EFFECTIVELY TRANSFORMING OUR ELECTRIC DELIVERY SYSTEM TO A SMART GRID

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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EFFECTIVELY TRANSFORMING OUR ELECTRIC DELIVERY SYSTEM TO A SMART GRID

THURSDAY, JULY 23, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:08 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chairman of the Subcommittee] presiding.

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Committee on Science and Technology
Subcommittee on Energy and Environment

Hearing on

Effectively Transforming Our Electric Delivery System to a Smart Grid

Thursday, July 23, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Ms. Patricia Hoffman
Acting Assistant Secretary
Office of Electricity Delivery and Energy Reliability
U.S. Department of Energy

Ms. Suedeen G. Kelly
Commissioner
Federal Energy Regulatory Commission

Dr. George Arnold
National Coordinator for Smart Grid Interoperability
National Institute of Standards and Technology
U.S. Department of Commerce

Mr. Paul De Martini
Vice President of Advanced Technology
Southern California Edison

Mr. Jeff Ross
Executive Vice President
Gridpoint

Mr. Michael A. Stoessl
Group President
Cooper Power Systems - Div HQ

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HEARING CHARTER

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Effectively Transforming Our Electric Delivery System to a Smart Grid

THURSDAY, JULY 23, 2009
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, July 9, 2009 the Subcommittee on Energy and Environment will hold a hearing entitled: *"Effectively Transforming Our Electric Delivery System to a Smart Grid."*

The hearing will explore the roles of both the Federal Government and industry in transitioning our aging power generation and distribution infrastructure into a smart grid. A smart grid will function as a two-way communication system offering utilities and consumers more information regarding electricity supply, consumption, and price which would ultimately modify patterns of electricity usage. Continued efforts to research and develop innovative smart grid technologies and establish the appropriate inter-operability standards to enable all these devices and systems to communicate with each other are necessary to make this transformation and realize significant efficiency, reliability, security and environmental benefits. Today, our massive interconnected power grid is a century old and over-burdened. It is imperative that we modernize our electric delivery system so that our economy can thrive and growing power needs will be met efficiently and reliably.

Witnesses

- **Ms. Patricia Hoffman is the Acting Assistant Secretary for the Department of Energy, (DOE) Office of Electricity Delivery and Energy Reliability.** Ms. Hoffman briefly will describe the Department's vision for development of a smart grid and offer testimony on the current research, development and demonstration activities at DOE to achieve widespread use of innovative smart grid technologies. She will discuss the challenges associated with a successful transition to a smart grid and how DOE is working with other federal agencies and stakeholders to address these issues. She also will describe the Department's strategy and timeline for distributing funds available under the *American Recovery and Reinvestment Act* for smart grid demonstrations, investment grants, transmission planning and other related initiatives.
- **Ms. Suedeen Kelly is a Commissioner at the Federal Energy Regulatory Commission (FERC).** She will provide a brief overview of FERC's actions and programs designed to modernize our electric delivery system and the issues that we must address to ensure we have a successful transition to a smart grid. She will describe FERC's collaboration with NIST to develop inter-operability standards for smart grid devices and systems. In addition, she will explain the important role of the states in this transition and the tools FERC has available to help the states implement smart grid strategies.
- **Dr. George Arnold is the National Coordinator for Smart Grid Inter-operability at the National Institute of Standards and Technology (NIST).** Dr. Arnold will offer testimony regarding NIST's progress toward facilitating the development of a framework for standards and protocols to achieve inter-operability of smart grid devices and systems. He will discuss some of the technical challenges presented with standards development and how NIST will address those issues. In addition, he will describe how NIST is working with other federal agencies and interested stakeholders to achieve widespread use of innovative smart grid technologies.
- **Mr. Paul De Martini is Vice President of Advanced Technology at Southern California Edison (SCE).** SCE is the largest subsidiary of Edison Inter-

national and supplies electricity to eleven million people in southern California. Mr. De Martini will testify about SCE's research, development and pilot programs related to advancing smart grid technologies and modernization of our electric grid. He also will give an overview of SCE's strategy to deploy innovative smart grid technologies, their work with DOE and NIST, provide a utility perspective on integrating these new technologies with existing technologies, and discuss some of the benefits anticipated for the company and consumers as that strategy is implemented.

- **Mr. Jeff Ross is the Executive Vice President at GridPoint.** GridPoint is a technology company engaged in the development of innovative smart grid platform that enables utilities to optimize electrical grid management. Mr. Ross will discuss GridPoint's technology portfolio to illustrate the type of innovation that will facilitate the modernization and advancement of the Nation's electricity system, as well as some of the challenges encountered along the way. He will also describe GridPoint's experience in the smart grid demonstration in Boulder, CO.
- **Mr. Michael A. Stoessl is the Group President for Cooper Power Systems.** Cooper Power Systems engineers and manufactures medium and high-voltage electrical equipment, components, and systems that deliver reliable electric power to homes, industries, businesses, and institutions worldwide. The company is a member of the National Electrical Manufacturers Association (NEMA) and he will testify on NEMA's behalf. Mr. Stoessl will provide a brief overview of NEMA and its history in developing standards for power equipment and the grid. He will discuss how the association is fulfilling its Congressionally-directed role to work with federal agencies and accelerate the deployment of innovative smart grid technologies. In addition, he will describe the technical challenges of integrating new smart grid technologies with the current grid and provide examples of successful deployment.

Background

In the 20th century, widespread electrification brought power to our homes, businesses, farms and cities, changing our lives dramatically. In 1935 President Roosevelt established the Rural Electric Administration (REA) and directed the agency to electrify the continent. As part of that massive undertaking, innovations were undertaken that included standardized designs for distribution lines, mass production and construction techniques, system protection and wide area distributed power planning. Now, nearly seventy-five years since the REA was created, we still consider electrification one of the greatest engineering achievements of the 20th century.

Electricity has to be used the moment it is generated. While this system has worked for decades, it is not very efficient. Demand for power varies greatly throughout the day and throughout the year as demands for lighting, heating and cooling fluctuate through the seasons. Because the capacity for generation of power matches the consumption of power, the electricity supply system must be sized to generate enough electricity to meet the maximum anticipated demand (e.g., peak demand). This inefficiency becomes more evident when considering that it is possible the peak electricity demand for any given year could be for a very short period—a few days or even hours. The deployment of innovative smart grid devices is intended to reduce this inefficiency.

Our century-old power grid is the largest interconnected machine on Earth consisting of more than 9,200 electric generating units with more than one million megawatts of generating capacity connected to more than 300,000 miles of transmission lines.[1] Currently, our electric grid is a centralized, generator-controlled network where electrons and information flow in one direction, from generator to end-user. The transition to a smart grid will change this completely. A modern power grid is envisioned to operate more like an energy internet with a two-way flow of electricity and information that will be capable of monitoring everything from power plants to customer preferences to individual appliances. This transformation will give utility operators and customers the proper tools and information so that electricity generation is better-managed and consumer choices are exercised to control costs and lower electric bills.

Smart grid technologies, including energy storage technologies will offer operators new opportunities for managing distributed power production and zero-emission power generation from solar and wind sources. Also pushing modernization of our electric infrastructure is the increasing demand for electricity driven by population

[1] *The Smart Grid: an Introduction.* Prepared by Litos Strategic Communication for the U.S. Department of Energy, 2008, page 5.

growth, bigger homes, and greater appliance use. While our electric grid is considered one of the most reliable in the world, there have been five massive blackouts over the past forty years, three of those occurring in the past nine years. The recent Northeast blackout of 2003 resulted in a $6 billion economic loss to the region.[2] Further compounding the reliability risks is the trend in our economy to become ever-more digital and to be more reliant upon electronic equipment and automated manufacturing. These trends place increasing demand on our electric delivery system.

Even as we anticipate continued rising demand for power, under-investment in the upgrading of our electric infrastructure has left the grid overburdened and inefficient. According to the Department of Energy, if the grid were just five percent more efficient, the energy savings would equate to permanently eliminating the fuel and greenhouse gas emissions from 53 million cars.[3] The *American Recovery and Reinvestment Act* (ARRA) authorized the Department of Energy to spend approximately $4.5 billion on smart grid projects under programs established in Title XIII of the *Energy Investment and Security Act of 2007* to begin to address these needs.

From the funds made available by the ARRA, the Department of Energy's Office of Electricity Delivery and Energy Reliability (OE) has issued Funding Opportunity Announcements for smart grid demonstrations, smart grid investment grants, and a smart grid information clearinghouse. The goal of the demonstration projects is to verify smart grid technology viability, quantify smart grid costs and benefits, and validate new smart grid business models at a scale that can be readily adapted and replicated across the Nation. These projects could fund different energy storage technologies, including battery storage, compressed air energy storage and other new promising storage options. In addition, these projects could demonstrate synchrophasor measurement technologies and approaches to improve transmission system reliability through large-scale deployment of synchrophasor technology. These synchrophasors or "phasors" have the potential to significantly improve transmission reliability because they take data measurement with Global Positioning System (GPS) timing. The gathered data allow grid operators to see dynamic conditions on the grid in a more real-time (time and location) manner and with greater accuracy. As a result, the operators have better system control and earlier detection of potential grid disturbances for better mitigation.

The Smart Grid Investment Grant Program is intended to gain improvements in cost and performance of smart grid technology. The program will provide federal assistance to fund up to 50 percent of investments by electric utilities and other entities for projects that promote the goal of deployment of smart grid technologies. The investments are designed to help implement the necessary digital upgrades to the electric grid enabling it to work more efficiently and make it better able to effectively integrate power generated from renewable energy technologies, energy efficient technologies, and demand management practices. Demand Response or load management is defined as the planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. These practices or programs refer only to energy and load-shape modifying activities that are undertaken in response to utility-administered programs and not the normal operation of the marketplace.[4] Demand response practices are used today, but will be ever-more prevalent as we transition to a smart grid.

The Smart Grid Information Clearinghouse is intended to consolidate public technical, legislative, and other information on smart grid development and practices, and direct web site users to additional information sources both in the United States and internationally. The goal is to facilitate coordination among all smart grid stakeholders to support the development and deployment of smart grid technologies.

EISA also authorized a federal Smart Grid Task Force that is led by DOE's Office of Electricity Delivery and Energy Reliabilty to coordinate federal activities related to smart grid technologies and practices. The Task Force works closely with the Federal Energy Regulatory Commission and the National Institute of Standards and Technology. The Department also established an Electricity Advisory Committee which issued a report in January 2009 entitled: "*Keeping the Lights On in the New World.*" The report discusses current trends for our electricity infrastructure related to both power demand and supply, and it offers options for meeting future electricity needs with recommendations for specific actions by DOE.

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[2] *Ibid*, page 7.

[3] *The Smart Grid: An Introduction.* Prepared by Litos Strategic Communication for the U.S. Department of Energy, 2008, page 7.

[4] *Keeping the Lights On in a New World,* Electricity Advisory Committee, January 2009, page 84.

The Recovery Act also included $10 million for NIST to conduct its work on interoperability standards for smart grid devices and systems. This standards development process covers the entire electricity system including generation, transmission, distribution and end-user equipment and devices. These standards are essential to ensure that all the different software and hardware components of a smart grid, supplied from various vendors, will work together seamlessly and secure the grid against disruptions. In other words, such standards will support the ability of different devices to exchange data, communicate, and participate in business activities regardless of the operating systems or programming languages underlying those devices. NIST has established domain working groups and is identifying and evaluating existing standards and measurement methods to support the transformation of our electric delivery system.

In mid-May, Secretaries Locke and Chu announced the initial batch of sixteen NIST-recognized inter-operability standards. NIST is directed to issue a report to Congress when it determines that the work is completed or that a federal role is no longer necessary for standards development. EISA further calls on FERC to institute a rule-making proceeding to adopt such standards and protocols as may be necessary to insure smart-grid functionality and inter-operability in interstate transmission of electric power and regional and wholesale electricity markets. FERC has authority to determine when NIST's process has led to sufficient consensus of the stakeholders.

A Smart Grid

There is a lot of talk about deploying smart meters, a process that is underway. It is important to note that metering is just one of numerous possible applications that make up a smart grid. The smart grid is far more than meters as it will function like an energy internet and innovative technologies will be empowered by the two-way digital communication and plug-and-play capabilities that exemplify a smart grid.

For consumers, the smart grid means they will have access to real-time pricing and these price signals will help to educate consumers about energy consumption and actively engage them in energy decisions. Ultimately, consumer participation will result in reduced peak demand—when electricity demand is its greatest. Today our electric bills provide little information about energy consumption patterns and costs, and the bills come monthly, days after actual consumption takes place. New smart grid technologies will allow consumers to see the price they are paying for their energy in real-time, helping them to lower their electric bills as they use less electricity during peak demand times when prices are high. This behavior in turn benefits the utilities because shedding load at peak demand times will help to relieve stress on the grid and avoid costly infrastructure and maintenance costs. Reducing peak demand also allows utilities to reduce reliance on its least efficient generating plants that are necessary to meet peak demand.

It is estimated that smart grid enhancements will ease congestion on the grid and increase capacity significantly, sending 50 to 300 percent more electricity through existing energy corridors.[5] Maximizing the efficiency of the electricity infrastructure reduces the need for owners and operators to pay for additional generation capacity to meet our nation's growing demand for electricity. Transforming our power system to a smart grid will save money, save energy, and lower emissions from the utility sector making this transition a smart alternative to building more power plants, substations, transformers and transmission lines.

In addition, a smart grid will increase reliability of the grid and enhance the grid's security. Today's grid is dominated by central generation with many obstacles for distributed energy resources interconnection. This centralized system can be vulnerable to disruptions from natural or human events. A modern grid would more readily integrate distributed energy resources, such as electric vehicles and other storage technologies, making our power supply less centralized and less vulnerable. Smart grid technology will include an immense communications network and will vastly improve the utilities' ability to manage the grid under emergency conditions. A smooth transition of our electricity delivery system to a smart grid is critical to realize the benefits associated with a more efficient, reliable and secure electricity infrastructure.

[5] *Ibid*, page 17.

Chairman BAIRD. If our guests will take their seats, the hearing will come to order.

Good morning to everyone, and welcome to today's hearing on "*Effectively Transforming Our Electric Delivery System to a Smart Grid*." I would like to welcome our expert panelists who will discuss both the role of the Federal Government and industry stakeholders in transforming our power grid.

Even today with tremendous advancements in technology, electrification is considered the greatest engineering achievement of the 20th century. However, parts of this infrastructure are nearly a century old and our increased reliance on electrical power is straining our system's capacity.

In the past nine years, we have experienced three big blackouts. It is estimated that the blackout of 2003 resulted in a $6 billion economic loss to the region. In order to improve efficiency of power delivery and incorporate renewable energy technologies, we need to modernize our grid infrastructure.

A smart grid is a sophisticated, two-way communication system for managing our electric infrastructure. It will operate more efficiently and reliably and empower consumers to more actively engage in energy use decisions. The technology to encourage their participation in these decisions will be at their fingertips. Accurate and timely price signals will help consumers reduce energy consumption during peak demand when prices are highest. This shaving off of the peak load, in turn, offers power plant operators the opportunity to avoid investment costs for new generation capacity. In addition, utilities will be better equipped to manage their systems and integrate energy from renewable sources, plug-in-electric vehicles and other storage technologies.

Also, there is growing recognition that a smart electric grid is extremely important for responding to environmental problems such as ocean acidification and lethal overheating of our planet. More efficient energy production and increased use of renewable energy resources will help to set us on a course to address these environmental challenges.

I would like to thank the witnesses for their participation today, and I am looking forward to your testimony. I am sincerely excited and interested in this as I think so many of us are as it is going to be central to solving our nation's energy problems, and we have an outstanding panel of experts.

With that, I yield to our distinguished colleague and my friend, Mr. Inglis, for an opening statement.

[The prepared statement of Chairman Baird follows:]

PREPARED STATEMENT OF CHAIRMAN BRIAN BAIRD

Good morning and welcome to today's hearing on "*Effectively Transforming Our Electric Delivery System to a Smart Grid*."

I would like to welcome our expert panelists who will discuss both the role of the Federal Government and industry stakeholders in transforming our power grid.

Even today with tremendous advancements in technology, electrification is considered the greatest engineering achievement of the 20th century. However, parts of this infrastructure are nearly a century old, and our increased reliance on electrical power is straining this systems' capacity.

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Also, there is growing recognition that a smart electric grid is extremely important for responding to environmental problems such as ocean acidification and lethal over-heating of the planet. More efficient electricity production and increased use of renewable energy resources will help to set us on a course to address these environmental challenges.

Again, I would like to thank the witnesses for their participation today, and I look forward to your testimony.

Mr. INGLIS. Thank you, Mr. Chairman, and thank you for this very important hearing.

In our last hearing, we discussed obstacles in getting renewable energy, wind and solar in particular, into the electricity market in a meaningful way. One of the biggest gaps we heard about was getting renewable energy onto a grid designed for centralized generation from conventional power plants. In order to move away from fossil fuels, we need to upgrade the grid. A smart grid presents many exciting opportunities. First, we will be able to use distributed generation to supply our population centers, enabling a shift toward renewable power. Second, we will improve efficiency and increase capacity on the electricity grid. Finally, we will create a new model of consumer participation. With the two-way communication made possible by smart grid technologies, consumers will have access to new information about their energy use and prices and get more involved in how they use electricity.

So now we have to figure out how to get to a modern electricity grid. I am looking forward to hearing from our witnesses about where we are now and where we have to go. Governments and professional associations will certainly play an important role in the research and development of smart grid technologies and in setting the standards that will govern the new electricity delivery system. Private enterprise will step in with cutting-edge technology designed to integrate the grid, better manage peak loads, and give consumers the tools they need to make informed decisions.

I have several questions about smart grid. We are working on developing a new grid and a new pattern of energy generation at this time. I hope to learn all these efforts are working in tandem and if we are going forward at the right pace. I also wonder what the proper relationship between private and public investment is in a project like this that serves both interests together.

Finally, the smart grid will support electricity from sources far away from population centers. While this will support development of renewable electricity, it may also support continued reliance on old and polluting facilities that operate in some remote areas. I hope we can address these concerns today, and I thank the Chairman for holding this hearing.

[The prepared statement of Mr. Inglis follows:]

PREPARED STATEMENT OF REPRESENTATIVE BOB INGLIS

Good morning and thank you for holding this hearing, Mr. Chairman.

At our last hearing, we discussed obstacles in getting renewable energy, wind and solar in particular, into the electricity market in a meaningful way. One of the biggest gaps we heard about was getting renewable energy onto a grid designed for centralized generation from conventional power plants. In order to move away from fossil fuels, we need to update the grid.

A smart grid presents many exciting opportunities. First, we'll be able to use distributed generation to supply our population centers, enabling a shift toward renewable power. Second, we'll improve efficiency and increase capacity on the electricity grid. Finally, we'll create a new model of consumer participation. With the two-way communication made possible by smart grid technologies, consumers will have access to new information about their energy use and prices and get more involved in how they use electricity.

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I have several questions about the smart grid. We're working on developing a new grid and a new pattern of energy generation at the same time; I hope to learn how these efforts are working in tandem and if we're going forward at the right pace. I also wonder what the proper relationship between private and public investment is in a project like this that serves both interests together. Finally, the smart grid will support electricity from sources far away from population centers. While this will support development of renewable electricity, it may also support continued reliance on old and polluting coal facilities that operate in the same remote areas. I hope we can address these concerns today.

Thank you again for holding this hearing, Mr. Chairman.

Chairman BAIRD. Thank you, Mr. Inglis.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

Thank you Chairman Baird. I am very pleased that the Energy and Environment Subcommittee is holding this hearing today to discuss our efforts to transform our electricity infrastructure into a smart grid.

Digitizing our electrical power grid is a massive endeavor that offers exciting possibilities and a wide range of benefits. Modernization will increase the reliability of our grid, provide significant energy efficiency gains, and will enable us to broaden the use of renewable energy sources and energy storage technologies. A smart grid will allow active consumer involvement in decisions to use energy, and businesses will reduce their energy costs by managing their demands for power.

Because transformation of our electricity delivery system is such an enormous undertaking, it comes with many challenges as well. We are investing billions of federal dollars toward the smart grid transition, and we need to make certain those dollars are invested well.

I look forward to hearing from our panel of expert witnesses about our progress to deploy innovative smart grid technologies and the hurdles we must yet overcome to modernize our power infrastructure.

I thank the witnesses for testifying today and I look forward to an interesting dialogue.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. Thank you, Mr. Chairman, for holding today's hearing to transition our aging electric delivery system to a smart grid infrastructure.

