standards, technology can be developed that is open, if you will. It may not be plug-and-play, but if it can be upgraded with—relatively easily, at relatively little cost, it may be open enough to be approved.

But, the point you raise is an important one. We don't think that we have to wait until standards are promulgated, but we do think that addressing the issue of how open the architecture is, or the technology that's proposed, is something that's very important.

We also believe that some of the demonstration projects can help with standards development, because some of the standards and protocols that are being discussed—there isn't consensus around them, because, in part, they haven't been tested. So, the demonstration projects could help further the standards process, if it's handled appropriately.

Senator MURKOWSKI. So, Dr. Gallagher [sic], is this what you were referring to when you said that the standards would not be static?

Mr. GALLAGHER. That's correct. I think that anytime you're developing standards in a realm where the technology itself is rapidly evolving—and I think some of the demonstration projects that will be funded through the DOE program are designed to basically push the technology forward—interoperability in this environment is dif-

difficult because you can't write a standard against a technology that doesn't exist yet. So, this issue of extense-ability and extend-ability of the standards to preserve the upgrade-ability of the devices is going to be a key component.

Senator MURKOWSKI. Let me ask you, Ms. Hoffman—you mentioned the information clearinghouse is going to make this smart grid data available to the public. How does DOE propose to undertake this responsibility, just in terms of the information that is out there? How do we deal with the privacy concerns?

Ms. HOFFMAN. In implementing the clearinghouse, what the Department of Energy plans to do is release a solicitation asking for competitive bids for an organization to manage the clearinghouse and to have it Web-based. We have worked with FERC and NARUC to develop a consensus of what types of information should be placed in the clearinghouse in order to evaluate costs and benefits of each of the different smart-grid-type demonstration projects, so there can be a consistent framework or architecture for evaluation of the different projects. Those are our initial thoughts on what we plan to do with implementing the clearinghouse.

Senator MURKOWSKI. Question for all three of you. Is NIST the right entity to deal with the interoperability framework? Dr. Gallagher, you said you're ready to take it on. You've been given the task, you've been given the money. Are you the right entity?

Mr. GALLAGHER. I think the answer to that question, from our perspective, is yes, but it's not, in the sense that we were a smart-grid agency ready to be deployed. What we are is an agency that has a long track record of working on standards-related issues, including interoperability of standards; for example, in health IT, in computer security standards. It's not so much not just the technical expertise within NIST and our laboratories, but it's also our ability to work—we have a long track record of working effectively with standards development organizations, of understanding how to coordinate Federal involvement in standards, and we believe this positions us somewhat uniquely.

But, I would say it's not a question of NIST doing this alone. I take most seriously the language in the EISA Act, that NIST coordinate. This has to be intrinsically an interagency process, and that the governance and priority-setting has to be done in concert with DOE.

Senator MURKOWSKI. Commissioner Kelly, you agree?

Ms. KELLY. Yes, Senator, I agree. We believe that NIST does have the in-depth expertise to handle this task, and also, it does have established relationships with standards-development organizations, including international ones. In particular, attempting, at this point, to transfer the task to another agency would cause delay. As I mentioned before, the \$10 million that the stimulus bill provides in funding for the standards development work should enable the process to be accelerated, which is what we would like to see; we would like to see it accelerated. We think that we can play a very constructive role, as Dr. Gallagher mentioned, providing information that we have, that NIST doesn't have, about the technology and the day-to-day workings of the industry.

Senator MURKOWSKI. My time is up. Did you want to add something, Ms. Hoffman?

Ms. HOFFMAN. Yes, very quickly, Senator. I agree with, and I concur with, the statements that were said earlier.

One other point is, we do need to be able to bring things to closure, to be able to adjudicate, to be able to actually get acceptance of the standards, with FERC and the States, just to bring things to closure, to keep things moving.

The CHAIRMAN. Senator Cantwell.

Senator CANTWELL. Thank you, Mr. Chairman. Thank you for having this hearing this morning.

I was looking at the statute, section 1305, which is called a Smart Grid Interoperability Framework. I'm noticing, thankfully—remembering, thankfully, how much we wrote that word “framework” into that language in the section, because, listening to the testimony this morning—and I think—Commissioner Kelly, I think you even have a section where you talk about open architecture, which—I think, Dr. Gallagher, what we're really talking about here is APIs, right? We certainly want open standards, but we want, you know, application program interfaces so that various technologies can talk to each other. Is that correct?

Mr. GALLAGHER. I think that anytime you're including looking at digital information technology being added to something, the communication interfaces and protocols are going to be at the heart of that system.

Senator CANTWELL. I'm comparing that to the difference between open architectures, which means, you know, opening up someone's entire architecture; you don't care what someone's architecture is, as much as it can communicate with other companies and that there's a protocol that can do that. We've had a lot of confusion in the stimulus bill about this issue, and so, I want to make sure that we're clear this morning.

Mr. GALLAGHER. Yes, I think our position is that this has more to do with the characteristics of the standard both being flexible, uniform, and technology-neutral; in other words, not having proprietary lock-in as part of the standards, that's correct.

Senator CANTWELL. Wouldn't you say that a lot of the standards bodies that are referenced in the statute—they are like IEEE and others—you know, are pretty good organizations for helping us get this done?

Mr. GALLAGHER. Oh, I think there's no question. In fact, I think, in the United—

Senator CANTWELL. That we might even impede them sometimes?

Mr. GALLAGHER. I think so, and I think they don't like to be held back. I think, in the United States, we have a long track record of having standards developed in the private sector. The NIST role is not to take over their role. We basically want to harness that energy and ability. The issue has been the priority-setting and coordination. We believe that's been the missing piece.

Senator CANTWELL. So, we have to figure out how we can do that in this particular instance, because I think there's a lot going on with the technology in the private sector that probably is already coordinated, to a certain degree. Anyway, I'd just go back to the point that it is about a framework, and it is about APIs and open

standards, as opposed to open architectures; that being an important point.

Another issue is, as it relates to, say, for example, like, wireless meters, you know, there's a certain element here that the packets of information are so small, it's not really cost-effective to do, you know, on an Internet protocol. Is that your understanding?

Mr. GALLAGHER. I don't have a specific understanding on that issue, at this point.

Senator CANTWELL. OK. I think that's something else that we also—because, again, there was a lot of discussion in the stimulus about, you know, an IP architecture, where, you know, there's—which is great for a lot of data to flow—may not be as cost-effective for a small amount, a packet of information. So, that's why these networks that are already there are working effectively. So, we need to keep our eyes on that.

I think this discussion we've had here, and I'm sure the next panel will have a lot of input, and so, I look at it, and I think, OK, coordinate with IEEE and others, and make our way down this road, leaning on them, but the one thing that we can do, the one thing that we have to really think about, is rate recovery. Commissioner Kelly, you touched on it, and others. That's a key issue here. That's the stumbling block. We look at this issue from weatherization, and we say, yes, invest in weatherization now; it's costing you some money, and you save money in the future. Yet, the same principle is here. The same principle of smart metering, from an investment perspective, is "Invest now, and you're going to get a return." So, how can we do a better job, as policymakers, on this greater recovery issue, and flatten this so that we can make this energy-efficiency platform happen at a more rapid rate?

So, Commissioner Kelly.

Ms. KELLY. Yes, Senator. You raise an excellent point. The demonstration project, and the funding of it, I think, is a real opportunity to advance this, because, with the 50-50 match, it will give an incentive to spend the money and recover the outlay for the utility. I think what we anticipate seeing is a real demonstration of the benefits, and that the benefits justify the cost.

At the transmission level, it's easier for us to do that, frankly, than at the distribution level, because some of the benefits at the distribution level are, as yet, unknown, and it's unclear exactly how the interfaces will work with consumers, and what the consumer acceptance will be, and the consumers' ability to respond. I think the demonstration projects will help establish that.

Senator CANTWELL. Anybody else on that point?

No? OK, I guess I'll save my follow up for the second panel, on this point.

But, Mr. Chairman, I actually think that this is—I think this rate-of-recovery issue is one that we need to spend more time thinking about. So, I thank you for the hearing.

The CHAIRMAN. Thank you.

Senator Corker.

Senator CORKER. Very good. Mr. Chairman, thank you for this hearing. Thank each of you for testifying.

I have to say that the smart grid is interesting to me. OK? I can see some tremendous benefits, and, at the same time, we sort of

live in this world right now where, you know, quote, “capitalism has failed,” and we’re going to kind of make everything happen from this central government. This one doesn’t seem quite as concerning as some of the other things that I’ve heard throughout the last several weeks. But, what is your greatest fear? I mean, as you look at this, at the smart grid—and I can see all kinds of benefits, if this is done properly—what is—as you step back away from it, and maybe somebody else occupies your position in a couple of years, and maybe they make a huge blunder of this—what are your biggest concerns? Each of you. Briefly. Thank you.

[Laughter.]

Mr. GALLAGHER. That could be a long list.

[Laughter.]

Mr. GALLAGHER. Thank you. I have a number of concerns, but I think going narrowly to the position of trying to establish an effective mechanism because what NIST is talking about is putting together the machinery that makes the standards development activity work very effectively—is basically making sure that all the players are brought to the table. The concern is that you have, in some cases, the technology moving forward in some areas already—States, localities, and so forth—and we want that type of innovation; and yet, it can start to jam the ability to get people together to reach consensus. We think that everyone understands the urgency to work together, because the entire system depends on reaching a broad agreement about how these devices will work in concert with each other. That’s really what makes smart grid smart, is the ability of these systems to work together.

So, NIST can work with DOE, we can convene, we can help set priorities, but the real pace of this is going to be set by the willingness of this entire sector—the utility companies, consumer groups, industry, manufacturers—to work effectively together. I think they’re up to it, but I think that’s the concern. That’s really the major issue I think about.

Senator CORKER. OK, thank you.

Ms. HOFFMAN. Following on with what Dr. Gallagher said, my concern is that we may miss an opportunity if we don’t adequately integrate the technology with the policy options—i.e., for consumers you can have a smart meter, but you need to have an innovative rate for the consumers to help them, educate them on their consumption. It’s not just energy efficiency, it’s energy management at the consumer level. So, my concern is that we don’t miss any opportunities to educate the consumers to advance energy efficiency to the next level, to advance the intelligence on the transmission system, that we can have faster recovery and resiliency on the system.

Senator CORKER. Commissioner.

Ms. KELLY. Thank you, Senator.

Our first concern is security and cyber-security, and we want to ensure that, with the two-way communication capability, that the security is retained.

Our second concern is the possibility of stranded costs and obsolescence, but we think that, with the appropriate emphasis on openness for the demonstration projects, that that concern will be minimized or eliminated.

Then, the third concern is, Will the benefits to the consumer actually be able to be demonstrated? There are a number of things that have to come into place to ensure that that happens, including that the information that the consumer needs is readily available and that the ability of the consumer to respond with demand response is available.

Again, we think that, with the appropriate handling of the demonstration projects that DOE has money to implement, that we can achieve those objectives.

Senator CORKER. So, I look at the stimulus bill. I know that has \$4 and a half billion in there. I've watched the healthcare situation. I think all of us scratch our head to look at a healthcare system that doesn't have a standard technology where everybody talks with each other. I mean, it's been the most frustrating thing, I think, that most of us have looked at in that industry. So, I can see why developing this framework in advance is important, before people get sort of married to certain types of software and hardware.

So, on the stimulus bill, does it not make sense for you all to sort of finish that before money starts being spent on a smart grid, in that, aren't we simultaneously creating a problem for ourselves? It's not as massive as we have in the healthcare system, but that part doesn't make a lot of sense to me.

Since my time's running out and I won't be able to ask another question, also, How important is this to transportation? To me, it seems like it might be very important down the road.

But, I'd love any answers along both those lines, if the Chairman will let you answer.

Ms. HOFFMAN. I think it's very important to implement the \$4.5 billion in the Recovery Act, especially the demonstration projects and such, to get that moving further along, as Commissioner Kelly has already brought up. It will provide us great insights along with some of the existing projects currently going on, into, what are the costs, what are some of the benefits, and what are some of the hurdles that we need to plan for.

Ms. KELLY. Senator, I would agree with Ms. Hoffman that we can ensure a minimum risk of obsolescence and stranded costs if the applications are evaluated with an eye to their openness and their ease of upgrade-ability with minimum cost.

Mr. GALLAGHER. Yes, I'm going to answer the question from a different perspective. Speaking as somebody looking at the standards development process, while it's desirable to lower the risk of these investments by having the standards in place first and making it a precondition, two things make that not necessarily the right approach.

One is, we want to see the innovation coming out of these projects, because they will, in essence, drive some of the standards work itself. But, the other issue is that it can turn the priority-setting around. In other words, the priorities can become about which standards need to go out to release funding to do specific things, rather than which standards need to go out to basically promote the overall interoperability of the system. So, we believe that the priority-setting process within the standards development framework needs to be driven by this major goal of making sure the sys-

tem is interoperable, and not necessarily according to other criteria.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, I was on the floor of the Senate, so I missed the presentations. However, I've had a chance to read some of the testimony.

My colleague from Tennessee asked the question about government involvement. Let me ask it in a different way. What if smart grid, as a terminology and as a point of discussion with respect to government policy, just takes a complete backseat. I know we've got money out there in the stimulus bill, but let's assume that this is not about government, but about companies deciding what they want to do in their own interest. What would become of what we now call smart grid initiatives?

Ms. Hoffman.

Ms. HOFFMAN. From my perspective, it would still move forward, but at a slower pace. Currently, I believe FERC estimates there are 7 million meters out there. I know that a recent report from KEMA estimates, that by 2015, they're going to see approximately 30 million meters come out in the marketplace. I do believe the technology will move forward. The question is how can we coordinate as Federal agencies to make sure that we have the most open architecture possible and that we actually can advance the state of communication and capabilities within the United States.

Ms. KELLY. Senator, I would say that one of the differences here is that we have a regulated industry, versus deployment of technology in a competitive market without regulated industries. Because we have regulated industries, we have a couple of gatekeepers. We have the utility, which is a gatekeeper, and we have the Federal and State regulators, which are gatekeepers. That process makes the deployment of advanced technology in the sector much slower.

So, providing stimulus money helps cut through that and enables—and the other thing I guess I was going to say is that those gatekeepers, particularly the utility, when it spends money on smart grid technology, the benefits don't necessarily accrue entirely to the utility. So, it's—having a stimulus funding helps them get over that hurdle.

Senator DORGAN. Yes. In many ways, smart grid is kind of at odds with the traditional concept of a utility company. A utility company is in place to sell electricity for the benefit of its shareholders and to earn a profit. One would expect that better performance is measured by better sales and more sales. However, smart grid is, in many ways, about more efficient use and conservation. The CEO of Duke Energy, James Rogers, for example often speaks before our committee about the basic model of our system.

Let me ask a question about Xcel Energy's Boulder Smart Grid City initiative. What is happening with respect to a demonstration project, like Boulder, and the interaction between the folks that put that project together and the folks that are developing standards? What kind of interaction exists, at this point?

Mr. GALLAGHER. I don't have specific names, but I know that the NIST folks who are working on the standards development are working with the city of Boulder, in terms of their demonstration

projects. That's true of many of the areas where these demonstration projects are going on, we are actually very interested in these demonstration projects, and want the people involved with them to be involved in the standards development effort.

Senator DORGAN. Ms. Hoffman.

Ms. HOFFMAN. The Xcel project looks at different aspects of the smart grid, from the smart home to the smart city. So, what it does is, it provides some insights on the different technologies that are used at the home which will allow some of the standards to be developed with respect to communicating with a hybrid vehicle or with other home area networks. It provides insight, as well as feedback, into the development of the standards, as required.

Senator DORGAN. Dr. Gallagher, you talked about cybersecurity some. I had a CEO of a major corporation meet with me, within the last 2 weeks, who talked about your company setting up a computer with the substantial protections and so on. They did it as a demonstration to find out what kind of attacks were going to be coming against that computer. Within 24 hours, of establishment, there was an attack against that computer. They traced it to an eastern European company, which was traced then to an African country, and then they lost the trace. But, there was still an attempt to infiltrate that computer. So, the issue of cyber-security is really important. Should there be demonstration projects that deal with cyber-security—

Mr. GALLAGHER. I think there's—

Senator DORGAN [continuing]. As we put together smart grid?

Mr. GALLAGHER. I think there's absolutely no question that, when you combine digital information technology into a system that's controlling and moving electricity, that the security implications are enormous. The way I view it is, the information security has to be built in. It's the very foundation of these standards. It can be, not only in the demonstrations, in terms of looking at vulnerabilities in those deployed demonstrations, but it's a key part of the conformity assessment piece. In other words, you have to have the ability to test these systems to make sure that they're complying with the standards, including the security standards.

Senator DORGAN. If I might just make a comment, as my time is up, that I think the two barriers on smart grid have been described as the standards, both technology standards and interoperability standards. I think Senator Cantwell talked about that. The second, I referred to in my first question; that is, the need for regulatory reform and incentive structures. Because the existing model, is a model largely—it has been, for decades—to sell more and increase your revenue—this actually is counterintuitive to that model. But, there are a number of utility companies—I mentioned Xcel and Duke—that are very interested in helping us and working with us to change that model, which I think is refreshing, as well.

Let me thank the panel.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman. I want to thank the members of the panel. I apologize for missing the presentation.

Mr. Chairman, I want to thank you for the leadership that you showed this morning on getting Tony Blair and others here to dis-

cuss the issues of global climate change, energy, and those needs. I thought it was very productive. One of the things we discussed was smart grid and the need to have that kind of interaction and opportunity and technology.

So, as we talked about energy and the economy and the environment, all together, smart grid is an important part of that. Obviously, deploying this is going to require significant cost. When you turn on the news and find, now, 27 percent of Americans are having a hard time sleeping because of the economy, the question is, What are the costs going to be, and what's the impact going to be, on the users, and what those expenses are going to be? Are there thoughts of that? Someone mentioned the idea of informing the consumer, educating the consumer. What's being done about that?

Ms. KELLY. Senator, through the regulatory process, there has to be approval by the Federal regulator, for smart grid advancements to the transmission system, and the State regular, for smart grid advancements to the distribution system. As part of that process, the cost-benefit analysis is required to be demonstrated. The clearinghouse, the information clearinghouse provisions that you added to the stimulus bill, will help us in this effort, because we don't always fully understand what the benefits are likely to be, because it's new technology, and it hasn't been deployed, and it hasn't been used by consumers. But, the point that you make is a critical one. We have to have a benefit, and be able to show consumers a benefit for the investment.

Senator BARRASSO. Yes. Ms. Hoffman, you had mentioned the stimulus package, and there was a front-page story in the Wall Street Journal, "Next Challenge On Stimulus: Spending All That Money," and they specifically talked about the Department of Energy. It says, "The new Energy Secretary says he'll have to transform how parts of his agency work if the President's—if the President's stimulus plan is to succeed." This goes on, and there's a picture of the new Secretary with the President; talks about, "DOE is going to have to dramatically change how it does business if it hopes to push all this money out the door," said a former senior Energy Department official who—it says, quote, "They're going to need more people, more oversight, and more freedom to waive regulations." Could you talk about what's going on in that area, please?

Ms. HOFFMAN. Thank you, sir.

The Secretary has made a statement, even within the Department, that we are going to put the resources necessary to implement all aspects of the stimulus bill at the Department of Energy. We are looking at accelerating as many processes as possible with respect to the smart grid legislation. We are trying to get more information out to the public sooner, so that they can plan for projects, proposals, and submissions in a timely fashion. We plan to release funding opportunities for smart grid activities shortly. From that point, we hope to teach potential applicants faster, as well as through the Web site, grants.gov, and get them engaged in the process so that they're informed and we can expedite implementation.

Senator BARRASSO. This article goes on to say, "The Department has a history of delays, of letting—and of letting costs spiral." It says, "The Energy Department has missed deadlines and mis-

judged the cost of projects before.” It said, “Mr. Chu has heard an earful about such delays,” and he says he’s talking to officials at other agencies that he says have, quote, “a better track record of getting financial aid to companies quickly. Some of these agencies’ employees could be temporarily reassigned,” it says, “to the Department of Energy to help it mete out the funds.” Are you doing things along those lines yet?

Ms. HOFFMAN. Yes, sir. The Secretary is looking at all possible avenues, as well as talking to other agencies, and is looking at bringing folks onboard to help implement the program.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Dr. Gallagher, let me just ask if you could, maybe, provide us with something. In your testimony, you talk about suites of standards to be developed for different aspects of this smart grid, including distributed energy resources, demand-response devices, appliances, electric vehicles, wide area measurement systems, and other parts of the grid. You also talk about the various standard-setting organizations, or standards development organizations, SDOs. Could you give us sort of an inventory—I don’t mean right now, but I mean submit it to us—as to what the different standards are that you currently think will need to be developed and what the organizations are that would logically be involved in the development of those?

Mr. GALLAGHER. Yes, we’d be happy to provide both the structure of why we set this framework up in these areas, identify the standard suites that we envision, and, to the extent we know them at this point, the standards that are involved in each of those areas. We’d be happy to—

The CHAIRMAN. That’s great. As I understand it, this draft framework you’re talking about having this summer will at least begin to prioritize which of these standards have to be done first and what the timeframes are. Is that accurate?

Mr. GALLAGHER. That’s accurate. The idea is to provide the coordination so we can decide what’s most important to move forward.

The CHAIRMAN. Yes. That would be very useful, I think.

Senator Murkowski, did you have anything else from this panel? We have a second panel.

Senator MURKOWSKI. Just very, very quickly. This follows up on Senator Barrasso’s comments about the cost. There was an article in the Wall Street Journal, just a week or so ago, speaking to the effort in Boulder, Colorado. It was very interesting reading. You know, you think about Boulder as a pretty innovative community looking to take on some cutting-edge things, and the comments about just how people were dealing with a smart grid capability within their home, and what it meant, I think—the comment that struck me was the—was that of the head of the university, or the president of the university, and his wife. You would think that these would be some pretty progressive people. It’s going to be a challenge for us to really educate consumers as to, How do you take advantage of this? Because if you don’t take advantage of it,

you're going to be billed for it, and you're not going to be seeing the benefits.

So, haven't really heard as much this morning about how that outreach will actually work, how this information clearinghouse is actually going to work. I do hope that we will be aggressive, and we will be aggressive before things are put in place, because then you're just going to be playing catch-up with people. So, I would hope that, within the Department, that effort, as far as public education and how we transmit this information, is really a very aggressive one.

Ms. Hoffman, do you care to comment on that?

Ms. HOFFMAN. Briefly. The Department has been appropriated \$100 million for work force training and education as part of the Recovery Act, and we will make an effort to help consumers better understand the smart grid, and the benefits and the costs as part of that.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Shaheen, we're through with our questions of this panel. We have a second panel coming on, here. Did you want to ask some questions of this panel?

Senator SHAHEEN. No, I'll wait.

The CHAIRMAN. OK.

Thank you all very much for your testimony, and we will stay in touch.

I'll call the second panel forward. We have The Honorable Frederick Butler, who is the head of the National Association of Regulatory Utility Commissioners—he's the president of that organization this year, as I understand it; Edward Lu, who is with Google, Inc.; Katherine Hamilton is with GridWise Alliance; and Evan Gaddis, who is with the National Electrical Manufacturers Association. So, thank you all for being here.

I think if we could follow the same basic procedure with this panel and each of you take maybe about 6 minutes and tell us the main points you think we need to understand, and then we will have a few questions.

Why don't we start with you, Fred, if you would go ahead and give us the perspective of the National Association of Regulatory Utility Commissioners.

Thank you.

STATEMENT OF FREDERICK F. BUTLER, PRESIDENT, NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS, NEWARK, NJ

Mr. BUTLER. Thank you very much, Senator. Good morning, Senator Bingaman and Senator Murkowski, members of the committee.

My name is Fred Butler, and I am a member of the New Jersey Board of Public Utilities. I also serve as president of the National Association of Regulatory Utility Commissioners, NARUC, on whose behalf I'm testifying here today. I am honored to have the opportunity to appear before you and to offer our State's perspectives on smart grid.

We have submitted testimony, which I hope will go into the record, and I will summarize our views for you.

My message is simple: the timing and deployment of smart grid is the key here, and that we don't think we should put the cart before the horse. As a State regulator in New Jersey, and as co-chair of the national board of the FERC-NARUC collaborative studying smart grid issues, I'm convinced of the smart grid's potential to revolutionize how energy is delivered and consumed. I know the smart grid can change how utilities oversee their networks and improve reliability. I know that consumers could have greater control over their usage and have potential to conserve energy and lower their carbon footprint and lower their bills. I also know that if we do not do this correctly, in terms of implementing this, we can endanger our coming even close to meeting any of those lofty aspirations.

The benefits of the smart grid are obvious, and we must be sure that we move deliberately so that the costs of rolling out the necessary infrastructure are borne by those who will benefit. This means that we should not focus immediately on the end user; rather, we must start with the backbone, the transmission and distribution systems themselves, while proceeding carefully to go inside consumers' homes.