Our current electric grid is inefficient and outdated. These problems have been highlighted by the three massive blackouts the Nation has experienced in the last nine years. Smart grid technology will reduce inefficiency, provide consumers more control over their electricity costs, and give utility operators more flexibility in generating and transmitting power. In addition, smart grid technology will improve the security of our electricity infrastructure, making it less susceptible to threats. With the House of Representative's passage of the *American Clean Energy and Security Act,* the need for a modernized, clean electricity grid has become increasingly important.

Developing and demonstrating these technologies will require coordination between the Federal Government and the private sector. The *American Recovery and Reinvestment Act*'s $4.5 billion investment in smart grid technology was an important step in moving forward with early smart grid research efforts. DOE has distributed these funds to universities, including the Illinois Institute of Technology, and private companies to move these projects towards large-scale demonstrations. I would be interested to hear from our witnesses how Congress can continue to support these collaborative efforts. In particular, how can Congress support efforts to move these important projects towards commercial application?

I welcome our panel of witnesses, and I look forward to their testimony. Thank you again, Mr. Chairman.

Chairman BAIRD. It is now my pleasure to introduce our witnesses at this time. Ms. Patricia Hoffman is the Acting Assistant Secretary of the Office of Electric Delivery and Energy Reliability at the Department of Energy. Ms. Suedeen—am I pronouncing that right? Is it Sueldeen or Suedeen?

Ms. KELLY. Suedeen.

Chairman BAIRD. Suedeen G. Kelly is the Commissioner of the Federal Energy Regulatory Commission. Dr. George Arnold is the National Coordinator for Smart Grid Interoperability at the National Institute of Standards and Technology. Mr. Paul De Martini is the Vice President of Advanced Technology for Southern California Edison, Mr. Jeff Ross, Executive Vice President for GridPoint Incorporated, and finally, Mr. Michael Stoessl is the Group President of Cooper Power Systems. We thank you all. As I think you have been briefed by staff, we try to keep the testimony as near to five minutes as we can. As my distinguished friend, Dr. Ehlers, used to say when he chaired the Committee, as you go past five minutes there is a risk the chair drops out from under you and you don't get to testify for the rest of the hearing. Please keep your comments brief, but we sure appreciate your testimony. Following your comments, then we will have a series of questions from the panel Members.

So with that, I will start from Ms. Hoffman from the Department of Energy. Thank you. Please begin.

STATEMENT OF MS. PATRICIA HOFFMAN, ACTING ASSISTANT SECRETARY, OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY, U.S. DEPARTMENT OF ENERGY

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

The *Energy Independence and Security Act of 2007* and the *American Recovery and Reinvestment Act* expanded the role of the Federal Government substantially in research, development, demonstration and deployment of smart grid technologies, tools and techniques. To fulfill this role, the Department of Energy and the Office of Electricity Delivery and Energy Reliability are carrying out smart grid activities in three primary areas: smart grid investment grants, smart grid demonstrations and smart grid research and development.

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

While these programs are about transforming the delivery and management of electric power through the application of today's smart grid technologies, tools and techniques such as phasor measurement units and advanced metering infrastructure, we are simultaneously working on the next generation systems for expanding the capacity and increasing the flexibility and functioning of the electric transmission and distribution system. Our fiscal year 2010 budget request for smart grid and related R&D is aimed at harnessing the Nation's scientific and engineering talents in electric systems and focusing it on discovery and innovation for new materials, algorithms, concepts and prototypes for power lines, substations, transformers, storage systems and power electronics.

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

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

A key aspect for implementation of smart grid technologies is the need to address inter-operability and cyber security. Development of industry-based standards governing how the many different devices involved in a smart grid can communicate and inter-operate with each other in a seamless, efficient and secure manner is one

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of the top priorities for DOE and other federal and State agencies. Since the smart grid vision involves the two-way flow of information and electric power, for higher degrees of automation and control than what exist today in the electric transmission and distribution system, it is necessary for there to be standards that guide manufacturers and smart grid developers, foster innovation and provide a platform that enables a wide range of offerings to come to market and have the opportunity to compete. As occurred with the telecommunications and the evolution of the Internet, effective standards form the basis upon which entrepreneurs can bring innovations to the marketplace, build new businesses and create job opportunities.

The public-private partnerships on phasor measurement units have been instrumental in the development and deployment of this technology and the formation of the North American SyncroPhasor Initiative. The SyncroPhasor Initiative is an important technology to provide greater insight into system operating conditions and holds the promise to enable better indication of grid stress as well as other performance characteristics. An important goal is to use the phasor measurement unit (PMU)-derived information to trigger corrective actions and maintain reliable system operation.

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

[The prepared statement of Ms. Hoffman follows:]

PREPARED STATEMENT OF PATRICIA HOFFMAN

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

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

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

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

Smart Grid Performance Metrics and Trends

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

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

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

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

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

The Smart Grid Investment Grant Program

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

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

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

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

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

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

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

Project applications will be considered in six topic areas:

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

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

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

The Smart Grid Demonstration Program

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

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

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

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

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

Inter-operability and Cyber Security

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

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

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

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

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

- A summary of the cyber security risks and how they will be mitigated at each stage of the life cycle (focusing on vulnerabilities and impact).
- A summary of the cyber security criteria utilized for vendor and device selection.
- A summary of the relevant cyber security standards and/or best practices that will be followed.
- A summary of how the project will support emerging smart grid cyber security standards.

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

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

1. Adequacy of the Technical Approach for Enabling Smart Grid Functions (40 percent)
2. Adequacy of the Plan for Project Tasks, Schedule, Management, Qualifications, and Risks (25 percent)
3. Adequacy of the Technical Approach for Addressing Inter-operability and Cyber Security (20 percent)

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

Smart Grid Research and Development

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

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

- Integrated communications,
- Advanced components,
- Advanced control methods,
- Sensing and measurement,
- Improved interfaces and decision support, and
- Grid materials research.

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

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

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

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

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

Conclusion

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

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

BIOGRAPHY FOR PATRICIA HOFFMAN

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

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

Chairman BAIRD. Thank you, Ms. Hoffman.

Ms. Kelly.

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

Ms. KELLY. Thank you, Mr. Chairman and Members of the Subcommittee for the opportunity to testify today. My name is Suedeen Kelly. I am a Commissioner on the Federal Energy Regulatory Commission, and what I am going to do now is describe FERC's efforts to develop and implement a range of technologies which has come to be known collectively as the smart grid. I am going to discuss three topics: our authority to act, the coordinated efforts we have undertaken to date with other federal regulators and State regulators, and the activity that we have undertaken on our own.

Regarding our authority to act, it derives from two statutes: the *Energy Independence and Security Act* passed in 2007 and the *Federal Power Act,* which has been with us for over 70 years now. The *Energy Independence and Security Act* gives FERC authority in the area of inter-operability standards for the smart grid. The *Federal Power Act* gives FERC jurisdiction over part of the electricity industry and part of the electricity market. Specifically, there are three areas under the *Federal Power Act* where we have jurisdiction that are relevant to smart grid development.

First, we have jurisdiction over the transmission of electricity by public utilities but we don't have jurisdiction over the distribution of electricity, which is subject to State regulation. We have jurisdiction over the wholesale sales of electricity in interstate commerce by public utilities, but we don't have jurisdiction over retail sales, which is under the jurisdiction of State regulators. And we have jurisdiction over the approval and enforcement of reliability standards for the bulk power system.

We have been coordinating over the last two years with federal and State agencies. In the federal arena, smart grid efforts involve a broad range of government agencies and the federal agencies include primarily those who are with you today: the Department of Energy, the National Institute of Standards and Technology, and FERC, as Ms. Hoffman has described DOE's role on smart grid and Dr. Arnold will soon describe the role of NIST. NIST will be involved in setting up the framework for inter-operability standard development and overseeing that development. Once FERC determines that NIST's work has led to sufficient consensus regarding a standard, then FERC's role under the *Energy Independence and Security Act* is to adopt the inter-operability standards "needed to ensure the functionality and inter-operability of smart grid." So it may be that some of the standards developed through the NIST process will not ultimately fall into the category of "needed to ensure the functionality and inter-operability" but to the extent those standards do fall into that category, it is FERC's responsibility to adopt them as regulations, or at least we have the authority to do that.

Development of the inter-operability framework, as Dr. Arnold will discuss, is a very challenging task. Recent funding for NIST's efforts will help but coordination among government agencies as well as among industry participants is just as important. DOE, NIST and FERC have been working with each other to ensure progress, and those efforts will continue.

In the State arena, as I mentioned, utilities are regulated by FERC at the transmission level and the wholesale level, and most of them are also regulated by one or more State regulatory commissions at the distribution level and the retail sales level. Now, because smart grid technologies span the grid from the transmission through the distribution level, the concurrent jurisdiction of federal and State regulators, we believe, will best be served if both federal and State regulators adopt complementary policies to avoid sending regulatory signals. To address this as well as other issues related to deployment of smart grid technology, I and Mr. Fred Butler, who is Chairman of the New Jersey Public Utility Commission as well as President of the Association of State Utility Commissioners, formed a collaborative and we co-chair that collaborative between FERC and the State commissions. At present, there are 21 states that have become a member of that collaborative. Since its creation 15 months ago, the collaborative has explored a host of technological and regulatory issues involving the smart grid including the development of a clearinghouse of information at the Department of Energy as well as the drafting of criteria that we suggested to the Department of Energy for the funding of smart grid technologies under the stimulus bill and we are now participating with the help of Lawrence Berkeley Lab and the Pacific Northwest National Lab in the NIST process as a collaborative and in the development of DOE's clearinghouse for information from smart grid demonstration projects.

A critical issue as smart grid is deployed is the need to ensure grid reliability and cyber security. FERC can use its existing authority to facilitate implementation of smart grid under the *Federal Power Act.* Last week FERC adopted a smart grid policy statement that basically has two parts. The first part identified priorities that we see from our position of regulator of the electric industry for the development of inter-operability standards. Cyber security is one of those priorities as is standardized communication across inter-system interfaces. We also listed four functional priorities: wide area situational analysis, demand response, electric storage and electric transportation. The policy statement also specified certain cost recovery mechanisms available for recovery of costs of transmission-owning utilities that want to invest in the smart grid facilities.

I appreciate the opportunity to testify today and I would be happy to answer any questions that you might have.

[The prepared statement of Ms. Kelly follows:]

PREPARED STATEMENT OF SUEDEEN G. KELLY

Introduction and Summary

Mr. Chairman and Members of the Subcommittee, 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 uses 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. While we are moving forward expeditiously on smart grid, its implementation will take time.

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 the FERC. DOE's tasks include funding research and development; awarding grants for smart grid projects; managing the Smart Grid Task Force, discussed below; and developing a smart grid information clearinghouse. NIST has primary responsibility for coordinating development of an "inter-operability framework" allowing smart grid technologies to communicate and work together. The FERC is then responsible for adopting inter-operability standards, once FERC is satisfied that NIST's work has led to sufficient consensus.

Development of the inter-operability 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.

The FERC can use its existing authority to facilitate implementation of smart grid. For example, through its recent final smart grid Policy Statement (Policy Statement), the Commission has specified criteria for recovery of costs of investing in jurisdictional smart grid facilities.

A critical issue as smart grid is deployed is the need to ensure grid reliability and cybersecurity. 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 that everyone must comply with the smart grid standards adopted by the Commission under the *Energy Independence and Security Act of 2007* (EISA), additional legislation would need to be considered.

What is the Smart Grid?

"Smart grid" refers to the effort to modernize the electric grid to improve the way we deliver and use power. The smart grid takes the existing electricity delivery system and makes it smarter by linking seamless communications systems to the electrical transmission and distribution system between any point of generation and any point of consumption. It can monitor, protect and automatically optimize the operation of the interconnected elements. The smart grid will provide a two-way flow of electricity and information to create a more automated and efficient energy delivery network.

The smart grid concept encompasses all levels of the electric system, and, therefore, a comprehensive list of applications and technologies could be quite long. Two key examples, however, include: (1) smart thermostats capable of receiving and responding to electricity price or dispatch signals to lower or raise demand as necessary to balance available supply at the device level; and (2) advanced sensor networks on the distribution and transmission grids to improve awareness of actual system conditions and, thus, permit more advanced control and use of those grids.

How do Technology and Regulation Interact?

Existing retail and wholesale regulatory frameworks generally assume that load (i.e., customer consumption; also called demand) is an uncontrollable variable that can only be addressed with controllable generation. Accordingly, load pays to consume the energy it needs, and generation is paid to meet that need no matter how variable and unpredictable it may be. This mutes any incentive for load to shift its usage in grid-favorable ways and increases the challenge and cost of accommodating such load with generation. The smart grid concept seeks to move away from this framework by making all aspects of the electric system, including the load side, more transparent, interactive, and responsive.

This interplay between technology and regulation is visible in the Commission's examination of its rate policies in light of the new Congressional directive in the EISA to initiate rule-makings on smart grid inter-operability standards. As explained in more detail below, the Commission recently issued a smart grid Policy Statement that adopts an interim rate policy to help encourage investment in smart grid systems.

At the consumer level, a smart grid could include smart devices, such as smart thermostats capable of receiving and responding to electricity price or dispatch signals to lower or raise demand as necessary to balance available supply at the device level. State regulators have the authority and ability to provide pricing and dispatch signals at retail. If signals reflect real-time costs, consumers are likely to buy and install smart devices. For example, consumers might install smart thermostats if regulators provide real-time price signals.

What Federal Regulation Applies?

Federal regulation relevant to smart grid is found in the following statutes: EISA; the *Energy Policy Act of 2005;* and the *American Recovery and Reinvestment Act of 2009.* The provisions of the FPA can also be used to advance smart grid technologies. These are discussed below.

Section 1301 of the 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 the EISA gives NIST "primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve inter-operability 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 the EISA does not define inter-operability, 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 and security. (See GridWise Architecture Council, "Inter-operability Path Forward Whitepaper," *www.gridwiseac.org*)

Pursuant to EISA section 1305(d), once the Commission is satisfied that NIST's work has led to "sufficient consensus" on inter-operability standards, it must then "institute a rule-making proceeding to adopt such standards and protocols as may be necessary to insure smart-grid functionality and inter-operability 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.

The Commission'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.

Recently, 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 inter-operability framework.

The Stimulus Bill also directed 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 inter-operability 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 Inter-operability and Decision-Maker's Checklist," page 4, *www.gridwiseac.org*)

The Commission's interest and authority in the area of smart grid derives not only from the EISA but also from its authority under the *Federal Power Act* (FPA) over the rates, terms and conditions of transmission and wholesale sales in interstate commerce and its responsibility for reliability standards for the bulk-power system. Specifically, the Commission has jurisdiction over transmission and sales for resale of electric energy in interstate commerce by public utilities pursuant to FPA section 201 and over the approval and enforcement of reliability standards for the bulk-power system under FPA section 215.

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 FPA, requires the Commission to promulgate standards, but does not provide that the standards are mandatory or provide any authority or procedures for enforcing such standards. If the Commission were to seek to use the full scope of its existing FPA authority to require compliance with smart grid standards, most of its authorities apply only to certain entities (i.e., public utilities under its rate-making authority in sections 205 and 206, or users, owners and operators of the bulk power system under its reliability authority in section 215). The Commission also has asserted jurisdiction in certain circumstances over demand response programs involving both wholesale and eligible retail customers. However, The Commission's authority under the FPA excludes local distribution facilities unless specifically provided; its rate authority under sections 205 and 206 applies only to public utilities; and its section 215 reliability authority does not authorize it to mandate standards but rather only to refer a matter to NERC's standard-setting process. Further, its section 215 reliability authority excludes Alaska and Hawaii. If the intent of Congress is that everyone must comply with the smart grid standards adopted by the Commission under the EISA, additional legislation should be considered.

While FERC, by itself, may be able to take steps 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, 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." On another front, DOE's authority to support up to 50 percent of the cost of a smart grid project must be matched with regulatory approvals allowing utilities to recover the rest of their costs in rates. Similarly, the concurrent jurisdiction of the FERC and State commissions over many utilities will require regulators to adopt complementary policies to avoid 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 the North American Energy Standards Board, and the industry and government agencies should support the work needed to evaluate and develop those changes.

How are the FERC, NIST and DOE Collaborating?

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 of the smart grid efforts of other participants as well as the efforts outside the Federal Government. FERC has designated two employees (one from the Office of Energy Policy and Innovation and one from the Office of Electric Reliability) to the Task Force. These employees bring a policy, rates, reliability and cybersecurity perspective to the Task Force. The FERC routinely updates the Task Force on the FERC/NARUC smart grid Collaborative, discussed below, and other FERC orders regarding smart grid policy.

Independent of the Smart Grid Task Force, the Commission has coordinated closely with NIST and DOE on the development of inter-operability standards for the smart grid. Several FERC commissioners and staff have participated in relevant meetings and conferences as speakers and/or session chairs. FERC staff also confers regularly with NIST and DOE staff on inter-operability standards, discussing matters such as accelerating the timeline, strategies to achieve consensus, and setting priorities.

How is FERC Collaborating with the States?

In February 2008, 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. Initiation of a collaborative effort 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 inter-operability, 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 accompany 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. In keeping with the Stimulus Bill, DOE is working 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. Funding is being sought 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, once the clearinghouse information becomes available. DOE recently selected a contractor to set up the clearinghouse.

The Collaborative also developed criteria to apply to projects seeking smart grid grants. The Collaborative members focused on criteria that could help them fulfill their legal responsibilities as to smart grid projects they would be asked to approve. DOE has adopted many of the Collaborative's suggested funding criteria regarding data disclosures, cybersecurity, inter-operability and requirements related to the identification of project benefits.

In addition, the Collaborative has met with DOE staff to discuss possible funding for technical assistance to the Collaborative and State regulators as they engage with NIST and other stakeholders in the development of smart grid inter-operability standards and protocols.

The Commission and NARUC also have a Demand Response Collaborative headed up by FERC Chairman Jon Wellinghoff, Commissioner Phyllis Reha of the Minnesota Public Utilities Commission, and Commissioner Katrina McMurrian of the Florida Service Commission. The Demand Response Collaborative often focuses on smart grid issues because demand response will play an integral role in the smart grid. Smart grid technologies have considerable potential to facilitate demand response, and demand response can help address bulk-power system challenges, including reliably integrating unprecedented amounts of renewable resources into the grid.

How is the FERC Reaching Out to Industry?

The Commission performs continuing outreach within the electric power industry to ensure that regulated entities are aware of NIST's process for the development of the framework for inter-operability standards and to encourage participation in this process. Numerous discussions have occurred with regional transmission organizations, the ISO–RTO Council (a coordinating entity comprised of ten independent system operators and regional transmission organizations in North America), and public utilities that have been actively involved in smart grid projects, including Xcel, AEP, SoCal Edison, PG&E, Oncor, Consumers Energy, and Duke. The Commission has also followed the efforts of the GridWise Architecture Council in order to get a better understanding of smart grid inter-operability standards from an information technology point of view. The GridWise Architecture Council was formed by DOE to promote and enable inter-operability among the many entities that interact with the Nation's electric power system.

The FERC's Policy Statement

Last week, the Commission approved its smart grid Policy Statement. This action was preceded by the issuance of a proposed policy statement on March 19, 2009. Over 70 comments were received in response to the proposed policy statement.

The Policy Statement prioritizes the development of key inter-operability standards. This prioritization will facilitate progress on the smart grid technologies that will provide the largest benefits to a broad group of market participants.

The Policy Statement establishes two cross-cutting and four functional priorities for inter-operability standards. The cross-cutting priorities are cybersecurity and standardized communication across inter-system interfaces. To insure the integrity and reliability of the underlying bulk-power system, the Commission has required a demonstration of sufficient cybersecurity protections in all proposed smart grid standards to be considered in the FERC rule-making process directed by the EISA, including, where appropriate, a proposed smart grid standard applicable to local distribution-related components of smart grid. The Commission has also recognized that development of a common semantic framework and software models to enable effective communication and coordination across the inter-system interfaces is critical to supporting all of the smart grid goals, such as system self-healing, integration of diversified resources and improved system efficiency and reliability.

The four functional priorities are wide-area situational analysis, demand response, electric storage, and electric transportation. First, wide-area situational analysis awareness is imperative for enhancing reliability of the bulk-power system because it allows for greater knowledge of the current state of available resources, load requirements and transmission capabilities. Second, smart grid technologies have considerable potential to promote demand response, which can reduce wholesale prices and wholesale price volatility and reduce potential generator market power. Third, as the technology advances, electricity storage will become a valuable resource providing a variety of services to the bulk-power system, including helping to address large-scale changes in generation mix. Finally, to the extent that new electric transportation options become more widely adopted in the near future, maintaining the reliable operation of the bulk-power system will require some level of control over when and how electric vehicles draw electricity off the electric system. Therefore, the Commission has urged the early development of standards that can permit distribution utilities to facilitate electric vehicle charging during off-peak load periods.

In the Policy Statement, the Commission also adopted an interim rate treatment to encourage the near-term deployment of smart grid systems capable of helping to address challenges to the operation of the bulk-power system, if certain conditions are met. Those conditions include showing that (1) the smart grid facilities will advance the smart grid concept, (2) reliability and cybersecurity of the bulk-power system will not be adversely affected, (3) the applicant has minimized the possibility of stranded investment in smart grid equipment, and (4) the applicant must share feedback useful to the inter-operability standards development process with the Department of Energy Smart Grid Clearinghouse. The conditions that FERC has put in place for FERC-jurisdictional costs may serve as a model for retail regulators.

Conclusion

A 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. The dynamic nature of smart grid technologies and practices are, in some cases, creating challenges in government oversight of the power industry. There is a great need for continued collaboration between State and federal regulators and between industry and government in general. The 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 attempt to answer any questions you may have.

BIOGRAPHY FOR SUEDEEN G. KELLY

Suedeen G. Kelly is a Commissioner at the Federal Energy Regulatory Commission, who has served since November 2003. In December 2004, she was confirmed to a second term that expires June 30, 2009. Previously she was a Professor of Law at the University of New Mexico School of Law, where she taught energy law, public utility regulation, administrative law and legislative process. She also worked with the law firm of Modrall, Sperling, Roehl, Harris & Sisk in Albuquerque from 2000 through 2003 and the law firm of Sheehan, Sheehan, and Stelzner from 1992 through 1999. In 2000, Ms. Kelly served as counsel to the California Independent System Operator. In 1999, she worked as a Legislative Aide to U.S. Senator Jeff Bingaman.

Prior to joining the faculty of the Law School, Ms. Kelly served as Chair of the New Mexico Public Service Commission, which regulated New Mexico's electric, gas and water utilities. She had been a lawyer in the Office of the New Mexico Attorney General and with the New Mexico firm of Leubben, Hughes & Kelly. She also worked in Washington, DC, for the Natural Resources Defense Council and Ruckelshaus, Beveridge, Fairbanks & Diamond.

Education: University of Rochester, B.A. with Distinction in Chemistry and a J.D. *cum laude* from Cornell Law School. She is admitted to the bars of New Mexico and the District of Columbia.

Chairman BAIRD. Thank you, Ms. Kelly.
Dr. Arnold.

STATEMENT OF DR. GEORGE W. ARNOLD, NATIONAL COORDINATOR FOR SMART GRID INTER–OPERABILITY, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Dr. ARNOLD. Chairman Baird, Ranking Member Inglis and Members of the Subcommittee, thank you for this opportunity to discuss NIST's progress in accelerating the development of standards needed to realize a secure and inter-operable nationwide smart grid.

Working with industry, government and consumer stakeholders, NIST is providing strong national and technical leadership to help make a reliable, robust smart grid a reality. The Recovery Act provided NIST with $10 million from the Department of Energy and we are using this funding to speed up the process to build a standards foundation for the smart grid. First, I would like to summarize our three-phase effort to expedite development of this foundation.

Phase I is well underway and nearing completion. On the basis of stakeholder input, we have identified an initial slate of 16 standards and 64 more are undergoing public review. In September, we intend to issue for public comment Release 1.0 of the NIST framework and roadmap for smart grid inter-operability standards. The document that we deliver to FERC will describe a reference architecture, an initial set of standards to support secure and inter-operable implementation and prioritized action plans to fill gaps. In Phase II, which we launched last month with a request for proposal, NIST is establishing a formal standards panel, a private-public partnership to drive long-term progress in the development and implementation of the hundreds of standards that eventually will be needed. Later this year in Phase III, NIST will announce plans for a framework for testing and certifying how standards are implemented in the smart grid devices, systems and processes.

As we work with the many stakeholder groups, we are uncovering and addressing many issues that are impediments to a fully operational smart grid. For example, there is a foundational smart meter-related standard that is so feature-rich that different meter vendors have implemented it in different ways. This ambiguity undermines inter-operability. We have commissioned a fast track effort to revise the standard and to ensure upgradability to extend the useful life of smart meter deployments.

We are also focusing on the plethora of wired and wireless communications technologies being employed by the smart meter manufacturers. The goal is to provide guidance on the selection of communication standards—one size does not fit all in this case—and not to mandate the use of a particular technology or spectrum.

Then there is the matter of supporting plug-in electric vehicles, or PEVs. The interface between the PEVs and the grid needs to support two-way flow of electricity and information and to meet relevant standard codes. At least seven sets of standards under the auspices of five different standards development organizations needs to be completed or revised to provide this functionality. These are but a few of the many technical issues that we are addressing with the engagement of the many hundreds of stakeholders in our process.

Mr. Chairman, I would like to conclude with some final thoughts. First and foremost, we will continue to stress the critical dimension of security in our work. We need to design in the necessary safeguards at the very beginning. Second, I believe the approach we are taking to develop standards for the smart grid, a strong public-private partnership forged with active White House and Cabinet-level leadership is the right one. Third, we must aim to develop and use international standards wherever possible to enable U.S. manufacturers to capture global market opportunities. Fourth, NIST is engaging, as Commissioner Kelly has cited, the states as integral partners in the standards effort. And finally, it is essential that we base the smart grid on open standards in order to foster innovation.

In conclusion, NIST is proud to have been given such an important role in the smart grid effort. We are committed to achieving the Administration's vision of a cleaner, greener, more efficient and effective electric power grid that creates jobs and reduces our dependence on others to meet our energy needs.

Thank you for this opportunity, and I would be happy to answer any questions.

[The prepared statement of Dr. Arnold follows:]

PREPARED STATEMENT OF GEORGE W. ARNOLD

Introduction

Chairman Baird, Ranking Member Inglis, and Members of the Subcommittee, I am George Arnold, the National Coordinator for Smart Grid Inter-operability at the Department of Commerce's National Institute of Standards and Technology (NIST).

Thank you for the opportunity to appear before you today to discuss NIST's progress in accelerating the development of standards needed to realize a secure and inter-operable nationwide Smart Grid.

A Smart Grid would replace the current, outdated system and employ real-time, two-way communication technologies to allow users to connect directly with power suppliers. The development of the grid will create jobs and spur the development of innovative products that can be exported. Once implemented, the Smart Grid is expected to save consumers money and reduce America's dependence on oil by improving efficiency and spurring the use of renewable energy sources.

President Obama's comprehensive energy plan sets ambitious short- and long-term goals. And, the *American Recovery and Reinvestment Act* includes $11 billion in investments to "jump start the transformation to a bigger, better, smarter grid."[1] The President's Council of Economic Advisors estimates that the number of environment-based jobs will increase by more than 50 percent between 2000 and 2016, and jobs created by the Smart Grid are part of this.

The Smart Grid is a critical piece of the Administration's overall goal of fostering and creating millions of jobs in a green economy through the creation of whole new industries and green entrepreneurs, who are able to grow and thrive as a result of the investments made in a Smart Grid. NIST's mission to advance innovation and U.S. industrial competitiveness fits perfectly with this goal and we're committed to helping make that vision a reality.

Modernizing and digitizing the Nation's electrical power grid—the largest interconnected machine on Earth—is an enormous challenge and a tremendous opportunity. Success requires a combination of quick action and sustained progress in implementing and integrating the components, systems, and networks that will make up the Smart Grid.

NIST is providing strong national leadership to drive the creation of inter-operability standards needed to make the Smart Grid a reality. We are carrying out our standards-related responsibility with a strong sense of urgency. We are engaging industry, government, and consumer stakeholders in an open, public process to expedite identification and development of standards critical to achieving a reliable and robust Smart Grid. An initial slate of 16 standards has already been identified, 64 more are undergoing public comment, and a roadmap for development of additionally-needed standards will be published in September.

Congress assigned NIST responsibility to coordinate development of these standards in the *Energy Independence and Security Act of 2007.*

The Recovery Act provided NIST with $10 million in funding from the Department of Energy (DOE) to ensure that we had the resources to get the job done. Development of standards typically occurs at a glacial pace. ARRA funds are the providing the major boost needed to dramatically speed up this process.

NIST is well suited for the role of leading the charge for rapid standards development. The agency has earned a reputation as an "honest broker"—an impartial, technically knowledgeable third party with a long history of working collaboratively with industry and other government agencies. These partners include the DOE, which leads the overall federal Smart Grid effort. They also include the Federal Energy Regulatory Commission (FERC), State regulatory commissions, and many others.

In its role as the Nation's metrology institute, NIST has provided measurement technology and technical assistance to utilities, equipment manufacturers, and other power-system stakeholders. For example, NIST has developed measurements and a special calibration service for power monitoring instruments so that utilities can know the operational state of the power grid in real time to minimize disruptions and outages. With such an integrated monitoring system major blackouts that have ravaged regions of the Nation in the past can be mitigated. NIST participates in key international standards organizations, and NIST's measurement and testing expertise is recognized worldwide.

NIST also is a recognized expert in advanced networking technology and in the cyber security countermeasures needed to prevent or detect and mitigate intrusions and network disruptions. NIST also has collaborated with businesses and standards organizations on guidelines and standards to protect industrial supervisory control and data acquisition (SCADA) systems and to secure their interfaces to the power grid. NIST know-how extends to standards and measurements for building control systems and their links to the grid.

These strengths are allowing NIST to make a unique contribution to public and private sector efforts to build the Smart Grid.

NIST Plan to Expedite Standards for the Smart Grid

The need to get this critical standards development work done now is clear. A recent Congressional Research Service report,[2] for example, cited the ongoing deployment of smart meters as an area in need of widely accepted standards. Ultimately, the U.S. investment in smart meters is predicted to total $40–$50 billion.

[1] "The American Reinvestment and Recovery Plan—By the numbers," *http://www.whitehouse.gov/assets/documents/recovery_plan_metrics_report_508.pdf*

[2] S.M. Kaplan, *Electric Power Transmission: Background and Policy Issues.* Congressional Research Service, April 14, 2009.

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Globally, 100 million new smart meters are predicted to be installed over the next five years.[3]

DOE's Smart Grid Investment Grant Program will provide $3.4 billion for cost-shared grants to support manufacturing, purchasing and installation of existing smart grid technologies that can be deployed on a commercial scale.

Sound inter-operability standards are needed to insure that these technology investments are not stranded. Such standards enable diverse systems and their components to work together and to securely exchange meaningful, actionable information.

NIST took aggressive action in March of this year to accelerate the identification of needed standards. The agency established a Smart Grid National Coordinator position—my role—to provide visible leadership at the national level and focus accountability for managing NIST smart grid resources to ensure success.

In April, NIST launched a three-phase plan to expedite development and promote widespread adoption of Smart Grid inter-operability standards. This plan was developed after consulting with dozens of stakeholders in industry, the standards community, and Federal and State government. It satisfies the need to rapidly establish an initial set of standards, while providing a robust, well governed process for the evolution of smart grid standards.

Here's a rundown of the three phases, parts of which run in parallel:

Phase I—Engage stakeholders in a participatory public process to identify applicable standards, gaps in currently available standards and priorities for new standardization activities.

The work required in this phase is a very large task being done over a short period of time. Work on Phase I began in April and will conclude in September with the publication of Release 1.0 of the NIST Inter-operability Framework. To expedite progress, NIST augmented its own technical resources through a contract with the Electric Power Research Institute (EPRI). EPRI assisted NIST in engaging Smart Grid stakeholders in assessing existing standards and identifying new standards needs.

EPRI technical experts compiled and distilled stakeholder inputs, including technical contributions made at two EPRI-facilitated, two-day, public workshops—one in April and the other in May. The two workshops drew more than a thousand participants. The results are documented in EPRI's "Report to NIST on the Smart Grid Inter-operability Standards Roadmap," which NIST released for public comment on June 18. NIST is using this report, along with comments received, as an input in developing the NIST framework for Smart Grid inter-operability standards, as called for in EISA. Other inputs include the accomplishments of five Domain Expert Working Groups established by NIST in 2008, and the Cyber Security Coordination Task Group established in 2009. Cyber security is a top priority. The Cyber Security Coordination Task Group was established to help ensure that NIST is addressing the cyber security requirements of the Smart Grid as part of the NIST Smart Grid Inter-operability Framework. The group includes over 150 experts from industry, academia and government agencies.

Early next month, NIST will convene another public workshop to get down to the nuts and bolts of developing plans and setting timelines for development of the new or revised standards identified through this process. Representatives of standards developing organizations—SDOs and user groups—will lead sessions at this workshop.

Developing standards for an advanced metering infrastructure is an example of one priority area. Research suggests that the combination of smart meters and demand response could reduce peak power demand by more than 20 percent. Such benefits will also require standards for grid-connected consumer products and building systems.

The September Release 1.0 document will describe an initial Smart Grid architecture; priorities for inter-operability standards, including cyber security; an initial set of standards to support implementation; and plans to meet remaining standards needs.

Phase II—Establish a formal private-public partnership to drive longer-term progress.

While initial standards for the Smart Grid will be identified in 2009, further standards development will be needed to address gaps, harmonize standards, and incorporate evolving technology. Industry has made it clear that a representative,

[3] ON World, "100 Million New Smart Meters within the Next Five Years." June 17, 2009; *http://www.onworld.com/html/newssmartmeter.htm*

reliable, and responsive organizational structure is needed to support and sustain this evolutionary development. By the end of 2009, NIST plans to use ARRA funds to establish, through a contract, a more permanent public-private partnership entity—a Smart Grid Inter-operability Standards Panel to serve this function.

Phase III—Develop and implement a framework for testing and certification.

Testing and certification of how standards are implemented in Smart Grid devices, systems, and processes are essential to ensure inter-operability and security under realistic operating conditions. Industry has indicated that this is a high priority. NIST, in consultation with industry, government, and other stakeholders, intends to develop an overall plan for a testing and certification framework by the end of 2009 and initiate steps toward implementation in 2010.

Now, I'd like to shift to some observations on the process and to identify several issues that could impact standards-related efforts and, ultimately, progress toward realizing the Smart Grid vision.

Pace, Perseverance, and Perspective

The task of developing standards for a national infrastructure like the Smart Grid is a large and complex undertaking. However it is eminently doable. There have been several previous national infrastructure standards projects of similar magnitude that were accomplished successfully and with which I have personal experience.

Thirty years ago, Bell Laboratories successfully put in place architecture for the complete automation of maintenance and operations in the nationwide telecommunications network, with an underlying foundation of protocols and standards that utilized distributed computing and data networking technology of that era. That job was comparable in scale to the current challenge of the Smart Grid; however the coordination challenge was a bit easier because the national network at that time was owned and operated by a single entity with a captive manufacturer rather than 3100 utilities and many more suppliers.

A more recent effort that required industry-wide cooperation was the development of standards for so-called "next generation networks" that are transforming legacy voice networks into packet networks integrating voice, video and data. These networks are being successfully deployed, embodying hundreds of standards developed over a five-year period.

However, the situation we face with the Smart Grid is that the deployment of some elements is out pacing the availability of firm standards. Clearly, the need for identification and development of Smart Grid inter-operability standards is urgent. This means that the diverse community of Smart Grid stakeholders must commit to picking up the pace of standards development and to engaging in productive collaboration.

Fortunately, executives in government and industry agree with the Administration that the challenge, while daunting, must be addressed as quickly and as thoroughly as possible to ensure success. Energy Secretary Steven Chu and Commerce Secretary Gary Locke hosted a meeting at the White House of 70 industry leaders from the IT, utility, manufacturing, and other sectors. The secretaries encouraged the executives to devote the organizational energy, will, and resources necessary to expedite the development and adoption of standards. The response was overwhelmingly positive.

Yet, by its very nature, the process of developing voluntary standards from scratch can be painstakingly slow. Years—not weeks or months—are the customary measurement units. In fact, when NIST announced its three-phase plan to expedite the process, a newsletter called it an "unnaturally paced standards effort."

So, if the standards process were a track competition, it would be part sprint, part mid-distance race, and part marathon.

In the sprint portion, we are identifying already-existing standards that can be applied to Smart Grid needs. In May, after analyzing input received at our first workshop, NIST identified 16 standards for inclusion in the initial Smart Grid inter-operability standards framework. This list of standards—all of which require further development—was submitted for public review and comment.

There are additional examples of this "low hanging fruit." In fact, the EPRI report identified more than 80 existing standards that could be applied or adapted to Smart Grid inter-operability or cyber security needs.

EPRI's report to NIST also flags 70 gaps and issues, and NIST continues to identify others. We are in the process of distilling, categorizing, and prioritizing these gaps and issues. For those at the top of the list, we are developing "priority action plans," in consultation with standards organizations and other stakeholders.

Our goal is to achieve agreement on individual and collaborative responsibilities of the standards development organizations—the SDOs—to address and resolve standards issues and gaps. And, we are asking the SDOs to achieve "personal bests" in terms of the time required to go from start to finish.

This is the mid-distance portion of the effort, and we will be setting ambitious timetables for developing sound standards, along with associated conformance requirements. Clearly, there is a need for speed, but the standards process must be systematic, not *ad hoc*.

That, in effect, will complete the first leg of the marathon. Ultimately, a robust, secure Smart Grid that fosters sustainability and promotes innovation will be built on an infrastructure consisting of hundreds of inter-operability standards. Persistence and perseverance in the domestic and international standards arenas will be required over a span of, perhaps, a decade or more. The standards panel, which will be established in the second phase of the plan, will help to maintain the consistency of effort that will be critical to success.

Standards are necessary but not sufficient—a testing and certification regime is essential. Developing a framework for testing and certification constitutes the third phase of the NIST plan.

Examples of Issues

I would like to give you a few examples of the issues we are uncovering and how we are going about addressing them in collaboration with industry and the SDOs.

Smart Meters are one of the earliest elements of the Smart Grid to be deployed and they play an important role by allowing near real-time collection of data on power usage that enables new forms of demand response programs and pricing. One of the "low hanging fruit" standards identified by NIST is the ANSI C12.19 standard, which specifies the data tables captured by these meters. The National Electrical Manufacturers Association (NEMA) was the lead for this standards effort. This is one of the most fundamental standards needed for the Smart Grid. Through our workshop process, it was determined that this standard is so "feature rich" and allows so much room for interpretation that different meter vendors have implemented it in different ways. This is a serious impediment to inter-operability. We now know the standard will have to be revised, and it will take some time to gain industry consensus on the revision.

As soon as we learned this, we called upon NEMA to convene a standards effort with the leading meter manufacturers to develop a plan to upgrade the related standards and develop an upgradeability standard for smart meters to ensure that firmware in meters to be deployed in near future can be upgraded to accommodate needed changes to the ANSI C12 standard. This effort will ensure that deployment of smart meters conforming to this specification can proceed without risk of becoming stranded investments that are prematurely obsolete.

I would like to commend NEMA and the involved industry participants for recognizing the issue and for rising to this challenge.

We are also urgently focusing efforts on the plethora of communications technologies being employed by the smart meter manufacturers, both wired and wireless. There are proposals for new approaches, such as the Utility Telecom Council's proposal for the allocation of dedicated spectrum for utility communications. With the high demand for spectrum from many different kinds of radio systems, the concept of dedicating spectrum for one particular application must be considered carefully so as not to use the critical resource inefficiently. A standards issue is the need that multiple standards be supported to meet different real-world requirements and is in keeping with Congress's requirement that the NIST Inter-operability Framework be technology neutral to encourage innovation. However, the Federal Communications Commission has received reports that some wireless meters operating on unlicensed frequencies have experienced interference from other unlicensed devices that share the same frequencies. The potential for interference to wireless meters will require study in order to develop recommendations and guidance on appropriate standards and technologies for wireless smart meter communications.

Moreover, regardless of the outcome of these technical studies, there is no intention to mandate for smart meter systems the use of specific spectrum (licensed or unlicensed) or the use of specific wireless technologies. Thus, all current systems, as well as all systems under development, which fully comply with FCC requirements, will be allowed.

I would like to discuss one final example to illustrate the complexity of the coordination task to develop standards for new smart grid applications. Consider the standards that are needed to support the wide-scale deployment of plug-in electric vehicles (PEVs).