Our Nation's energy problems will not be slain by a silver bullet, but rather by what's been referred to by many, and what's become one of my mantras, the silver buckshot. This includes building some new transmission, encouraging renewable resources, promoting efficiency, resolving the nuclear waste storage problem, and developing new technologies.

Meanwhile, achieving the ultimate goal of reliable service at a fair and reasonable price is becoming harder in this era of rising costs. There's a high probability that, within the next 3 to 10 years, all electric consumers will be facing higher bills due to increased costs driving rate increase, new environmental regulations, and other factors. I mention this right now because some of us are selling the smart grid as that silver bullet that will empower consumers to lower their usage and, correspondingly, their energy bills. While this may ultimately be the case, we must learn from electricity restructuring experience that many States have had.

The promise of restructuring is that consumers would save money by shopping for power. In many States, rates were cut and/or frozen for a set number of years so that, at the outset, the restructuring seemed to be a success. The 2000–2001 western energy crisis prompted many to rethink this approach. Instead of lower prices, consumers saw their rates skyrocket as utilities were forced to buy electricity through the volatile spot market, which we later found out was being manipulated. Also, in Illinois and along the East Coast, starting in 2006, when the rate caps expired in Maryland and, to a certain extent, in Delaware, ratepayers and politicians led a mutiny that nearly resulted in the demise of the States' public service commissions in those jurisdictions. The problem was not restructuring, per se, but the way it was sold to consumers; we promised too much and we delivered too little. Because of this approach, the concept of restructuring has taken a significant hit. We cannot make the same mistake with the smart grid. If we want to make the biggest impact, we should focus on the operational side first, before moving to the end-use consumers.

Many have extolled the virtues of how an updated transmission system will give grid operators a much better view of their transmission and distribution network. New technologies can be installed on distribution poles in neighborhoods, and on those lines themselves, to give advanced warning of an imminent power system failure. A modernized grid can help utilities lower costs by avoiding some outages, reducing the need for sending out trucks to read meters or restore power. Business operations can be streamlined, reliability can be improved, and money can be saved.

The question of who pays is of utmost importance, and with consumers already being challenged because of rising rates and the economic downturn, we must be careful before putting more on their plate. In this case, starting with the backbone means the initial investments would be paid for mostly by the utilities themselves, as they will be the largest initial beneficiaries. Meanwhile, advanced meters, and the applications they enable, can be deployed strategically in pilot and demonstration projects, thus proving the benefits to those end-use customers.

The second part of smart grid should be implemented by and at the State and local—by a State and local effort. In my experience, I’ve found that a key component for an initiative such as smart grid is public outreach. We must use Federal resources and State resources to explain to consumers that a new smart grid program is worthwhile. Most State commissioners understand the benefits of advanced-metering infrastructure and time-of-use rates, but most consumers do not. Because these new programs will need new rate structures, States must be sure that consumers will embrace the technology and tolerate the initial investment. You can’t have a smart grid and dumb rates. So far, this is only occurring in a few States.

In terms of where we go from here, a good place to look is at the work we’ve done with the NARUC-FERC smart grid collaborative, which I co-chair with FERC Commissioner Suedeen Kelly. As this is an issue that cuts across both wholesale and retail energy markets, the dialogs we are initiating through this process will help us all as we move forward. The collaborative has met three times since its February 2008 inception; most specifically, at NARUC, the winter meeting, recently, last month. In my role as co-chair, I have spent a considerable amount of time getting up to speed on different technologies and pilot programs throughout the country. This collaborative is analyzing these pilot and demonstration projects, such as the Boulder, Colorado, Smart Grid City, to see what works and what doesn’t.

Smart meters are not cheap. Right now we’re talking about approximately \$150 to \$200 per meter. So, we must be careful in forcing anyone to upgrade if they are not willing and if they’re not ready.

Pilot programs must be structured to create the buzz, create the interest in the possibilities that exist, and a certain level of excitement, not a taxpayer revolt—or, a ratepayer revolt.

In addition, there should be large-scale demonstration projects that cover a larger geographic area, that reflects a microcosm of the country at large, including different incomes and different education levels.

Smart grid can be successful, provided that we have Federal and State governments working in concert with one another as partners, not working in contrast as adversaries. The challenge before us is great. The technology and the potential benefits are exciting.

I respectfully request that this committee and this Senate recognize and respect the unique roles of the Federal and State governments and enable us to work together toward a truly 21st-century electricity delivery system.

Thank you for your time, and I would be happy to answer any questions.

[The prepared statement of Mr. Butler follows:]

PREPARED STATEMENT FREDERICK F. BUTLER, PRESIDENT, NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS, NEWARK, NJ

Good morning Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee:

My name is Frederick F. Butler, and I am a member of the New Jersey Board of Public Utilities (NJBPU). I also serve as President of the National Association of Regulatory Utility Commissioners (NARUC), on whose behalf I am testifying here today. I am honored to have the opportunity to appear before you this morning and offer a State perspective on "Smart Grid".

NARUC is a quasi-governmental, non-profit organization founded in 1889. Our membership includes the State public utility commissions serving all States and territories. NARUC's mission is to serve the public interest by improving the quality and effectiveness of public utility regulation. Our members regulate the retail rates and services of electric, gas, water, and telephone utilities. We are obligated under the laws of our respective States to ensure the establishment and maintenance of such utility services as may be required by the public convenience and necessity and to ensure that such services are provided under rates and subject to terms and conditions of service that are just, reasonable, and non-discriminatory.

There's a worn-out cliché that goes something like this: Don't put the cart before the horse. In an industry as old as the electric utility sector, this saying aptly describes the situation we face in dealing with the modern Smart Grid and future demand growth. As a State regulator in New Jersey and co-chair of a national board analyzing Smart Grid issues, I am absolutely convinced of the Smart Grid's potential to revolutionize how energy is delivered and consumed. I know the Smart Grid can change how utilities oversee their networks and improve reliability. I know that, in the end, consumers could have greater control over their usage and have the potential to lower their bills. I also know, however, that if we do not do this correctly, if we move too quickly and promise too much we can endanger our coming close to meeting any of those lofty aspirations.

That is why it is important to remember that old cliché and not put the cart before the horse. The benefits of the Smart Grid are obvious, and we must be sure that we move deliberately and in stages so that the costs of rolling out the necessary infrastructure are borne by those who will benefit. If we expect the horse—i.e. the consumers—to push the cart before it is ready, we may never get the Smart Grid off the ground. This means that we should not focus immediately on the end user and demand response; rather, we must start with the backbone—the transmission and distribution systems—while proceeding carefully to go inside consumers' homes.

Achieving the ultimate goal of reliable service at a fair and reasonable price is becoming harder and harder in this era of rising costs. There is a high probability that within the next three to 10 years all electricity consumers will be facing higher costs because of rising fuel and commodity prices, as well as the initial sticker shock of Federal and State initiatives to increase renewable generation and the anticipated costs associated with climate change legislation. These costs are and will continue to hit energy companies hard, and State regulators are faced with having to approve rate increases that a growing number of consumers may not be able to afford. Should the potentially substantial price tag of Smart Grid be suddenly thrust upon them, not withstanding the Federal funding increase in the stimulus law, ratepayers will not be happy.

The utility industry is facing tremendous challenges, and we all need to welcome new technologies that could help this country become more efficient while bolstering the existing transmission grid. The Smart Grid has this potential, but only if em-

braced by utilities and, most importantly, consumers. Without getting the consumers on board, the Smart Grid may just be another good intention.

Before going too much further, it must be stated that our nation's energy woes will not be slain by a single silver bullet, but rather by what has been referred to as silver buckshot, a whole array of various and new revolutionary energy programs. This includes building some new transmission, encouraging renewable energy resources, promoting energy efficiency, resolving the nuclear-waste storage problem, and developing new technologies. The easiest and cheapest of this list is, of course, energy efficiency, but we must consider the role new technologies can play in helping us fix our current situation.

Here is where the Smart Grid comes into play. With the right investment and incentives, modernizing the nation's transmission system could revolutionize how and when we use electricity. If done correctly, utilities can streamline their operations and have more control over their networks. The more efficient we get, the less electricity will be lost on the transmission grid. Consumers, meanwhile, can reduce their usage across the board, and especially during peak times. This can actually lead to reduced electricity bills. From an operational, business, environmental and economic standpoint, the Smart Grid, if implemented properly, can be a major win-win.

But we do need to be careful. Right now, we are selling the Smart Grid as a means of empowering consumers to lower their usage and, correspondingly, their energy bills. While this may ultimately be the case, we must learn our lesson from the restructuring experience before heading down this path. The promise of restructuring was that consumers would save money by shopping for power. Nearly half the States introduced some kind of restructuring legislation in the mid- and late-1990's. Congress also considered mandating a national restructuring scheme during the late 1980's and early 1990's. In many States, rates were cut and/or frozen for a set number of years, so at the outset, restructuring seemed to be a success.

The 2000–2001 Western Energy Crisis prompted many to rethink this approach. Instead of lower prices, consumers saw their rates skyrocket as utilities were forced to buy electricity through the volatile spot-market costs which, we later found out, were being manipulated. Along the East Coast, starting in 2006, when rate caps expired in Maryland, ratepayers and politicians led a mutiny that nearly resulted in the demise of the State's Public Service Commission. Cooler heads prevailed and the massive rate increases were phased in over time, but many consumers still feel burned. Delaware and Illinois have had similar experiences. We have not had these kinds of problems in New Jersey, but the sting in many States is being felt across the country.

The problem here was not restructuring per se, but it was the way it was sold to consumers. Instead of determining the best way to move forward deliberately, we jumped right in, with the promise of lower rates to follow. Because of this approach, and because of the results, the concept of restructuring has taken a significant hit. Indeed, we put the cart before the horse.

We cannot make this same mistake with the Smart Grid if we want it to succeed. There is no doubt that the Smart Grid will bring consumers significant benefits. However, if we want to make the biggest impact, we should consider a different approach and concentrate first on the operational side while we educate consumers and deploy smart meters very strategically. Many utilities, engineers, and vendors have extolled the virtues of how an updated, modernized transmission system will give grid operators a much better view of their transmission and distribution network. New technologies can be installed on distribution poles and on the lines themselves to give advanced warning of a power surge. A modernized grid can help utilities lower costs by reducing the need for sending out trucks to read meters or restore power. Business operations can be streamlined, reliability can be improved, and money—real money—can be saved.

For instance, phasor measurement and backscatter sensors on the transmission grid, along with video sagometers and wireless mesh sensors, can use radio-frequency identification (RFID) technology to give utilities real-time information on the status of specific lines. These sensors can detect problems on the grid as they develop and that are relayed back to the utility for resolution before they escalate into a massive blackout. Instead of relying on costly and time-consuming manual visits from work crews, utilities will have up-to-date information on their system and can act accordingly. These reasons alone will make the Smart Grid a safe and worthwhile investment for utilities, whether or not end-users choose to get on board later.

From my perspective as a State regulator, it seems to make the most sense that if we're going to begin investing in a Smart Grid, we should start here. If we start with the backbone—if we update and improve the delivery system first—we will see the utility company side benefits of the Smart Grid. The question of who pays is

important—and with consumers already challenged because of rising rates and the economic downturn, we must be careful before putting more on their plate. In this case, starting with the backbone means the initial investments would be paid for by the utilities themselves, as they will be the initial beneficiaries, and not immediately by ratepayers. While we all would like to see end users enjoy the benefits of Advanced Metering Infrastructure, the Smart Grid can still make an immediate and long-lasting improvement for the industry by making the delivery system more efficient. This alone will result in considerable savings and fewer outages. Meanwhile, advanced meters and the applications they enable can at the same time be deployed strategically in pilot and demonstration projects thus demonstrating the benefits to end-use customers. Moreover, these backbone investments are necessary at some point during the transition to the Smart Grid. So let's ready the cart to be pulled before asking the horse—or consumers—to pull it.

The second part of Smart Grid should be developed and implemented in an effort coordinated by State and local officials. In my experience as a Commissioner I have found that a key component for an initiative such as Smart Grid is public outreach. We should use some Federal resources to explain to the consumers that a new Smart Grid program is worthwhile. Most State commissioners understand the benefits of Advanced Metering Infrastructure and time-of-use rates, but most consumers do not. Because these new programs will need new rate structures that will be disruptive to habits of paying energy that have been in place for over 120 years, we must proceed carefully to avoid public backlash. Time-of-use rates are being welcomed by some sectors of society and feared by others. States must be sure that consumers will embrace the technology and tolerate the initial investment. So far, this is only occurring in a few States. In California, for example, the Public Utilities Commission is committed to rolling out the Smart Grid to their consumers. The State has taken a number of steps laying out the initial foundation, including a decision in September 2008 approving a smart-metering program for Southern California Edison, one of the State's three investor-owned utilities.

Still, my colleague on the California PUC, Commissioner Dian Grueneich, said that despite the commission's conclusion on the benefits, key California consumer groups remain unconvinced that the Smart Grid will deliver. The advanced metering infrastructure deployment for Southern California Edison will cost about \$1.63 billion, with estimated benefits ranging from \$9 million and \$304 million for consumers. Speaking in September 2008 at the Grid Week forum in Washington, D.C., Commissioner Grueneich said the PUC moved forward despite the strong opposition from some consumers. "Very significant costs have been authorized and put into rates," she said. "Our consumer groups are not comfortable" with this.

The concern that many of my colleagues are trying to resolve is that consumers are convinced that the Smart Grid will only raise their rates with no discernable benefits. In a high-priced environment, some or perhaps most consumers see advanced metering rollouts as just one more headache and budget buster and are particularly scared that utilities and vendors will keep raising rates as the technology changes.

California will be launching a major education, marketing, and outreach campaign next year. This will need as much support as possible from all parties so the program can succeed and perhaps reduce the sting on ratepayers. Once they see the benefits, they should also see how they can turn this into savings.

As this experience demonstrates, the way a Smart-Grid program is structured and rolled out is absolutely key to its success, and regulators and industry must be flexible to ensure that consumers will not feel inundated or overwhelmed. Depending on how a Smart-Grid program is structured and rolled out will be the key to its success, and Congress, regulators, and industry must be flexible to ensure that consumers will not feel inundated or overwhelmed. As a State regulator, here's how I think we should proceed.

A good place to look is at the work we're doing with the NARUC-Federal Energy Regulatory Commission (FERC) Smart Grid Collaborative, which I co-chair with FERC Commissioner Suede Kelly. As this is an issue that cuts across both wholesale and retail energy markets, the dialogs we are initiating through this process will help us all as we move forward. The Collaborative brings together a diverse group of State and Federal regulators, consumer groups, and industry experts and allows us to talk in a public setting about these issues.

The Collaborative has met three times since its February 2008 inception, most recently at the NARUC Winter Committee Meetings last month. We have discussed issues such as cost allocation, specific technologies, interoperability, and pilot programs with consumers and industry executives who are promoting Smart-grid technologies.

In my role as co-chair of this Collaborative, I have spent a considerable amount of time getting up to speed on the different technologies and pilot programs throughout the country. I am, as is the entire Smart-Grid industry, very interested in the pilot program in Boulder, Colorado, which is aiming to become the nation's first "Smart Grid City." I have discussed the many different pilots with my regulatory colleagues and am convinced that we must take a deliberate approach to introducing these new technologies to end-use consumers. As described above, consumers have yet to "buy into" the concept of the Smart Grid, and when they see any associated rate increases, they are more than likely not going to be pleased. Smart meters are expensive—right now we're talking about approximately \$150–\$200 per meter—so we must be very careful in forcing anyone to upgrade if they are not willing. Pilot programs must be carefully structured in such a way that creates a "buzz" and excitement, not a ratepayer revolt.

In addition, there should be large-scale "demonstration projects" that cover a larger geographic area. We are all watching the Boulder, Colorado effort and that project's success is instrumental to the future of the Smart Grid. These kinds of projects must cover a significant demographic area that reflects a microcosm of the country at large, including different incomes and education levels. While the pilot programs are useful, these larger projects will give us a glimpse as to how a larger pool of consumers will react to the Smart Grid. The project doesn't have to be huge, but it must be an accurate representation of the society.

This approach lets consumers take part by building interest and selling the product amongst themselves, rather than having Congress, utilities, or regulators do it for them. The consumers who want the meters will get the meters, and through word-of-mouth, others will find out how valuable this new system can be, and will be more willing to endure a slight rate increase to pay for it. What concerns me is that under some proposals, millions of people will get these smart meters whether they want them or not. They will be getting a rate increase and new gadgets that they do not know how to use installed in their homes. I am not sure if this will breed anything but hostility among a rate class that is already facing challenging economic times.

Smart Grid can be successful provided we have Federal and State governments working in concert with one another as partners; not working in contrast to one another as adversaries. The challenge before us is great, the technology and potential benefits exciting. The Federal Government has resources that the States do not; the States have expertise in the development and implementation of programs that the Federal Government does not have. Therefore, this challenge calls for a true partnership between the States and FERC that we are already developing through the NARUC-FERC Smart Grid Collaborative.

We have to remember that the Smart Grid will only achieve its vast potential if consumers embrace it. While we can certainly see major improvements in efficiencies and reliability by upgrading the transmission and distribution backbone, we will not change consumers' habits and consumption if we are unable to convince them of its promise. I respectfully request that this Committee and this Senate recognize and respect our unique roles so that we can work toward a truly 21st Century electricity delivery system.

The CHAIRMAN. Thank you very much.

Ms. HAMILTON.

STATEMENT OF KATHERINE HAMILTON, PRESIDENT, GRIDWISE ALLIANCE

Ms. HAMILTON. Chairman Bingaman, Ranking Member Murkowski, members of the committee, thank you for inviting me to testify on smart grid. On behalf of our membership, thank you for your support and attention to the vision and goals of smart grid, including creating the smart grid title 13 in the Energy Independence and Security Act of 2007. Now, with the enactment of the American Recovery and Reinvestment Act, we'll have the opportunity to realize the impact of that title.

GridWise Alliance is a coalition of 78 organizations advocating for a smarter grid for the public good. Our members include utilities, independent system operators, utility equipment manufacturers, large IT and communications companies, small technology

companies, venture capital firms, consultants, universities, research organizations. By design, we are a very broad representation of the energy value chain. That puts us in a position to be an unbiased advisor.

We operate on a consensus basis. Everyone has the same voice. We focus on policy solutions rather than technologies. We believe the market should determine which smart grid technologies will prevail.

GridWise Alliance advocates for making the entire grid smarter, from the power plant bus bar through the transmission lines and substations all the way to the meter and load center. Since smart grid includes a broad range of solutions, there are many working definitions of smart grid, and just as many examples of initiatives that are underway that could be considered smart grid projects.

In the simplest terms, smart grid is a dynamic, ubiquitous, two-way communication system that allows for greater choice by every stakeholder on the grid. A smart grid can look like a lot of different things, and it depends on the regional and local systems, as well as the goals of that system.

We're delighted that Congress and the President identified smart grid as a priority and that it was funded significantly in the Recovery Act. We have projected with substantial Federal investment, smart grid could create as many as 280,000 jobs over 4 years. These jobs include retaining and retraining the current work force, as well as creating new jobs in software and communications, analyzing and engineering, manufacturing, and supplying goods and services. Those smart grid jobs are based on what we see as the intent of Congress in the Recovery Act, and that was that the \$4.5 billion appropriated to smart grid would be allocated to demonstration projects and investment project matching funds.

Investment projects, we think, are more likely to stimulate the economy, since they will be the first out of the chute, and they will accelerate the deployment and advancement of smart grid. We do not consider building transmission lines to be part of smart grid, but do expect some projects to be funded that include smarter transmission systems and technologies.

Smart grid was included in the Recovery Act because we thought Congress correctly identified the smart grid as a key economic stimulator. We expect DOE to fund a variety of competitively solicited projects that can show scaled deployment of smart grid technologies all across the electric grid. We think these projects will stimulate economic growth, helping utilities retain jobs, spurring offshoot industries, and increasing jobs through installation of clean energy technologies.

The GridWise Alliance is also pleased that the Recovery Act funded the NIST standards-making process. As you know, NIST was given an unfunded mandate to develop smart grid standards, but DOE was able to fund the Pacific Northwest National Lab and created the GridWise Architecture Council to bring industry together to work closely with NIST to develop the architecture for system interoperability. This process should continue and be aggressively supported.

We understand the importance of developing standards and protocols, also realize that entrepreneurs, utilities, universities, and

other businesses developing smart grid technologies will continue to implement smart grid. We do not want to hold up these efforts that can stimulate the economy by waiting for standards to be developed.

The GridWise Alliance thinks of the smart grid holistically, as a means to an end, not an end in and of itself. A smart grid can increase reliability, heighten security, optimize the entire electricity system from the generation end to the consumption end, and contribute to the de-carbonization of the electric industry.

A smarter grid enables integration of dynamic forecasting, energy storage, clean distributed generation, energy efficiency technologies, and plug-in hybrid vehicles. A smarter grid allows for the effective deployment of energy from renewable energy sources, reaping the full benefits of wind, solar, geothermal, hydropower, and biomass power.

So, additional smart grid policies should be included when energy or climate legislation is considered that involves our electricity system. Smart grid, as a key enabler of integrating dynamic renewable energy generation, should become an element of an RPS. Smart grid, as an enabler of efficient distribution technologies, should be built into an energy efficiency standard. In a transmission bill, any additional transmission should perhaps be required to have smart grid technologies embedded to maximize the use of the grid.

In conclusion, GridWise Alliance reiterates that it's important and critical that smart grid projects be funded through the Recovery Act and that smart grid should be considered an essential enabling component for any energy legislation.

We can help Congress in defining what additional policies for incentivizing smart grid we should consider and how to integrate smart grid as a means to fulfilling many overarching goals.

We thank you for allowing our collective industry voices to be taken into consideration as this committee moves forward on many energy fronts.

[The prepared statement of Ms. Hamilton follows:]

PREPARED STATEMENT OF KATHERINE HAMILTON, PRESIDENT,
THE GRIDWISE ALLIANCE

Chairman Bingaman, Ranking Member Murkowski, members of the Committee, thank you for inviting me to testify on smart grid on behalf of the GridWise Alliance before the Senate Energy and Natural Resources Committee. The GridWise Alliance has worked closely with this Committee and its members since our inception in 2003, testifying before you on several occasions. On behalf of our membership, I would like to thank you all for your support and attention to our vision and goals, including creating the Smart Grid Title XIII in the Energy Independence and Security Act of 2007. With the enactment of the American Recovery and Reinvestment Act, we will have the opportunity to realize the impact of that smart grid title.

The GridWise Alliance is a coalition of 78 organizations advocating for a smarter grid for the public good. Our members broadly represent the nation's interest in smart grid, including leading utilities, independent system operators, large IT and communications companies, small technology companies, consultants, universities, and research organizations. We operate on a consensus basis and remain technology neutral, focusing on the policy issues surrounding the deployment of a smarter grid. We believe the market should determine which technologies prevail.

The GridWise Alliance advocates for making the entire grid smarter—from the power plant bus bar through the transmission lines and substations, all the way to the meter and appliances and equipment that consume electricity. We define a smart grid as a dynamic, ubiquitous two-way communication system involving the

entire grid that allows for greater choice by every stakeholder on the grid. A smart grid will include a variety of technologies and solutions, depending on the regional and local systems as well as the goals of the system.

The GridWise Alliance thinks of a smart grid as a means to an end—not an end unto itself. A smart grid can increase reliability, heighten security, optimize the entire electricity system from generation to consumption, and contribute to the decarbonization of the electricity industry. A smarter grid can also enable the integration of dynamic forecasting, energy storage, clean distributed generation, and energy efficiency technologies, including plug in hybrid vehicles. A smarter grid allows for a more effective deployment of energy from renewable sources, reaping the full benefit of wind, solar, geothermal, hydropower, and biomass power.

Speaking on behalf of the entire industry, we were delighted that Congress and the President identified smart grid as a top priority and that it was funded significantly in the American Recovery and Reinvestment Act of 2009 (Recovery Act). We projected that, with substantial Federal investment, creating a smarter grid could result in as many as 280,000 jobs over the next 4 years. With stimulus funding of \$4.5 billion and 50 percent cost share for smart grid projects, we have determined, based on projects already in the hopper, that we could create nearly 75,000 jobs within the first year. These jobs range from technicians and new field installers, to new jobs in software and communications; from analysts and engineers, to manufacturers and suppliers. While the smart grid is clearly an evolving concept, we believe that deployment of existing technologies is the most effective way to encourage the development of the supply chain, to encourage redesign of existing appliances so that they may be incorporated into a smarter grid, and to familiarize consumers with the numerous benefits that a smart grid offers. Stated somewhat differently, commercial deployment is the most effective tool to encourage private sector product research and development.