Supporting PEVs on the grid is not just a matter of plugging them into an ordinary electric socket. Ideally PEVs should be charged when demand on the grid, and hence the price of electricity, is low. The charging system into which a PEV is connected needs to be integrated into the Smart Grid demand response capability. The batteries in PEVs can also be a source of energy for the grid, providing regulation service or even energy support during periods of peak demand. Thus, the interface between the PEVs and the grid needs to support two-way flow of electricity. In order to be deployed, these interfaces and charging systems need to meet relevant electric codes to ensure safety.

There are at least seven sets of standards developed or being developed by five different organizations that need to be completed or revised to provide this functionality. SAE International[4] is developing the standards for the connector on the vehicle and the associated charging system; IEEE[5] develops the standards that are needed for these charging systems to feed power back into the grid; NEMA develops the standards for smart meters that need to be able to support the two-way flow of electricity and information; and Underwriters Laboratories Inc. (UL), National Fire Protection Association (NFPA), and IEEE develop standards needed to ensure electric safety of the overall system.

An additional standard that will be needed is an information management standard to allow electricity usage for roaming vehicles to be billed appropriately.

Observations

To conclude, a few overarching observations:

First, the scale and complexity of this standards effort may be unprecedented. Consider, for example, that the 5.4 million miles of distribution and transmission cables that make up today's grid could circle the Earth at the equator more than 200 times. The grid includes some 22,000 substations and 130 million watt-hour meters. But as I observed earlier, we have faced similar challenges before, successfully, and have valuable experience to draw upon to ensure the success of this effort.

Second, I believe the approach we are taking to develop standards for the Smart Grid—a strong public-private partnership forged with active White House and Cabinet-level leadership—illustrates the effectiveness of the U.S. approach. The American way abhors "one size fits all" solutions and prizes innovation and flexibility. In the Smart Grid we are capitalizing on our strength—a dynamic and flexible decentralized system—as well as our innovation in solving problems. Our spirit of public/private partnership motivates cooperation to find the right balance of "top down" and "bottom up" to achieve the coordination needed for the smart grid. The rest of the world is following our effort closely.

Third, it is important that we base our standards, wherever possible, on international standards or work to get our approaches adopted as international standards. This will maximize the opportunities for U.S. suppliers to address a large, global market opportunity. Fortunately, we are well-connected to International Electrotechnical Commission (IEC), IEEE and other international organizations and are pursuing those connections vigorously in our effort.

Fourth, one of our challenges is our regulatory complexity. Jurisdiction over the grid is divided among 50 states, the District of Columbia, and the Federal Government. Regulatory uncertainty can impede investment and create an inertia that slows innovation and the adoption of new technology. NIST is working closely with National Association of Regulatory Utility Commission (NARUC) and the FERC/NARUC Smart Grid Collaborative to engage the states as integral partners in the standards effort.

However, the regulatory model for the Smart Grid will need to keep pace with the reality that the information and communications technologies that enable the Smart Grid have a much faster life cycle than traditional power system technologies.

Fifth, it is essential that we base the Smart Grid on open standards. This is essential to unleash the power of innovation and competition to create new applications and businesses that grow the benefits that the Smart Grid can offer to the economy and the environment.

Finally, and most important, we need to continue to stress the critical dimension of security in our work. This is an area in which we need to take the time to do it right because security must be built into the foundation of the Smart Grid. It can-

[4] SAE—formerly known as the Society of Automotive Engineers is now referred to by the acronym SAE only.

[5] IEEE—formerly known as the Institute of Electrical and Electronics Engineers, Inc., is now referred to by the acronym IEEE.

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not be added on later. We are treating this aspect with the utmost priority and I would refer to my NIST colleague, Cita Furlani's July 21, 2009 testimony before the House Committee on Homeland Security's Subcommittee on Emerging Threats, Cyber Security, and Science and Technology, which describes NIST's approach to ensuring the security and reliability of the information and communication aspects of the Smart Grid.

Conclusion

The Smart Grid, with the unique investment opportunity afforded by the *American Recovery and Reinvestment Act*, represents a once in a lifetime opportunity to renew and modernize one of the Nation's most important infrastructures. NIST is proud to have been given such an important role and is committed to achieving the Administration's vision of a cleaner, greener, more efficient and effective electricity grid that creates jobs and reduces our dependence on others for our energy needs..

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

BIOGRAPHY FOR GEORGE W. ARNOLD

George Arnold was appointed National Coordinator for Smart Grid Inter-operability at the National Institute of Standards and Technology (NIST) in April 2009. He is responsible for leading the development of standards underpinning the Nation's Smart Grid. Dr. Arnold joined NIST in September 2006 as Deputy Director, Technology Services, after a 33-year career in the telecommunications and information technology industry.

Dr. Arnold served as Chairman of the Board of the American National Standards Institute (ANSI), a private, non-profit organization that coordinates the U.S. voluntary standardization and conformity assessment system, from 2003 to 2005. He served as President of the IEEE Standards Association in 2007–2008 and is currently Vice President—Policy for the International Organization for Standardization (ISO) where he is responsible for guiding ISO's strategic plan.

Dr. Arnold previously served as a Vice President at Lucent Technologies Bell Laboratories where he directed the company's global standards efforts. His organization played a leading role in the development of international standards for Intelligent Networks and IP-based Next Generation Networks. In previous assignments at AT&T Bell Laboratories he had responsibilities in network planning, systems engineering, and application of information technology to automate operations and maintenance of the nationwide telecommunications network.

Dr. Arnold received a Doctor of Engineering Science degree in Electrical Engineering and Computer Science from Columbia University in 1978. He is a Senior Member of the IEEE.

Chairman BAIRD. Leave it to NIST to hit it within one second of the time. I am sure you are proud of that, and we are appreciative. Well done, Dr. Arnold.

Mr. De Martini.

STATEMENT OF MR. PAUL DE MARTINI, VICE PRESIDENT OF ADVANCED TECHNOLOGY, SOUTHERN CALIFORNIA EDISON

Mr. DE MARTINI. Thank you, Mr. Chairman and distinguished Members of the Subcommittee, for the opportunity to be here today.

Southern California Edison is one of the Nation's largest utilities, serving a population of nearly 14 million people in a 50,000-square-mile service territory. As a subsidiary of Edison International, Southern California Edison is uniquely qualified to share our experience, progress and vision in the development of a smarter electricity grid.

Edison purchases more renewable energy than any utility in the country including 65 percent of the Nation's solar power. We pioneered demand response programs and helped our customers conserve more energy than any other utility. We are a leader in the implementation of advanced transmission and distribution technologies, including one of the largest smart meter programs in the country, and 20 years ago we launched an electric transportation program that includes our electric vehicle technology center opened in 1993, allowing us to be a critical player in the development not only of the electric vehicle but also of improved battery storage technologies.

As Members of this committee are well aware, the current stakes for addressing climate change, energy independence and infrastructure security could not be higher and our nation's climate and energy goals simply cannot be met by our aging grid. We need a smarter, more robust electricity infrastructure if we as a country are to rely on greater amounts of intermittent renewable energy, use electricity as a fuel for vehicles, empower our customers to manage their monthly energy bills, and ensure the continued reliability and vitality of our nation's energy economy.

In California, we are on a critical path as we also have a number of ambitious climate and energy policy goals that will require many aspects of our smart grid vision to be operational by the year 2020. Southern California Edison saw the limitations associated with aging grid and began implementing components of a smarter grid over the past decade to improve our ability to anticipate and prevent outages and empower our customers to make smarter consumption decisions in the best interests of our environment and their bottom line. Three examples illustrate the breadth of these investments.

Edison pioneered synchrophasor technology that allows operators and engineers the ability to monitor the grid at critical points every one-thirtieth of a second, which significantly reduces the likelihood of widespread outages or a system collapse, such as the 2003 Northeast blackout. Edison also has one of the largest deployments of substation and distribution automation technologies in the industry including an advanced distribution circuit called Avanti cofunded by the Department of Energy. After the California energy crisis, Edison deployed smart meters to all of its largest commercial and industrial customers that consume in total about 60 percent of the energy delivered on our grid. Over the next four years, Edison is making an additional capital investment of $1.5 billion in smart grid infrastructure that has already been approved by the California Public Utilities Commission. This year, Edison's new meter program will begin rolling out to our five million small commercial and residential customers. We are also expanding our synchrophasor technology to all of Edison's bulk transmission system, which will be the largest deployment in the United States.

As we look forward, Edison believes the deployment and development of a smart grid is a journey that will evolve over the next decade or more and will require significantly more R&D and capital investment to achieve our goals. It will require new technology, open standards and more robust security. We are actively collaborating with research institutes, universities, product manufacturers, aerospace and defense and information technology firms to identify opportunities to develop game-changing energy technologies such as energy storage, high-temperature superconducting equipment as well as adapting telecommunications, cyber security and data management technologies. Edison believes that advancing the smart grid inter-operability and security through standards adoption fosters innovation and accelerates robust, secure and reliable technology developments. We have been active for the past five years in several DOE-sponsored efforts including the GridWise Architecture Council and have been increasingly active with Dr. Arnold in the National Institute of Standards and Technology efforts to identify and recommend standards for the smart grid.

As the smart grid technology is deployed, we believe consumer adoption of new pricing, energy conservation and demand response programs will be one of the largest behavioral change management initiatives undertaken in public policy. However, the time appears right for introducing change. Edison's research indicates consumers more clearly recognize that the smart use of energy will save them money and help make a positive difference for the environment.

In conclusion, Edison is making significant investments in both capital infrastructure and R&D to accelerate our country's transition to a cleaner, smarter energy future. We look forward to continuing to work with Members of this committee, Congress and the Administration to make our vision a reality in the best interests of our customers, our environment and our economy. Thank you.

[The prepared statement of Mr. De Martini follows:]

PREPARED STATEMENT OF PAUL DE MARTINI

Thank you Mr. Chairman and distinguished Members of the Subcommittee for the opportunity to share Southern California Edison's smart grid strategy and activities to enable federal and California climate and energy policies over the next decade.

My name is Paul De Martini, I am the Vice President for Advanced Technology for Southern California Edison. My responsibilities include Smart Grid and Electric Transportation strategy, policy and technology research, development and demonstration. Southern California Edison (Edison) is a subsidiary of Edison International and one of the Nation's largest electric utilities, serving a population of nearly 14 million via 4.9 million customer accounts in a 50,000-square-mile service area within Central, Coastal and Southern California. Edison is a recognized global leader in the development and implementation of a smarter electric grid. This leadership is based on solid research and development capabilities and existing and current capital deployments in advanced technology to create a smarter grid.

Edison Smart Grid Strategy

The United States has arrived at a critical juncture in its energy future. The current stakes for addressing climate change, energy independence and infrastructure security could not be higher. Federal and State policy-makers alike have recognized the need for a smarter, more robust electricity infrastructure if we as a country are to rely on greater amounts of renewable generation, use electricity as a fuel for vehicles, enable consumers to become active participants in the energy supply chain, and ensure the continued reliability and vitality of our nation's energy economy.

Edison is in the process of modernizing and expanding its electric power delivery systems. In doing so, it is critical that Edison deploy technologies that enable it to provide service in a manner consistent with present and future customer needs, while accommodating changes in market participation. Edison's vision of a smart grid is to develop and deploy a more reliable, secure, economic, efficient, safe and environmentally-friendly electric system. This smart grid will incorporate high-tech digital devices throughout the transmission, substation and distribution systems and integrate advanced intelligence to provide the information necessary to both optimize electric services and empower customers to make informed energy decisions.

Consistent with the 2007 EISA and the U.S. Department of Energy's and National Energy Technology Laboratory's Vision for the Modern Grid, Edison's smart grid will enable the increase of intermittent and renewable resources (such as wind and solar power) and spark greater use of Plug-in Electric Vehicles (PEVs) by increasing system flexibility; reduce greenhouse gas emissions; avoid the economic losses associated with catastrophic failures and wide-area blackouts; foster energy conservation, energy efficiency and demand response capabilities by providing customers with better energy use information and choices; reduce operating costs and improve reliability and safety by providing real-time information for system monitoring and system automation; improve maintenance and operations practices on the electrical grid; and facilitate the development of a "Clean Tech" economy, which is expected to include the creation of new jobs. We believe a true smart grid can help America achieve a more secure energy future and meaningful greenhouse gas reductions.

Additionally, Edison believes that many aspects of our smart grid vision will need to be operational by the year 2020 to enable California's ambitious policy goals, such as the AB 32 greenhouse gas reductions, zero net energy homes, California Solar Initiative, smart metering infrastructure, California's renewable portfolio standard, low carbon fuel standard, and wide-spread consumer adoption of plug-in electric vehicles.

To accomplish this objective, Edison's overall smart grid strategy encompasses six areas that address a broad set of requirements:

- Renewable and Distributed Energy Resources Integration
- Grid Control & Asset Optimization
- Workforce Effectiveness
- Smart Metering
- Energy-Smart Customer Solutions
- Secure Telecommunications & Computing Systems

Smart Grid Research, Development & Deployment

Edison seeks to discover, evaluate, and adopt energy and information technologies to implement our smart grid strategy. It is important to keep in context that California is the Nation's leader in many of these areas and as such, several components of a smart grid are already in development within Edison's service territory. For example, Edison has already achieved significant results in energy efficiency, demand response, and renewable energy, and is a recognized national and international leader in these three areas. Other aspects of a future smart grid are under development, but their future implementation will enable Edison to meet increased renewable energy goals, further reduce greenhouse gas emissions, and improve system reliability and safety.

Existing Smart Grid System

Edison has made significant investments over the past decade in the deployment of transmission system measurement and control technology, distribution and substation automation, and smart meters for our large commercial and industrial customers. Edison has been a leading developer of wide area measurement and control technologies for over 15 years. Edison's pioneering efforts in the area of synchronized phasor measurement systems allows operators and engineers the ability to monitor the grid at critical points every one-thirtieth of a second. This is a significant improvement in our ability to assess and respond to the dynamic operating characteristics of the grid that can help avoid widespread electric system collapse. Synchrophasors as compared to SCADA systems is analogous to MRI as compared to X-ray. Edison's synchrophasor efforts were awarded the 2007 T&D Automation Project of the Year award from *Utility Automation & Engineering T&D* magazine.

Edison has one of the largest deployments of substation and distribution automation in the industry with over half of its 900 substations equipped with automation technology, including state-of-the-art microprocessor-based systems. Edison has also equipped over a third of its 4,300 distribution circuits and most of its nearly 10,000 capacitor banks with automation equipment that operates using wireless networks. Edison's automation strategy allows for both remote control/monitoring and autonomous control of critical grid components, which helps protect the system during abnormal conditions and maintain reliability.

After the energy crisis in California, it was recognized that providing energy use and pricing information to customers would allow them to make informed decisions about energy consumption that could mitigate wholesale market constraints. As part of a State initiative, Edison deployed smart meters to all of its largest commercial and industrial customers to provide timely energy information and online energy analysis tools to help them manage their energy costs. These customers with peak demand of 200kW or greater consume about 60 percent of the energy delivered on our grid. Edison's new smart meter program is designed to extend this capability to our small commercial and residential customers.

Current Smart Grid Projects

Edison is currently poised to take our grid to the next level over the next four years with another round of investments. In 2008, the California Public Utilities Commission (CPUC) approved our deployment of our Edison SmartConnect™ meters to five million residential and small commercial customers beginning this year and proceeding through 2012. Earlier this year, the CPUC approved Edison's 2009 general rate case that included about $270 million in smart grid investments related to advanced electric grid measurement and control systems that enable, in part, the integration of large-scale and distributed renewable generation and improve the overall operation of the electric grid. Also, Edison will expand synchrophasor technology to all of Edison's bulk transmission system—the largest deployment in the United States. Combined, these projects bring Edison's planned level of smart grid capital investment to about $1.5 billion over the next four years. This investment will provide important foundational elements, but more technology investment over the coming decade will be required to meet federal and California climate, renewable and energy policy objectives and to realize additional operational efficiencies.

RD&D Overview

In the electric utility industry, Edison has a unique and comparatively large research, development and demonstration (RD&D) effort to support the achievement of our 2020 objectives. The current RD&D strategy is focused on three key themes:

1. **Integration and managing complex systems**
   - Renewable integration modeling and analysis
   - Telecommunications
   - Computing systems and data management
   - Inter-operability standards development
   - Cyber-security
2. **Game-changing energy technology**
   - Energy storage
   - Superconductivity applications
   - Electric transportation
   - Self-healing distribution automation
   - Consumer end-use technology
3. **People and processes**
   - Customer adoption of energy smart technology
   - 21st Century electric utility workforce
   - Robotics, unmanned aerial vehicles, mobile workforce automation
   - Safety equipment

A significant level of complexity will be introduced to the electric grid over the next decade. Edison is working with leading research universities such as Caltech, MIT, Stanford, University of Southern California and Carnegie Mellon to better understand "system of systems" complexity, designing computing systems models and event scenarios to understand the nature of the future electric grid. Edison is also working with aerospace-defense and information technology firms to identify opportunities to adapt telecommunications, cyber-security and data management technologies.

Several game-changing energy technologies are expected to become commercially and economically viable over the next decade, including various forms of energy storage, high-temperature superconducting equipment, various forms of electric transportation, advanced self-healing distribution automation equipment and energy smart consumer devices/appliances. Edison is working with several national research labs, EPRI and manufacturers on the development of products from prototype testing to field demonstrations through commercial introduction on Edison's system. One example is the live demonstration of second generation distribution circuit automation on a Department of Energy (DOE) co-funded project called Avanti that also includes the world's first high temperature superconducting fault current limiter. Another is the work Edison is conducting at our Electric Vehicle Technology Center (EVTC), where we work closely with auto manufacturers on electric-drive systems and battery manufacturers on emerging mobile and stationary storage applications. Edison was honored to have President Obama visit our EVTC facility earlier this year.

In the area of people and processes, Edison is looking ahead to evaluate the consumer, organizational and workforce impacts of introducing a vast range of new technologies, customer programs and related operational process changes. Edison has engaged a consortium of universities to conduct research on the "Energy Workforce of the 21st Century" and has conducted consumer research to better understand technology adoption behavior with leading design firms like IDEO.

Edison is actively pursuing stimulus funds for two smart grid demonstrations and development of electric transportation. For smart grid, Edison will seek matching funds for both utility-scale energy storage utilizing automotive grade batteries and a regional smart grid demonstration that includes the development of a secure energy network for the smart grid. Edison participated in three electric transportation proposals currently under evaluation with the DOE. One was related to the development of plug-in electric vehicles with GM, The second proposal was for plug-in hybrid utility bucket trucks with Ford and Eaton and the third expands public charging infrastructure with Ford, the California Air Resources Board and other stakeholders in Southern California.

Inter-operability Standards and Cyber-security

Edison recognizes that advancing smart grid inter-operability and security through standards adoption fosters innovation and accelerates robust, secure and reliable technology deployments. This is achieved by lowering the barriers to entry for vendors; accelerating secure and inter-operable product time to market; and ultimately lowering costs for consumers. Unfortunately, realizing the benefits of standardization requires more than just selection of a standard. Full realization of the benefits will require a shared government, utility and product supplier focus on a common set of smart grid functions, and a standards life cycle framework supporting those functions. The goal of this standards life cycle framework is to align policy, standards development, product development and procurement actions to create a self-sustaining smart grid market. A successfully operating, self-sustaining smart grid product market is defined by public policy supported by standards that are rapidly adopted by product suppliers seeking certification, and driven by utility procurement agents only buying products certified to those standards.

To realize this goal, Edison has been active over the past five years in several DOE sponsored efforts, including the GridWise Architecture Council to define use cases, user requirements, and reference designs. Over the past year, we have been increasingly active with the National Institute of Science and Technology's efforts to identify and recommend standards for the smart grid. Edison's long standing participation with several industry and standards organizations provided an opportunity to work more closely with both DOE and NIST on the development of standards in several areas, including customer access to energy information and a set of smart grid cyber-security specifications and profiles. For example, Edison is one of a dozen utilities that contributed funding to the smart meter security effort with DOE last year and is currently co-funding a broader smart grid effort in collaboration with DOE and NIST. Also, Edison along with several other utilities has been championing the development of an open standard and secure interface for customer access through a web services provider to customer related energy information on utility computing systems. NIST is leading an effort to coordinate the development of such a standard and Edison is actively supporting the effort.

Integration of new technologies with existing technology

Edison defines "inter-operability" as a characteristic that permits seamless communication and exchange of information between diverse, disparate systems. The national and utility grids will need inter-operability of key future smart grid technology components to support a robust, flexible, and secure energy infrastructure. Edison's vision for a smart grid has long been premised on the idea of "inter-operability from the generator to the customer, and everywhere in between." This is important for stimulating vendor competition, fostering innovation, and realizing lower costs. Edison also supports criteria that, where appropriate, call for future smart grid deployments and enhancements to be inter-operable with existing capital investments. The challenge is developing a systems architecture and roadmap that provides a graceful transition from the existing systems to the future state. For example, Edison has invested heavily in substation and distribution automation, and believes it is prudent to leverage this existing infrastructure for future smart grid enhancements as much as possible. Computing systems and telecommunications have evolved over the past twenty-five years to the mostly plug and play state that we know today—Edison expects the smart grid to similarly evolve over the next two decades given the typically long asset lives and the need to balance large capital costs with consumer rate impacts.

Smart grid benefits & Consumer adoption

Smart grid benefits can be generalized into three categories; utility operational benefits, customer energy savings benefits and societal benefits. In terms of utility operational benefits, many of the smart grid technologies involve automation of existing business practices that create substantial reductions in labor. For example, Edison's residential smart metering program created benefits that exceeded costs by about 110 percent on a net present value basis, with nearly 60 percent of the benefits derived from reduction in labor and related costs due to the elimination of the meter reading function. Other operational savings result from operational efficiencies in financial transaction management and field operations. The other 50 percent of the smart metering benefits come from energy procurement cost savings as a result of enabled demand response programs and reduction in residential energy consumption due to energy information.

Consumers will have a new range of energy management services and programs available from utilities and third parties that are enabled by smart metering, energy storage, energy smart appliances and plug-in electric vehicles. In a survey of research studies by Oxford University, and subsequently validated in limited field trials in the industry, consumers are expected to save on average between 5–15 percent on their monthly electric bills if they actively participate in dynamic pricing and energy conservation related programs. Consumer benefits also include improved customer experience from automated services like turning the electric service on when moving in to a house or apartment. Over 20 percent of Edison's 4.9 million customers move each year so this is a significant improvement. Customers will also experience improved service reliability and faster outage response as the smart grid is deployed.

A substantial portion of smart grid benefits are societal in nature and include national and State priorities, such as achieving energy independence, reducing greenhouse gas emissions, and increasing grid security, safety, and reliability. These benefits are often difficult to quantify, they may vary widely in their justification of various smart grid technologies, and they are multi-tiered in terms of who benefits from them. Benefits may relate to Edison customers, California residents in general, or society at large. These benefits should be considered by policy-makers within the context of a complete portfolio of smart grid technologies, as the benefits may not accrue to any one project, but the integrated system which would necessarily be deployed over an extended time horizon.

Consumer adoption of new pricing, energy conservation and demand response programs will be one of the largest behavioral change management initiatives undertaken in public policy. However, based on Edison's research, we believe our customers are ready to change how much and when they use electricity. Edison has conducted persona based customer research over the past five years and the majority of our customers now are actively looking for a way to either reduce their energy costs to manage their monthly budget or reduce their energy use to reduce their carbon footprint. Consumers do not want to be wasteful and recognize that the smart use of energy will save them money and help make a positive difference for the environment.

One key is to provide customers information that is actionable. This is one of the values of a smart meter system especially combined with dynamic pricing. Another key is make the process simple and use technology to automate the customer's desired outcome. For example, to enable a customer who wants to manage to a monthly budget amount for electricity, Edison is creating a daily electric budget manager that notifies the customer if their usage will likely exceed the target budget in advance through online, text messages or cell phone application. Edison is also working with many product and service providers to create this type of automation. Edison recognizes that we have a once in a lifetime opportunity to engage and educate our small commercial and residential customers when we replace all our approximately five million meters over the next three plus years.

Conclusion

The electricity infrastructure delivering power from a variety of generating sources to our homes, businesses and communities is not suitable for today's needs. The challenges that face our nation's energy future simply cannot be met by our aging electric grid. Growing renewable energy capacity requirements, global climate change provisions, and the pressing need for more energy self-determination on behalf of customers all require a smarter, more intelligent grid. Edison is making significant investments in both capital infrastructure and smart grid R&D to accelerate our ability to support the future.

BIOGRAPHY FOR PAUL DE MARTINI

Paul De Martini is Vice President of Advanced Technology in the Transmission & Distribution Business Unit of Southern California Edison (SCE). Advanced Technology is SCE's R&D organization responsible for SmartGrid development, which includes advanced grid technologies, electric transportation, smart metering and integration of energy smart consumer products.

Prior to joining SCE in 2002, De Martini held senior management positions with ICF Consulting, Sempra Energy, Coastal Corporation and PG&E Corporation.

De Martini is a member of the California Energy Commission's Public Interest Energy Research (PIER) Advisory Board, Electric Power Research Institute's Power Delivery and Utilization Sector Council and Smart Grid Advisory Committee, Co-Chair of both the Utility Smart Grid Executives working group and the Western Electric Industry R&D Collaborative.

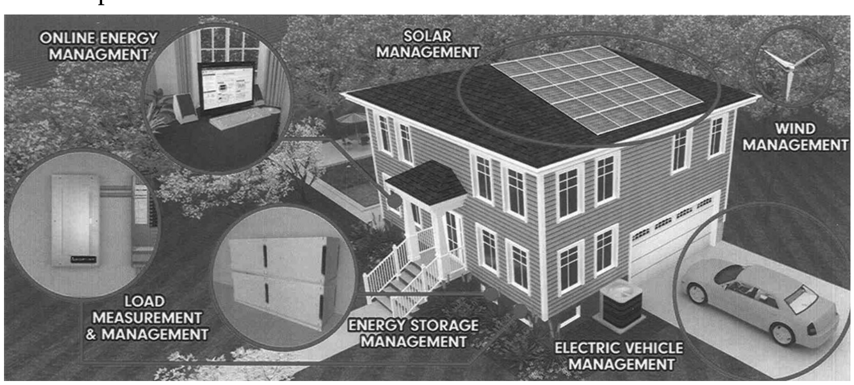
De Martini earned a MBA from the University of Southern California and a BS from the University of San Francisco. He also completed the technology management program at the California Institute of Technology. De Martini is currently a Fellow of the Wharton School, University of Pennsylvania.

Chairman BAIRD. Thank you, Mr. De Martini.

Mr. Ross.

STATEMENT OF MR. JEFFREY L. ROSS, EXECUTIVE VICE PRESIDENT, GRIDPOINT, INC.

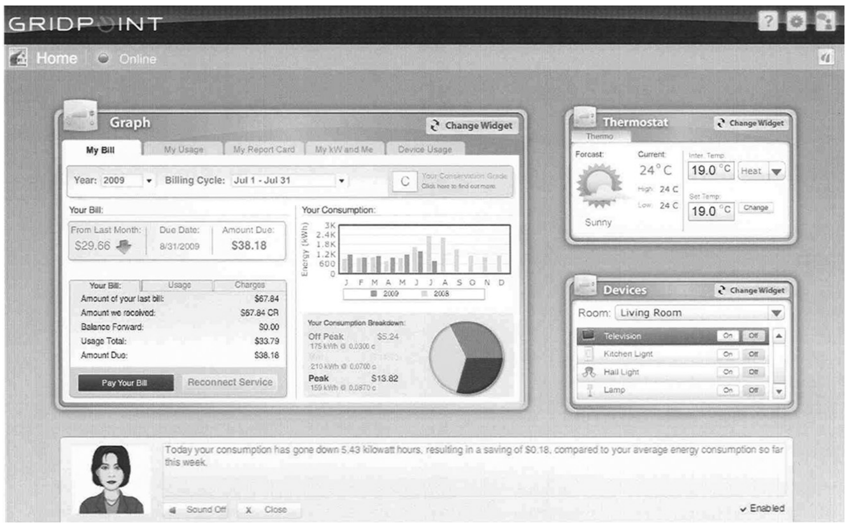
Mr. ROSS. Good morning, Mr. Chairman, Ranking Member Inglis and distinguished Members of the Subcommittee. Thank you for the opportunity to testify today. I am Executive Vice President at GridPoint, a leading smart grid software company. We have developed an online energy management solution that enables customers to obtain near-real-time information on their energy use and empowers them to make informed decisions about their energy consumption.



Our solutions also help utilities better balance supply and demand across a wide range of areas including electric vehicle charging, storage, integration of renewable energy and demand response in an economical, efficient and environmentally beneficial manner.

I have three points I would like to leave with you today. First, while the infrastructure of smart meters and advanced communications is important in modernizing the Nation's grid, to realize the benefits of increased efficiency, reliability, security, we also need software that allows utilities to better control and optimize load.

Second, we need to realign the regulatory and economic policies and incentives guiding investor-owned utilities such that those utilities are motivated to invest in smart grid technologies. Third, we must provide consumers with greater information on their energy use if we expect them to be able to reduce their consumption and their energy costs.



The term "smart grid" refers to energy delivery and distribution using two-way communications and digital technology to enhance the grid with sensing, communications, analysis, feedback and control technologies in order to improve efficiency, increase reliability, ensure security and reduce environmental impacts. The *Energy Independence and Security Act of 2007* and the *American Recovery and Reinvestment Act* provide for regional demonstration projects to develop advanced techniques for measuring peak load reductions and energy efficiency savings from smart metering, demand response, distributed generation and storage systems and to validate new business models and best practices for implementing advanced smart grid technologies that can be replicated throughout the country. These goals encourage the testing of new technologies. While the smart grid will benefit from investments in smart meters and advanced communications, these investments alone will not realize the true promise of the smart grid. Smart meters and advanced communications cannot by themselves manage peak demand, integrate renewable energy, manage electric vehicle charging and storage, or provide customers with information they can use to manage their energy consumption, all of which can help the electric grid operate more efficiently and reliably. The electric grid needs software and applications to work in conjunction with meters and communications to realize these benefits.

Xcel Energy's Smart Grid City is the U.S.'s first full-scale pilot project designed to test smart grid technologies and the new business models they enable. Since 2008, Xcel Energy and its partners have developed a website portal for customers to better manage their energy use, launched the Nation's first test of plug-in hybrid electric cars with vehicle-to-grid capability, turned the Chancellor's residence at University of Colorado into the Nation's first fully integrated "smart house" with solar, backup power, electric vehicle charging and consumer controls, installed nearly 15,000 smart meters and implemented a wind-to-battery program to create a more predictable, reliable source of energy. The city of Austin, Texas, also announced late last year a new smart grid deployment called the "Pecan Street Project" that would create a virtual 300-megawatt clean power plant through a combination of efficiency and clean power. These types of efforts would likely increase as funding under the Recovery Act is awarded.

There is real value in these types of demonstration projects because they provide a test bed for new and innovative smart grid technologies. Only through testing new technologies can we determine what works in order to spur innovation. Studies have shown that when consumers have more information about their energy use, they typically reduce their consumption by 10 to 20 percent. Near-real-time information on energy use through a portal or an in-home display will empower consumers to control their energy consumption. The portal, or in-home display, provides customers with energy savings tips and a comparison of their use against earlier periods, among other benefits, which will help them lower their energy consumption.

In conclusion, we have an historic opportunity to transform and modernize our nation's electric grid. To do so, we need to look beyond smart meters and communications and invest in the applications that reside on top of this infrastructure to make the smart grid more efficient, reliable and secure. We must create the regulatory and economic structures that incentivize utilities to make smart grid investments and we need to provide consumers with information about their own energy use to empower them to control their energy consumption.

Thank you for this opportunity to testify here today. I am happy to answer any questions you may have.

[The prepared statement of Mr. Ross follows:]

PREPARED STATEMENT OF JEFFREY L. ROSS

Good morning Chairman Baird, Ranking Member Inglis, Full Committee Chairman Gordon, Ranking Member Hall, and distinguished Members of this subcommittee. Thank you for the opportunity to testify at today's hearing. My name is Jeffrey L. Ross, and I am an Executive Vice President at GridPoint, a leading smart grid company that has developed an online energy management solution for consumers, as well as products and services that help utilities manage energy in the areas of electric vehicle charging, storage, integration of renewable energy, and demand response. We are a private company headquartered in Arlington, VA with approximately 130 employees. I would like to request that my full statement be entered into the record.

I appreciate the leadership you, the Full Committee, and this Congress have demonstrated in supporting the *Energy and Independence Security Act of 2007* (EISA) and the *American Reinvestment and Recovery Act of 2009* (ARRA), the provisions of which have the potential to reshape positively the energy ecosystem in our country.

I am here to provide GridPoint's perspectives on the role of the Federal Government and industry in transforming the Nation's electric grid from an over-burdened, outdated system into an interconnected, intelligent "smart grid."

I have three points I would like to leave you with today:

1. First, while the infrastructure of smart meters and advanced communications is important in transforming the Nation's grid, we also need other new

innovative technologies to realize the benefits of increased efficiency, reliability, and security.

2. Second, we need to realign the regulatory and economic policies and incentives pertaining to investor-owned utilities (IOUs), such that utilities are motivated to invest in smart grid technologies.
3. We must provide consumers with greater information on their energy use if we expect them to better manage their energy consumption.

An Historic Opportunity

The term "smart grid" refers to the means by which energy is delivered from generators to consumers using two-way communications and digital technology to improve efficiency, increase reliability, and add transparency. This generally involves enhancing the grid with sensing, communications, analysis, feedback, and control technologies to realize operational efficiencies and improve environmental impacts. Much of the attention around "smart grid" has focused on the distribution side of the electricity system, which is where GridPoint offers its solutions. While this area benefits from improvements in "smart" meters (often referred to as Advanced Metering Infrastructure (AMI)) and advanced communications systems, there needs to be a wider range of technologies adopted to realize the full benefits of the smart grid. These technologies will provide utilities and consumers with the ability to understand and better manage energy consumption. They also will help improve energy efficiency and/or reduce demand, and thereby help reduce greenhouse gas emissions.

EISA and the ARRA set forth the following goals and benefits for smart grid: create a modern electric grid, enhance security and reliability of energy infrastructure, and facilitate recovery from disruptions to the energy supply. The ARRA and EISA envision that there will be a variety of regional demonstration projects to develop advanced techniques for measuring peak load reductions and energy-efficiency savings from smart metering, demand response, distributed generation, and electricity storage systems; quantify costs and benefits; verify technology viability; and validate new business models and best practices for implementing advanced smart grid technologies that can be replicated throughout the country. These goals encourage the testing of new technologies, in addition to improvements in smart metering and advanced communications infrastructure.

The ARRA provides $4.5 billion in funding for the smart grid investment program. More than $2 billion of this funding will likely be spent on smart meters and advanced communications systems. While this new metering and communications infrastructure is important, it is critical to include applications that run on this infrastructure as new smart grid projects roll out. Without the applications to improve efficiency, reliability, security, and provide consumers and utilities with additional information, the true promise of the smart grid will not be realized.

The Promise of the Smart Grid

Our system for generating, transmitting, and producing electricity was developed more than a century ago when all we required of electricity was that it be cheap, ubiquitous, and reliable. Over the last century, we have constructed a complex network of power plants that are connected regionally via transmission lines to population centers, with electricity distributed to homes and businesses over power lines. Today, this system is experiencing issues with reliability, efficiency, and security. We are increasingly asking more from the electric grid—not just greater demand, but also that delivery of our energy be efficient and green. Without significant technological upgrades, our electric grid cannot meet these 21st century challenges.

If we take advantage of the historic opportunity presented to us today, with the policies set in place in EISA, to upgrade our grid and make it "smarter," the benefits are limitless. Imagine if you could access real-time information about how much energy you were consuming, and which appliances and devices in your home consumed the most energy. What if, armed with that information, you could make small changes in your behavior that would save significant amounts of energy and lower your monthly utility bill?

What if solar panels on peoples' roofs and electric vehicles in garages were networked together such that their capacity could be used to relieve areas of stress and high demand in the grid? What if your utility and your electric vehicle were smart enough to delay your charging until nighttime, when electric rates are less expensive, demand on the grid lower, and more renewable energy is available?

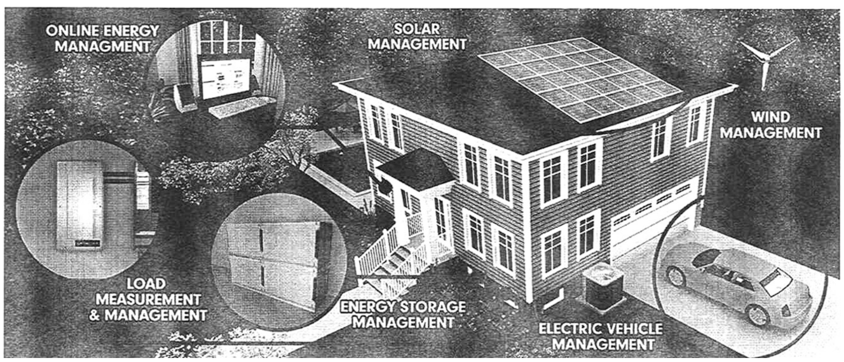
What if a utility could sense an overheating transformer, and divert its load by shifting it to other resources in the system? Imagine if a utility could make wind reliable and predictable by storing electricity in the form of a battery to back up the intermittent renewable power so, together, these became a continuous, reliable source of energy? That is, the wind could be used to charge a large battery. When the wind blew at night the battery would charge, and when the wind died down, the battery would discharge to keep a constant amount of power available.

Smart grid technologies exist today to enable all of these benefits. Just imagine if utilities and consumers were to implement them. How many power plants could we avoid building? How much money would we save? How much carbon dioxide would we prevent from entering the atmosphere?

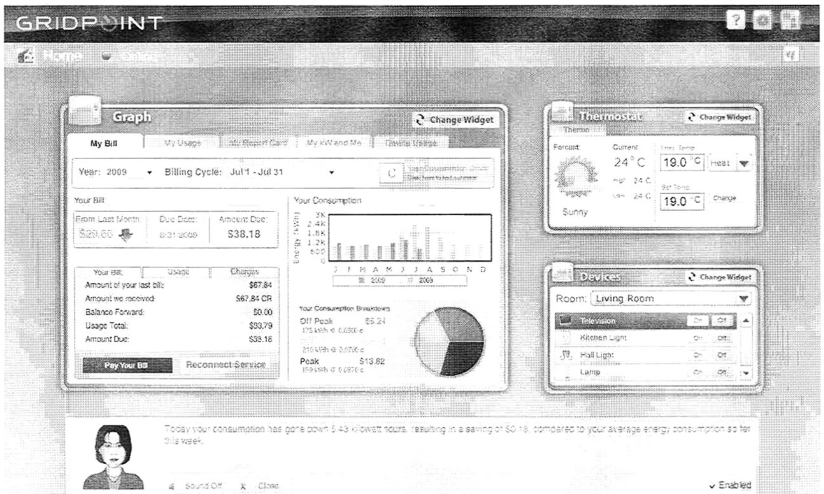
The technologies that can make the "smart grid" a reality offer consumers greater insight and control over their energy usage and improved environmental benefits, while utilities gain greater efficiency in their operations, improved reliability, and increased security.

GridPoint's Technology and the Benefits of a Modern Grid

GridPoint has developed a software platform (i.e., management system) that enables utilities to have visibility into, and manage, their distributed energy assets. The platform seamlessly integrates five solutions: online energy management, load management, electric vehicle management, storage, and integration of renewable energy. With GridPoint's platform, utilities efficiently balance supply and demand in an economical, scalable and environmentally beneficial manner.

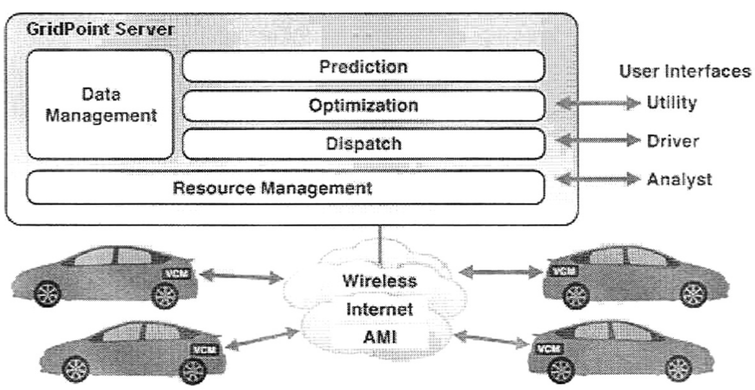


In online energy management, the GridPoint solution offers utilities a portal to provide their customers far greater awareness of their energy consumption. It also provides consumers with insight into their energy usage with features such as carbon calculators, comparisons to their bill from a previous month or year, and energy savings tips based on their consumption patterns. Consumers benefit by having control over, and being able to reduce, their energy usage. Studies have shown that simply providing consumers information about their energy use can lead to reductions in consumption of between 10 to 20 percent. Providing consumers with information about their energy use is an important first step in empowering them to control their energy consumption.