The GridWise Alliance jobs analysis conducted by our member company, KEMA, Inc., had a positive impact on the discussion around funding smart grid; however now we must answer the larger question about how this funding will be allocated. We believe that the majority of the \$4.5 billion appropriated for smart grid in Recovery Act—that on which we based our jobs numbers—is to fund Title XIII of the Energy Independence and Security Act of 2007 (EISA). To that end, we have prepared a set of recommendations to the Department of Energy to provide guidance on the best way to spend those funds consistent with Title XIII. Because we focused on impacts and not specific technologies, we did not recommend numbers of meters or miles of transmission. Instead, we looked at a variety of quantitative and qualitative metrics. In our recommendations, we define the key metrics the DOE should use to assess smart grid project applications; we describe a process for achieving stakeholder buy-in to the metrics and for identifying weighting of metrics to feed into the application evaluation process; we suggest approaches for allocating funding to different categories of smart grid projects that cannot easily be compared to each other; and we recommend a process for monitoring and reporting on effective use of funding.

The GridWise Alliance believes that critical issues for funding smart grid projects include: 1) establishing clear guidelines for applicant submittals, including a re-statement of what types of projects are eligible for funding and clearly incorporates the language of EISA as amended in the Recovery Act; 2) establishing an expedited contracting process consistent with the OMB Initial Implementing Guidance for the Recovery Act; 3) establishing a rational approach which fully respects both pre-existing Intellectual Property rights and new intellectual property which emerge from the deployment of existing intellectual property in R&D, demonstration or investment projects; 4) establishing minimum smart grid standards for other energy infrastructure projects that are undertaken pursuant to provisions of the Recovery Act apart from those that contain the specific smart grid language; and 5) establishing a transparent, but not onerous, process for monitoring allocations among different types of smart grid endeavors and altering new allocations to secure balance as seem appropriate in light of the overall Recovery Act and EISA objectives.

As part of this process, the GridWise Alliance believes that the intent of Congress is clear: the \$4.3 billion appropriated to smart grid in the Recovery Act should be allocated to large-scale demonstration projects and investment project matching funds as provided for in sections 1304b and 1306 of EISA as amended. Between the two, the investment projects should receive the larger funding overall as these projects in general are more likely to both stimulate the economy and accelerate the deployment and advancement of the smart grid. We do not consider building new transmission lines to be part of the smart grid, but certainly expect some projects to be funded that include smarter transmission systems.

The GridWise Alliance is pleased that the Recovery Act also funded development of the NIST process. In EISA 2007, NIST was given an unfunded mandate to develop smart grid standards; DOE funded the Pacific Northwest National Laboratory to begin the process and created the GridWise Architecture Council to work closely with NIST and industry to develop the architecture for system interoperability that could be used as a foundation in developing standards. Much of the groundwork has begun and this process deserves to be aggressively supported. The GridWise Alliance prefers open standards and protocols so that all players are allowed to compete in the market. Because of cyber security issues, certain criteria in developing technology are critical. Industry has been engaged in this process collectively through several partnerships so that the security architecture for all smart grid technologies will be consistent. Developing standards and protocols for smart grid is important, yet entrepreneurs, utilities, universities, and other businesses developing smart grid technologies will continue to implement smart grid in the absence of NIST standards. We do not want to hold up these efforts that can stimulate the economy by waiting for standards to be developed.

Smart grid can be implemented differently in different places. The simplest definition is a two-way communications, control and data system from power station to home load center. The design and implementation can vary, however, depending on the technologies and solutions deployed and the needs of the regional utility, transmission operator, and customer mix. For example, in some areas smart meters are a good first step in providing information to consumers who want increased choice in how they use their energy and for utilities who want more data on consumer loads. In other areas, it would be wiser to start developing the smart grid with transmission technologies like phase shifting transformers. The issue is not so much which specific technology application is better, but what improvements can be made to the entire system. The GridWise Alliance believes that implementing smart grid technologies on the current grid is just as important as planning for additional transmission. While we recognize the need for additional transmission to alleviate congestion and take renewable energy generation to load centers, we strongly believe that planning for this increase should include integrating smart grid technologies. We reiterate that smart grid funding in the Recovery Act should not be used to build those new lines, but rather to make the overall system smarter, including making any additional transmission lines smarter.

While the electric grid has the same basic components everywhere, the entities operating and using the grid vary according to region, as do the goals of those systems. For example, a rural cooperative may have higher reliability needs because of the vast area it serves and the need to know who has electricity and where they have outages on their system. A municipality may need to contain costs and have consumers adjust demand given rate incentives and smart meter technologies. A data center may require redundancy and security measures. The stimulus funding will only go so far. Our government has additional resources that can assist in developing the smart grid. We have experts in state energy offices, Department of Commerce Manufacturing Extension Partnership, and Department of Energy Industrial Assessment Centers. Many universities—like Florida State, Northern New Mexico College, University of Colorado, Washington State University, and North Carolina State University—have smart grid technology research programs. Edison Electric Institute has worker training centers as does the IBEW. This technical expertise coupled with public utility commissions and regional planning authorities should enable this country to maximize the grid we have and make it smarter, stronger, more reliable, and freer of carbon.

The real benefits of a smart grid will not be realized without including the consumer in making informed decisions on how they use electricity. Modern information technologies have transformed almost every other sector of our lives; many of those same technologies can change the way we use our electricity. Most consumers will not change behavior without price signals, education, and technological assistance. Because our electric system is so ubiquitous and robust, we take it for granted. Electricity has become an integral part of our lives and a necessity for businesses and homeowners. Most people don't think about where electricity comes from other than the outlet in their wall. They get their bill at the end of the month and react based on the size of the bill, but don't know what they did to make it go up or down. With increased information, and technological innovation, consumers could see in real time the impact of their electricity use and take action to reduce their bills. Utilities that have experimented with smart grid technologies have received positive results and feedback from their customers. As we move forward it is important that we not just deploy a smarter grid but build coalitions with consumers and other stakeholders so that they are fully engaged in the implementation of that smart grid.

Smart grid was included in the Recovery Act because Congress correctly identified the smart grid as a key potential economic stimulator. The proof will be in the implementation, of course. We expect DOE to fund a variety of competitively solicited projects that can show a plethora of smart grid technologies and gather information about how smart grid affects the system operators, utilities, and consumers. The projects will be spread around the country to see how smart grid differs by location. Those projects will stimulate economic growth—by helping utilities retain jobs, by spurring offshoot industries, by increasing jobs through installation of clean energy technologies. But this is just the beginning. The GridWise Alliance believes that, since a smarter grid is a means to an end, additional smart grid policies need to be included when energy or climate legislation is considered that involves our electricity system. Smart grid is the great enabler of getting dynamic renewable energy generation on line; smart grid could become an element of an RPS. A smart grid enables integration of clean distributed generation including solar and plug in hybrids; smart grid could be built into an energy efficiency standard. In a transmission bill, any additional transmission could be required to have smart grid technologies imbedded to maximize the use of that grid. We are counting on this Committee to make sure that a smart grid is the foundation to fulfill our nation's energy independence, national security, and carbon mitigation goals.

In conclusion, the GridWise Alliance reiterates that smart grid projects funded through the Recovery Act will create the cornerstone of a more reliable, affordable, and cleaner grid. In addition, smart grid provisions must be included as critical parts of future energy legislation. Our Alliance is always available to help define what policies are important and intend to keep you apprised of smart grid developments in the coming months. We thank you for allowing our voices to be taken into consideration as this Committee moves forward on many energy fronts.

The CHAIRMAN. Thank you very much.

Mr. Lu, go right ahead.

**STATEMENT OF EDWARD LU, ADVANCED PROJECTS
PROGRAM MANAGER, GOOGLE, INC., MOUNTAIN VIEW, CA**

Mr. LU. Mr. Chairman and members of the committee, my name is Edward Lu, and today I would like to share my perspective on how to advance the deployment of smart grid technology, and, in particular, on the importance of energy information to consumers.

I serve as a program manager in advanced projects at Google, and I lead several energy-related projects, including one that is developing an energy information software tool that will enable consumers to make informed choices about their energy use as they browse the Web, read their e-mail, or use a mobile phone.

Prior to my position with Google, I served as a NASA astronaut for 12 years. I had the privilege of flying two Space Shuttle missions, a Russian Soyuz mission, and spent 6 months abroad the International Space Station. By training, I'm an electrical engineer, and I have a Ph.D. in applied physics.

As you know, the United States is currently building out a smart grid that will bring our 1950s-era electricity infrastructure into the digital age. The main point I would like to make today is that we need to develop this grid in a way that spurs innovation, that drives competition, and supplies maximum information to consumers.

First, we must not forget about the consumer. That means deploying smart grid technology that empowers consumers with greater information, tools, and choices about how they use electricity; and, second, that the energy information that the consumers get should be open. That means that it is in a nonproprietary format that spurs the development of products and services to help consumers save energy and money.

Google is working in this space because this, fundamentally, is a large-scale information-delivery problem, and Google's strength is in bringing useful information to millions of consumers.

So, why is energy information crucial? The way Americans buy electricity today is a bit like shopping for groceries in a store that has no prices and no cash register. Take what you want, you leave, and at the end of the month you get a bill. So, how could a family, like that, keep to a budget or make smart choices about what they're buying? It's very difficult.

When it comes to electricity, how many consumers know how much electricity their house uses, what appliances cost the most to run, or how to even go about saving energy and money? How many of you have gotten a big electric 1 month and wondered, "What caused it last month?" I know I have.

Studies show that when consumers can see, in realtime, how much energy they are using, they naturally save 5- to 15-percent on their electricity use with simple behavioral changes. That's even before they make investments in energy efficiency. You manage what you measure.

Energy information empowers consumers to make smart choices. The average United States residential consumer spends about \$1200 a year on electricity, so savings, simply based on realtime feedback, could amount to \$60 to \$180 per year, per consumer. The real power of this is when you scale that up to millions of consumers. If just half of American households cut their demand by 10 percent, the CO₂ emissions avoided would be equal to eliminating the emissions from about 8 million cars.

So, where's this data going to come from? A key step in establishing a smart grid is to equip homes with advanced electricity meters, or smart meters. These smart meters will enable utilities to provide better service and a more robust electricity delivery system, as we've heard already today. Already, utilities are in the process of deploying 40 million of these new meters, replacing the old-style electric meters.

Alternatively, consumers could opt to put in their own energy monitoring devices into their own homes. So, the data is forthcoming. But, installing the smart meters themselves does not mean automatically that the data is either in realtime or that consumers will have access to the data in a convenient fashion. So, we encourage efforts by the utilities, and the public utility commissions in the States, to ensure that the data is as close to realtime as practical and is easily accessible by consumers.

One open question is, Who owns the data? Google believes that this personal energy information rightfully belongs to consumers, and they should control who has access to it. But, in many States there is no clear statement on this. So, we're hoping that policy-makers provide clarity on ownership of data as the smart grid is built out, because it will encourage entrepreneurs and businesses to get involved in this space.

So, what form should this data take? We think it's important the consumer-facing data, that part that the consumer actually sees from the smart meter, should be available in an open, nonproprietary format. This will allow consumers to easily and conveniently share their data with third parties. The goal is to foster a thriving

ecosystem of partners, where third parties develop products to help consumers decrease and manage their energy demand and save money. For example, a utility or a third party could offer service that analyzes the household's electricity usage data, identifies inefficient appliances or practices in the house, and offers tips on how to reduce energy, or even provide discounts on efficient appliances or electronic equipment.

So, what are we doing at Google? We're partnering with utilities with smart meter deployments, and with companies that manufacture devices that measure the energies in your home, to give consumers access to their data. Our engineers have developed a simple and secure software tool, called Google Power Meter, that will allow users to monitor their own home electricity consumption, in realtime, on their computer or on their cell phone. I have my own house information on my phone, for instance. Our tool is free and scalable, and we plan to release the technical specifications so anyone can build applications on it.

The Google Power Meter is not yet available to the public, since we're testing it out with Google employees first. We're busy collecting data on the impact, how much people are saving. The initial results are very promising.

It's important to note that there's really no one-size-fits-all solution for providing consumers with this data. The challenge is going to be to provide this information at the scale of tens or even hundreds of millions of consumers. We look forward to working with utilities and other industry stakeholders to enable consumers to have a greater understanding of, and control over, their energy use.

Thank you, Mr. Chairman, for the opportunity to testify today, and I look forward to answering any questions you have.

[The prepared statement of Mr. Lu follows:]

PREPARED STATEMENT OF EDWARD LU, ADVANCED PROJECTS PROGRAM MANAGER,
GOOGLE, INC., MOUNTAIN VIEW, CA

Mr. Chairman and members of the Committee, my name is Edward Lu and I am pleased to share my perspective on how to advance the deployment of smart grid technology. I serve as a Program Manager in Advanced Projects at Google. I lead a number of energy-related projects including one that is developing an energy information software tool that will enable consumers to make informed choices about their energy use as they browse the web, read email, or use a mobile phone.

Prior to my position with Google, I served as a NASA astronaut for twelve years. I had the privilege of flying two Space Shuttle missions, a Russian Soyuz mission, and a 6-month tour on-board the International Space Station. I am an electrical engineer and have a Ph.D. in applied physics.

Google's mission is to organize the world's information and make it universally accessible and useful. We believe that access to information about personal energy consumption is critical to helping consumers save electricity and money, but unlocking this data requires upgrading the electricity grid to make it smarter. We are tackling this informational challenge on several fronts including developing consumer tools, investing in energy technology companies, and advocating for policies that advance a smarter grid.

The United States can build a "smart grid" and bring our 1950's-era electricity infrastructure into the digital age. The main point that I will make today is that we need to develop this grid in a way that spurs innovation, drives competition, and supplies maximum information to consumers.

- First, we must develop and deploy smart grid technology in a manner that empowers consumers with greater information, tools and choices about how they use electricity, including access to real-time energy information.

- Second, energy information should be made available based on open non-proprietary standards to spur the development of products and services to help consumers save energy and money.

I will also briefly describe a free software product that Google is developing to enable people to get better information about their home electricity consumption.

I. INFORMATION HELPS CONSUMERS SAVE ENERGY AND MONEY

The way Americans currently buy electricity is like shopping for groceries every day but not getting the bill until the end of the month. How can a family keep to a budget or make smart choices? When it comes to electricity, how many consumers know how much electricity their house uses, what appliances cost the most to run, or how to go about saving energy or money?

Studies show that when consumers can see in real time how much energy they are using, they save 5 to 15 percent on their electricity use with simple behavioral changes, and even more with investments in energy efficiency. The average U.S. residential customer spends about \$1,200 a year on electricity, so savings simply based on a real-time feedback monitor could amount to \$60 to \$180 per year. In fact, if just half of American households cut their demand by 10 percent, the CO₂ emissions avoided would be equal to taking approximately eight million cars off the road.

As a first step to establishing a smart grid, homes must be equipped with advanced energy meters called “smart meters” that identify detailed real-time energy consumption information. With the help of state public utility commissions, utilities throughout the United States are working to replace 40 million old-style electric meters with digital smart meters that can be automatically read throughout the day. Congress also recently included a provision in the American Recovery and Reinvestment Act to speed the installation of smart meters and other smart grid technology. Google applauds these efforts, and encourages utilities, transmission operators, technology companies, and public utility commissions to continue to modernize our electricity infrastructure with the support of Congress.

The benefits of energy information can be enhanced when combined with programmable appliances and dynamic energy pricing. A study conducted by the Department of Energy’s Pacific Northwest National Laboratory (PNNL) gave customers access to energy consumption information, broken down by appliance, every fifteen minutes and allowed them to program their water heaters and thermostats to respond to changes in electricity prices. Participants in the PNNL study received cash when they operated their household loads in collaboration with the needs of the grid by reducing their energy usage at times of peak energy demand. Over the year of the study, peak load on the grid was reduced by approximately 15 percent and consumers saved approximately 10 percent on their electricity bills over the previous year. Based on these results, the authors determined that if all customers nationwide engaged in reducing peak loads, peak electricity prices would be substantially reduced and approximately \$70 billion in new generation, transmission, and distribution systems could be avoided, with the savings passed along to rate-payers.

II. CONSUMERS SHOULD HAVE ACCESS TO REAL-TIME ENERGY INFORMATION

Google believes consumers should have access to real-time information about their home electricity use. This means that consumers should know how much energy they are paying for at the time of use. Personal energy information belongs to consumers and they should control who has access to it. Policymakers should provide clarity on ownership of data as the smart grid is built out.

To access energy information in greater detail, homes must be equipped with smart meters or consumer-installed energy monitoring devices. Smart meters are a key part of the smart grid and will enable utilities to provide better service and a more robust electricity delivery system, in addition to enabling consumer access to information. However, installing smart meters does not automatically mean that consumers will receive real-time information about their electricity usage. While there are some limitations today on the ability of utilities to provide real-time data to consumers, we believe that there are substantial benefits to doing so. Utilities should be encouraged to provide consumers with real-time access to their energy information.

III. OPEN STANDARDS SPUR INNOVATION AND DRIVE COMPETITION

In order to achieve the greatest potential for energy savings, consumers should receive information as part of an open ecosystem of hardware and software for energy monitoring, home automation, and device control. For that to happen, the con-

sumer-facing data from the smart meter needs to be available to the consumer in an open non-proprietary format as well as in real time.

Truly open standards would allow consumers to share their data with third parties in a format that is standardized, freely published, and unencumbered by a patent or proprietary claim. The goal is to foster a thriving ecosystem of partners where third-parties will develop and provide products to help consumers decrease and manage their energy demand and save money. For example, a utility or a third-party could offer a service that analyzes a household's electricity usage data, identifies inefficient appliances or practices in the home, and offers tips on how to reduce energy or provides special discounts on efficient appliances or electronic equipment.

The Texas legislature and Public Utility Commission have taken a thoughtful approach to these issues and provides a useful example of a consumer-friendly energy information policy:

- Smart meters must be capable of providing consumers with direct, near real-time access to electricity usage data.
- That data must be stored on the meter in a form that complies with nationally recognized non-proprietary standards.
- Smart meters must also be capable of communicating with other devices on the premises, such as monitoring devices, load control devices, and prepayment systems.
- Consumers own their energy usage data.
- As smart meters are deployed in Texas, consumers will not have to pay an additional fee or have to obtain special permission to view their data.

IV. WE'RE DEVELOPING A SOFTWARE TOOL CALLED GOOGLE POWERMETER

Over the last year, our engineers have developed a simple and secure software tool called Google PowerMeter. This will give consumers a means to draw data from their utility or from devices they install themselves to see their own home electricity consumption in near real time, on their computer or cell phone. The default view shows the current day's energy consumption compared to the previous day's, but the graph can easily be extended further back in time to look for peaks, troughs and other outlying data points. Our tool is free and scalable, and we plan to release the technical specifications (application programming interfaces or "APIs") so anyone can build applications from it. Google PowerMeter is not yet available to the public since we are testing it out with Google employees first. Currently we are building partnerships with utilities and independent consumer device manufacturers to roll this tool out in pilot programs. We are busy collecting data regarding the impact that energy information provided by Google PowerMeter has on electricity savings and consumption, and preliminary results are promising.

There is no one-size-fits-all solution to providing consumers with detailed energy information. It will take the combined efforts of Federal and state governments, utilities, device manufacturers, software engineers and non-governmental organizations to empower consumers to use electricity more wisely by giving them access to energy information. We look forward to working with utilities and other industry stakeholders to enable consumers to have a greater understanding of, and control over, their energy use.

Thank you, Mr. Chairman, for the opportunity to testify today. I look forward to working with the Committee in its important examination of ways to build and deploy a smarter electrical grid.

The CHAIRMAN. Thank you very much.
Mr. GADDIS.

STATEMENT OF EVAN R. GADDIS, PRESIDENT AND CEO, NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, ROSSLYN, VA

Mr. GADDIS. Mr. Chairman, Ranking Member Murkowski, and members of the committee, thank you for the invitation to speak on behalf of the over 400 electrical manufacturers in NEMA. Our member companies represent the full spectrum of the grid, from transformers, switch gear, thermostats, wire meters, and energy storage, to lights and plugs. Better said, from the power plant to your living room and your business.

Innovation and research is a constant driver in our companies, and their technologies would be on the market today if we had certainty of standards. I'll speak on the current obstacles to, and the proposals to, advance building the smart grid.

Historically, utilities have made piecemeal investments, often resulting in customized solution; as we call them, stovepipes. In certain instances, manufacturers responded with proprietary systems; more stovepipes.

As to the regulators, their objective is to ensure just and reasonable cost. Until recently, standardized systems was not a major cost factor. The current grid was designed for one purpose: to flow electricity downstream from nearby generators to our homes, offices, and factories. Today, we need a grid to do more. Our computers need constant reliable power. Our climate policy requires green generation. We want to charge our cars at home and at the office. Grids that were set up for steady one-way power flow must now become more nimble and more adaptable. Our smart grid must use new device communication strategies. Utilities and their customers must communicate. They must be interoperable.

What we need is not just a common language, but a common alphabet. On the grid, this alphabet includes time, location, and measurement. We need agreement on how we will time-stamp events and commands. We need a standard for locating devices and disturbances, both geographically and electrically. We need to agree on how to record current and voltage, the fundamental measurements of electrical power. Simply said, we need common standards.

We can build on existing efforts. For example, NIST maintains the official time of the United States. We already have widely used standards for geographic information systems. We, as an industry, need to adapt and adopt these existing methods. We need common standards from the turbine to the plug.

In the 2007 energy bill, Congress recognized the need for common standards, and Congress entrusted NIST with this critical task. NEMA was named as a partner in this endeavor. The process is not working. I think we got the taskings backward. NIST was designated to provide guidance and coordinate the standards. In more than a year, we have not seen the first standard. NEMA and other standards development organizations should write the standards, NIST should be our navigator and approval authority.

NEMA has extensive experience in writing standards. We administer over 50 U.S. technical advisory groups, and hold six secretariats from the International Electrical Technical Commission. We have over 240 ANSI-approved standards, including 39 for power equipment products. Today, anyone who uses a wall outlet or a thermostat interacts with NEMA standards.

In the grid, NEMA is already at work writing levels of intelligence which will provide decisionmakers with a quick and objective measure of the intelligence of the grid. We have worked hand in hand with NIST as we defined these levels of intelligence.

Let me say it again. NIST should be the navigator and approval authority. NEMA and other standards development organizations should write the standards. Industry is ready now.

From traffic signaling to baggage screening, NEMA has developed standards that enable commerce today. We want to accelerate our energy policy goals, your goals: independence, renewables, and reliability. We will need a smart grid.

If we get grid standards in place before we start building, we will save time and money. NEMA and our member companies stand ready to deliver the grid technology compliant with consensus standards and—excuse me—compliant with consensus standards that regulators, utilities, and customers embrace. We’re waiting on the green light from government to do just that.

Thank you for your time. It’s an honor to talk with you today.
[The prepared statement of Mr. Gaddis follows:]

PREPARED STATEMENT OF EVAN R. GADDIS, PRESIDENT AND CEO, NATIONAL
ELECTRICAL MANUFACTURERS ASSOCIATION, ROSSLYN, VA

Good morning, Mr. Chairman and members of the committee. On behalf of the over four hundred NEMA member manufacturers, thank you for the invitation to speak. I would also like to thank Commissioner Kelly and Chairman Wellinghoff of the Federal Energy Regulatory Commission for inviting us to host a grid technology demonstration day in April. Our companies represent the full spectrum of the grid, from transformers and switchgear to thermostats and advanced meters, with a burgeoning energy storage section. Research and innovation is a constant driver in our companies, and for now, the world still looks to the U.S. for energy innovations. However, uncertainty on standards obstructs adoption of many beneficial technologies and threatens our technology leadership position. I will speak on the current obstacles to and proposals for accelerating smart grid implementation.

Historically, utilities—NEMA member customers—have made piecemeal investments, often resulting in customized solutions. And in certain instances, manufacturers responded with proprietary systems. The regulators’ objective has been to ensure just and reasonable cost, and until recently, standardized systems was not a major cost factor. The grid of the 1900’s was designed for one purpose—to let electricity flow downstream from nearby generators to our homes, offices, and factories.

Today, we need the grid to do more. Our computers need reliable power; our climate policy requires green generation; we want to charge our cars with domestic electrons. Grids that were set up for steady one-way power flow must now become more nimble and adaptable, which requires more communication among devices. Common sense suggests common languages simplify complex systems.

In the 2007 Energy Independence and Security Act, Congress recognized the need for interoperability standards and entrusted the National Institute of Standards and Technology (NIST) with coordinating this critical task. Congress also named NEMA to assist NIST in this work.¹

Smart thermostats are an example of a device whose adoption today is hampered by the lack of standards. A user-friendly smart thermostat could intelligently talk to the utility to minimize your electric bill, maximize comfort, or both. These devices are available today and are incorporated into many demand response pilot programs, but do not necessarily communicate using the same protocols. We need national standards so that a thermostat or any equipment made for San Francisco will also work in Syracuse.