The GridPoint load management solution assists utilities in managing capacity-strained areas by providing visibility and control of devices in the home or business to address peak loads. This increases reliability in the electric grid. The solution provides utilities detailed measurement and verification of achieved reductions against a projected baseline, which enables carbon measurement. It allows the utility to shift load and reduce peak demand through demand response programs with circuit-level visibility and control of large load classes by type (e.g., Air conditioners) either in aggregate or by substation, feeder or individual customer.

By market share, 70 percent of automobile manufacturers have announced plans to launch electric vehicle models, the first of which will hit the road, and the electric grid, in 2010. The GridPoint smart charging solution controls the flow of electricity to plug-in electric vehicles, allowing utilities to balance real-time grid conditions with the needs of individual drivers. During peak periods, the flow of energy can be delayed or slowed to shift the charging load into an off-peak period—minimizing grid stress and ensuring service reliability. When wind or solar power is available, the charging rate can be increased to expand the use of renewable energy in the grid. The solution enables smart charging at every charging level and from any point on the grid, whether the driver is at home, work, or a public charging station.



The GridPoint storage management solution provides aggregated, real-time control over the charging and discharging of distributed storage assets located in the utility's transmission and distribution systems. Its software algorithms allow energy storage devices to be managed in isolation or aggregated at various levels of the system and dynamically dispatched in a coordinated fashion. Charging and discharging scenarios include: load leveling, load shaping, integrating renewable energy, economic dispatch based on price signals, system regulation, and spinning reserves to respond to an unexpected power disruption. These capabilities allow utilities to manage the grid more cost effectively; increase predictability, availability and optimization of renewable energy sources; and improve the efficiency of transmission and distribution resources.

Finally, the GridPoint renewable integration solution predicts and precisely monitors the production of distributed renewable power systems, like a solar panel array, to allocate the associated energy, renewable credit, and carbon credit value streams. It also maximizes the value of grid-connected renewable power sources, both residential and utility-scale, by balancing output variability via automated dispatch of other distributed energy assets, including demand response, storage, and plug-in hybrid vehicles. Utilities benefit from the monitoring and prediction of residential and commercial grid-connected renewable systems. Consumers benefit by having insight into their personal solar production and consumption, reductions in their carbon footprint due to environmental data based on renewable production and consumption, and weather information to help predict their future solar energy production.

Challenges to Realizing a Truly "Smart" Smart Grid

With all of the tremendous benefits inherent in a "smart grid," one might ask why the technologies are not being adopted more widely by utilities. There are several reasons, but perhaps the most important is that the regulatory model for investor-owned utilities (IOUs) does not incent those utilities to make investments in smart grid technologies.

IOUs make money for their investors by receiving a guaranteed rate of return on capital to deploy generation, transmission and distribution assets and to ensure system reliability. The more energy IOUs need to produce, the more capital they can deploy to purchase these assets. This, in turn, allows them to include those assets into the rate base and receive a return on their investment. Therefore, the more power an IOUs produces, transmits, or distributes, the more money that IOU will earn.

One of the benefits of smart grid technologies is that they create efficiencies in the electric grid, thereby reducing the amount of energy needed to serve the same population. If an IOU deploys smart grid technologies, it could serve its customer base while producing less energy. This would benefit ratepayers, who would not face an increase in rates, and the environment, by reducing the need for additional power generation assets. However, this scenario—under the current regulatory structure—would leave the IOU without the need to deploy new generation, transmission or distribution assets and would reduce the IOU's ability to receive a return on investment. IOUs may actually risk losing money if they deploy smart grid technologies that serve their customers more efficiently and improve environmental impacts. Not all IOUs face this economic deterrent all of the time; however, the challenge of this economic and regulatory model is prevalent enough to dampen IOUs investment in smart grid technologies.

Xcel Energy's SmartGridCity (Boulder, CO)

SmartGridCity is the U.S.'s first and largest full-scale pilot project designed to test smart grid technologies and the new business models they enable. It is sponsored by Xcel Energy Corporation, a fully-integrated power utility, headquartered in Minnesota, with a service territory extending into eight states, including Colorado, and a total of 3.3 million electric and 1.8 million gas customers. Xcel is a leading utility in the use of wind power, with nearly 3,000 MW of capacity installed. SmartGridCity is a demonstration project designed to understand how the utility and its customers collectively manage power generation, delivery, and energy consumption.

SmartGridCity is a multi-phase project that began in the spring of 2008. The first phase, over 18 months, was designed to test capabilities and gauge customer reaction. It involves upgrades to two substations and five feeders, as well as 15,000 residential and commercial premises. The second phase will be a full deployment with a larger reach to a broader customer base, and includes an additional two substations, 20 feeders, and 35,000 premises. Grid Point is providing demand and supply side management, solar integration, plug-in hybrid electric vehicle support, online energy management and integration services to the SmartGridCity project.

Xcel Energy conceived of this project as a way to test a number of business, customer and social issues. The principal benefits centered on the following:

1. **Peak Energy Consumption:** Can real-time pricing and environmental signals, in conjunction with advanced in-home energy management systems reduce residential peak energy consumption?
2. **Grid Reliability:** Will there be a reduction in the number and duration of customer outages as a result of the technology installed in the distribution network?
3. **Capital Expenses:** Will the reduction in peak load demand result in a deferral of capital spent on distribution and transmission infrastructure?
4. **Operating Expenses:** Will there be cost savings to Xcel from the implementation of smart meters, distribution automation and home energy automation?
5. **Carbon Footprint:** Will there be a meaningful and measurable reduction in carbon emissions as a result of the lowered residential peak demand and other efficiency programs?

Xcel's vision is to make SmartGridCity a fully-connected and horizontally-integrated system that would require real-time and automated decision-making across all parts of the network. The project includes:

1. High-speed communications network (broadband over power line and wireless) and sensing equipment.
2. Smart meters with the ability to provide near real-time data on consumption.
3. Improved intelligence at the substations.
4. A feeder distribution system with communications-enabled reclosers and switches, and other assets to provide power system information.
5. Power analyzers at each transformer to provide real-time data on power consumption, outages, restorations and fault locations.
6. Integration of renewable energy generation and distributed storage, including a large scale wind-to-battery project.
7. Integration and optimization, or smart charging, of plug-in hybrid electric vehicles within the grid.
8. Customer programs and incentives that help them save energy, track energy usage, and manage demand in response to real-time price signals, all through a custom web portal interface that provides: (a) control to set energy preferences; (b) analysis of information, billing history and a means for helping customers discover how to best manage energy; and (c) information to effectively educate customers about how their energy is produced and how to lower their carbon footprint.

The SmartGridCity project is about half way through its duration. Since construction began in 2008, Xcel Energy and its partners have:

- Installed nearly 15,000 smart meters with another 10,000 more "opt-in" customers;
- Launched the SmartGridCity Control Room and Operations Center;
- Implemented over 327 network elements for grid communication and monitoring;
- Developed a web site portal for customers to better manage their energy use;
- Launched the Nation's first test of plug-in hybrid electric cars with vehicle-to-grid capability;
- Turned the Chancellor's residence at the University of Colorado into the Nation's first fully-integrated "smart house," with solar, back-up power, PHEV smart charging and consumer control; and
- Implemented Xcel Energy's wind-to-battery program to test the control and firming quality of an integrated wind and storage system.

Although we are still at an early stage in the project, Grid Point, as a participant, has learned some valuable lessons about demonstrating and deploying "smart grid" technologies as we move forward with the SmartGridCity team to create a more resilient and responsive grid. There is real value in demonstration projects such as SmartGridCity that can provide a test bed for new and innovative smart grid technologies. Consumers must be able to understand their energy consumption and usage with greater frequency and granularity than the information in their bill at the end of the month. Near real-time information on energy usage can influence positively consumers' behavior and provide them with the means to control their energy consumption.

Importance of Smart Grid Demonstration Projects and Innovation

Other cities have begun to follow Xcel's SmartGridCity project with their own demonstration projects. The city of Austin, Texas announced late last year a new smart grid deployment called the Pecan Street Project that would create a virtual 300MW clean power plant through a combination of efficiency and clean power. The City of Miami, Florida likewise has announced a high-profile project. These efforts will likely increase as funding under the ARRA is awarded. It is important that smart grid demonstration projects test a broad range of new technologies and measure and verify the costs and benefits of the technologies. Only by doing this, can the best technologies gain recognition and acceptance to improve the grid.

Conclusion

In conclusion, we face an historic opportunity today to transform our nation's electric grid. To do so, we need to leverage the funding Congress has made available. While we need the advanced infrastructure of meters and communications, we also need the applications that reside on top of the infrastructure to make the grid more efficient, reliable, and secure. We need to continue to work toward regulatory and economic structures that incent utilities to make smart grid investments. Finally, we need to provide consumers with information about their own energy use to empower them to control their energy consumption.

Thank you for this opportunity to testify here today.

BIOGRAPHY FOR JEFFREY L. ROSS

Jeffrey L. Ross is Executive Vice President at GridPoint, Inc., a leading smart grid software company. Mr. Ross works on business development, marketing, and corporate development matters for the company. Prior to GridPoint, he served as a partner at Dakota Ventures, a technology investment fund.

Earlier in his career, Mr. Ross served as General Manager & Vice President of the Identity & Enterprise Security business for Gemalto North America. In this role, he was responsible for sales, marketing, solutions development and management, strategy, partnerships and alliances, and customer delivery and technical support. He previously served as Vice President for Marketing & Solutions for Gemplus' North American Enterprise Security & Identity and Banking & Retail businesses.

Prior to joining Gemplus in 2004, Mr. Ross founded Alereon, Inc., a leading wireless semiconductor company focused on ultra wideband technology for wireless USB and next generation Bluetooth. He held the position of Executive Vice President at Alereon responsible for finance, marketing, strategy, and administration. Mr. Ross also worked as Senior Vice President for Corporate and Business Development at Time Domain Corporation from 1999 to 2003. Prior to Time Domain, Mr. Ross practiced corporate law at Patton Boggs in Washington, D.C.

Mr. Ross has considerable experience working with growth clean technology, wireless, software, and semiconductor companies. Mr. Ross is a frequent speaker on technology issues and has appeared on television and radio and in print in such venues as CNBC and the *Wall Street Journal*. Mr. Ross holds a B.A. Degree, *magna cum laude,* from Washington University in St. Louis and a law degree from the University of Virginia.

Chairman BAIRD. Thank you, Mr. Ross.

Before moving on, are you any connection to the Ross of the Ross Power Station fame in the Pacific Northwest?

Mr. ROSS. No, not that I am aware of.

Chairman BAIRD. Ross is a great name in Northwest energy, so there may be some connection there.

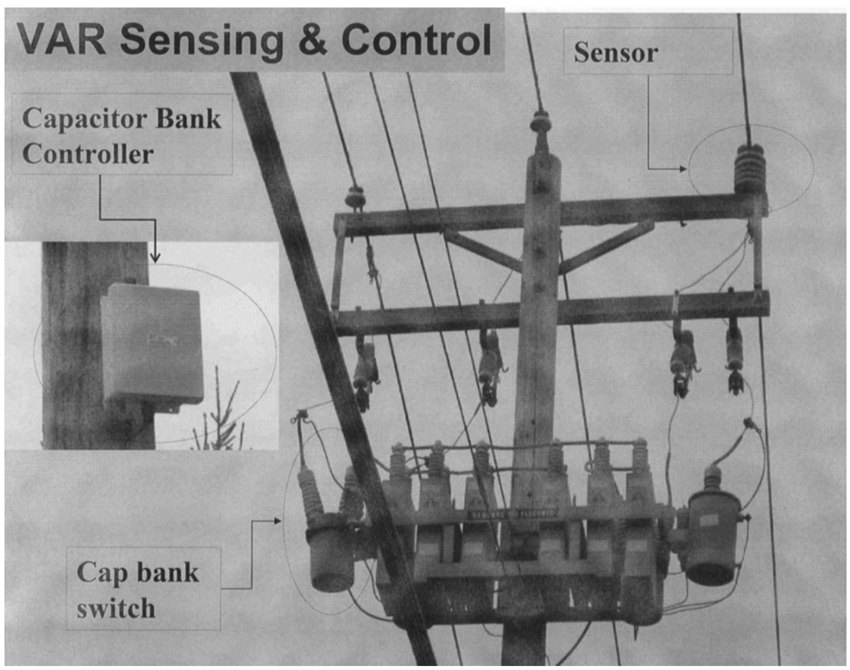
Mr. Stoessl.

STATEMENT OF MR. MICHAEL A. STOESSL, GROUP PRESIDENT, COOPER POWER SYSTEMS

Mr. STOESSL. Good morning, Mr. Chairman and Members of the Committee. On behalf of the National Electrical Manufacturers Association, I am Mike Stoessl, Group President of Cooper Power Systems. I have been asked to appear here today to help describe some of the challenges our industry faces in actually making the grid smart.

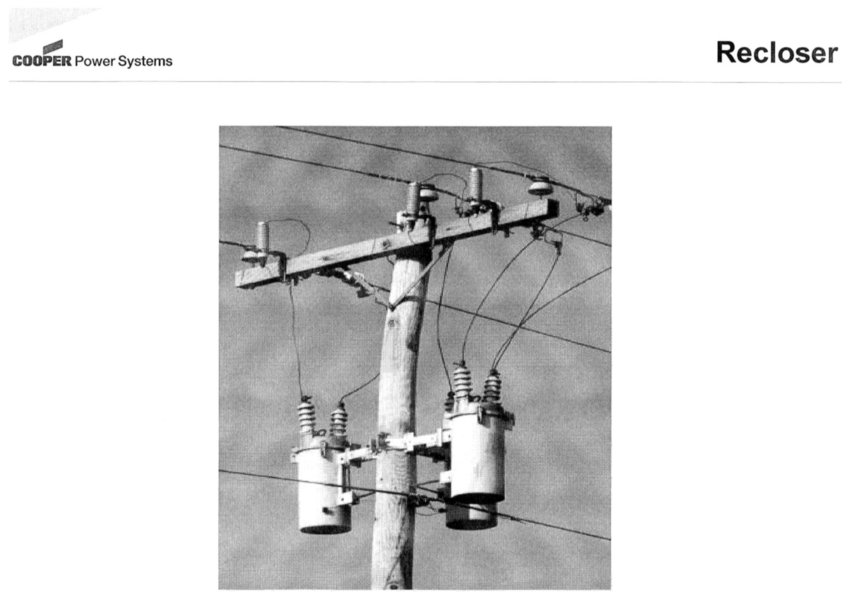
Now, Cooper Power Systems has been providing equipment and solutions to the electric utility industry literally since the days of Thomas Edison. We provide transformers and components needed to connect and restore energy, switchgear and automation technology needed to make the electrical grid reliable and efficient as well as AMI and demand response capabilities that help manage the grid's overall load. Our solutions cover the range of smart grid intelligence.

Now, all smart solutions have in common the ability to sense activity on a grid, communicate that information back to some sort of decision support application, send a decision back to the grid and actually make some change.



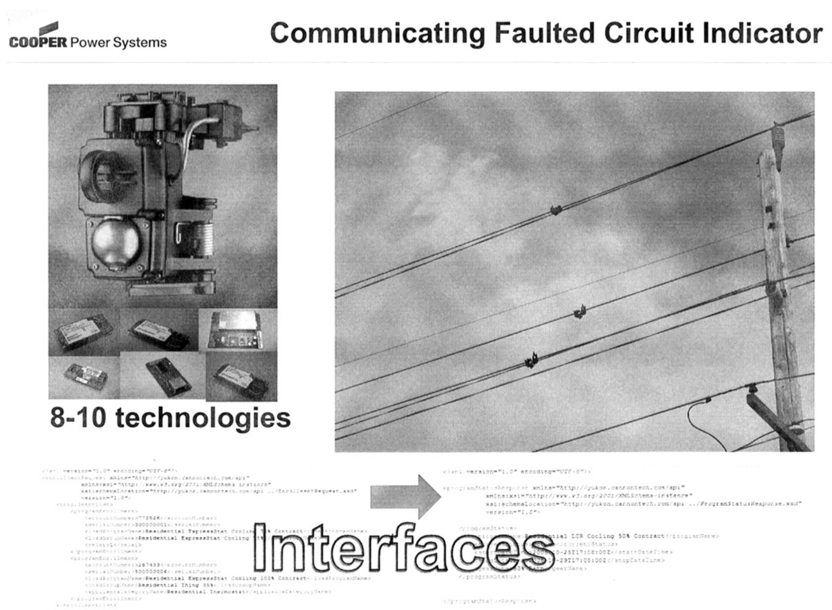
So as an example, we brought a picture here of a sensor that can help determine when the grid is becoming more or less efficient. If air conditioning comes on in the middle of the day, the grid can actually start wasting energy as it responds to that increase in load. So the sensor you see in the upper right working with the capacitor bank controller that you see in the middle on the left can determine that inefficiencies are occurring. Equipped with radio technology or some other form of communication, it will send a signal back to the utility alerting them to the situation. They in turn can then choose to take that capacitor bank, which is in the lower middle of the screen, and turn it on or off using the cap bank switch. This is just one example of a smart application and the sort of things that have to be installed in the field to make it work.

Now, one of the big challenges we face with building out the smart grid is the integration of legacy equipment that already exists. Many pieces of apparatus installed on the grid do not provide or support any external interface or have custom communication protocols. So, for example, this recloser that is pictured here provides over-current protection to our overhead lines.



If there is a fault, for instance, a branch falls and shorts out a power line, the recloser will open, isolate the circuit and basically try to restore power. Many of these devices do not support two-way communications, so while they are an effective isolated solution, they cannot be truly part of a smart grid without being replaced or being retrofitted. The key to doing these kind of upgrades will be an economic cost benefit to the utility, or it is going to be government incentives based on the value, more intangible value of a truly more reliable grid. With more than 500,000 of just these type of reclosers out in service today, retrofits of product like this will be an important part of making the grid smart.

Another challenge we face in building out the smart grid is the range of communication options that are already available. In the past three years we have seen an increase in availability of cost-effective two-way communication technology. Cellular, Wi-Fi, WIMAX, Mesh RF, line-of-sight RF are a few of these technologies. Now, these cost-effective two-way communications have become an enabler of adding intelligence to the grid but they also present a host of challenges. So as an example, the fault circuit indicator shown here in the upper left is a great example of a successful product making the transition from being a dumb, isolated solution to a smart, integrated solution.



The original form of a fault circuit indicator had no communication capabilities. It simply displays a local orange visual indication when a fault has occurred on the line. And prior to communications capabilities, the utility would literally dispatch their line crew, who would drive the lines, looking up, trying to find the orange indicator. When they found it, they knew where the fault was and they could begin repair. When you actually can communicate with the utility, the utility can now know that a fault has occurred, dispatch linemen directly to the source of the fault, which reduces fuel consumption, reduces CO_2 emissions and also potentially can reduce the time of an outage from hours into minutes. That is just one example of what the smart grid can do. However, what is pictured directly below the fault circuit indicator are the range of hardware options that we have to add into the device in order to communicate. Even though there are standards, if we want to communicate over the AT&T cell network, there is a different card required versus communicating through a Mesh RF network versus a line-of-sight network versus the Verizon cell network. Each different choice necessitates a new card. Each card then requires that we integrate it into our package so it has to fit into the device itself, validate it with a variety of standards, certify it with a communications provider and then write software, which we grabbed some screenshots and put at the bottom to actually interface it with our software as well as the software that the utilities themselves use and have deployed over past decades.

So in conclusion, Cooper Power Systems believes Congress, NIST and the DOE should continue to drive smart grid standards. We also commend the DOE in their preparation for evaluating grant applications for the $4.5 billion stimulus for smart grid investments. We believe the swift and judicious release of these funds will help stimulate the economy and support the process of converting the legacy grid into a smart grid. We would also encourage Congress to consider favorable incentives for utilities and vendors for replacement or upgrades to existing legacy equipment.

Thank you for the opportunity to appear before you this morning and I am prepared to answer any questions you may have.

[The prepared statement of Mr. Stoessl follows:]

PREPARED STATEMENT OF MICHAEL A. STOESSL

Good morning, Mr. Chairman and Members of the Committee,

On behalf of the National Electrical Manufacturers Association (NEMA), I am Michael Stoessl, Group President of Cooper Power Systems. Cooper is represented on the NEMA Board of Governors and on its Smart Grid Advisory Panel. NEMA is the leading trade association in the U.S. advancing the interests of 430 electrical manufacturers of a wide array of electrical industry products used in utility, industrial, commercial, institutional, medical imaging, and residential applications.