The lack of adequate grid standards has already cost our nation dearly. After the 2003 blackout, a major obstacle to decoding the data was to determine if 2 pm recorded on one device meant 2:01 pm on another. Recommendation 24 from the blackout report notes that piecing together the events from the numerous logging devices would have been “significantly faster and easier” if the devices were synchronized. A standard for time synchronization would have shaved months of data analysis, and we may have even had enough data to prevent the grid’s problems from cascading across the country.²

Before we can create a common language, we must assemble a common alphabet. On the grid, this alphabet includes time, location, and measurement. We need agreement on how we will time stamp events and commands, as we learned from the 2003 blackout. We need a standard for locating devices and disturbances, both

¹ PL 110–140 s. 1305

² US-Canada Power System Outage Task Force, “Final Report on the August 14, 2003 Blackout in the United States and Canada,” April 2004.

geographically and electrically. Finally, we need to agree on how to record current and voltage—these are the fundamental measurements of electrical power.

For each of these areas, we can build on existing efforts. NIST, of course, maintains the official time for the United States. We already have widely used standards for geographic information systems. And NIST and the Department of Energy (DOE) are working on the standards for sensors on the transmission system.³ For a smart grid framework, we as the industry need agreement to adapt or adopt existing methods for use on the entire electric system, from the plant to the plug.

Once we have agreement on a fundamental alphabet, we can begin the process of harmonizing the languages. For example, once we have agreement on time precision and accuracy, we will need to revise substations or meter protocols to be readily interpretable to and from a common framework. Each further revision will lead to systems that require less and less customization.

As DOE Secretary Chu has alluded, one way to get industry agreement is to lock the experts in a room until the right answer emerges. NEMA has extensive experience in accelerating standards for urgent needs. We administer more than 50 U.S. Technical Advisory Groups and hold 6 secretariats for the International Electrotechnical Commission. We have over 240 ANSI-approved standards, including 39 for power equipment products. Today, anyone who uses a wall outlet or a thermostat interacts with NEMA standards.^{4 5}

In the smart grid, NEMA is already at work. Our companies have proposed a “Levels of Intelligence” rating system, which will provide decisionmakers with an objective measure of the intelligence of the grid.⁶ We are polling our companies on the protocols in use today to draw a map from where we are now to where we want to go. And as directed by Congress, our staff have assisted NIST since day one to get the interoperability framework up and running.

The government has stepped in before and recommended that the industry adopt a standard. In the 1960’s, there were many competing methods for encoding the alphabet on magnetic and paper tapes. IBM, NCR, and RCA accounted for eight different schemes. One proposal was the American Standard Code for Information Interchange, or ASCII. In 1968, President Lyndon Johnson issued an executive order that directed the Federal Government to purchase only computers that complied with the ASCII standard “to minimize costly incompatibility.”⁷

To establish a similar incentive today, Congress, NIST, or the DOE should direct accredited standards development organizations like NEMA to accelerate the priority standards of time, place, and quantity. Such an effort would be conducted in a consensus-based process, and NIST could then review and “bless” the final outcome. To create a further incentive to get the work done quickly, Congress should condition the release of the 50 percent smart grid matching fund on the development of NIST endorsed standards.⁸

NIST is our navigator, and the industry is ready to row. From traffic signaling to baggage screening, NEMA has developed the standards that enable commerce and demonstrate world leadership in technology adoption. If we want to accelerate our energy policy goals—independence, renewables, reliability—we will need a smart grid. If we get grid standards in place before we start building, we will save time and money.

NEMA and our member companies stand ready to deliver the standards that will make the smart grid a national reality. What we need today is a green light from the government to get the consensus process underway, and assurances that our efforts would be fruitful and adopted.

Thank you very much for the opportunity to testify.

The CHAIRMAN. Thank you very much for your testimony.

Senator Shaheen, why don’t you go ahead. You haven’t asked any questions yet.

³North American Syncro Phasor Initiative, materials posted at <http://www.naspi.org/>

⁴NEMA WD-6, “Dimensional Requirements for Wiring Devices,” revised 2008. Available at <http://www.nema.org/stds/wd6.cfm>.

⁵NEMA DC-3, “Electrical Wall-Mounted Room Thermostats,” revised 2003. Available at <http://www.nema.org/stds/dc3.cfm>.

⁶NEMA Emerging Technologies Task Force, “Standardizing the Classification of Intelligence Levels and Performance Of Electricity Supply Chains,” December 2003. Available at <http://www.nema.org/smartgrid>.

⁷Lyndon B. Johnson, Memorandum Approving the Adoption by the Federal Government of a Standard Code for Information Interchange, March 11, 1968). The American Presidency Project, Accessed 2009-02-27 via Wikipedia. <http://www.presidency.ucsb.edu/ws/index.php?pid=28724>

⁸The matching fund was codified in PL 110-140 s. 1306 and amended by PL 111-5 s. 7002

Senator SHAHEEN. Thank you, Mr. Chairman. Here I was waiting for all of you to ask the brilliant questions of the morning.

Let me go back—I don't know who wants to respond to this, but there was an earlier session this morning, with former Prime Minister Tony Blair and a number of Governors, CEOs, and Senators, talking about the importance of addressing global warming. Several people suggested that we couldn't get to an energy revolution without dealing with global warming, because we needed to set a price on carbon that would make industry—give industry some certainty about the cost, and therefore, create a willingness to invest.

Now, many of us—and I think your comments speak to the fact that we're not going to be able to get to our energy revolution without dealing with our transmission issues. One suggestion, earlier, was that the private sector would be willing to be an investor as we look at what we need to do with our transmission system.

So, how do we get the private sector to invest? What kinds of incentives—or do we need incentives to get the private sector to invest as we move to a smart grid and a new transmission system?

Whoever would like to take that on.

Mr. GADDIS. Senator, the companies will build the technologies if they have certainty that their product will be sold. The way you do that is, you develop a standard that they can build to.

Mr. BUTLER. Senator, the issue of getting the private sector to invest, in terms of transmission, there are some merchant transmission companies that are working in this country, but mostly all of the local distribution transmission systems are owned by utilities. So, I think we need to create an environment where those utilities are going to invest in improving the outcome—the performance of those distribution systems, and making them smarter so that we can allow for addressing carbon issues and reducing carbon footprints of individual end-use customers, whether they're residential or large industrial, as well.

So, I think it's all of—a piece—there's a whole range of things that we have to be addressing as we move forward.

Senator SHAHEEN. Certainly I would agree that, in an ideal world, we would hope that the utilities would invest because they would benefit from that investment, but—we have an example, in northern New Hampshire, where we have a number of—we have a wind project and two biomass projects that are ready to go, but there isn't the transmission capacity to bring them down to the southern part of the State and southern New England. The utility doesn't want to make the investment without passing that cost on to the ratepayers. The ratepayers obviously are not interested in paying for power that's going to go to somebody else. So, how do we share that burden and get everybody to invest in the way that's going to allow us to make this smart grid a reality?

Mr. BUTLER. You've hit, exactly on the head, the issue here, and that's getting a source of funds, revenue—rates—that actually goes to the people that are going to benefit from the increase in those rates. I think regional planning—New England regional planning, which has improved, is—and has improved in other regions of the country—is one of the approaches that needs to be taken.

Then, you know, finding a way that you actually are passing the costs on to those who are benefiting. I think regional planning and RTOs can work on that score.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Mr. Lu, I appreciated your comment the—your statement was, “The consumer will manage what we can measure.” I think we recognize—and your example is pretty apt, about going into the grocery store and, if there’s no prices and there’s no checkout, but you just take what you want, and you get billed later, that’s what we’re facing as energy consumers. So, the effort to figure out how we measure is what we’re all talking about here with the smart grid.

I actually have a coffee cup that I drink out of every morning. I’m kind of a creature of habit. There’s a saying on it that says, “Before we can measure, we must first know the standard.” That goes back to Mr. Gaddis’s point here, that it’s so imperative that we have these standards, because, without a standard that we can reference, we’ll never get to that measure that will be helpful for us, as individuals and as families.

I wanted to ask you, Mr. Lu, in the stimulus bill, there’s a new requirement that demonstration projects must use, quote, “open protocols and standards, including Internet-based protocols and standards, if available and appropriate.” Is this something that works for a company like Google, as you are—you’re really moving out, in terms of your own power meter issues. The opponents of this requirement are arguing that the Internet-based standards can be slow and are perhaps not appropriate in addressing reliability concerns. Can you just speak to that aspect of what we have in the stimulus?

Mr. LU. Sure. The language, in particular—the key part of it is “where appropriate.” There are areas where Internet protocols are appropriate; in particular, for the aspects of it that face the consumer. When you deliver data to the consumers, the Internet protocol is a fine way to do that, because there is a host of platforms out there, almost everybody has a device, a computer or a phone or something like that, that can read that standard and can accept that data.

Now, we recognize that there are parts of this that are involved—the—sort of, the back end of things, the guts of the transmission, and so on, or the data going back to utilities, that doesn’t touch the consumers. So, again, the appropriateness of the—that there is something that needs to be discussed by the manufacturers of that equipment and the utilities.

I don’t want to give the impression that it’s appropriate everywhere, because it’s not.

Senator MURKOWSKI. Mr. Gaddis, you spoke to the concern of stove-piping if, in fact, we don’t have the confidence that certain standards are in place there. You heard the testimony from first panel, where all three were in agreement that we don’t need to be withholding stimulus moneys, at this point in time, in making certain that those standards and protocols are in place first, and then the money comes. The comment that was used was that there will be a suite of standards, and that the standards will not be static.

Do you agree with this, or do we still have the stovepipe issues that you raised?

Mr. GADDIS. I don't totally agree with it, Senator, but let me explain.

First off, I do think we need to get these projects moving, so I do support that. We need to put people to work. I think if the government does its job—and that's NIST and FERC—and they quickly come out and they designate the standards-writing organizations—if they tell NEMA or—I believe Senator Cantwell brought up the IEEE—if you tell us, "Start writing these standards," we will get them written quickly and—

Senator MURKOWSKI. How quick is quickly?

Mr. GADDIS. You know, it really depends on the standard—let me give you a good example. Homeland Security came to NEMA a few months ago and said, "We need a standard written in 6 months to be able to do baggage screening." We will have that standard done in 6 months. Now, I would say a normal timeframe is between 9 months and a year for a standard, but if we know what it is that we have to do, and we have the approval, the authorities given to us by the government—i.e., we're designated to do this particular thing—the companies will come together, everybody will come together, and we will start working on these things. So, I think we can do it; we just need to get on with it.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator CANTWELL.

Senator CANTWELL. Thank you, Mr. Chairman.

Mr. Gaddis, I didn't mean to—in mentioning the IEEE, to exclude your organization, because I do think it can play a very big role in the process. So, thank you for elaborating on it this morning in talking about the process and how the private-sector groups can move more quickly, because there is a great deal of competitiveness, but also cooperation. So, thank you for talking about that.

Ms. Hamilton, you mentioned the job-creation elements of smart grid. I think you had a number, 280,000 over the next 4 years. That sounds like a very robust number. Do you know how many of your member companies are hiring, today? Of the businesses? I know you have utilities in the GridWise Alliance. Do you know how many—

Ms. HAMILTON. I would say all of my member companies are either hiring or retraining on some level, and the stimulus funding will greatly advance that, because projects that are in the hopper, waiting for approval, will then get that extra boost from the government to enable them to get started on their projects that are, maybe, you know, waiting for PUC approval. Then, once we see that there's another investment stream coming in, that that will help get them out.

But, I would say all of my 78 members are actively working in smart grid, and so, everyone is trying to look at where the jobs are and where they could increase their work force.

Senator CANTWELL. I know, for example, there's a couple of companies in Washington State, both have openings, one having openings for over 100 people. So, I think actually showing, today, the potential—I mean, this is even without further approval of projects;

this is what—where people are looking for jobs—I mean, where there are jobs right now, where people are looking for a work force. I think the 280,000 probably, to a lot of people, sounds like down the road. It sounds very enticing, but I think the reality is, is that this is producing jobs right now, one sector that is producing jobs, and a lot of jobs.

Ms. HAMILTON. That's absolutely right, Senator Cantwell. There is actually going to be a work force issue in the utility industry, because of an aging work force. So, we will need new people to come online, we will need new people to build new high-voltage transformers, because a lot of those folks have retired or are retiring. So, yes, there's a huge work force issue.

Senator CANTWELL. I think Chairman Bingaman is looking at the work force issue for the larger energy bill, which I appreciate, because I think it is a key issue to matching up.

But, I wanted to ask you about depreciation rates on smart meters, as well, because I think it was 2001 when I first introduced legislation saying we ought to have a better depreciation rate. We actually got it down, you know, from the 20-year period. Now everybody is kind of at a plateau, if you will. I mean, they're so glad we got it down, but, in my opinion, it should be treated like all computerized equipment, because that's really—I mean, it shouldn't be discriminated against. I mean, it basically is in that same category. A faster depreciation rate is one of the ways to help make these projects more cost-affordable.

I'm going to get to Mr. Butler in a second about rate recovery, which I'm sure—I don't know whether we're going to agree or not, but would you—on this particular issue, it is one remedy that we have at our hands right now to give a 5-year computerized depreciation across the board, including smart meters.

Ms. HAMILTON. That's absolutely right. We appreciate you putting it in the stimulus for a period of time there. We definitely agree, 5 years is the right amount, because it is computer equipment; we would extend it to all energy management devices, so not just meters, but extend it to all of those technologies that would be operated just as, you know, data could be—

Senator CANTWELL. If GridWise has any information about what that would do in the acceleration or advancement of projects, that would be very helpful.

Ms. HAMILTON. OK.

Senator CANTWELL. Because, again, I think people think, "Well, we just passed this policy, so why not just keep it where it is?" But, the fact that we made some progress, you know, is—there's no reason why we shouldn't make more progress, when there's so much job opportunity at hand here.

Commissioner Butler, I wanted to talk to you about the, obviously, rate-of-recovery issue. I know that you are talking about consumer groups and consumer interest. I don't if you have a thought about the depreciation rate of smart meters, but do you know if anybody's taken advantage of the language that we had in the—you know, the directive that we had in the 2007 energy bill, to utilities?

Mr. BUTLER. I'm sure they are, utilities, Commissioner—Senator. We have 20 States that are involved in the smart grid collaborative

now, including your own, and eight others that showed up at the last meeting, after the stimulus money was announced. It's amazing how \$4 and a half billion can incent some interest among some people. So, there is interest in reducing the depreciation time period. That's one of the silver buckshot items, I think, that I was talking about earlier.

States are anxious to get approval for these as quickly as possible, while, at the same time, protecting the interests of ratepayers. No State commissioner wants to be the one that approves something that proves, later on, to be the wrong project, or a project that's not open architecture, that cannot be easily improved by plugging in some new components. So, I think there is this great interest out there, and we're going to try to move as quickly as is reasonable. At the same time, educating our ratepayers so that they know the benefits that can accrue to them.

Senator CANTWELL. So, do you think—so, utilities have used that, recovering remaining book-value cost of equipment?

Mr. BUTLER. They have certainly asked for it, and I know that, in certain place, I think that it's been approved.

Senator CANTWELL. Yes, I think having more information about that—what else do you think we should do about stranded costs?

Mr. BUTLER. Stranded costs is always an issue. I think it has to be discussed with the utilities, in terms of what the danger of stranded costs might be, so that they can be addressed as part of a—an agreement of a—an agreement that is reached by the utility and the public utility commission, in terms of moving forward, that if there is a potential for stranded costs, that that be worked into the process.

I know, when you go back to restructuring, when utilities were divesting themselves of their generation assets, there were provisions for stranded costs worked into those agreements between those utilities and their State commission. So, it's not something that hasn't been done before, and it certainly would be something that commissioners would be willing to discuss.

Senator CANTWELL. I see my time is expired, Mr. Chairman, but, yeah, I'd love to ask—to follow up more about that particular policy, because I think—without more robust discussion of rate recovery on these projects, I think the incentive here, for job creation and energy savings, whether we get a—some sort of more fair cost on carbon or not, is going to keep pushing this technology out there. Otherwise, the Federal Government will look at a larger role. So, I'd love to explore that later with you, Mr. Butler.

Mr. BUTLER. Yes.

Senator CANTWELL. Thank you, Mr. Chairman.

The CHAIRMAN. Let me ask Mr. Gaddis—you say, at the end of your testimony here, "What we need today is a green light from the government to get the consensus process underway and assurances that our efforts would be fruitful and adopted." What you're saying, more precisely, is, you want some agency in the government—either NIST or FERC, I guess; and you can clarify that—to tell you that NEMA should go ahead and develop certain standards, and give you a timeframe for the development of those. Is that right?

Mr. GADDIS. Yes, Senator, that's—I would say, Department of Energy or NIST. Yes, once you designate the standards-writing or-

ganization—we're one of them—you'll find that the companies will rally around this. All the stakeholders will rally around this, and they'll come together so that we can write that standard and begin building whatever the product is.

The CHAIRMAN. Now, do you have a list of the standards that you believe NEMA is most appropriately situated to establish?

Mr. GADDIS. Oh, I could easily provide that for you, but obviously we're experts in the electrical industry. Some of the things that come to mind are meters, energy storage, plug-in cars. So, the answer is, we have a wide array, but I'd be happy to, before—

The CHAIRMAN. If you could give us that, that would be useful, because then we could perhaps go to Dr. Gallagher or to Secretary Chu, if those are the two people in the government, and say, What do they think? I mean, is it appropriate for them to designate NEMA to do that, or is there somebody they think is better? Maybe you could also indicate how long you think it would take to establish some of those standards.

Mr. GADDIS. Yes, sir. I should say that I've already had talks with Dr. Gallagher, and I think he agrees that NEMA and other standards-writing organizations should be writing these things. It really depends on the standard, how long it would take; but, I would say, on average, 9 months to a year, depending on what the standard is, to get a standard out. I'll be happy to submit, for the record, a list of the things that NEMA would recommend.

The CHAIRMAN. You also say in your testimony that, "Congress should condition the release of the 50-percent smart grid matching fund on the development of NIST-endorsed standards." Now, one of the drumbeats around here when we were passing the so-called stimulus bill was that we needed to get jobs created right away, and that we weren't interested in things that were going to take a lot of planning and a lot of delay. How does that concern square with what you're suggesting here? You're saying that, of the money that was provided, we should say, "Hold on, don't spend any of that until we get these NIST-endorsed standards established," as I'm understanding what you're saying. Is that right?

Mr. GADDIS. Mr. Chairman, what I'm saying is—you know, I realize, like everybody else, NEMA realizes, like everybody else—we've got to get jobs going. I believe we could do this process much quicker. Over a year ago, in EISA 2007, NIST was designated to put this roadwork out there and to start writing the standards. In fact, NEMA has been pushing this, quite honestly, to get that done. We should have it done right now. We should be able to get these standards out in very quick time. At least the ones we need to start so that we've got interoperability, the really important standards. We can do this, and we can start building at the same time.

The CHAIRMAN. OK.

Mr. Lu, let me just ask about the device that you folks have developed, or the software that you folks have developed, to allow people to monitor their energy use—the power meter. I would think that if you have this on this Google Power Meter, it would be appropriate to have all the smart meters that we are paying for getting installed all around the country here as part of this stimulus effort, have them contain some device to communicate with the Google Power Meter so that anyone who's got a smart meter could

access that smart meter by looking at their cell phone or their computer or whatever. Am I thinking about that right?

Mr. LU. There's two ways to get the data, either directly off the meter, if you're at home; and then you can get very, very high-quality data, because you're close to the meter, and the meter can send data to you very, very frequently. Now, the other way to get the data is through a partnership with your utility, who is pulling the data back anyhow for their purposes of running the grid. That's how it operates today.

We'd like to see various ways of getting the data. In fact, we actually are—we want to be sort of somewhat agnostic about this. This is our solution; it isn't necessarily the best solution, and we'd like to encourage that the data be made available. We think that the consumers have a right to see their data. We have a way that we think is very good to do that, but, you know, we certainly don't want to say that this is, far and away, the best, or this is the only way to do that, because more competition is better.

The CHAIRMAN. But, you're basically saying that—I guess, that utilities, perhaps, should—if they put in these various systems, they should have this on the Internet so that it is compatible with your power meter software.

Mr. LU. Yes, we'd like to see it be compatible. We'd like to see it be in an open format, an open, nonproprietary format, so that anyone can use it, and we could use it, too.

The CHAIRMAN. Right. OK. All right.

Senator Murkowski, do you have additional questions?

Senator MURKOWSKI. Not necessarily a question, Mr. Chairman, just a comment about where we are.

I was just looking through the background memo here and appreciating what we did under EISA-07 in outlining the expectations at that time as to what we anticipated with a smart grid. We created a Smart Grid Advisory Committee to advise the government on the deployment, created the Smart Grid Task Force of Federal Agencies to coordinate the grid policies, established an R&D and demonstration program, tasked NIST with the development of an interoperability framework, established Federal Matching Grant Program, directed States to do smart grid considerations. A number of reporters, none of which I understand, have actually been released. We did this back in 2007.

Now, I appreciate that it's—always comes down to money and the fact that NIST wasn't given the dollars to do it, but now that we're at “go,” and we've got \$4 and a half billion out there on the table, it seems like we're playing more than just a little bit of catch-up, here. This is too important for us to get it wrong. So, I would just urge expediency at the same time as, just, real oversight and review that we are getting as close to where we need to get as possible. I think we saw the vision several years ago, and now we're moving with it, but we haven't laid that framework quite yet.

The CHAIRMAN. Senator Shaheen, did you have additional questions?

Let me thank this panel. I think this has been a useful hearing, and very useful testimony. Thank you very much.

[Whereupon, at 12:02 p.m., the hearing was adjourned.]

[The following statement was received for the record.]

STATEMENT OF THOMAS R. STANDISH, GROUP PRESIDENT, REGULATED OPERATIONS,
CENTERPOINT ENERGY, INC.

Mr. Chairman and Members of the Committee. My name is Tom Standish and I am submitting this statement on behalf of CenterPoint Energy, Inc., an investor-owned utility which includes an electric transmission and distribution subsidiary serving the metropolitan area of Houston, Texas. CenterPoint, in collaboration with other industry leaders, has been actively pursuing a Smart Grid strategy entitled the "Intelligent Utility Network," which links electricity with communications and computer controls to create a highly automated, responsive and resilient power system.

In the American Recovery and Reinvestment Act of 2009 ("ARRA"), the Congress allocated \$4.5 billion to the Department of Energy's "Electricity Delivery and Energy Reliability" account. The ARRA provides that approximately \$200 million of this amount should be used for certain worker training, resource assessment, and technical development activities. We recommend that a substantial majority, if not all, of the remaining funds should be used to make grants to enable the commercial deployment of projects under Section 1306 of the existing Smart Grid Program which the Congress created in the Energy Independence and Security Act of 2007.

The Smart Grid Program supports a combination of technologies deployed throughout the electricity generation, transmission and distribution systems that will turn today's antiquated electric transmission and distribution grid into a more modern, efficient, technologically advanced, economically smart, and environmentally focused infrastructure, with real-time, two-way communication capabilities throughout. The technology, including devices and communication networks that can make this happen, exists today and is awaiting immediate commercial deployment.

The Smart Grid is, and always will be, an evolving concept. The question is how best to encourage it to evolve more rapidly and efficiently. We submit that the best way is to rapidly get into the field those Smart Grid elements which are in existence today. CenterPoint is a perfect example of the benefits of this approach. As we deploy our smart meter system, we encourage the development of a technological supply chain. As we begin operation of that system, we encourage the development of complementary technologies—both IT and smart appliances. And as we enhance that system with our Intelligent Grid system, we will facilitate the wider use of renewable energy and advanced technologies like plug-in electric hybrid vehicles ("PHEVs").

There are four reasons why use of ARRA funds for the commercial deployment of eligible Smart Grid projects and investments should be encouraged.

First, the physical deployment of commercial Smart Grid infrastructure will preserve and create jobs, inside and outside the electricity sector. Commercial Smart Grid implementation requires numerous hardware products that must be manufactured and installed at every end-user's facility or home. When implemented at the commercial level, this will require a vast, labor-intensive work force. The evolution of these products will create a sustainable job market. Smart Grid also utilizes computer hardware and innovative software. The development, implementation, and technical assistance required for this advanced technology will create many sustainable positions throughout the IT sector. Only the large-scale, commercial deployment of Smart Grid—not isolated research and development—has the ability to create these direct and indirect employment benefits. For instance, we estimate that implementation of CenterPoint's proposed Smart Grid initiative on its current schedule will create up to 8,000 new jobs over the next 5 to 7 years. Our obtaining a DOE grant could accelerate the creation of these 8,000 jobs in a much shorter timeframe, which has the dual benefit of creating jobs now and speeding up the implementation of a key component of our new energy future. These jobs will fall across a broad spectrum of the labor force—factory employees will be hired or retained to manufacture more meters and transmission switching gear, software and computer hardware output will increase in sales, and a large number of new employees will be needed in a very short amount of time to install these meters and new relay systems for the transmission grid.