NEMA companies are actively engaged in the research, development, manufacturing and promotion of a wide range of smart grid technologies and products, including advanced transmission devices, end user controls, and utility distribution equipment. NEMA is an ANSI-accredited standards development organization and publishes several hundred standards, including dozens used today in electrical grid equipment. In the 2007 *Energy Independence and Security Act,* Congress directed NEMA to advise the National Institute of Standards and Technology on a smart grid inter-operability framework. NEMA along with its member companies are actively supporting NIST in identifying standards and protocols that will accelerate deployment of smart grid technologies, including the one(s) in my presentation today.

Cooper Power Systems has been providing equipment and solutions to the electric utility industry since the days of Thomas Edison. Our product range covers the transformers and components needed to connect and restore power, the switchgear and automation technology needed to make the electric grid reliable and efficient, as well as AMI and Demand Response capabilities that help manage the grid's overall load. Our solutions cover the range of "Smart Grid" intelligence. Our "Smart" offerings include Smart Metering (AMI/AMR), Demand Response, VAR Management, Voltage Regulation, Over-current Protection, Outage Detection and Substation Automation. These solutions are known as "Smart" because they are communications equipped and provide decision support both locally on the grid and in back office software solutions. What they all have in common is the ability to sense activity on the grid, communicate that information back to a decision support application, send a decision back to the grid, and then make an actual change to the grid itself. As an example, consider that electricity flow can become inefficient as central air conditioning load increases on a hot day. "VAR" sensors on the grid [picture] can detect this inefficiency, alert decision support software, which can use two-way communication to turn on capacitor bank and improve the load flow efficiency. Cooper has been developing and providing these types of solutions to the industry since the late 1980's.

One of the big challenges we face with building out the smart grid is the integration of legacy equipment in operation on our grid. Many pieces of apparatus installed on the grid do not provide or support any external interfaces, or use custom communication protocols. For example, these reclosers provide over-current protection to overhead lines on the distribution grid. In the event of a fault (say a tree branch momentarily short circuits a line) it will open the circuit to try to isolate the problem. Many of these devices do not support two-way communications, so while they are effective as an isolated solution, they can not be part of a truly "Smart" grid without being replaced, or being retrofitted to integrate with the grid. The key to these upgrades will be an economic cost benefit to the utility through operational savings, a variety of government incentive programs, or a combination of both. With more than 500,000 of these types of devices in service today, this is an important undertaking.

Another challenge we face in building out the smart grid is the range of communication options available. In the past three years we have seen an increased availability of cost effective two-way communications technology. Cellular, Wi-Fi, WiMAX, Mesh RF, and Line of sight RF are a few of those technologies. These cost effective two-way communications have become an enabler of adding intelligence to the grid but also present a host of challenges. As an example, Cooper's Faulted Circuit Indicator (FCI) [see photo] has been one of the successful products making the transition from "dumb" to "smart." Our legacy FCI has no communications capabilities. It simply displays a local visual indication that a fault has occurred; it is visible to utility line crews from the ground. When a power outage is reported, utility line crews drive along the overhead distribution grid beginning at the substation looking for an FCI indicating a fault. We have transformed this product using today's low cost communications into a communicating FCI. These devices report the outage event to the utility control center allowing them to dispatch the crew directly to the correct FCI location. This can translate into less miles traveled thus saving fuel and reducing CO_2 emissions. It also can potentially reduce outage time from hours to minutes. One of our challenges with this technology is that we must support a host of communication technologies within this device. Each communication technology must be integrated into our package, validated with a variety of standards, often certified by the communications provider, and interfaced into utility backend IT infrastructure. This adds to the amount of time it takes to bring each communication technology to the market and the amount of research and development investment made by companies like ours.

Cooper Power Systems believes Congress, NIST, and the DOE should continue to drive smart grid standards, as they have begun to do. These industry standards should be directed through standards organizations like NEMA, they should be based on existing or de facto standards, and they should be able to evolve with the emerging smart grid technology. We commend the DOE in their preparation for evaluating FOA grant applications for the $4.5 billion stimulus for smart-grid investments. We believe the swift and judicious release of these funds will help stimulate the economy and support the process of converting the legacy grid into a smart grid. We would also encourage Congress to consider favorable incentives to utilities and vendors for smart grid replacement or upgrades to existing "dumb" equipment, and for U.S.-based research and development investments in smart grid technology.

Thank you very much for the opportunity to testify.

BIOGRAPHY FOR MICHAEL A. STOESSL

Michael A. Stoessl was named Group President, Cooper Power Systems in 2004, reporting directly to Kirk S. Hachigian, President and CEO, Cooper Industries. He had been President, Cooper Bussmann since 2002. Mr. Stoessl joined Cooper Bussmann from Emerson Electric Company where he had been employed from 1993 to 2002, most recently as General Manager and Vice President of a unit of Emerson's Liebert Power business. In his nine years at Emerson, Mr. Stoessl held a number of positions, starting as a Marketing Manager in Emerson's Specialty Motors business, to President of Hurst Manufacturing, to President of Rosemont Analytical Uniloc and then to General Manager and Vice President of Astec DC–DC Power Supplies before joining Liebert.

Prior to Emerson, Mr. Stoessl was with the Circuit Protection Division of Raychem Corporation for four years, serving in marketing, strategic planning and operations management positions.

Mr. Stoessl began his career as a Business Analyst with McKinsey & Company, Inc. after graduating with Highest Honors from Princeton University with a B.S. in Computer Science and Electrical Engineering. Mr. Stoessl also holds an M.B.A. from Harvard University where he graduated as a Baker Scholar.

Cooper Power Systems manufactures equipment, components and systems for the distribution and management of electrical power for electrical utilities, industries, businesses and institutions worldwide. Headquartered in Waukesha, WI, Cooper Power Systems has manufacturing facilities in ten domestic locations and three foreign locations, and approximately 3,400 employees worldwide.

Cooper Industries, Ltd. (NYSE: CBE) is a global manufacturer with 2008 revenues of $6.5 billion, approximately 88 percent of which are from electrical products. Founded in 1833, Cooper's sustained level of success is attributable to a constant focus on innovation, evolving business practices while maintaining the highest ethical standards, and meeting customer needs. The Company has eight operating divisions with leading market share positions and world-class products and brands including: Bussmann electrical and electronic fuses; Crouse-Hinds and CEAG explosion-proof electrical equipment; Halo and Metalux lighting fixtures; and Kyle and McGraw-Edison power systems products. With this broad range of products, Cooper is uniquely positioned for several long-term growth trends including the global infrastructure build-out, the need to improve the reliability and productivity of the electric grid, the demand for higher energy-efficient products and the need for improved electrical safety. In 2008, 61 percent of total sales were to customers in the Industrial and Utility end-markets and 37 percent of total sales were to customers outside the United States. Cooper, which has more than 29,000 employees and manufacturing facilities in 23 countries as of 2008, is incorporated in Bermuda with administrative headquarters in Houston, TX.

DISCUSSION

Chairman BAIRD. I thank our witnesses for a very interesting and informative testimony. I recognize myself for five minutes for questions.

ANTICIPATED DEVELOPMENT TIMELINE

Give us a sense of the glide path of when we begin to see these technologies becoming more adopted. You know, the temptation is to say when will this be ready. I know it is going to be a gradual transition but give us kind of a sense, metrics that give us a sense of what will be established by what time, and I know that is dependent also on incentives and markets, et cetera, but give us some thoughts about that. Mr. De Martini, you might be in one of the best places.

Mr. DE MARTINI. Sure. Well, I think certainly across the country we are seeing, and California in particular, the adoption of smart meter technology as a foundational element as was discussed. Certainly as we see over the next, in our case in California, over the next three and a half years all three investor-owned utilities will have smart meters deployed for all their customers, building on what we have done already for our largest industrial customers. At the same time, there is a lot of push, and we are certainly at the forefront, but others looking at opportunities as part of the ARRA funds for synchrophasor technologies. It is very cost-effective. So we see that over the next couple years, that being deployed on the transmission systems, and that has two benefits, not only the one that I mentioned in terms of helping to reduce, or improve, I should say, the reliability and reduce the exposure to these large blackouts. It also has the benefit of allowing us to be able to understand how large amounts of wind energy can be integrated into the grid because of the very dynamic nature of wind energy. So that is one of the things that we look at in California with the strong reliance on renewable energy in our system. We are anticipating over the next five years as much as 4,500 megawatts of new wind energy coming on and so we are looking at that. As we look at these other distribution automation technologies, while we have deployed and many others in the country have deployed quite a bit of distributed automation, what we have had in the last 10 years needs to be taken further. I think it was mentioned in the other testimonies and I think at the outset in the opening comments that when we start to look at two-way power flow in the distribution system, many of the protection schemes, how we think about and design these distribution systems, need to be taken to another level. So part of what we are looking at with this Avanti circuit but also other demonstration projects is, how do we accommodate two-way power flow on the distribution system that for the last 100-plus years has been designed as a one-way power flow from central plant down to the customer?

FEATURES OF SMART METERS

Chairman BAIRD. Excellent summary. If I am an average citizen and you say the word "smart meter," you are installing a smart meter, what is the difference between the dumb meter I have outside and the smart meter?

Mr. DE MARTINI. Well, the dumb meter hasn't really changed in 50 years and really in basic form type in 100-plus years. So it is an electromechnical device. It has magnets and it spins on a disc. I think most folks have taken a look at one of those. It is extremely difficult to read because of the way the clocks in terms of the numbers are there so it is very difficult for folks to understand, the average consumer. What the digital meter will do, first and foremost, it is digital. It is two-way communicating, has two forms of communication included in the meter, one two-way communication methodology back to the utility to be able to do remote metering——

Chairman BAIRD. Real time?

Mr. DE MARTINI. Real time—well, near real time. So we can get the information and we can collect it on an hourly or up to 15-minute increments and then we usually download it once a day or a couple times a day, but we can get real-time reads off the meter as needed. The other communication goes into the home so many of us are looking at wireless technology. Zigbee in particular is one that we are looking at that allows us to bridge to many of the devices that Mr. Ross talked about in terms of being able to allow energy management systems in the home to get the read right off the meter every 10 seconds, really real-time information, and take advantage of that. So these sorts of things and more processing and memory capability in the meter are really what distinguish it, and features like remote service switches that allows us to remotely turn on the power when somebody moves in. In our case, we have over 20 percent of our customers move every year. That is over a million and a half customers moving.

Chairman BAIRD. Thank you. I am not going to have time to ask a couple other questions but I will just put those out if someone could be kind enough to share down the road with us. If we get to a second round of questions, we will get to it. I am interested in the extent to which the energy bill that we recently passed out of the House—a number of folks mentioned incentives as key to adopting or not adopting some of these technologies—how the system of allowances and credits, et cetera, particularly in the cap-and-trade system would relate to incentives, or disincentives possibly for adoption of this. The other thing is, Dr. Arnold, you know, when we travel the world we are used to now carrying these little plug adaptors, and I am interested in, you mentioned global standards. I am interested separately in how we are coordinating with the rest of the world smart grid technology so that, you know, we don't create yet another layer of incompatibility for international travel and international trade and consumption of international goods. With that, I recognize Mr. Inglis for five minutes.

FLEXIBILITY AND PACE OF STANDARDS DEVELOPMENT

Mr. INGLIS. Thank you, Mr. Chairman. Mr. Ross was talking earlier about the feedback loop of customers figuring out how much power they are using. The first house that my wife and I bought was heated with electric baseboard resistance heaters and so the first time it turned cold, I went outside and watched the meter and I called out to her to turn them on. I thought the thing was going to come busting through the glass and become a dangerous projectile going through the neighborhood, it was going so fast. That was the beginning of the feedback loop but 30 days later when we got the bill was when the real feedback came about, gee, do we have to change this technology, and so we changed pretty rapidly because even in warmer South Carolina it is not that cold, you know, but wow, was it expensive. So I can see the value of a quick feedback loop to change behavior because you realize oh, my gosh, this is costing a fortune to heat this house.

Mr. Ross, Dr. Arnold is working on standards. You are in a rapidly evolving area. Software moves rapidly. Is it time for standards? Are you ready for standards or are you hoping for more development before he gets his standards in place or do his standards help you implement your technology?

Mr. ROSS. We have been very supportive of the NIST standards efforts and really would like to commend Dr. Arnold and all the work that they have done there. You know, they are dealing with a huge area and have set forth a plan in multiple phases that really is moving with good, deliberate speed while taking into account all the complexities of the issues they are needing to deal with. From our standpoint, I think most people in industry are supporting open standards. It would be helpful to have the standards in place obviously as quickly as possible but you really need to balance that with getting it right and making sure there is enough time to investigate and work through all the issues.

Mr. INGLIS. Is there a way to keep this flexible? Because it seems to me in an area of rapidly evolving technology, which I hope is what we are dealing with, particularly in the software, to keep those standards flexible. It may be a question for Mr. Ross and Dr. Arnold.

Mr. ROSS. I can just comment, and then Dr. Arnold would have a lot more to say. I think there is. I mean, I think the intent is not to pick winners or losers or very specific technologies, but to be able to pick the types of technologies broadly that will at least allow for inter-operability and connectivity, which is a hallmark of the smart grid, but I will let Dr. Arnold talk about that.

Dr. ARNOLD. Thank you. Well, we have to be careful not to over-specify things because we do need to facilitate innovation, which will benefit the consumer. There are certain aspects in the standards that everyone agrees have to be common like you have to have some common understanding of what data are you going to have, how is it going to be represented, and these are things that people can agree on. We can allow a lot of flexibility in terms of things people can innovate and get benefits to consumers and they are built on this foundation, sort of the key fundamental standards, data models and so forth. So we are proceeding to address this in I think a thoughtful fashion.

NET METERING

Mr. INGLIS. What is the holdup with net metering? I hear, you know, a lot of people have trouble with—theoretically I think EPACT 2005 really requires power companies to allow us to do that, right? But then there are all kinds of questions about the ability, the actual ability to sell your power back to the grid. What is the holdup? Is it technological or is it a business issue and we really don't want to move quickly if you are in the power business?

Mr. DE MARTINI. In terms of net metering, there are actually two dimensions. One is net metering where you are netting out how much energy is being used by the home, and then there is the metering that involves a separate meter to be able to then get paid for, for the energy being produced at the home. The current meters that we are deploying, the electronic meters have capability to do net metering. They also have the ability if we put a discrete measurement device on, say, a solar panel to be able to measure that and we are looking at this also for the vehicle—I think Dr. Arnold talked about this—as well as when we look at energy storage potentially in the home or at the business, how we would be able to measure that as well in terms of its contribution to the grid, not only for energy but also what other services it might provide in terms of grid stability. So we are looking at that. It is really—it is not a technology issue. I think we are looking at what the new form factors need to be to be able to do that and then there are standards both in terms of interconnection standards that might be required as well as some technology standards to deal with these different form factors because in most cases these meters would have protection on them, unlike the meter on the side of the house that doesn't and so there are different safety considerations.

Mr. INGLIS. Thank you.

Chairman BAIRD. Mr. Luján.

INTER-OPERABILITY STANDARDS

Mr. LUJÁN. Thank you very much, Mr. Chairman. I would like to start off where our Chairman and Ranking Member's questions have gone as well with talking about some of the open standards and not picking winners or losers, but the importance of inter-operability, and as we look to see some of the technologies that we depend on every day, our cell phones as an example, which are developed in open platforms but in the United States have not kept up with some of the technological advances that have occurred in other nations, and when you talk about an open platform but some of the restrictions that are placed on consumers as a result of carving out niches within this industry. Can you talk about the importance of inter-operability and some of the minimum performance standards that should be included so that way we are able to maximize efficiency, cost-effectiveness when we are looking at consumers' implementation and the integration with utilities as well?

Dr. ARNOLD. Well, I think we have to be careful not to fall into the trap of thinking that one size fits all because the smart grid has to accommodate a nationwide infrastructure. Environments in rural context are very different than urban areas so there will have to be a range of technologies that utilities can employ, and we don't want to impede innovation. So the challenge in this effort is to identify the critical interfaces in which there needs to be a standard and the nature of the standard has to be right as well. One example that I will give you is that a standard for communicating dynamic pricing information across the grid is going to be a very fundamental standard for the smart grid, but we have 53 jurisdictions in the United States that set tariffs and rates and they are not all the same. So we can't have one pricing model. So the type of standard that we need, there is language to describe pricing models, and this is quite doable. So it is a combination of recognizing which are the key interfaces and applying the right type of technology to create the right type of standard.

Mr. LUJÁN. Very good. Does anyone else want to comment on that?

Ms. KELLY. From the regulatory perspective, both the federal and State regulators have recognized the importance of inter-operability at some level. And in the absence of inter-operability of open architecture, and the State commissions adopted a resolution at their meeting, their national meeting yesterday, that pledges the State commissions to ensure that any smart grid technology that is sought to be deployed on their systems that they will require that the architecture be open. (And in FERC's policy statement for cost recovery, we have made the same statement.)

Mr. LUJÁN. Thank you. And I would also like to second the thoughts of Mr. Inglis as well as it pertains to net metering. As we are looking to smart meters and the importance of making that inclusion as we are making this critical investment now to prepare homes and the investments to be made with smart meters for those individuals that would like to get involved in that type of an environment, I think it is critical and I hope that that would be some type of a parameter that would be established.

And lastly, Commissioner Kelly, just to applaud your efforts with what you have done in the collaborative effort between FERC and NARUC[1] to bring those two entities together to talk about the regulatory environment that exists, the framework that has to be adopted and how the two can truly adopt best practices throughout the United States to help carry this out. And if you can just touch upon any of the practices that you have already identified or the progress that can be made and how we as a Congress can provide the support that you need, whether it is for FERC, DOE, NIST, with NARUC to help you do what it is that we need to do, recognizing that all of your testimony supports the robust investment that has been made in smart grid applications, recognizing the investments that can be made and the progress that can be made over the next five, 10 and 15 years.

Ms. KELLY. Well, thank you, Congressman. It has been a very fruitful effort, this collaboration between the states and the Federal Government. In addition to adopting a policy that inter-operability has to be met by all smart grid investment, cyber security has also been a concern of State regulators as well as federal, and we have pledged ourselves to demand that any smart grid technology that comes before us for approval for deployment to the grid will have

[1] National Association of Regulatory Utility Commissioners

to be shown to be cyber secure. You already have helped us with the stimulus funds and in the ARRA you created a clearinghouse of information which the Department of Energy is working to establish right now, and we see both of these as very helpful for the encouragement of deployment of the smart grid. With the stimulus funds, we are anxious to see them spent on demonstration projects that actually demonstrate a range of technologies from the transmission end down to the distribution end, because some of these technologies are not known. So if we can have a demonstration project and get the information from that project that shows that this technology performs, that it actually provides benefits that we can quantify and report on and that it has been accepted by consumers, this is a wonderful way to kick start the deployment of smart grid technology and advance it. So thanks for your legislative efforts.

Mr. LUJÁN. Thank you, and thank you, Madam Chair. I see my time is expired. I want to invite any of the other panelists to submit a response to that question if you so choose in writing for the record. Thank you very much. Thank you, Madam Chair.

Ms. GIFFORDS. [Presiding] Thank you, Mr. Luján.

The Chair will recognize Mr. Bartlett.

Mr. BARTLETT. Thank you very much.

NATIONAL SECURITY CONCERNS

Just about a week before the G–8 ratified the framework agreement that ended the Kosovo conflict, I was sitting in a hotel room in Vienna, Austria, with three members of the Russian Duma and the personal representative of Slobodan Milosevic. One of those Russians was Vladimir Lukin, who is Ambassador here and at that time the Chair of what would be our Foreign Affairs Committee. He was very angry. He spent two days with his arms crossed looking at the ceiling and finally he said if we really wanted to hurt you with no fear of retaliation, we would launch an ICBM.[2] We would detonate a nuclear weapon high above your country and shut down your power grid and your communications for six months or so. The third-ranking Communist was there, Alexander Shabanov, and he smiled and said and if one weapon wouldn't do it, we have some spares like about 10,000, I think. What was he talking about? I won't ask Ms. Hoffman because I know that she knows what he was talking about. Let us start with Ms. Kelly. Because it really is relevant to this hearing and what you all are doing. What was he talking about?

Ms. KELLY. Well, Congressman, he was talking about electromagnetic pulse and he was thinking about using it as a threat to the stability of the United States, and it is a concern. It is a physical threat as opposed to a cyber threat, but nevertheless a very real threat.