Second, the commercial deployment of a modern and expanded Smart Grid will provide the enabling technology necessary for inventing, developing, and implementing renewable energy systems and PHEVs. The two-way electricity transfer capability of Smart Grid is vital to the expansion and use of renewable energy systems such as solar and windpower. Smart Grid will also provide the technological change needed to accommodate the battery storage and energy redistribution potential that is vital to efficient utilization of distributed renewable energy. If PHEVs are to be used as a source of power to discharge the batteries during peak times, then a

Smart Grid will be needed to control and account for power flows. Thus, the Smart Grid enables the use of PHEVs to contribute both to demand reduction and peak energy production, with environmental benefits resulting from both. Furthermore, the mere commercial availability of Smart Grid is likely to spur the creation and development of future technologies that will serve to further the nation's electricity delivery efficiency and energy reliability. There is simply no way with the existing grid to fully exploit these renewable sources of energy because the grid as currently designed and operated cannot readily accommodate and measure the two way flow of electricity.

Third, the commercial deployment of smart metering systems, capable of two-way communication, will lead to more efficient electricity generation, transmission, and demand-side use, which will create electricity cost savings for all end-use consumers. Computerized metering systems measure, collect, and analyze energy usage for each individual consumer. The two-way communication capability of the smart metering system allows for the distribution of real time information to customers, service providers, utility companies, and electricity generators. This enables electricity providers to efficiently manage their energy supplies, provides customers with information on how to alter their energy consumption to achieve more efficient and cost-effective energy usage habits and allows the power provider and the consumer to communicate directly as to the consumer's consumption choices. Thus, by connecting smart metering systems to the Internet, consumers will have the ability to immediately increase the efficiency of their energy use by remotely accessing and controlling their homes' energy intensive appliances. The commercial deployment of these smart metering systems will also increase the number of end-use consumers who are able to alter their energy consumption habits through time-of-day pricing, thereby increasing the Nation's overall energy efficiency and cutting into the demand for new power plants.

Fourth, directing ARRA funds to immediately deployable commercial Smart Grid projects will allow DOE to obligate and expend funds promptly, with full transparency, to projects that can obtain specific, tangible results. Several energy providers are either in the process of implementing or are ready to implement Smart Grid projects. No further research is needed for this implementation to occur. Smart Grid is ready for commercial deployment and its benefits are known, obvious, and desired. Investor owned energy providers also operate under the financial monitoring of Public Utility Commissions, which can assure that the funds will be spent prudently and directed as intended.

In summary, the Smart Grid provides THE enabling technology that must be commercially available if the Nation hopes to increase its utilization of clean, secure, and reliable renewable energy. By financially supporting immediately deployable Smart Grid projects, DOE can accelerate the attainment of the Congress's and the Administration's goals that are set forth in the ARRA. The Committee should encourage DOE to prioritize its award of grants to those commercially deployable Smart Grid Projects that are immediately ready to be implemented.

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF EVAN R. GADDIS TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources. In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. Reliability and efficiency benefits can be achieved within existing transmission corridors. Reliability, in terms of reduced outage duration and occurrences, can be improved through monitoring devices and replacement of mechanical controls with digital controls. Smart appliances and controls can shut down or delay usage with minimal inconvenience to the consumer, resulting in lower energy bills. Demand response technologies can optimize use of existing transmission by reducing peak demand. Real time transmission line rating technologies and high temperature conductors can be used to expand capacity along existing transmission corridors.

Integration of renewables will require both new transmission corridors and a grid that can adapt to their intermittent nature, including incorporation of storage. The amount of transmission will increase in relation to the quantity of renewables or carbon reduction required.

Question 2. “Smart Metering” projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

Answer. NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85 percent of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15 percent will come from End-User Energy Management.

Policy objectives must be clearly articulated in order to prioritize correctly the demonstration projects. For example, if the primary objective is carbon reduction, then transmission and distribution systems should receive substantial funding. These systems need upgrades to handle new intermittent resources. However, if the primary objective is to reduce consumer utility bills, then smart meter projects would be more applicable than transmission projects. Many advanced meter pilot projects have already demonstrated substantial savings for end users. Since there are likely to be multiple objectives, including reduced carbon emissions, reduced utility bills, and reduced dependence on foreign energy, it is likely that projects in all domains will need to be pursued.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. NEMA has proposed a metric called the “Levels of Intelligence,” which measures the integration of logic and communication into grid devices. The Department of Energy has also developed its seven smart grid characteristics, which can be used to measure the outcomes or capabilities of a modernized grid as a whole. Both measures could be used to determine how much modernization has occurred as a result of the stimulus investment.

We are already beginning to see service quality improvements as a result of advanced meter deployments. Improvements throughout the system will be continuous as new technologies are developed, demonstrated, standardized, and deployed across the nation.

RESPONSES OF EVAN R. GADDIS TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Is NIST the right agency to develop consensus-based standards and protocols?

Answer. NIST is an objective and technically capable organization to develop a Smart Grid roadmap and to coordinate the development of consensus-based standards. However, NIST itself should not develop standards. The tasks of developing new standards or assembling consensus on existing standards should be delegated to accredited standards development organizations.

Question 2. What is a realistic time-frame for establishing an Interoperability Framework?

Answer. Based on the work over the last year, NEMA is hopeful that NIST can establish the framework, which includes prioritization of standards areas, by June 2009. The NIST framework may also incorporate specifications or requirements of standards changes that need to be incorporated into existing standards by various standards development organizations. Once standards development organizations are identified to establish consensus around a new or existing standard area, NEMA anticipates the process taking from 9–12 months.

Question 3. Do you agree with NEMA that Congress should condition the release of Smart Grid funds on the development of NIST endorsed standards? If we proceed without an Interoperability Framework are we just building “custom projects”—which is really just a nice way of saying projects that will soon become obsolete?

Answer. To clarify, NEMA advocates conditioning only the 50 percent investment matching fund on the NIST standards, with the understanding that NIST will produce the standards framework in a timely fashion. Demonstration projects can and should be put into place immediately, which will generate both jobs and technical expertise. The information from these demonstrations will help the industry refine and improve standards in preparation for widespread deployment. The matching funds should be used to encourage the regulators, utilities, and manufacturers to follow a nationwide approach.

There are some standards that are ready or almost ready for implementation today. The industry needs a recommendation from NIST for FERC to make those standards the law. Projects that use these standards would be eligible for the matching fund immediately.

Question 4. A smarter grid is supposed to enhance our system’s security but technologies like smart meters, sensors and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks. How do we address these cyber security concerns? Do the agencies have sufficient authority or is additional Federal legislation needed?

Answer. Communications protocols must incorporate security concerns from the ground up, and the standards development organizations are aware of this concern. For example, smart meter standards already incorporate mechanisms for authentication and encryption. Equally important is ensuring that operational practices incorporate security criteria. Even the most hardened grid device is vulnerable if the installer does not change the default password. In this arena, NERC has the appropriate lead on cyber security.

Question 5. In your testimony, you note that in 1968 President Lyndon Johnson issued an Executive Order that directed the Federal Government to purchase only computers that complied with a certain standard in order to “minimize costly incompatibility.” Are you suggesting an Executive Order for Smart Grid standards?

Answer. Certainly, the President could order that the Federal Government only purchase energy systems that complied with the NIST framework. The example was given to show that the government can use multiple policy levers to encourage the industry to converge on one or a suite of standards. In addition to an Executive Order, the current policy incentives of matching funds and potential FERC mandates are suitable mechanisms to encourage interoperability.

Question 6. How far away are we from so-called “smart” appliances that can interface with the grid? Do you need standards and protocols in place first?

Answer. At the level of individual components, smart appliances and end user controls, such as thermostats, are already here. It is not difficult to design a thermostat that shuts off during certain periods of the day. It is not difficult to design a system that communicates with the thermostat. The difficulty lies in the non-uniform nature of the utility industry. It is difficult to design one communicating ther-

mostat that will talk to every utility system in the country, because not every utility uses the same communications methods.

We could install smart appliances today, as many pilot projects have done. But each pilot has involved some degree of customization to the host utility, and we do not yet have a common home area network standard. If we want to attract businesses to fund research, product development, and manufacturing of smart appliances, we must create a market large enough to offset the upfront investment costs. We need nationwide standards in order to create nationwide markets.

RESPONSES OF EVAN R. GADDIS TO QUESTIONS FROM SENATOR STABENOW

Question 1. As we know, Smart Grid can promote electric transportation technologies, particularly plug-in hybrid electric vehicles (PHEVs). A PHEV connected to the grid will enable consumers to charge up during the overnight hours when electricity is cheaper, and then wake up to a car ready for their morning and evening commutes. Some people have proposed that the smart grid (someday) could allow energy providers to draw power from a PHEV battery during the day. Do you think this is possible? If so, what timeframe would you forecast that it is possible?

Answer. Yes. We will see mass deployment of one-way smart charging (i.e. only drawing power during low-cost periods) within a few years. However, mass deployment of charging and discharging technologies in plug-in hybrids will take some time. Two-way energy flow to and from stationary batteries is possible and is in commercial operation in several markets across the nation. Two-way energy flow with mobile automotive batteries has been demonstrated, but there are unresolved questions over battery wear and end user safety. In addition, the utility's distribution system must also be reconfigured to handle two-way power flows. Many protective devices are only set up to detect short circuits and faults when power flows toward the home. We are likely several years away from a national system that can support two-way charging and discharging from PHEVs.

Question 2. What can we be doing to ensure that the manufacturing of this equipment leverages as many American jobs as possible?

Answer. Congress can start by establishing steady funding for domestic energy research and demonstration programs to attract the brightest scientists and engineers. Businesses that commercialize new technologies tend to locate near their inventors. Congress should also promptly establish long term policies, such as renewable energy standards, carbon pricing, or production tax credits, which demonstrate a predictable market for clean technologies. If there is domestic demand for new domestic technologies, those products will tend to be made in the U.S.

RESPONSES OF EDWARD LU TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources.

In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. A broad smart grid vision includes new transmission lines able to carry clean, renewable power from remote areas to population centers where it is needed. Google has developed a "Clean Energy 2030" proposal that envisions 300 GW of on-shore wind and 80 GW of concentrating solar power generation, an amount that would require 20,000 miles of new transmission lines to support (currently there are 200,000 miles of high-voltage lines in the U.S.). Our Clean Energy 2030 plan is available at: http://knol.google.com/k/-/15x31uzlqeo5n/1#Electricity_Sector.

Question 2. "Smart Metering" projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund? NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85 percent of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15 percent will come from End-User Energy Management.

Answer. Significant energy savings can result from smart metering programs—studies show that just being aware of energy consumption in real-time can lead to individual reductions of 5 to 15 percent. If just half of U.S. households cut their demand by 10 percent, the electricity savings would be greater than today's total U.S. wind and solar power output. The CO₂ emissions avoided would be equal to taking approximately off the road. Moreover, additional savings would result if real-time, consumer-centric smart meters are combined with real-time pricing incentives that reward consumers for reducing their consumption during peak demand. Of course, if smart meters are not enabled to provide real-time information to consumers then their benefits could be small indeed. Smart meters should provide information to consumers in a timely fashion and useful format.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. We should consider actual reductions in electricity consumption that can be measured with deployed smart grid equipment, including smart meters and home energy management devices. We should expect to see more accurate projections of future demand requirements, which will mean more cost-effective planning and likely deferrals of investments in new generation before it is actually needed. President Obama has said he wants to jump start the deployment of 40 million smart meters in American homes.

RESPONSES OF EDWARD LU TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Is NIST the right agency to develop consensus-based standards and protocols?

Answer. NIST has a role, but it should not delay the private sector from reaching a consensus on standards and protocols, a risk to keep in mind given NIST's former lack of funding and time required to act.

Question 2. What is a realistic time-frame for establishing an Interoperability Framework?

Answer. We have no position on the time-frame for the Interoperability Framework generally (except that it should be established as soon as possible), but we do think that consumer-facing data formats specifically could be developed very quickly.

Question 3. Do you agree with NEMA that Congress should condition the release of Smart Grid funds on the development of NIST endorsed standards? If we proceed without an Interoperability Framework are we just building "custom projects"—which is really just a nice way of saying projects that will soon become obsolete?

Answer. No, Smart Grid funds should not be thus delayed—particularly since Congress clearly addressed the issue of standards for funds when it required that stimulus projects utilize "open protocols and standards (including Internet-based protocols and standards) if available and appropriate" a precondition for winning stimulus dollars. (ARRA, Sec. 405). This provision in the American Recovery and Reinvestment Act also removes the danger that proceeding without a NIST-blessed Interoperability Framework will lead to Federal funding of projects that will soon become obsolete. To the extent that utilities move forward with large scale meter deployments based on open standards and protocols, such delay will not be necessary. Moreover, to the extent that the meters deployed have a way to communicate with devices inside of consumers homes (as contemplated by Section 1301 of EISA-07) that is based on open standards and protocols there will be less reason to be concerned about obsolescence.

Question 4. A smarter grid is supposed to enhance our system's security but technologies like smart meters, sensors and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks. How do we address these cyber security concerns? Do the agencies have sufficient authority or is additional Federal legislation needed?

Answer. Agencies have authority now as well as direction provided in Title 13 of the Energy Independence and Security Act of 2007 (EISA-07). The smart grid should be deployed with cyber security in mind.

Question 5. You tout the potential cost-saving benefits of Smart Grid but isn't it true that customers will need to act in response to their price signals in order to realize the benefits?

Answer. The benefits of having information about electricity consumption do not depend on price signals. An increasing awareness of consumption will help consumers find ways to reduce consumption. One review of research on the effects of providing immediate feedback on electricity usage found that overall demand reduc-

tions generally ranged from 5 to 15 percent. See Sarah Darby, *The Effectiveness of Feedback on Energy Consumption: A Review for DEFRA of the Literature on Metering, Billing and Direct Displays* (2006), available online at: <http://www.defra.gov.uk/environment/climatechange/uk/energy/research/pdf/energyconsump-feedback.pdf>. Price signals will further increase the benefits of simply having realtime information about electricity consumption, which is possible if smart meters are required to provide consumers with such information (or if consumers otherwise have access to such consumption information, for example through a home energy management device).

Question 6. Do we need to do some kind of public outreach or marketing to get consumers comfortable with this new technology? Do you see any particular problems associated with Smart Grid technology for low-income consumers?

Answer. Yes, public outreach or marketing may be important but the need for such efforts can be reduced if meter deployments support robust Home Area Networks that give consumers information and easy to use tools. This could be as simple as a display on the kitchen counter, or a software tool on a computer or telephone. With low income consumers, the importance of communicating the value of Smart Grid may require special efforts but all consumers should be given as many options as possible when it comes to information and tools. Google and others in the private sector (for example, our Smart Grid policy partner General Electric) are engaging in such educational efforts concerning smart meters and the smart grid more generally—our PowerMeter announcement is part of that effort.

Question 7. I understand Google is currently developing a PowerMeter that will provide consumers with the ability to monitor their energy consumption in a meaningful way. When do you expect this to be released in the market?

Answer. Yes, we're working on a home energy monitoring tool called Google PowerMeter that provides near real-time energy information right on your computer. This is an internal project only at this time, but we are working with utilities and device manufacturers around the world to gradually roll out programs for their customers sometime this year.

RESPONSES OF EDWARD LU TO QUESTIONS FROM SENATOR STABENOW

Question 1. A number of utilities already have begun modernizing their grids by installing digital electric meters and technologies that enable two-way communication capabilities between the utilities and their customers. This transformation to a "smart grid" should benefit the companies and their customers. How will the smart grid enable entities to detect and repair outages faster, hookup customers quicker, and give consumers the capability to manage their homes' appliances more efficiently?

Answer. The Smart Grid is essentially an Energy Internet and consists of three things: sensors, software and two-way communications. The more high-speed the communications component of a smart grid, the more capable it will be. In fact, Title 13 of the Energy Independence and Security Act of 2007 (EISA-07) suggests that to qualify as a smart grid communications should be capable of real-time connection with consumers. For example, Section 1301 of the EISA-07 states lists among the characteristics of a Smart Grid: "Deployment of 'smart' technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation." The same section also lists, "Provision to consumers of timely information and control options." (emphasis added).

Question 2. Although Smart Grid does not require new transmission lines, utilities will still need to implement lots of changes and upgrades, the costs of which will be borne ultimately by ratepayers. In-home devices will also be expensive up-front investments, although their long-term value for energy savings is clear. When will these investments in Smart Grid become cost effective for consumers and what can government do to help?

Answer. Given the potential energy savings, smart grid investments will be cost effective. Moreover, investments in Smart Grid will also become more cost-effective as the cost of in home devices fall as a result of more purchases and the inevitable improvements in information and communications technology reduce costs, just as has happened with other consumer electronics like mobile phones. Also, stimulus funds will help to make some investments in Smart Grid cost-effective that would not otherwise have been at this time.

RESPONSES OF KATHERINE HAMILTON TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources. In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. The GridWise Alliance as an organization advocates for deploying smart grid technologies holistically on the existing grid to improve the efficiency, reliability, and security of the grid. We understand, however, that even with a fully optimized grid, additional transmission lines will be needed to access remote renewable energy resources and integrate those resources onto the existing grid. We defer to experts in utilities and Regional Transmission Organizations to quantify the amount of new transmission needed to fully access areas rich in renewable resources.

While we do not take a position on how many of these new lines will need to be built, we do advocate that, wherever feasible, smart grid technology be embedded into additions to the transmission system. Different approaches should be taken for transmission and distribution since the priorities of each are different (for example, on the transmission side, regional operations and renewables access may be the highest priorities). Extending the use of existing transmission could mean upgrading existing lines to carry additional capacity offered to the transmission system. This upgrading could occur more quickly and would not require new rights of way.

Once smart grid technologies are considered best practice for building and optimizing both transmission and distribution, we can achieve benefits from both central and distributed renewable energy, system and consumer energy efficiency, power reliability, and operational cost reduction.

Question 2. “Smart Metering” projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

Answer. The GridWise Alliance as an organization does not advocate for specific technologies, but rather for a host of technologies and applications that will make our electric grid smarter. The benefits of each component of the smart grid—advanced metering, infrastructure and smart meters, distribution and transmission grid operations, demand response programs, distributed energy resources—must be fully integrated to provide the greatest benefits.

Smart metering is one such technology that, with accompanying customer data and interaction, can help in determining distribution system upgrade and optimization needs. More frequent time-based information at the service delivery point provides data that can assist in determining distribution system upgrade and optimization needs. Data from smart meters can help assess deployment maintenance schedules, demand response, asset utilization, and work force management. Delivering this information to end users will allow them to understand and interact with the grid in real time so they can make informed choices to control their carbon footprint and employ energy efficiency and demand response technologies. Even more importantly, the marriage of smart metering to Home Area Networks (HAN) portends a future where demand reductions can occur automatically when intermittent renewable generation ceases, increasing the value of renewables and reducing the need for fossil-based generation to act as “back-up”. While smart metering is only part of the smart grid, a metering program in combination with distribution smart grid technologies can generate more benefits than any one program individually.

Additionally, smart grid technologies can support improved reliability and help mitigate the societal impact from severe weather damage to transmission and distribution systems. Societal impacts are generally measured in the billions of dollars; for example, in Houston the societal cost of Hurricane Ike was estimated at \$5.4 billion. With smart grid communication, restoring power 2 days sooner could have saved the city millions of dollars. A challenge utilities and customers face is the inability to have real time data regarding the actual condition of the system; a smart grid can provide that data.

Thus, the GridWise Alliance advocates that demonstration funding should go to a variety of technologies and applications without singling out any one as having higher preference.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. Projects selected for funding should readily provide data on a variety of benefits including economic stimulus (including, but not limited to, job creation and/or retention), increased renewable energy integration, increased clean distributed energy systems, increased energy efficiency, demand response, overall system optimization, better reliability and increased security. The GridWise Alliance is prepared to collaborate with the Department of Energy to recommend specific metrics that would be a suitable proxy by which benefits can be ascertained. Indeed, developing the relative certainty of these metrics today would enable more effective disbursement of the funds currently available. GridWise Alliance may be providing input to the Department of Energy's Notice of Intent for investment grant projects during the public comment period. If the funding is disbursed efficiently and effectively, depending on the specific application, we should begin to see immediate results from smart grid applications on our electricity system.

Question 4. Ms. Hamilton, you state in your testimony that a critical issue for funding of smart grid projects is establishing minimum smart grid standards for other energy infrastructure projects that are undertaken pursuant to provisions of the Recovery Act apart from those that contain specific smart grid language. Could you expand on this point and suggest how we in Congress might address this?

Answer. In my testimony I was referring to transmission system expansion. Any transmission bill should include language that such expansion incorporates smart grid capabilities where feasible and cost effective. In addition, it is important for Congress to encourage the continual integration of smart grid technologies through energy policy. Smart grid applications are critical to enable stable and effective management of intermittent sources. Without the integration of smart grid technologies we will not realize the full potential of energy produced from renewable resources, even to the levels being discussed in many of the proposed renewable portfolio standards. Congress should consider how smart grid deployment could enhance the implementation of a renewable portfolio standard, an energy efficiency standard, or a reliability standard.

RESPONSES OF KATHERINE HAMILTON TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Is NIST the right agency to develop consensus-based standards and protocols?

Answer. As the National Institute of Standards and Technology, NIST has the appropriate mission, experience, and skills for coordinating the development of consensus-based standards and protocols in domains like building systems automation. These skills should transfer easily to smart grid interoperability standards with the funding now in place. NIST has coordinated well with the DOE GridWise Architecture Council as well as other organizations and individuals during this first year of activity. NIST has received no funding for this mandate prior to the stimulus bill and, as a result, is just now able to devote more resources to focus on the standards. While NIST has coordinated well with the DOE GridWise Architecture Council as well as other organizations, NIST needs to accelerate its outreach efforts to bring in the work of these groups and drive convergence in the industry. Although we believe that continued oversight is important, simply removing the activity from NIST would only delay the process.

Question 2. What is a realistic time-frame for establishing an Interoperability Framework?

Answer. Once NIST's outreach to the existing efforts is completed, it should support work like that of the GridWise Architecture Council that is already underway, while initiating any new efforts within the context of standards development organizations. With the communities working in parallel, the mapping of each point of interoperability between the various smart grid systems should be between 3–6 months of focused effort. NIST's domain expert work groups are a positive start to this activity. Once the mapping is complete, development and approval of consensus standards for each point of interoperability could take anywhere from 2 months to 2 years, depending on the technical complexity of the issues.

Question 3. Do you agree with NEMA that Congress should condition the release of Smart Grid funds on the development of NIST endorsed standards? If we proceed

without an Interoperability Framework are we just building “custom projects”—which is really just a nice way of saying projects that will soon become obsolete?

Answer. The GridWise Alliance does not agree with NEMA that Congress should condition release of the smart grid stimulus funds. We can make significant progress on making our grid smarter prior to the completion of the standards process. Much of the work is already quite far along—or even complete—on achieving interoperability between systems that make up the smart grid. Emphasis should be placed on rapid progress of work in areas that will benefit smart grid projects that are already being proposed by industry.

The interoperability process will benefit from and be accelerated by stimulus funding for projects. Since utilities and others deploying smart grid technologies do not want stranded assets, they are driving early interoperability standards development in work groups that can feed into the NIST process. They are also designing deployment such that software could be revised rather than entire equipment investments changed out. This is common practice for other industries and is an effective means of driving deployment without excessive redeployment cost once the standards are finalized.

Moreover, the stimulus bill requires that demonstration initiatives and Federal matching grants use open protocols and standards if available and appropriate. We feel that this direction from Congress, as well as the activities listed above, will ensure that expeditious disbursement of stimulus funds is money well-spent.

Question 4. A smarter grid is supposed to enhance our system’s security but technologies like smart meters, sensors and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks. How do we address these cyber security concerns? Do the agencies have sufficient authority or is additional Federal legislation needed?

Answer. We agree that cyber-security issues are paramount when installing intelligent two-way communication devices on the grid. Best practices exist for segmenting different business functions such as generation, transmission, distribution, customer operations, and corporate IT to ensure grid reliability. Strong access control, secure authentication and confidentiality mechanisms have existed for many years and can be applied to securing the smart grid.

Utilities and other industry partners are developing a consensus process around specifications for security around some technologies that should be applicable to other smart grid technologies across the grid. Further, security for smart grid technologies is being “baked-in” from the start instead of “bolted on” as in the past; the security of the grid will benefit from this up-front, holistic approach. Digital devices exist already in transmission substations; smart grid investments will serve to upgrade cyber security for these systems. The GridWise Alliance supports the coordination of FERC, NERC, and NARUC with the Department of Homeland Security and industry efforts as critical to the development of cyber security standards.

Question 5. You testified that commercial deployment of Smart Grid technologies is the most effective tool to encourage private sector product research and development. In our rush to spend the money provided in the Stimulus bill, are we getting ahead of ourselves by putting the “cart before the horse” like Commissioner Butler claims?

Answer. As with all technology development, the business case associated with commercial success often drives continued research and development. While we have substantial smart grid technology today that creates benefits for our grid, we can continue to enhance these applications through research and development. Research and development does not end when commercialization begins, but can continually improve performance, price, and other benefits from any given technology. The smart grid demonstration projects could serve to both spur widespread investment in these technologies as well as to provide greater clarity of the need for any additional research and development.

Question 6. The recent Stimulus bill imposing a new requirement that demonstration projects must use “open protocols and standards (including Internet-based protocols and standards) if available and appropriate.” Please explain this new requirement and tell the Committee whether or not you support it. Opponents of this requirement argue that internet-based standards can be slow and therefore are not appropriate to address reliability concerns.

Answer. The GridWise Alliance is fully supportive of open protocols and standards which would allow all technologies to compete without picking a winner at this stage. Technology choice should not be legislated, but should be left to the industry to make choices based on the best technology for the situation as well as the interoperability standards enforced by the appropriate Federal and state regulators. We believe legislative language should maintain technology neutrality—that open interface specifications are important, that competition between solution providers en-

courages innovation while driving down cost, and that performance-based measures can remain technology-neutral.

Question 7. You testified that since a smarter grid is a “means to an end, additional smart grid policies need to be included when energy or climate legislation is considered that involves our electricity system.” For example, you suggest that smart grid could become an element of an RPS. Please elaborate.

Answer. The GridWise Alliance strongly believes that smart grid technologies enable the rapid and effective deployment of other clean energy technologies and, as such, should be considered when policies to incentivize those technologies are developed. The electric system and all of its components need to be thought of holistically and interactively when designing energy or climate legislation. In an energy efficiency standard, for example, smart grid could be included in the definition of distribution efficiency (by specifying reduced line losses, for example). In climate legislation, smart grid bonus allowances could be included much the way bonus allowances for demand response activities were included in the Clean Air Act Amendments of 1990.

Question 8. In your written testimony, you note that “most consumers will not change behavior without price signals, education, and technological assistance. Despite GE’s Smart Grid Superbowl ad, what do consumers know about Smart Grid today?”

Answer. Consumers have varying degrees of understanding of smart grid based on whether they live in an area served by a utility that has started to deploy those technologies. To a large percentage of the population, the concept of smart grid may be misunderstood; they will equate the grid with transmission towers and high voltage lines but will have little sense that these elements need to be made more intelligent. With first-hand knowledge, consumers will begin to understand what a smart meter is and how this technology impacts their life and their pocketbook. For the majority of the people in this country, however, a scarecrow on a power line, while creative, does not help them understand what the smart grid will do for them. It will take an increased level of education on the part of all stakeholders—our businesses, government, utility commissions, and consumer groups—to help consumers understand how they can benefit from more information about and control over their energy use. The GridWise Alliance is in a position to provide much of that education. We are already working with the National Energy Education Project to develop curriculum materials for K–12. We are also working with states—through state energy offices, utilities, and Governors—to provide information for commissioners and state legislators.

RESPONSE OF KATHERINE HAMILTON TO QUESTION FROM SENATOR STABENOW

Question 1. We understand that smart grid will give customers more choices—and during certain times in the summer for example, a customer may be able to opt in or opt out and get certain benefits from their providers. Would low-income customers be able to plug-in the amount of energy that they want to spend and how would the smart grid benefit low income customers or residents on fixed incomes?

Answer. Low or fixed income consumers certainly stand to benefit from smart metering applications. Ultimately, a consumer could set up the amount he or she could spend in a given month and the energy management program would then indicate how the consumer should use their energy to meet that goal (for example, thermostat setting, plug load management, etc.). As the month unfolds, the system would alert them to high demand times and give them opportunities to adjust their use and prevent increased bills, eliminating surprises at the end of the month. By utilizing the smart grid and smart metering technologies, many creative programs could be formed to address this market. For example, customers unable to make these decisions could elect to have their energy consumption sent to caretakers or other support groups. Those consumers who are able to make lifestyle changes based on smart grid information defer capacity requirements which benefit all consumers, regardless of their desire or ability to participate in or opt out of a specific program.

RESPONSES OF SUEDEEN G. KELLY TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources. In order to achieve the benefits that we want from Smart Grid, how much

new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. In response to your first question, the North American Electric Reliability Corporation (NERC) has determined that significant new, extra high-voltage transmission facilities are essential in order to deliver power from the remote renewable resources. This “transmission superhighway” would be overlaid on the existing grid. NERC does not estimate the amount of new transmission facilities that are necessary, and FERC has not undertaken any study to identify an amount. The Department of Energy (DOE), in 2008, issued a study titled, “20 percent Wind Energy by 2030.” This study referred to a conceptual plan by AEP, a large utility and transmission owner/operator, that estimated that 19,000 miles of new 765 kV transmission line would be required to meet the “20 percent” goal. FERC has not undertaken any study to confirm or dispute the reasonableness of AEP’s estimate. (NB: AEP’s estimate was only targeted to wind.) It is impossible to gauge how much or the type of transmission (upgrades vs. new) is needed to bring America’s renewable resources to market without a sophisticated transmission planning effort to analyze numerous alternatives. This planning process must take into account the locations of the resources, the locations of load centers, the nature of the demand for the renewable resources, siting and cost allocation. Transmission planning, siting, and cost allocation are interwoven and affect what actually gets built. The Nation will require new transmission facilities. However, to the extent the current grid is sited appropriately for the transmission of renewables to load, and it can be upgraded cost-effectively, that should be given priority over the building of new transmission lines.

Question 2. “Smart Metering” projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85 percent of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15 percent will come from End-User Energy Management.

Answer. Smart Grid involves a comprehensive plan of adding intelligence to all aspects of the electricity system, from the transmission operator’s control room down to customer systems and equipment, including household appliances. As such, application of Smart Grid at all levels of the power system has the potential to generate great benefits, bringing efficiency to utility operations, and helping to manage the bulk power system, as well as enabling customers to have more options in managing their electricity. FERC believes that the portfolio of demonstration projects funded by DOE should include projects on both the transmission and distribution system and should include a range of technologies-not just meter installation. FERC would like to see the funded demonstration projects include technologies such as sensors on transmission and/or distribution equipment, digital communications in substations, and/or high-speed communications equipment. FERC would also like to see equipment that can accommodate a variety of different communications protocols in order to increase the range of devices that can participate in this effort, thereby increasing the overall functionality of the smart grid system. Neither smart metering nor grid optimization and renewables integration alone will leverage all the potential benefits of a smart grid.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. FERC is hopeful that the information that DOE will require from the smart grid grantees will show how effectively the money has been spent. DOE is developing an Information Clearinghouse to be populated with lessons learned from the Smart Grid pilot and demonstration projects. Indeed, the American Recovery and Reinvestment Act of 2009 (ARRA) authorizes DOE to require the grantees of these projects to provide it with information to be put into the Clearinghouse. FERC, along with the state members of the FERC-NARUC Smart Grid Collaborative, has provided DOE with a proposed set of information/data requirements that grantees should be required to provide to DOE, including the following information:

- a. Any internal or third party evaluations, ratings, and/or reviews including all primary source material used in the evaluation;

- b. Detailed data and documentation explaining any improvement in the accurate measurement of energy efficiency, energy conservation or demand response resources;
- c. Detailed data and documentation explaining the expansion of the quantity of energy efficiency, energy conservation or demand response resources that resulted from the project and the resulting economic effects;
- d. Detailed data and documentation for any improvements in the ability to reliably integrate variable renewable generation resources;
- e. Detailed data and documentation that shows any achievement of greater system efficiency through a reduction of transmission congestion and loop flow;
- f. Detailed data and documentation showing how the information infrastructure supports distributed resources such as plug-in electric vehicles;
- g. Detailed data and documentation that shows how the project resulted in enhanced utilization of energy storage;
- h. Detailed data and documentation that shows reductions in energy and demand associated with the project, and,
- i. Detailed data and documentation that shows how the project encouraged new business models, market innovation, and third party and private capital participation.

FERC and the state members of the Collaborative also proposed to DOE that the grantees be required to independently monitor and measure customer response to the project and that this information be included in the Clearinghouse. If the above information is required and reported, FERC believes it will go far toward helping DOE measure whether the money has been spent effectively.

Regarding how soon we can expect to see grid improvements, within the past year, FERC has acted on several rate applications that involved the deployment of transmission-level Smart Grid equipment. For example, several utilities have identified the deployment of Phasor Measurement Units (PMU), which, together with the dedicated communications infrastructure and advanced microprocessor-based controls needed to appropriately make use of high-quality PMU data, will increase the accuracy and availability of critical system information. This information is expected to lead to improved planning and operations of the system as well as increased efficiency of the relevant transmission facilities. These technologies are fairly well developed and these proposals were not contingent upon ARRA grant funding. Accordingly, some of the improvements envisioned for the Smart Grid, particularly in the area of improved use of grid resources, should begin to manifest themselves in the very near future. The more ambitious improvements that will likely be the subject of ARRA grant funded pilot projects will likely take longer to realize, depending upon the lessons learned from each pilot/demonstration project.

RESPONSES OF SUEDEEN G. KELLY TO QUESTIONS FROM SENATOR MURKOWSKI

1. What does Smart Grid technology promise in terms of reliability? A smarter grid is supposed to enhance our system's security but technologies like smart meters, sensors and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks. How do we address these cyber security concerns? Do the agencies have sufficient authority or is additional Federal legislation needed?

Answer. Cyber threats have been growing and continuously changing. Currently, FERC's main tools for increasing cyber security are reliability standards. In early 2008, FERC approved eight cyber and physical security-related reliability standards as part of its authority under section 215 of the Federal Power Act (FPA). These mandatory reliability standards apply to the bulk power system in most of the United States and will impose approximately 160 requirements and subrequirements. The provisions of these standards phase-in over an implementation period that ends by 2010. However, upon approval, FERC found that the standards required significant modifications and therefore directed the Electric Reliability Organization (ERO) to make changes to the approved standards. The drafting of those modifications is currently under way through the standards development process of the ERO, NERC. Although NERC is expected to complete an interim filing that addresses some of FERC's directives within the next few months, the majority of FERC's directives are not scheduled to be revised until sometime in 2010. Even though FERC gave considerable guidance on its expectations for improved cyber security standards in January 2008, at this point, we cannot predict the quality or timing of the revised cyber security standards industry is currently working on. It should also be noted that cyber security reliability standards are likely to evolve over time as technology and threats change. Achieving cyber security is not a one-time effort. However, at the very least, every standard that is developed as part of

NIST's interoperability framework must be consistent with the overarching cyber security and reliability provisions of the EISA as well as the existing FERC-approved reliability standards.

Regarding the second part of this question, section 1305 of the EISA, which is a stand-alone provision and does not amend the FPA, requires FERC to promulgate interoperability standards, but does not provide that the standards will be mandatory or provide any authority or procedures for enforcing such standards. FERC's existing FPA authority applies only to certain entities (i.e., public utilities under its ratemaking authority in sections 205 and 206, or users, owners and operators of the bulk power system under its reliability authority in section 215). However, FERC's FPA authority excludes local distribution facilities unless specifically provided. Its authority under sections 205 and 206 applies only to public utilities, and its section 215 authority does not authorize it to mandate standards but rather only to refer a matter to NERC's standard-setting process. If the intent of Congress is for the Smart Grid standards to be mandatory beyond the scope of the FPA, then additional legislation should be considered.

FERC's legal authority is inadequate to respond quickly to protect the grid against a cyber attack. Because of the tremendous disruption that could result from a cyber attack, legislation should be considered to allow the Federal Government to act promptly to protect against cyber threats or other national security threats.

Question 2. The Stimulus bill provided an unprecedented \$4.5 billion in Federal funds for smart grid activities. In your opinion, what is the best way to allocate these funds—matching grants for technology investments; research and development; pilot programs? Over what timeframe? What are the necessary first steps?

Answer. Most Smart Grid technologies have moved beyond the pure R&D stage, though not all to the same extent. Many transmission-level Smart Grid technologies appear to be close to commercial viability already. Other more ambitious Smart Grid technologies, particularly those at the customer end, appear to require further testing through pilot projects. The Department of Energy should remain flexible enough in its approach to permit well-developed technologies to receive matching grants for deployment while other less-developed technologies receive funding for pilot programs. An important first step would be to survey the range of Smart Grid technologies to determine their respective levels of developmental maturity.

There is an urgent need to move forward quickly on developing Smart Grid capabilities. The bulk power system faces reliability challenges that Smart Grid technologies could address. Among these challenges are the need to reliably and economically integrate large volumes of variable generation, deal with the changes in fuel mix and generation location that are likely to result from greenhouse gas control measures, and possibly the advent of a potentially large new load class in the form of electric vehicles.

Question 3. What capabilities and expertise in this area does each of your agencies bring to the table?

Answer. One of FERC's primary responsibilities under the FPA is to ensure that the rates, terms and conditions of transmission and sales of electric energy at wholesale by public utilities in interstate commerce are just, reasonable and not unduly discriminatory or preferential. Thus, FERC has decades of experience regulating wholesale energy transactions and markets and transmission. FERC also has a major role under the FPA in the reliable operation of the bulk power system in most of the Nation. FERC exercises this latter authority, which was enacted as part of the Energy Policy Act of 2005, by approving and enforcing mandatory reliability standards for the bulk power system applicable to the United States other than Alaska and Hawaii. More recently, EISA gave FERC the additional responsibility of instituting a rulemaking proceeding to adopt standards and protocols to ensure Smart Grid functionality and interoperability in interstate transmission of electric power and in regional and wholesale electric markets.

Question 4. In your opinion, is additional legislative authority in the Smart Grid area needed? In particular, is additional legislation needed to address cost-effectiveness, upgradeability, and cyber security concerns?

Answer. As discussed above in response to Question 1, Congress may wish to consider additional legislation with respect to the enforcement of Smart Grid standards if the standards are intended to be broadly applicable, mandatory, and enforceable. A separate area in which legislation is needed is with respect to authority to respond to an emergency related to a cyber or other national security threat to the transmission system.

Question 5. In order to realize the benefits of a smarter grid, what rate structure changes need to be made at both the wholesale and retail level?

Answer. Some Smart Grid capabilities, such as the efficiency gains that should come from deploying advanced sensors and controls on the transmission grid, likely

need no rate structure changes at the wholesale level to be realized. The efficiency and operational benefits coupled with cost recovery through transmission rates, in some cases including rate incentives, should be sufficient. The FPA provides FERC needed flexibility to institute any rate structure changes necessary to support Smart Grid development. For example, FERC just issued a proposed Smart Grid Policy that would allow utilities to seek to recover the costs of smart grid deployments that demonstrate system security and compliance with FERC-approved Reliability Standards and other criteria. The issue of rate structure changes at the retail level is a major issue being addressed among the states and is being discussed in the FERC-NARUC Smart Grid Collaborative.

Question 6. How can Smart Grid technologies reduce the need for massive transmission infrastructure investments? What kind of savings are we talking about? What are the impacts on transmission if we don't get the Federal Smart Grid program right?

Answer. Smart Grid technologies can allow more efficient use of existing and new transmission capacity thereby delaying the need for improvements to existing infrastructure and for the construction of new facilities. However, because most renewable generation will likely be located far from load and from the existing grid, new and upgraded lines will be needed. Smart Grid is unlikely to significantly reduce the need for a large build-out of the interstate transmission grid.

It is important to get the Federal Smart Grid program right because optimizing the design and operation of our transmission and distribution system can yield great efficiencies in the use of electricity, and enhance the ability to ensure the reliability of the bulk power system. Ultimately, a smart grid will facilitate consumer transactions and allow consumers to better manage their electric energy costs. For these reasons, FERC, along with other Federal and state agencies, as well as industry, is committed to developing and deploying a smart grid for the Nation's electric transmission system.

Question 7. Pursuant to the 2007 energy bill, once NIST has reached a sufficient consensus on an Interoperability Framework, FERC will begin a rulemaking process for adopting standards and protocols. How long do you expect that process to take? Should Congress legislate the standards and protocols instead? Is an Executive Order an option?

Answer. Pursuant to ARRA, Congress has provided important measures to move the process forward, including funding provisions, and a Smart Grid Clearinghouse for information exchange. In addition, as referenced above, FERC just issued a proposed Smart Grid Policy Statement which prioritizes the development of key interoperability standards, provides direction to the electric industry regarding cybersecurity requirements for Smart Grid projects, and proposes that utilities be eligible to seek to recover the costs of smart grid deployments under certain circumstances. In setting these "rules of the road," and providing encouragement for utilities and industry to deploy cutting-edge technology, coupled with the key provisions in ARRA, we are developing much-needed traction to accelerate the rulemaking proceeding.

RESPONSES OF FREDERICK F. BUTLER TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources.

In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. To me, one of the benefits of the Smart Grid is to make the system as a whole more efficient, thereby reducing the need to build more transmission. I don't think there is a "magic number" in terms of how much new transmission is needed; while improvements to the electric grid are certainly needed, ideally the less we need to build, the better. This begs the importance of a smart planning and siting process that gives ample consideration to non-wires alternatives to new transmission, particularly if the grid becomes more efficient. One of the most promising areas of potential for a "smart" grid is that it improves the performance of the system already in place; from there regulators and transmission providers can explore what new transmission might be needed. You don't build first and plan later; we must implement a bottom-up process that gives the States and regions the lead in

determining where we go: without this type of smart planning, the Smart Grid may not look so smart after all.

Question 2. “Smart Metering” projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85% of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15% will come from End-User Energy Management.

Answer. As I said in my testimony, the smart meter should be one of the last elements of the utility-deployed Smart Grid. That doesn’t mean it isn’t important, but until we do the work on the back end of the system, the smart meter will be meaningless. It may even be the case that the smart meter is optional, but the updates and upgrades to the backbone are most essential to the smart grid. I think we’ll get a better idea how customers respond to their smart meters when we see the results of the Boulder, Colo., demonstration project. We need to see how end-use consumers utilize these meters and build a “buzz” so others will participate. If we can’t prove the benefits of the smart meter to the consumer, then we have an uphill battle.

At the end of the day, we may find out that the meter is not only the last piece, but just an extra piece that is not an essential aspect of the Smart Grid.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. The FERC-NARUC Smart Grid Collaborative is in the process of drafting criteria that outline suggestions for how the Department of Energy can best spend the ARRA money. We met on March 19, 2009 to review and revise our draft and we submitted our criteria to the Department of Energy on March 26, 2009. The list of criteria is attached.

However, it’s clear that measuring effectiveness will vary by what kind of projects the money goes to. There is a continuum from demonstration to deployment that may have varying levels of cost-effectiveness. Without allowing for some demonstration projects to make mistakes, we won’t learn the lessons from those mistakes.

It is important to remember that the areas that are most likely to bring benefits for consumers and the electric sector more broadly deal with transforming the efficiency and operability of the distribution system. If mass smart meter rollouts are not supported by other improvements to the system that allow for these kinds of efficiency improvements through omni-directional communications and control on the grid, it is less likely that these investments will maximize the benefits possible.

RESPONSES OF FREDERICK F. BUTLER TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Is NIST the right agency to develop consensus-based standards and protocols?

Answer. No response. While the establishment of one set of consistent and implementable standards is of the highest importance, numerous standard-setting bodies exist; State regulators must leave the standard-setting process to those operating in that area of expertise.

Question 2. What is a realistic time-frame for establishing an Interoperability Framework?

Answer. Again, no response. Those directly involved have the expertise to respond.

Question 3. Do you agree with NEMA that Congress should condition the release of Smart Grid funds on the development of NIST endorsed standards? If we proceed without an Interoperability Framework are we just building “custom projects”—which is really just a nice way of saying projects that will soon become obsolete?

Answer. First and foremost, interoperability should be built in as much as possible to every deployment of Smart Grid technology. System obsolescence creates higher costs for ratepayers that State regulators are first in line to prevent. However, depending on the development of the system being demonstrated or deployed, it is important to allow some systems and approaches to succeed or fail in order to learn what works best. Software and firmware upgradability should help bridge improvements in interoperability, and that is a feature that is in the interests of every-

one. It will be important to balance room for innovation with ensuring that our investments will have the longest effective usefulness feasible. Moreover, many Smart Grid investments do not require universal interoperability to improve the effectiveness and efficiency of grid operation—particularly those operating on the distribution system side of the meter.

Question 4. A smarter grid is supposed to enhance our system's security but technologies like smart meters, sensors, and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks. How do we address these cyber security concerns? Do the agencies have sufficient authority or is additional federal legislation needed?

Answer. Our Committee on Critical Infrastructure has begun to investigate this issue, and it is of the highest importance. We need to move beyond the guns-gates-and-guards analogs of password protection and "security through obscurity" and move into a framework of maximum system resilience and next-generation safeguards that allows the network to be impregnable, even if devices connected to it are compromised. Three areas are worth considering in principle:

Hardware improvements in performance shouldn't be mistaken for improvements in security; likewise obscurity does not provide security. Firmware must be updateable to prevent quick obsolescence, but must be protected, for example with encryption, certification and authentication; and software must be deployed in a way so that even if an attack is successful, it will be unproductive, unappealing, unprofitable, and traceable. Even with these protections, the network must be designed to assume data is interceptable, and have an overall design with resilience as a core principle.

NERC has been setting cybersecurity standards for some time. FERC has also asked for authority to set standards on an emergency basis. While I would support action to close any existing vulnerabilities arising from the integration of communications networks with the electric grid, it is my sense that greater authority at the federal level is not a panacea for solving this issue. Improved communications within the sector and with stakeholders that puts greater emphasis on the network—the "smart" side of the Smart Grid—is even more critical.

Question 5. Mr. Butler, in your written testimony you note that within the next 3-10 years all electricity consumers will face higher costs, in part due to an increase in fuel prices, but also due to the "initial sticker shock of federal and State initiatives to increase renewable generation and the anticipated costs associated with climate change legislation." As you know, Xcel is currently undertaking a \$100 million Smart City project in Boulder, CO and Southern California Edison is moving out with \$1.6 billion in Smart Grid initiatives—much to the dismay of some consumer groups.

Given the current economic crisis, is it fair to ask consumers to bear the costs of a nationwide RPS, climate change initiatives, and advanced Smart Grid technologies? What is the impact to low-income consumers?

Answer. This is certainly a fair question, which is why I suggested that we start with the backbone of the transmission grid first and let the companies pay for it before we start giving smart meters to consumers along with the associated higher price tag. We are not advocating that smart-grid developments be delayed because of the economy, but rather that these developments be borne by those who benefit.

We can avoid much of the consumer backlash if we take this route, at least as far as it relates to the Smart Grid.

In terms of climate policy, NARUC supports federal action because it will actually bring the financial and regulatory certainty that, over time, will help reduce the cost of reducing carbon emissions. If we do not act soon, the costs of compliance will only increase, and the industry needs to know the rules of the road so we can finance the next round of energy infrastructure.

Energy costs are going up regardless of whether we tackle climate change or the Smart Grid. It is our hope that if we do this deliberately and ensure that consumers can actually benefit, we can stem the tide of these rising costs and share the benefits with end-use customers.

Question 6. You caution that we need to get consumers on board with Smart Grid in order for it to work or we could face a potential backlash from consumers forced to pay for the privilege of getting new gadgets installed in their homes that they don't necessarily know how to use. How can we best move toward public acceptance of Smart Grid technologies? Should we undertake some kind of public education or outreach program?

Answer. Yes, public outreach is key. We can't order consumers to take these smart meters and walk away. Doing so is a recipe for ratepayer revolt. In my view,

we need volunteers to participate in pilots so they can be excited about the opportunity to see how the Smart Grid works. If we see success, hopefully those consumers will talk with their neighbors about it, and they'll demand to participate as well. This really has to be a grassroots effort. The federal government can use its bully pulpit and help fund this.

My main point here is that we want to bring consumers on board in a way that they will feel like they are benefiting. No one benefits if consumers don't know how to or want to use their smart meters.

Question 7. In order to realize Smart Grid benefits, States will need to impose new rate structures, such as time-of-use rates. What are the pros and cons to this type of retail rate structure? What other models could be utilized?

Answer. I don't believe that States will need to impose time-of-use rates to see benefits from Smart Grid deployments. In fact, while demand response among consumers is touted as one of the key benefit-drivers of Smart Grid adoption, more important is the value coming from vastly improved outage detection and management, which does not require rate changes.

With that in mind, time of use rates have some documented benefits and some potential drawbacks. The benefits are well-described: pricing electricity based on the value set by supply and demand uses price to send a conservation signal when conservation is most needed, at times of peak usage. Demand response facilitated by these rates could have a large effect in mitigating high wholesale market prices by shaving the most expensive peaks. Time-of-use charges may also free customers from hidden charges and premiums paid by utilities to mitigate risk.

However, savings under time of use rates depends on consumer response: during high price periods, consumers are expected to respond to prices by conserving, either manually cutting back or by using appliances and devices to automatically cut back on electricity consumption. However, for a decent proportion of the population, behavioral change is not an option (such as turning off the air conditioning on the hottest days); and purchasing new appliances or price-responsive devices adds new costs to already-strained bills, simply to avoid the costs of higher peak prices under time of use rates. Even inexpensive, high value, off-the-shelf devices such as programmable thermostats generally only work for houses with central HVAC systems, and only around 60% of houses have this in the United States, disproportionately among middle-and upper-income ratepayers.

Under any circumstances, prices are rising for consumers, and energy efficiency programs that target low-income communities are of paramount importance. This is even more the case with time-of use-rates. These rates may be an important piece of the puzzle, but a range of technology options should be paired with existing or proposed rate designs that are consistent with the needs of the projects proposed. This may include dynamic rates along with other rate designs.

Question 8. IEEE 1547 describes how to connect distributed generators to the grid, and under the 2005 Energy Policy Act, Congress recommended that standard be adopted by all States. How many States have fully adopted this interconnection standard? How can States promote a nationwide Smart Grid if after four years, we still do not have nationwide standard for small-scale connections?

Answer. By 2008, 33 States had adopted or had been in the process of adopting an interconnection standard for distributed resources. While a national standard may be helpful, it is important to allow for States to have the flexibility to adopt the standards that work in their situation, and IEEE 1547 is a very good and adaptable standard.

It's worth remembering that our electricity markets and transmission systems are not nation-wide systems, they are regional systems, and there are no national utilities. More important than a nationwide Smart Grid is one that improves the efficiency and resiliency of the local distribution systems that make up 85% of the total grid infrastructure. As such, more than adopting national standards, an approach that best serves distribution-level, State-level, and regional-level systems, in a way that reflects the make-up of the electric grid, is the key.

RESPONSES OF FREDERICK F. BUTLER TO QUESTIONS FROM SENATOR STABENOW

Question 1. We understand that Smart Grid will give customers more choices—and during certain times in the summer for example, a customer may be able to opt in or opt out and get certain benefits from their providers. Would low-income customers be able to plug-in the amount of energy that they want to spend and how would the Smart Grid benefit low income customers or residents on fixed incomes?

Answer. As I stated before, prices are rising for consumers, and energy efficiency programs that target low-income communities are of paramount importance whether the Smart Grid deploys successfully or not. However, by focusing on components

of Smart Grid that improve system efficiency, outage management, network optimization and grid resiliency, the cost of operating the system can be reduced and prices can be lowered for all consumers. That is why the most urgent investments are those made on the utility distribution-system side of the meter, rather than on the customer side of the meter. Once we have these components in place, greater focus can be placed on systems on the customer-side of the meter that provide greater customer choice and empowerment, without forcing ratepayers into new expenditures, behaviors, and technology adoption that we may not have, as a society, properly prepared ourselves for.

Question 2. A number of utilities already have begun modernizing their grids by installing digital electric meters and technologies that enable two-way communication capabilities between the utilities and their customers. This transformation to a “Smart Grid” should benefit the companies and their customers. How will the Smart Grid enable entities to detect and repair outages faster, hook-up customers quicker, and give consumers the capability to manage their homes’ appliances more efficiently?

Answer. This will benefit consumers by making the whole system more efficient. But we can’t lose sight of the fact that this will also benefit utilities, and that is why we should start here, because they can pay for it at first. If utilities have a real-time view of their grid, they can identify problems before they get out of hand. They can also prioritize repair efforts and have instant information on how many houses have been restored after a damaging storm.

If a utility can see online that a specific transformer appears irregular, but is not necessarily malfunctioning, they can determine if that problem will become a bigger issue remotely before something physically goes wrong.

Utilities can streamline their operations and save money. Consumers can have the knowledge that reliability is improved and take heart in knowing that utilities’ response times will be faster.

Mr. Chairman and members of the committee, I wish to thank you for giving me the opportunity to answer these questions. In addition, I’d like to submit the following document for the record. It is a list of criteria generated by the FERC-NARUC Smart Grid Collaborative for the Department of Energy to consider when it starts providing grant and other funding for Smart Grid projects under ARRA.

NARUC/FERC SMART GRID COLLABORATIVE PROPOSED FUNDING CRITERIA FOR THE ARRA SMART GRID MATCHING GRANT PROGRAM¹ AND THE ARRA SMART GRID DEMONSTRATION PROJECTS²

The American Recovery and Reinvestment Act of 2009 (ARRA)³ includes the following language:

‘(e) Procedures and Rules—(1) The Secretary shall, within 60 days after the enactment of the American Recovery and Reinvestment Act of 2009, by means of a notice of intent and subsequent solicitation of grant proposals—

‘(A) establish procedures by which applicants can obtain grants of not more than one-half of their documented costs;

The Collaborative submits the following funding criteria that the Collaborative members would find helpful in carrying out their legal responsibilities as they relate to Smart Grid. The Collaborative asks the Department of Energy (DOE) to consider these criteria when establishing procedures under which applicants can receive ARRA funding for Smart Grid Matching Grants and for ARRA Smart Grid Demonstration Projects.

FUNDING CRITERIA

1. Preconditions for Grants—Any application for grant funding must address the following issues:

a. How the project will provide for interoperability in the absence of approved standards (e.g., adherence to existing open standards, secure upgradeability once standards approved);

¹ 42 USC 17386, Energy Independence and Security Act (EISA) Sec. 1306, Federal Matching Fund for Smart Grid Investment Costs, as amended by American Recovery and Reinvestment Act of 2009 (ARRA).

² 42 USC 17384, EISA Sec. 1304, Smart Grid Technology Research, Development, And Demonstration, as amended by ARRA.

³ See, ARRA, http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.txt.pdf.

- b. How the project will address cyber security issues and ensure that it maintains compliance with Federal Energy Regulatory Commission-approved reliability standards during and after the installation of Smart Grid technologies;
 - c. How the project has minimized the possibility of stranded investment in Smart Grid equipment by designing for the ability to be upgraded;
 - d. How the applicant proposes to share information with the Department of Energy Smart Grid Clearinghouse, as further described in the FERC Policy Statement;
 - e. How the project will maintain the reliability of the grid;
 - f. How the project will preserve the integrity of data communicated (whether the data is correct);
 - g. How the project will provide for authentication of communications (whether the communication is between the intended Smart Grid device and an authorized device or person);
 - h. How the project will prevent unauthorized modifications to Smart Grid devices and the logging of all modifications made;
 - i. How the project will ensure the physical protection of Smart Grid devices; and
 - j. How the project will address the potential impact of unauthorized use of Smart Grid devices on the bulk-power system.
- 2. Overarching Criteria:
 - a. The DOE funded portfolio of projects should include projects on both the transmission and distribution system, and on the customer side of the meter;
 - b. The DOE funded portfolio of projects should include a range of technologies—not just advanced meter installation (e.g., programmable communicating thermostats, smart appliances, and other technologies controlled by the end-use customer);
 - c. The DOE funded portfolio of projects should be broad reaching and with broad application potential;
 - d. The DOE funded portfolio of projects should be of sufficient scale that it will be able to apply statistical tests on where and how it impacts consumers, the grid, and technologies;
 - e. The DOE funded portfolio of projects should be geographically diverse to the extent practicable. All regions should be represented as well as projects in urban, rural and suburban settings;
 - f. The DOE may consider providing a waiver from some of the grant preconditions for a modest portion of the funds (say 10%), or for applicants with sales below a certain sales threshold (say 1-4 million MWH a year) in order to provide funds to small utilities who would not otherwise be able to comply with application requirements in a timely manner;
 - g. The DOE funded portfolio of projects should intend to provide benefits—which may include both customer and system-wide benefits; and
 - h. Early-adopter States should not be disadvantaged—existing projects can be eligible if they can show additional benefits or expansion of knowledge that are unique and not likely to be realized by other proposed projects.
- 3. Technologies—must first meet the preconditions above
 - a. A range of technologies should be included such as, but not limited to, sensors on transmission and/or distribution equipment, digital communications in substations, and/or communications equipment not just focused on AMI (e.g., programmable communicating thermostats, smart appliances, and other technologies controlled by the end-use customer).
 - b. Projects can include replacement of legacy equipment and systems such as old bulk meters and capacitor banks with intelligent, Smart Grid capable equipment and/or systems.
 - c. Different communications protocols should be tested.
 - d. Physical and cybersecurity attributes of the range of technologies should be highlighted and tested.
 - e. System integration performed as part of the project should be based, to the extent practicable, on existing broadly accepted industry standards.
 - f. Priority should be given to projects that have an open architecture base that can become the basis for interoperability with multiple applications.
- 4. Rate Designs

A range of technology options should be paired with existing or proposed rate designs, including dynamic rates, consistent with the purposes for which the project is designed.

5. Regulatory issues

- a. Consider the regulatory climate in the State where a project is proposed—is there legislative authority for dynamic rates?
- b. Is there coordination between a given project and the RTO and/or system operator?

6. Information/data requirements.—to be eligible for funding a grantee must agree to provide detailed data and documentation of project results, including the following information, as applicable to the project, to the DOE Clearinghouse⁴ [not every project will deal with all the items listed]:

- a. Any internal or third party evaluations, ratings, and/or reviews including all primary source material used in the evaluation;
- b. Detailed data and documentation explaining any improvement in the accurate measurement of energy efficiency, energy conservation, price responsive demand, or demand response resources;
- c. Detailed data and documentation explaining the expansion of the quantity of energy efficiency, energy conservation, price responsive demand, or demand response resources that resulted from the project and the resulting economic effects;
- d. Detailed data and documentation that shows reduction in both electric demand and energy consumption associated with the project;
- e. Detailed data and documentation for any improvements in the ability to integrate non-dispatchable renewable generation resources;
- f. Detailed data and documentation that shows any achievement of greater system efficiency through a reduction of transmission congestion and loop flow;
- g. Detailed data and documentation showing how the information infrastructure supports distributed resources such as plug-in electric vehicles;
- h. Detailed data and documentation that shows how the project resulted in enhanced utilization of energy storage; and
- i. Detailed data and documentation that shows how the project encouraged new business models, market innovation, and third party and private capital participation.
- j. All data on project results must be publicly available while protecting individual customer privacy and commercially sensitive data (See Below).

7. Protection of individual customer privacy and commercially sensitive data. The fund recipient must provide a detailed explanation of:

- a. The types of customer-specific data it proposes to collect;
- b. How it plans to protect this data from unintended disclosure;
- c. The extent to which this data can be provided to the DOE in summary or aggregate form and still be responsive to report preparation requirements and the policy of public transparency;
- d. The process proposed for obtaining customer permission to disclose private or commercially sensitive data, if such data must be disclosed; and
- e. Any State or local requirements that are relevant to the disclosure of data specific to individual electric customers.

8. Mechanisms to measure customer response must be included as a requirement for funding

- a. Grantees must include independent monitoring and measurement of customer receptivity to the project.
 - 1. This information must be made available to the DOE Clearinghouse.
 - 2. The DOE Clearinghouse will develop guidelines for gathering and reporting this information

RESPONSES OF PATRICK D. GALLAGHER TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require

⁴ See, ARRA Sec. 405(3), amending EISA Sec. 1304(b)(3), 42 USC 17381.

both the build-out of new transmission to renewable resource rich locations as well as upgrading our current grid to have the intelligence to handle these intermittent resources.

In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. NIST will defer to DOE and FERC on estimating “how much new transmission” is needed. However, it is clear that there is a need to build out new transmission to renewable resource-rich locations and to upgrade the grid to better handle these resources if our nation is to fully realize the benefits of Smart Grid. In addition, better and more storage and power conversion technologies are needed to make best use of these large-scale intermittent resources. NIST is working to develop the interoperability framework to coordinate and prioritize standards development to ensure that the Smart Grid devices and systems that will accommodate these large renewable power sources will be interoperable, and beyond that, allow for and encourage customers to adjust their energy usage.

Question 2. “Smart Metering” projects for residential consumers have become the poster child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85% of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15% will come from End-User Energy Management.

Answer. The Smart Grid addresses several goals, each of which is important. Renewable energy generation leads to the greatest impact for carbon reduction, and efficiency improvements in transmission and distribution lead to less wasted energy and greater reliability. Smart Metering addresses a different goal, reducing energy use by customers and smoothing load shape to improve grid utilization. Testing and validating Smart Grid standards interoperability is a key aspect of NIST’s program. We are working closely with DOE, and anticipate testing and validation will be a key aspect as the Smart Grid standards move forward.

Question 3. After the Department of Energy has spent out its nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. We defer to the Department of Energy on this question.

Question 4. Dr. Gallagher, in your testimony you state that NIST, as directed by EISA, will develop suites of standards for different Smart Grid aspects, including distributed energy resources, demand response devices/appliances, electric vehicles, wide area measurement systems, and other parts of the Smart Grid vision. Furthermore, during the hearing you stated that you expect that by this summer, NIST will have completed a road map to prioritize the order in which Smart Grid standards need to be developed.

As Senator Bingaman requested in the hearing, please submit to us:

- 1) an inventory of the suites of standards to be developed;
- 2) Each standard, that to the best of your current knowledge, will need to be developed; and
- 3) For each standard, a list of the standards development organizations that would logically be involved in the development of such standard.

Answer. To clarify, I stated at the hearing that NIST would, by this summer, have completed an initial version of a roadmap to prioritize the selection and/or development of standards. The roadmap will include an architecture and framework that will evolve to incorporate new technologies and requirements. Once this initial version of the roadmap is developed, it will be continuously updated and be used as a basis for developing priority actions in support of developing the standards framework.

The appended document lists suites of Smart Grid standards under development in different organizations.

It is important to note that there are several “suites” of standards as well as hundreds of individual standards that are key for Smart Grid interoperability. These suites are in different stages of maturity and cover many Smart Grid devices and

functionality. There are also overlaps among them that require harmonization, some of which are already being addressed.

Some of the existing standards have not yet undergone extensive use and conformity testing that would reveal whether they are truly interoperable, so it is not fully known what the weaknesses are in these standards and where they may need to be modified.

As the roadmap is developed and evolves and as new standards are published, more of these standards issues will be identified and addressed. The attached document lists some of the suites of Smart Grid standards under development in the various Standards Developing Organizations (SDOs). The list is not prioritized, nor is it exhaustive since NIST is continuing to develop the roadmap and standards from other industries such as networking, telecommunications and end use equipment are expected to play key roles in the development of the Smart Grid infrastructure. Input from these industries will be included as the interim roadmap and Smart Grid standards move forward.

Question 5. Dr. Gallagher, we have heard from many parties, most recently Secretary Chu, that standards and protocols development is lagging behind industry needs, and may soon hinder Smart Grid deployment. While I understand that your agency has lacked appropriated funds up until very recently (when \$10 million was appropriated in the American Recovery and Reinvestment Act), how do you plan to ensure that you now will move expeditiously? Can you provide us an approximate timeline for when you expect to begin releasing consensus standards?

Answer. Standards are developed for industry, by industry, through an established consensus process in which government participates. Thus, NIST as an organization will not be releasing consensus standards. However, NIST has and will play an important role, working alongside industry participants, providing both technical expertise and coordination to facilitate the development of consensus standards by the appropriate standards organizations. The recognition of Smart Grid as an urgent national priority, and especially the funding provided by the American Reinvestment and Recovery Act, makes it imperative to develop the standards more rapidly, requiring new approaches. NIST has recently taken several steps to accelerate progress.

We have committed to delivering an interim interoperability standards roadmap by June and are working to expedite this effort using ARRA funding. We are also planning to use the ARRA funding to accelerate the establishment of a public-private partnership, modeled on the most successful elements of the Health Care IT interoperability effort, to select and/or coordinate the development of new standards based on the roadmap. We will focus initially on the selection of existing standards to meet the highest priority needs, while working to develop new or harmonized standards where necessary to meet other needs. We anticipate that initial standards will be selected in 2009.

Question 6. Dr. Gallagher, in your opinion, is it a hindrance to industry and to Smart Grid development that NIST has not yet begun releasing consensus standards and protocols? At what point would you consider a lack of NIST approved standards a hindrance?

Answer. To clarify, consensus standards in the U.S. are developed by the private sector through standards development organizations (SDOs) and do not normally require formal recognition or approval by NIST. For example, the internet, a network about as complex as the Smart Grid, was established and continues to evolve based entirely on private-sector, voluntary standards. NIST's role is to support this process by working closely with industry and stakeholders as a third party technical expert. NIST and industry believe that this process produces the most effective and widely accepted standards. From that perspective, lack of NIST-approved standards for Smart Grid is not a hindrance to industry.

However, some standards for the Smart Grid may need to be mandated via adoption in regulation to ensure the reliability and security of the Smart Grid, which is one of the nation's critical infrastructures. Please note that even if standards were adopted in regulation, the private sector would continue to play a crucial role in their development, since OMB Circular A-119 and the National Technology Transfer and Investment Act oblige agencies to use existing private sector, voluntary standards as the basis for regulations. EISA specifically tasks NIST to coordinate development of an interoperability framework including protocols and model standards, which is appropriate for this reason. The steps NIST is taking will accelerate the availability of NIST-approved standards to support regulation so that they do not become a hindrance to industry.

RESPONSES OF PATRICK D. GALLAGHER TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1a. What does Smart Grid technology promise in terms of reliability? A smarter grid is supposed to enhance our system's security but technologies like smart meters, sensors and advanced communications networks can actually increase the vulnerability of the grid to cyber attacks.

Answer. There are many ways that Smart Grid technologies will improve the overall reliability of the Nation's electric distribution system, including greatly increased capabilities for controlling, monitoring and restoring system performance. While it is true that some aspects of Smart Grid technologies involve greater interconnectivity and potential vulnerability, proactive measures will be implemented to ensure cyber security. Currently, many components of the grid are interconnected to the Internet, either directly, or via the business component of a company. This has increased the potential for cyber attacks that could compromise the availability and/or integrity of the existing grid. This requirement to address potential vulnerabilities has been acknowledged by the Department of Homeland Security (DHS), through the Critical Infrastructure Protection (CIP) Program. They have a vulnerability assessment program that is available to critical infrastructures. Also, DHS is working with the critical infrastructures to promote reporting of potential incidents through the US—Computer Emergency Readiness Team (US-CERT) program. In addition, the Department of Energy, as the Sector Specific Agency for Energy, has a cyber vulnerability assessment program specifically for the electric grid. There are also several current initiatives to develop cyber security standards for components of the existing grid. These standards are intended to address existing vulnerabilities. Finally, the IT and telecom sectors have cyber security standards to address vulnerabilities, conformity assessment programs to evaluate cyber security products, and assessment programs to identify known vulnerabilities in systems.

Question 1b. How do we address these cyber security concerns?

Answer. One of the important lessons from the IT and telecom sectors is that network security must be inherently designed into the architecture of the network; it cannot be "bolted on" later. NIST is applying its extensive expertise in both computer security and advanced network technology to systematically assess risk and ascertain security requirements for the Smart Grid architecture.

There are a number of cyber security standards that are being developed that are applicable to the Smart Grid:

- The North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) Cyber Security Standards CIP-002 through CIP-009 provide a cyber security framework for the identification and protection of Critical Cyber Assets to support reliable operation of the Bulk Power System
- The ANSI/ISA-99/IEC 62443 suite of standards for Industrial Automation and Control System Security
- The Advanced Metering Infrastructure (AMI) has formed a Security task force (AMI-SEC) to define common requirements and produce standardized specifications for securing AMI system elements
- NIST Special Publication (SP) 800-53, Recommended Security Controls for Federal Information Systems, which provides security controls for Federal agencies, including those who are part of the Bulk Power System (e.g., Tennessee Valley Authority, Bonneville Power Authority). This Special Publication is incorporated by reference in Federal Information Processing Standards (FIPS) 200, Minimum Security Requirements, making it mandatory for Federal agencies.

Although these standards are being developed by different standards bodies, there is significant interaction among the working groups. For example, there are current efforts to harmonize the NERC CIP, ISA99/IEC 62443, and NIST Special Publication 800-53, Recommended Security Controls for Federal Information Systems.

The important objective is to assess the standards for applicability and interoperability across the domains of the Smart Grid, rather than develop a single set of cyber security requirements that is applicable to all elements of the Smart Grid. That is, the cyber security requirements of different domains, such as home-to-grid or transmission and distribution, may not be the same. There are significant cyber security requirements to ensure the confidentiality of Personally Identifiable Information (PII) that may not be required at the transmission and distribution domain.

In addition, the cyber security standards will require conformance testing. Conformance testing verifies that products adhere to the specifications defined in the standards. NIST intends to develop a conformance testing framework for the Smart Grid.

Question 1c. Do the agencies have sufficient authority or is additional federal legislation needed?

Answer. NIST has the necessary authority under the National Technology Transfer and Advancement Act (PL 104-113), the Energy Independence and Security Act (EISA), and other legislation, to carry out its role to coordinate the development of an interoperability framework for the Smart Grid.

Question 2. The Stimulus bill provided an unprecedented \$4.5 billion in federal funds for Smart Grid activities. In your opinion, what is the best way to allocate these funds—matching grants for technology investments; research and development; pilot programs? Over what timeframe? What are the necessary first steps?

Answer. NIST defers to the Department of Energy on this question.

Question 3. What capabilities and expertise in this area does each of your agencies bring to the table?

Answer. Ensuring interoperability of the Smart Grid requires capabilities in numerous disciplines. NIST brings 1) extensive knowledge of the electric utility industry through its research in supporting measurement technology and testing; 2) expertise in advanced networking technology; 3) expertise in computer and network security; 4) expertise in industrial controls and their interfaces to the electrical infrastructure; 5) expertise in the technology of buildings and their interfaces to the electric grid; 6) expertise in the consensus standards development process; and 7) expertise in conformity assessment.

Question 4. What is the role of the Standards Development Organizations (SDOs), such as NEMA, in the NIST framework? When will NIST be ready to utilize the expertise that the SDOs have available?

Answer. SDOs have an essential role in the NIST framework, as standards are developed by SDOs. The large majority of Smart Grid standards are already under development in an SDO. SDOs bring the stakeholder community together (via company supported volunteers and representatives of other stakeholder groups working in standards committees) to develop standards. NIST is already working with the technical experts who are developing Smart Grid standards, and already actively engaged with SDOs in developing the Smart Grid roadmap. National Electrical Manufacturers Association (NEMA) was named in the 2007 EISA for NIST to coordinate with and plays an important role representing a large vendor community. NIST will continue to work with NEMA and other stakeholders to coordinate the development of the interoperability framework.

Question 5. You testified that there should be no single standard for Smart Grid devices and systems because a smarter grid needs to be evolutionary. How can we best ensure that interoperability standards continue to evolve?

Answer. EISA requires the interoperability framework “to be flexible to incorporate regional and organizational differences, and technological innovations.” Attributes which will support this goal include, among others, technology neutrality, standards which are performance based rather than design specific, and a layered architecture. The “public-private partnership” entity (referred to in my answer to Senator Bingaman’s question) will provide an ongoing mechanism to evolve the interoperability standards.

Question 6. When will NIST have a Director in place?

Answer. The process to fill the NIST Director position is ongoing.

Question 7. You caution that it is difficult and time consuming to create good consensus-based standard—particularly if the resulting standards need to be applicable domestically and internationally. Don’t standards need to be applied nationwide, in a seamless fashion, or are you suggesting we could consider a more regional approach?

Answer. The standards absolutely need to be applied nationwide to ensure interoperability and they should ultimately be harmonized with international standards. The ability to dynamically move load to match demand and utilize distributed energy sources on a national electrical grid demands a national solution. Furthermore, the interconnection of the US grid with Canada and Mexico requires North American, not just U.S. standards. Finally, the equipment in the network is produced by global suppliers who want international standards so they can address multiple markets around the world.

ADDENDUM

SMART GRID FAMILIES OF STANDARDS

(RESPONSE TO SEN. BINGAMAN Q#4)

The following list contains leading industry families of standards that will enable the vision of the Smart Grid. The NIST roadmapping process is intended to reveal areas in the standards where weaknesses, gaps, and overlaps exist and will evolve

as new standards are developed and new implementations deployed and tested. The list is not exhaustive since standards from other industries such as networking, telecommunications and end use equipment are expected to play key roles in the development of the Smart Grid infrastructure.

The families listed below include some standards that have not yet been completed, released, or published. These families will have to be further developed to ensure that gaps covering additional Smart Grid functions, devices, and systems are addressed. Further analysis is needed to ensure that the standards are harmonized and conformance testing of implementations of these standards is needed to reveal where interoperability issues exist.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) 61968 FAMILY OF STANDARDS
FOR DISTRIBUTION SYSTEMS

- IEC 61968-1 (2003-10) Application integration at electric utilities—System interfaces for distribution management—Part 1: Interface architecture and general requirements
- IEC/TS 61968-2 (2003-11) Application integration at electric utilities—System interfaces for distribution management—Part 2: Glossary
- IEC 61968-3 (2004-03) Application integration at electric utilities—System interfaces for distribution management—Part 3: Interface for network operations
- IEC 61968-4 (2007-07) Application integration at electric utilities—System interfaces for distribution management—Part 4: Interfaces for records and asset management
- IEC 61968-14-1: Mapping between MultiSpeak 4.0 and IEC 61968, parts 3 through 10
- IEC 61968-14-2: A CIM profile for MultiSpeak 4.0, one profile for IEC 61968 parts 3 through 10

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) 61970 FAMILY OF STANDARDS
FOR TRANSMISSION

- IEC 61970 Energy management system application program interface (EMS-API)—Part 301: Common Information Model (CIM) Base”, IEC, Edition 1.0, November 2003
- IEC 61970-1 (2005-12) Energy management system application program interface (EMS-API)—Part 1: Guidelines and general requirements
- IEC/TS 61970-2 (2004-07) Energy management system application program interface (EMS-API)—Part 2: Glossary
- IEC 61970-301 (2005-03) Energy management system application program interface (EMS-API)—Part 301: Common Information Model (CIM) base
- IEC/TS 61970-401 (2005-09) Energy management system application program interface (EMS-API)—Part 401: Component interface specification (CIS) framework
- IEC 61970-404 (2007-08) Energy management system application program interface (EMS-API)—Part 404: High Speed Data Access (HSDA)
- IEC 61970-405 (2007-08) Energy management system application program interface (EMS-API)—Part 405: Generic Eventing and Subscription (GES)
- IEC 61970-407 (2007-08) Energy management system application program interface (EMS-API)—Part 407: Time Series Data Access (TSDA)
- IEC 61970-501 (2006-03) Energy management system application program interface (EMS-API)—Part 501: Common Information Model Resource Description Framework (CIM RDF) schema

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)—C12 METERING STANDARDS

- ANSI C12.19 2008: Utility Industry End Device Data Tables (Revenue Metering) (note: not yet formally released)
- ANSI C12.22 2008: Protocol Specification for Data Communication Networks (note: not yet formally released)

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS
(ASHRAE)—BACNET STANDARD

- ANSI/ASHRAE Standard 135-2004: BACnet—A Data Communication Protocol for Building Automation and Control Networks

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)—61850 FAMILY OF STANDARDS
FOR FIELD DEVICES

- IEC/TR 61850-1 (2003-04) Communication networks and systems in substations—Part 1: Introduction and overview
- IEC/TS 61850-2 (2003-08) Communication networks and systems in substations—Part 2: Glossary
- IEC 61850-3 (2002-01) Communication networks and systems in substations—Part 3: General requirements
- IEC 61850-4 (2002-01) Communication networks and systems in substations—Part 4: System and project management
- IEC 61850-5 (2003-07) Communication networks and systems in substations—Part 5: Communication requirements for functions and device models
- IEC 61850-6 (2004-03) Communication networks and systems in substations—Part 6: Configuration description language for communication in electrical substations related to IEDs
- IEC 61850-7-1 (2003-07) Communication networks and systems in substations—Part 7-1: Basic communication structure for substation and feeder equipment—Principles and models
- IEC 61850-7-2 (2003-05) Communication networks and systems in substations—Part 7-2: Basic communication structure for substation and feeder equipment—Abstract communication service interface (ACSI)
- IEC 61850-7-3 (2003-05) Communication networks and systems in substations—Part 7-3: Basic communication structure for substation and feeder equipment—Common data classes
- IEC 61850-7-4 (2003-05) Communication networks and systems in substations—Part 7-4: Basic communication structure for substation and feeder equipment—Compatible logical node classes and data classes
- IEC 61850-7-410 (2007-08) Communication networks and systems for power utility automation—Part 7-410: Hydroelectric power plants—Communication for monitoring and control
- IEC 61850-7-420 (2008-02) DER Logical Nodes, Final Draft International Standard (FDIS)
- IEC 61850-8-1 (2004-05) Communication networks and systems in substations—Part 8-1: Specific Communication Service Mapping (SCSM)—Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
- IEC 61850-9-1 (2003-05) Communication networks and systems in substations—Part 9-1: Specific Communication Service Mapping (SCSM)—Sampled values over serial unidirectional multidrop point to point link
- IEC 61850-9-2 (2004-04) Communication networks and systems in substations—Part 9-2: Specific Communication Service Mapping (SCSM)—Sampled values over ISO/IEC 8802-3
- IEC 61850-10 (2005-05) Communication networks and systems in substations—Part 10: Conformance testing
- IEEE 1547 Family of Standards for Distributed Energy Resources

IEEE 1547 STANDARD FOR INTEGRATING DISTRIBUTED ENERGY RESOURCES WITHIN THE
ELECTRIC POWER SYSTEM

- IEEE-P1547.1 standard for interconnection test procedures
- IEEE-P1547.2 guide to 1547 standard
- IEEE-P1547.3 guide for information exchange for DR interconnected with EPS
- IEEE-P1547.4 guide for DR island systems

ZIGBEE SPECIFICATION (BASED ON IEEE 802.15.4)

- Zigbee Smart Energy

CYBER SECURITY STANDARDS

Advanced Metering Infrastructure (AMI) System Security Requirements

- ANSI/ISA-99/IEC 62443 suite of standards for Industrial Automation and Control System Security
- FIPS PUB 140-2, Security Requirements for Cryptographic Modules (also ISO/IEC 19790:2006)
- FIPS PUB 180, Secure Hash Standard
- FIPS PUB 186, Digital Signature Standard (DSS)
- FIPS PUB 197, Advanced Encryption Standard (AES)
- FIPS PUB 199, Standards for Security Categorization of Federal Information and Information Systems

- IEC/TS 62351-1 (2007-05) Power systems management and associated information exchange—Data and communications security—Part 1: Communication network and system security—Introduction to security issues
 - IEC/TS 62351-2 Power systems management and associated information exchange—Data and communication security—Part 2: Glossary of terms
 - IEC/TS 62351-3 (2007-06) Power systems management and associated information exchange—Data and communications security—Part 3: Communication network and system security—Profiles including TCP/IP
 - IEC/TS 62351-4 (2007-06) Power systems management and associated information exchange—Data and communications security—Part 4: Profiles including MMS
 - IEC TS 62351-5 Power systems management and associated information exchange—Data and Communication Security—Part 5: Security for IEC 60870-5 and Derivatives
 - IEC/TS 62351-6 (2007-06) Power systems management and associated information exchange—Data and communications security—Part 6: Security for IEC 61850
 - IEC 62443 Industrial communication networks—Network and system security (DRAFT)
 - IEC 62443-1 Terminology, concepts and models
 - IEC 62443-2 Establishing an industrial automation and control system security program
 - IEC 62443-3 Operating a manufacturing and control systems security program
 - IEC 62443-4 Specific security requirements for manufacturing and control systems
 - IEC 62443-5 Security technologies for industrial automation and control systems
 - ISA-99: Manufacturing and Control Systems Security
 - IEEE P1689 Trial Use Standard for Retrofit Cyber Security of Serial SCADA Links and IED Remote Access
 - ISO 27001 information security management system (an ISMS) which replaced the old BS7799-2 standard
 - ISO 27002 This is the 27000 series standard number of what was originally the ISO 17799 standard (which itself was formerly known as BS7799-1)
 - ISO 27003 guidance for the implementation of an ISMS (IS Management System)
 - ISO 27004 information security system management measurement and metrics
 - ISO 27005 This is the methodology independent ISO standard for information security risk management
 - ISO 27006 guidelines for the accreditation of organizations offering ISMS certification
 - North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) CIP-001-1 Sabotage Reporting
 - NERC CIP-002-1 Critical Cyber Asset Identification
 - NERC CIP-003-1 Security Management Controls
 - NERC CIP-004-1 Personnel & Training
 - NERC CIP-005-1 Electronic Security Perimeter(s)
 - NERC CIP-006-1 Physical Security of Critical Cyber Assets
 - NERC CIP-007-1 Systems Security Management
 - NERC CIP-008-1 Incident Reporting and Response Planning
 - NERC CIP-009-1 Recovery Plans for Critical Cyber Assets
 - NIST Special Publication (SP) 800-53, Recommend Security Controls for Federal Information Systems NIST SP 800-82, DRAFT Guide to Industrial Control Systems (ICS) Security
 - The role concept in SCL: 2nd draft, ABB AN-PSTD07002WW, 29 August 2007
- INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) AND IEEE STANDARDS
INTEGRATION FOR SYNCHROPHASOR MEASUREMENTS
- IEC and IEEE are proposing “Dual Logo” standards development in this area that anticipates integrating related standards from both organizations. These include:
 - IEEE C37.118-2005 Standard for Synchrophasors for Power Systems and IEC 61850.

SAE BEST PRACTICES AND USE CASES FOR ELECTRIC VEHICLE COMMUNICATIONS

- SAE J2836, Recommended Practice for Communication between Plug-in Vehicles and the Utility Grid (2009 ballot)
- SAE J2847—Information Report for Use Cases for J2836 (2009 ballot)

GLOSSARY OF SMART GRID PRIVATE SECTOR STANDARDS DEVELOPMENT ORGANIZATIONS LISTED ABOVE

ANSI—The American National Standards Institute

ANSI is a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States. The organization also coordinates U.S. standards with international standards so that American products can be used worldwide. ANSI accredits standards that are developed by representatives of standards developing organizations, government agencies, consumer groups, companies, and others. These standards ensure that the characteristics and performance of products are consistent, that people use the same definitions and terms, and that products are tested the same way.

ASHRAE—American Society of Heating, Refrigerating, and Air-Conditioning Engineers

ASHRAE is an international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning, and refrigeration (HVAC&R). The Society allows exchange of HVAC&R knowledge and experiences for the benefit of the field's practitioners and the public. ASHRAE provides many opportunities to participate in the development of new knowledge via, for example, research and its many Technical Committees.

IEC—International Electrotechnical Commission

The IEC is a not-for-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies—collectively known as “electrotechnology”. IEC standards cover a vast range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fiber optics, batteries, solar energy, nanotechnology and marine energy as well as many others. The IEC also manages three global conformity assessment systems that certify whether equipment, system or components conform to its International Standards.

IEEE—(IEEE does not use a associated name)

IEEE is an international non-profit, professional organization for the advancement of technology related to electricity. It has the most members of any technical professional organization in the world, with more than 365,000 members in around 150 countries.

NERC—North American Electric Reliability Corporation

NERC oversees eight regional reliability entities and encompasses all of the interconnected power systems of the contiguous United States, Canada and a portion of Baja California in Mexico. NERC's major responsibilities include working with all stakeholders to develop standards for power system operation, monitoring and enforcing compliance with those standards, assessing resource adequacy, and providing educational and training resources as part of an accreditation program to ensure power system operators remain qualified and proficient. NERC also investigates and analyzes the causes of significant power system disturbances in order to help prevent future events.

SAE—Society of Automotive Engineers

SAE is a professional organization for mobility engineering professionals in the aerospace, automotive, and commercial vehicle industries. The Society is a standards development organization for the engineering of powered vehicles of all kinds, including cars, trucks, boats, and aircraft.

RESPONSES OF PATRICIA HOFFMAN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of the often stated key benefits of Smart Grid is in its ability to integrate large quantities of intermittent renewable resources into the grid and to efficiently route this power where it is needed. To achieve this will clearly require both the build-out of new transmission to renewable resource rich locations as well

as upgrading our current grid to have the intelligence to handle these intermittent resources.

In order to achieve the benefits that we want from Smart Grid, how much new transmission do you foresee being needed? And how do we prioritize the building of new transmission vs. upgrading our current grid?

Answer. Integrating large quantities of intermittent renewable resources into the grid and efficiently routing the power where it is needed can be accomplished in a number of ways. Methods currently being used to successfully integrate increasingly larger amounts of wind and solar include geographic diversity, which includes expanding the geographic size of utility balancing areas; improving markets for grid ancillary services; using storage or flexible low carbon generation such as existing hydro or natural gas plants; improving regional planning and grid operations; and better wind and solar forecasting.

The Department has been working diligently to facilitate the discussion and development of regional transmission interconnection-wide planning. In the coming year, the various transmission planning efforts in the West, such as that by the DOE-funded Western Renewable Energy Zone process of the Western Governors Association at the Interconnection level, are likely to provide realistic estimates of needed new transmission for renewables. Furthermore, the 2009 American Recovery and Reinvestment Act provides \$80 million to conduct a resource assessment and analysis of future demand and transmission requirements that will help accelerate the and better enable the nation's transition to a clean energy future in the electricity sector.

Question 2. "Smart Metering" projects for residential consumers have become the poster-child of the Smart Grid. However, some studies have found that the majority of the benefits of the Smart Grid will result from investments in grid transmission and distribution system upgrades and optimization, with only a small percentage of energy savings and emission reductions coming from smart metering programs. Could you comment on this? And how should we take these findings into consideration when prioritizing which Smart Grid demonstration projects to fund?

NOTE: as a data point, the Climate Group SMART 2020 Report estimates that 85% of the carbon reduction benefits of a Smart Grid come from Grid Optimization and Renewables Integration, and only 15% will come from End-User Energy Management.

Answer. The Smart Grid involves a number of technologies and functionalities with various levels of benefits. The Department is interested in conducting a comprehensive evaluation of the Smart Grid, including applications on the customer-side-of-the meter, within the distribution system, and at the transmission level. One of the primary objectives of the regional demonstrations is to collect the data that is needed to make such an assessment and the Department will request a benefits analysis from applicants applying for Recovery Act funding.

Question 3. After the Department of Energy has spent out it's nearly \$4.5 billion on Smart Grid Investments, how do we measure whether that money has been spent effectively? How soon and what improvements in our grid should we expect to see?

Answer. The Department recognizes the importance of measuring the outcomes and resulting benefits of the investments made with Recovery Act dollars. DOE is working closely within the Administration to develop meaningful performance measures and sound methodologies to evaluate the effectiveness of our investments, focusing in particular on the smart grid initiatives that will receive most of the \$4.5 billion. We hope to see improvements immediately as smart grid technologies are deployed, but will need to measure progress to determine actual improvements in performance of the transmission and distribution system.

Question 4. Ms. Hoffman, during the past several years, the Office of Electricity Delivery and Energy Reliability has subsisted on a budget of roughly \$130-\$180 million. We have just given the Office over an order of magnitude increase in their budget to roughly \$4.5 billion. What are DOE's plans regarding scaling up the size and expertise of the Office in order to spend these funds judiciously?

Answer. Managing the increase in appropriations is a significant challenge for the Office of Electricity Delivery and Energy Reliability (OE), given the current program level. Moreover, we understand that this is a one-time increase for the program, and therefore are cognizant that any growth in the program to administer the funds must be short-term, or accommodated within much lower program funding levels in the outyears.

OE has been evaluating its requirements for administering the distribution of funds and overseeing implementation of the Recovery Act funding. We plan to hire additional Federal employees on a limited-term basis to assist in implementation, emphasizing areas such as contract management that are uniquely Federal activi-

ties, and have already posted several job announcements. We will supplement Federal staff through technical support contractors that will perform less sensitive tasks. OE also plans to leverage expertise and resources within the Department and the national labs. For example, OE will use contract administration resources in Headquarters procurement and at the National Energy Technology Laboratory to manage grant solicitations and awards and plans to make use of expertise at the National labs to evaluate grant proposals.

Question 5. How does the office plan to allocate, percentage-wise, the funds provided in ARRA towards smart grid R&D and energy storage R&D vs. simply maintaining the integrity of our current grid?

Answer. The Department will evaluate the benefits provided by smart grid projects and energy storage projects applicable to Section 1306 of the Energy Independence and Security Act of 2007 (EISA), the smart grid regional demonstrations provision in Section 1304 (b), and smart grid R&D activities, including energy storage, demand response, and wide area measurement and control, as authorized in Section 1304 (a). Funding for these activities will be administered through a competitive procurement.

Question 6. Ms. Hoffman, do you foresee the current lack of protocols and standards hindering your timely funding of Smart Grid investments and demonstration projects and their progress?

Answer. At this time the Department believes there is sufficient effort underway to develop cyber security safeguards and interoperability standards to begin smart grid deployments without delay. The Department is proceeding with implementing smart grid deployments and standards development in parallel.

RESPONSES OF PATRICIA HOFFMAN TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. What does Smart Grid technology promise in terms of reliability? A smart grid is supposed to increase our system's security but technology like smart meters and advanced communication networks can actually increase the vulnerability of our grid to cyber attacks. How do you plan to address these cyber security concerns? Do the agencies have sufficient authority or is additional federal legislation needed?

Answer. The Smart Grid offers a number of opportunities to improve grid reliability. For example, through the use of AMI (advanced metering infrastructure) with two-way communications at the distribution level, utilities can remotely identify, locate, isolate, and restore power outages more quickly without having to send field crews on trouble calls. At the transmission level, phasor measurement units synchronized with global-position systems can provide enhanced situational awareness across wide areas of the power grid to detect and deter grid disturbances much faster than existing systems. In addition, the Smart Grid will enable greater use of distributed resources and technologies to control load to enhance reliability.

The Department has been working with the private sector for several years to enhance cyber security in the energy sector through the implementation of the Roadmap to Secure Control Systems in the Energy Sector. The Department has conducted cyber security assessments of more than 20 supervisory control and data acquisition (SCADA) systems, which represent over 90 percent of the current market offerings in the electricity sector. As a result, vendors have developed next-generation "hardened" systems that are now being deployed in the market.

In addition, the Department is partnering with the AMI Security Task Force organized under the UCA International User's Group to develop cyber security requirements for AMI—a foundational smart grid application. The Task Force is comprised of utilities, security domain experts, standards body representatives and industry vendors. On March 10, 2009, the Task Force published the AMI System Security Requirements, which provides critical guidance for vendors and utilities to help design and procure secure and reliable AMI systems. The Task Force will also produce a vendor catalog of smart meters, an implementation guide, and procurement guidelines. Because of the success of this industry-government partnership, the Department is expanding the scope of the project to develop comprehensive cyber security specifications (including penetration testing) for all critical Smart Grid applications.

At this time, we do not foresee the need for additional federal legislation to accomplish our goal through public-private partnerships. The Department will continue to work with the National Institute of Standards and Technology to accelerate the development of a framework for the complete suite of interoperability standards. Once a standard is completed by the applicable standards development organization, the Federal Energy Regulatory Commission will issue a rulemaking to adopt the standard as required under the Energy Independence and Security Act of 2007.

Question 2. The Stimulus bill provided an unprecedented \$4.5 billion in federal funds for smart grid activities. In your opinion, what is the best way to allocate these funds—matching grants for technology investments; research and development; pilot programs? Over what timeframe? What are the necessary first steps?

Answer. The Department is in the process of finalizing the allocation of funds it received in the American Recovery and Reinvestment Act of 2009 to initiatives that will most effectively achieve the Act's objectives of modernizing the electricity grid, enhancing energy security, conducting energy storage R&D, improving grid resiliency and efficiency, and implementing the Smart Grid programs authorized under Title XIII of Energy Independence and Security Act of 2007 (P.L.110-140) (EISA).

We anticipate that the bulk of the \$4.5 billion for Electricity Delivery and Energy Reliability will support programs authorized by the EISA. This includes the Smart Grid Investment program that provides matching federal funds for qualifying investments (Section 1306) and Smart Grid Regional Demonstration projects (Section 1304), as well as the development of the interoperability framework that is so critical to the effective application of smart grid technologies. We will also support initiatives that assist regional transmission planning and analysis, as well as workforce development.

Almost all of the funds will be distributed through a competitive process, generally through competitive grants or other financial assistance vehicle. The process begins with publication of a Notice of Intent alerting potentially interested parties of an upcoming opportunity, followed by a solicitation for proposals. The proposals we receive go through a structured evaluation process, and then grants are awarded.

We are working to expedite the distribution of funds so that the dollars can go where they are most needed and support the creation of jobs. That being said, a competitive process takes more time than a formula or block grant process, since proposals must be solicited and evaluated.

Question 3. What capabilities and expertise in this area does each of your agencies bring to the table?

Answer. The Department brings extensive capabilities to conduct R&D in grid modernization and advanced electric transmission and distribution technologies. For example, the Department has been conducting studies, analysis, and technology development activities for about a decade in advanced measurement, communications, and control systems to determine the potential for strengthening the integration of information technologies with the electric power system. The Department also has considerable experience, expertise, and capabilities in the development and analysis of cyber security technologies for power grid applications.

Since 2007, we have taken initial steps to begin implement our new smart grid responsibilities under Title XIII of the Energy Independence and Security Act of 2007 (EISA) by planning research and development for the next generation of smart grid technologies, establishing a Federal Smart Grid Task Force and Advisory Committee, providing assistance to the National Institutes of Standards and Technologies (NIST) and the Federal Energy Regulatory Commission (FERC) in the development of a national framework for smart grid interoperability standards, and planning for potential programs in regional demonstrations and Federal matching grants. In addition, Title XIII requires that we conduct a "Smart Grid System" report which is to be published every two years and provide information on the status of smart grid deployments nationwide and any regulatory or government barriers to continued deployment and a study of the security attributes of smart grid systems including a determination of smart grid deployments on the security of the electric system.

The Department is implementing a comprehensive approach to the integration of renewable and distributed resources with the electric transmission and distribution system. For example, studies and analysis have been conducted to assess the technical and economic issues associated with operating large numbers of wind turbines, interconnecting them with the grid, and integrating their operations with system planning and operations. These studies have pointed to the need for expanding the capacity of the electric transmission system to accommodate greater numbers of wind installations, and to develop better operating data on system conditions and wide-area visibility so grid operators can address fluctuations in the wind and match them to system requirements.

Question 4. Your office has received an unprecedented amount of funding in the Stimulus Bill. Does your office have the ability to utilize these funds in a targeted and meaningful way? How will DOE undertake its work? Will all the money be spent on matching grants or will DOE use some of the funding to perform R&D work and undertake demonstration projects?

Answer. Managing the increase in appropriations is a challenge for the Office of Electricity Delivery and Energy Reliability (OE), given the current program level but we are committed to applying the funds to initiatives that will most effectively achieve the Recovery Act's objectives of modernizing the electricity grid, enhancing energy security, and improving grid resiliency and efficiency. Recognizing that this is a one-time increase for the program, we plan to increase Federal staff on a limited-term basis, supplementing with technical support contractors as appropriate. OE also plans to leverage expertise and resources within the Department and the national labs as much as possible.

Almost all of the funds will be distributed through a competitive process, generally through competitive grants or other financial assistance vehicle. While the bulk of the funding will support Smart Grid Investment and Regional Demonstration projects, we will also support initiatives that assist regional transmission planning and workforce development.

Question 5. Energy storage technologies (plug-in-hybrid electric vehicles, large scale lithium ion batteries, flywheels, etc.) can provide many benefits: improved grid reliability, increased utilization of intermittent renewables, and deferred transmission investments. Unfortunately, market rules and interconnection requirements for storage devices are far from standardized. How can your agency accelerate the integration and the benefits of energy storage as part of the Smart Grid?

Answer. The Department's Office of Electricity Delivery and Energy Reliability (OE) will continue to provide national leadership in the development and deployment of a wide range of energy storage technologies and applications for the power grid. Current work includes cost-shared projects with the California Energy Commission, the New York State Energy Research and Development Authority, and utilities. These projects will help determine the feasibility, efficiency, and carbon footprint of storage technologies. OE will also continue to work with the Federal Energy Regulatory Commission (FERC), Independent Systems Operators, State Agencies, utilities, and vendors to accelerate acceptance of energy storage as an essential tool of smart grid technology and adoption of appropriate market rules to enable widespread application. Since energy storage is an integral part of a smart grid, we anticipate supporting applications for a wide range of energy storage technologies under the American Recovery and Reinvestment Act. These demonstrations with integration into the grid infrastructure will greatly accelerate the development and widespread adoption of energy storage. With respect to standards, the Department works closely with organizations such as the National Electric Manufacturers Association to establish standardization and interconnection requirements.

RESPONSE OF PATRICIA HOFFMAN TO QUESTION FROM SENATOR STABENOW

Question 1. I am very pleased that the Recovery Package includes \$100 million for workforce training. Could you explain how these funds may be used to start and leverage private investments? Also, will workforce training programs be necessary and at what point could we begin implementing training programs?

Answer. The Department is still in the process of defining how the \$100 million for workforce training provided in the American Reinvestment and Recovery Act will be implemented to build America's energy workforce in support of the Nation's grid modernization. DOE expects to release a solicitations to support the workforce training initiative within the next few months.