Mr. BARTLETT. Dr. Arnold.

Dr. ARNOLD. Well, this is indeed a very serious concern that we must address in the context of the smart grid, and although it is a physical threat, it does have cyber implications because the greatest damage with that threat is to the control systems which

[2] Intercontinental Ballistic Missile

are based on electronics. We consider that threat to be within the scope of the cyber security task force within the NIST standards program. We have a number of EMC[3] experts who participate in that group and NIST has expertise as well. I would just like to say that I am aware that some of the manufacturers are at least sensitive to the issue and several of the manufacturers on our working groups have informed us of research they are doing on component technologies that are more EM immune than conventional circuits. There are existing approaches with layered magnetic shielding to create EMP[4]-resistant designs and there are applicable standards. IEC[5] Subcommittee 77C has had work underway for some time and has produced a series of standards. The real challenge in this, and I am reminded of this by the report of the commission to assess the threat to the United States on EMP attack in which it says it is not practical to try to protect the entire electrical power system or even all high-value components from damage. So I think the key to this is identifying which are the critical assets that need to be protected and to apply the relevant design standards to ensure their protection.

Mr. BARTLETT. Yeah, the smarter we make the grid, the more vulnerable we are, and unless you are incorporating EMP protection, you are simply making it worse rather than better as far as security is concerned.

Mr. De Martini.

Mr. DE MARTINI. Yes. In addition to what Dr. Arnold described, the other potential threat, physical threat, has to do with the long-cycle currents that are induced under one of the three different scenarios. There are three different pulse sort of effects that result from EMP. The second looks and acts like lightning on the system and the current grid use of lightning arrestors and protection devices will mitigate that. The third, though, is the one that has the most potential physical damage for things like transformers and others large equipment that we have on our bulk transmission system and also in our distribution and subtransmission systems. There are ways to approach this. This is also similar to a phenomenon, solar flares, which is fairly well understood. There have been a number of scenarios over the last 20, 30 years, one by Hydro Quebec in the 1980s and some of the technologies that they have deployed. Again, I think to Dr. Arnold's point, what we need to look at is sort of a risk assessment and looking at what we think are the key vulnerabilities. In the case of the physical infrastructure, it is long lead time items like transformers so if a transformer was to fail, getting a new replacement transformer for a 500,000-volt transformer is very long.

Mr. BARTLETT. What is "very long"?

Mr. DE MARTINI. Could be two to three years, if we had a very wide scale. Usually if we have one fail, you know, there is a sharing arrangement usually with other utilities and manufacturers so that we can get something quick as in the case of an earthquake, but when we talk about widespread, you know, damage, then we would exhaust those standbys. So looking at ways to isolate those

[3] Electromagnetic Compatibility
[4] Electromagnetic Pulse
[5] International Electrotechnical Commission

transformers or dampen those currents that may get induced into the system is something we can look at, and our 500-KB system, for example, in the West, and particularly in California, we have series capacitors to help actually shorten the lines, which is one of the things you can do to mitigate the exposure from EMP.

Mr. BARTLETT. My time is up. Let us come back to this in the second round because it really needs more exploration because if we don't adequately respond to this, it could really, if we had that event, end life as we know it in this country. So let us come back to that in the second round. Thank you, Mr. Chairman.

Chairman BAIRD. Thank you, Dr. Bartlett.

Ms. Giffords.

ENERGY STORAGE

Ms. GIFFORDS. Thank you, Mr. Chairman, and thank you to the panelists for being here today. I come from southern Arizona, and it is a state that is abundant in solar energy and incredible potential in its natural resources. As you all know, smart grid technologies provide a real relevance to the goal of making our state and the country more dependent on renewable energy and particularly solar because of the storage capacity issues that deal with the sun setting at night and clouds coming overhead, so I want to talk a little bit about what happens under the traditional rate-making process. There are very few ways currently that utilities can monetized the benefits of storage. Since storage technologies do not fall into any of the traditional asset classes like generation or transmission or distribution, it is really a struggle for the utilities to use storage as part of their rate base. So my question is, what can FERC do to encourage the use of energy storage in light of these circumstances, and should FERC institute a separate asset class for storage since it provides benefits for the generation and transmission and distribution of energy?

Ms. KELLY. Thank you, Congresswoman. You are absolutely right. Storage is not a traditional resource on the system. The traditional resources are generation, transmission and distribution, and that is how rates have been set. Storage can potentially act as any one of them or all three of them, and that is where the difficulty comes in. If it is acting as a generator, for example, pump storage, a traditional storage facility, then it receives revenues as a generator. Some of the issues that get more difficult come if the deployer of the asset wants to capture multiple revenue streams. I know that there was a proposal by AEP that was at the distribution level in Texas that would have been a distribution asset and the Texas commission did approve that in distribution rates and I believe also allowed them to recover revenues as a generator at the same time. One thing that FERC has done to facilitate storage is to allow—in our organized markets, we have seven organized markets in the United States and we have allowed storage to qualify. We changed the rules so that storage can qualify as a demand response provider and we have lithium ion batteries in particular that, although they are expensive, can provide ancillary services because those ancillary services are costly. So we are working to change market rules to allow storage to sell power into the market. We also have an office of policy and innovation, and two months ago they began an effort internally to decide whether this is something that we should develop a comprehensive policy on or whether it is something that we should decide on a case-by-case basis, because you are absolutely right; storage can act as a number of different kind of entity within the system, and the question of whether or not they can recover as a transmission asset and a generation asset has a lot of implications for the market and the competitiveness of the market and cost recovery, but it is something that we are undertaking to look at to see whether we should come up with some sort of comprehensive policy.

Ms. GIFFORDS. Thank you, Ms. Kelly.

Would anyone else like to comment? Ms. Hoffman.

Ms. HOFFMAN. I just would like to comment that the best thing we can do for the industry is to develop a clear definition of those services and what can be covered under what cost structure so that the industry knows how to move forward and where they can get cost recovery so it is completely transparent and consistent.

Mr. ROSS. I would just like to say, we agree with your view. Storage is, you know, a very attractive solution for utilities. The price points are coming down now with some of the advantages gained through the development of batteries for electric vehicles, and I think those price points are now approaching new generation and I think more clarity would be beneficial for the industry because today where we are at, there are some utilities that have deployed storage solutions, grid-scale storage solutions, but it has tended to be basically on a pilot basis and not more widespread.

Ms. GIFFORDS. Mr. Chairman, just in closing, this seems to me a real key part of how we are going to figure out transitioning to renewable energy and, you know, I am glad that you are holding this hearing today and I look forward to working with all of you to make sure that we can actually get these changes in place so that we can really move forward and transform our economy and our energy usage.

Chairman BAIRD. Excellent point, as always, Ms. Giffords. Maybe we want to pursue specifically a hearing on the issue of storage in some more detail.

Ms. GIFFORDS. That would be a great idea.

Chairman BAIRD. Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. I don't know about you but I am having fun. It is not every day we have a panel on which every member knows what they are talking about. So I have learned a lot.

Just one quick comment on the EMP. When I look at that issue, I just think this is so far beyond what anyone should do that it almost is in the category of mutually assured destruction as being the only defense against it. We can protect some things but good grief, given all the processors around, if every car stops because of EMP, you have total gridlock, the Nation doesn't function. So it is something we would rather not think about it but I really think it is very, very difficult to address the whole issue.

On the smart grid, it seems to me a smart grid requires smart people too, and I think the comments about digital meters—I think we would do everyone in this country a great favor if every major energy consuming appliance had a digital display on the appliance showing how much energy it was using at that moment. You know, this would apply to stoves, dryers, washers, dishwashers, the major appliances, perhaps even the furnaces and air conditioners, although you wouldn't want the display on the machine per se but somewhere in the house. People have to become much more conscious about their energy usage if we are really going to be serious about conserving energy, and so I would—you know, I don't know, Dr. Arnold, whether you want to put this as one of the standards but I certainly wouldn't mind seeing a recommendation in there that this is something we should move towards, and perhaps it requires legislation at some point. I think the public will make intelligent decisions if they know the facts, and we have to make sure that we let them know the facts in every way possible.

THE PURPOSE OF THE SMART GRID

The question I have is, what is the primary purpose of the smart grid? It seems to me its origin was in the blackouts and concern about that, but what you are talking about today and discussing is far beyond just dealing with blackouts, and I don't have much time left but if you can each give just a short response of what really are we trying to accomplish with a smart grid. What is our purpose? What is our goal? We will start with—well, let us reverse the order. Ms. Hoffman, you get nabbed every time. Mr. Stoessl, and just go down. I am looking for short answers, not long ones.

Mr. STOESSL. I think unfortunately smart grid has become something that is ubiquitous. Everybody takes anything going on in the grid and calls it smart grid application but from our perspective, improving reliability is a key part of it. Improving conservation of resources, reducing waste is a key part of it, and providing signals to both consumers as well as the utilities on how to reduce waste, reduce usage is also a key part of it.

Mr. EHLERS. Thank you.

Mr. Ross.

Mr. ROSS. Yeah, I would agree with a lot of that. I think it is to create efficiencies. I think it is to improve reliability. We should have as a goal to increase security and I think there is a lot of work being done on that, and I think those are the main prongs.

Mr. EHLERS. Mr. De Martini.

Mr. DE MARTINI. I would say there are three things. One is that if we look at renewable energy integration, involving large amounts of wind and distributed solar energy, we need a different set of technologies to be able to integrate that energy in a reliable, safe manner. The other is the grid efficiencies that were talked about, two elements. One is, there are superconducting technologies that can make our grid, the inherent grid more efficient which means less energy wasted through losses on the system, and then obviously engaging our customers in the process that you described in terms of using more-efficient energy. So I would say those, and then overall reliability of the grid in terms of providing better service for our customers.

Mr. EHLERS. Dr. Arnold.

Dr. ARNOLD. I think of it as reducing energy usage, allowing consumers to manage their use of energy, increasing reliability and benefiting the environment.

Mr. EHLERS. Ms. Kelly.

Ms. KELLY. Congressman, I think of it as doing the same thing that the dumb grid does, which is send electricity, only doing it better, more efficiently and more reliably, and then increasing our ability to do things with the grid that it has never done before like sending electricity two ways, allowing for net metering and allowing for dynamic price signals and automated demand response, things that we can't do with the dumb grid today.

Mr. EHLERS. Ms. Hoffman.

Ms. HOFFMAN. I will summarize it as sensing, measurement, information, decision-making and automation such that we have a greater—as you eloquently stated, an educated consumer and a more sophisticated industry.

Mr. EHLERS. Thank you very much. Just to summarize, most of you mentioned the issue of efficiency, which I think is a huge issue that we have to deal with internationally, not just in this country, and I appreciate your comments. They are right on target. Thank you.

Chairman BAIRD. Dr. Lipinski.

FIRST STEPS TO A SMART GRID

Mr. LIPINSKI. Thank you, Mr. Chairman, and thank you for holding this hearing today. It is very important that we talk a lot about alternative energy. This is another critical part of the equation that oftentimes gets overlooked. I will start out by asking about this. I read recently that the National Association of Regulatory Utility Commissioners reported that the most effective place for initial investment in the smart grid for smart grid improvements is on the electric grid itself where energy and cost savings are immediate and that rely upon change in customer behavior or for customers to purchase and install in-home energy-saving devices. So I was wondering what the panel thinks about the commissioner's assessment. Do you think that that is the best way to start building the Nation's smart grids? Maybe we will start with Ms. Hoffman.

Ms. HOFFMAN. I actually think we need to drive innovation and smart grid technologies on all three levels, at the transmission level with the phasor measurement units, at the distribution level through substation automation, and at the customer level. The safest route from a regulatory commissioner's perspective is something that is dealing directly with the industry, or within the utility industry itself. The most competitive and most innovative aspect of the smart grid is on the consumer side for consumer decision-making.

Mr. LIPINSKI. Ms. Kelly.

Ms. KELLY. Congressman, I would agree with Ms. Hoffman. The State utility regulators are concerned because the technology that we are talking about putting in is new to them and so I think that the DOE demonstration projects will be very valuable in demonstrating that the technology does perform, that it does provide benefits and that it is accepted by the consumers. The technology that they referred to is technology that we understand pretty well and we could put on the transmission system, and I think that is one reason they endorse it because it is well known and we know how much efficiency can be delivered by it. And so from that perspective, I think that it is important that that kind of technology be deployed but in parallel we should be undertaking these demonstration projects to show that other technology can also work well.

Mr. LIPINSKI. Does anyone else have a comment? Mr. De Martini.

Mr. DE MARTINI. Yes. Thanks. I think that is important to recognize, for example, in California and certainly in southern California Edison's case, our peak, system peak is occurring on less than 60 hours of the year. During the period from 2002 to 2007 when we were experiencing the dramatic growth in our economy, our average peak demand was growing by about 1,000 megawatts a year. That peak, 30 percent of that peak, 7,000 megawatts is air conditioning load. As we look at investing more in capital to try and meet that type of growth, which we anticipate that we will see again once we come out of this downturn, it is important that we engage our customers in a way that they can see what prices are, what the cost of this energy is going to be so that we can have this, you know, mutually beneficial relationship that we can meet their needs but also that they can recognize what the cost of this is so we can end up with a much more efficient system. It is just not possible to continue to try and meet that sort of growth.

Mr. ROSS. Yeah, I would like to just comment on that as well. I agree with what the other panelists have said. I would like to point out that a lot of the work that has been done to date, though, really has been on the grid operations and reliability side. So we have done a lot in transmission, and we are doing a lot at substations and distribution automation. Where we haven't done a lot so far really is on the demand side and looking at efficiency, and so a lot of those things hopefully through the smart grid demonstration projects and elsewhere we will see new technologies that can be deployed, but those things have done, you know, at best very small pilots. So a real focus on efficiency and addressing the demand side as well as the supply side I think is needed.

Mr. LIPINSKI. Thank you. With the little time I have left, I want to ask Ms. Hoffman, is DOE spending any of the stimulus dollars on efficiency improvements on the electric grid itself?

Ms. HOFFMAN. We are. Through the demonstration program we will have a complete portfolio of generation as well as smart grid technologies that will hopefully show improvement in efficiency of the whole system, the system as a whole. For the investment grant program, there are very technology-specific actions or proposals that will be submitted to the Department so some of them could but not all of them probably will.

Mr. LIPINSKI. Thank you. I see my time is up. Thank you for your answers, and I yield back.

Chairman BAIRD. Thanks, Dr. Lipinski.

Ms. Biggert.

Ms. BIGGERT. Thank you, Mr. Chairman. This must be smart grid day. I co-chair a caucus on high-performance buildings, and the title of what we are having today is "Connecting Buildings in the Smart Grid." So it obviously is a topic that is very much in the forefront. I do chair this caucus with Representative Carnahan from Missouri, so if you happen to be down in the basement of Rayburn around 11:30, that is when that starts, if you need some more talk about the smart grid.

I read recently that the National Association of Regulatory Utility Commissioners has reported that the most effective place for initial investment in smart grid improvements or immediate investments in the smart grid improvements is on the electric grid itself where energy and cost savings are immediate and do not rely upon changes in customer behavior and do not need customers to purchase and install in-home energy-savings devices. Do you agree with that assessment as the best way to start building this Nation's smart grids? Ms. Hoffman.

Ms. HOFFMAN. Congresswoman, thank you. I believe that we really need investments at the transmission-level system as well as at the distribution and at the customer levels. The innovation that is occurring on the system is occurring at the customer level as you look at the wealth of technologies including the appliances, with intelligence. It will provide great advancement and great education to the industry as well as consumers on their energy consumption.

Ms. BIGGERT. Thank you.

Ms. KELLY. Congresswoman, the technology that they are discussing there will indeed provide a lot of efficiency and translate into a lot of savings for consumers. However, I don't think we want to lose sight of the fact that adding smart grid technology at the retail level in the home also has the potential to accomplish similar types of savings.

Ms. BIGGERT. Thank you. Anybody else?

Mr. Stoessl, you mentioned something in your testimony about——

Mr. STOESSL. Absolutely, and I think that while it is essential that we invest everywhere, I think if you really want immediate gains, the fastest response is going to come from going after management of efficiency on the grid itself. Voltage management and reactive power management, that first example that I provided, looking at how you turn capacitor banks on and off or turn voltage regulators on and off when demand shifts and the load comes up and down, that is something the utility can manage directly without relying on consumers to get cues and individually make a whole host of actions. And so I think there are opportunities for immediate benefits going in that direction while waiting for all the cues that the consumers will need to manage their own consumption, which is going to be very important down the road as well.

Ms. BIGGERT. Well, you know, we hear a lot about the smart meters and the programs to enable consumers to reduce energy use, you know, usage and shift part of it, you know, to particular times of the day but it seems that there is more to the smart grid, essentially making the utility systems themselves self-healing as you mentioned, Mr. Stoessl, and making them more reliable and more efficient and lowering the cost of electric delivery. But if this is so, Ms. Hoffman, how is DOE encouraging the deployment of these types of smart grid systems?

Ms. HOFFMAN. Well, hopefully we will get some wonderful proposals through the *American Recovery and Reinvestment Act* that demonstrate some of the objectives that the legislation asks us to do in advancing consumer behavior, managing load on the system as well as we look at supply and demand, increasing the availability of renewable resources. I believe that through the *American Recovery and Reinvestment Act* solicitations for both the demonstration as well as the investment grants, we will have taken a major step in the right direction in doing projects as well as documenting the benefits of these projects.

Ms. BIGGERT. Thank you. I yield back.

Chairman BAIRD. Thank you, Ms. Biggert.

Mr. Davis.

POTENTIAL ENERGY PRODUCTION SAVINGS

Mr. DAVIS. Mr. Chairman and Ranking Member, thanks for having the hearing today to better inform those of us who will be making decisions on energy issues in the future where America can become more energy independent and more economically secure and have greater national security. I look at the issues today that I hear discussed so often from everyone in this room and everyone in the District I represent and throughout the country, and each seems to have a better mousetrap. The windmills quit moving when the wind quits blowing and the solar systems quit working at least to 100 percent efficiency when the sun goes down. We are putting—50 percent of our energy production is from coal, which belches into the atmosphere carbon emissions that seems to be destroying our planet, about 24 to 25 percent from nuclear energy. We have no place to send the spent rods. And then some 20 percent or so would come from natural gas or from fuel oils and then one or two percent from hydro and the wind and the solar. And now we talk about a grid that would transfer all of the energy that we are producing where the source may be in a more efficient and effective way where perhaps we can reduce the amount of generation, which means we would reduce the amount of pollution and more efficiently and more effectively transfer electrical energy that we are producing in certain locations throughout America. It is my understanding today, and I live in the Tennessee valley area, I represent Kingston where the spill is located, and so obviously all of us are trying to find some way to find a better use of that. So with the grids that we have, my understanding is, we transfer now energy being produced from one particular company to another, from one area and one region to another. How do we redo the grid system to where it can become more effective, and if we do with the costs we are talking about, how much more can we wring out and how much can we reduce the generation that we have today as a result of that? One percent, two percent, three percent, five percent? Would you give me an estimation of how, if we had the perfect grid system based upon your knowledge and study, how much can we save in production?

Ms. HOFFMAN. I don't have an exact number for the savings, but I will characterize it a little bit differently. If we can reduce the peak on the system, we can show great savings. If we actually can flatten the loads of customers and flatten the transfer on the transmission system, we will get the greatest value and benefit. There are some numbers out for peak load reduction. I don't remember the exact savings numbers but I can provide that to you.

[The information follows:]

INFORMATION FOR THE RECORD

A 2009 industry report (Faruqui and Sergici with the Brattle Group, "Household Response to Dynamic Pricing of Electricity—a Survey of the Experimental Evidence," funded in part by Edison Electric Institute/Electric Power Research Institute) analyzed the results from the most recent 15 pricing pilot programs. The study concluded that, "Across the range of experiments studied, time-of-use rates induce a drop in peak demand that ranges between three to six percent and critical-peak pricing tariffs induce a drop in peak demand that ranges between 13 to 20 percent. When accompanied with enabling technologies (i.e., programmable thermostats), the latter set of tariffs lead to a drop in peak demand in the 27 to 44 percent range."

Mr. DAVIS. But when it gets to 100 degrees in Tennessee and it is 150 percent humidity, we all turn our air conditioners on and we want it to be about 75 degrees, and so that produces a peak. How do we convince that customer—and what you are saying is, we need to reduce the amount that we are consuming so therefore we don't have a peak. How do we do that? How does the grid system bring about a reduction in peak use for those customers who feel they need that energy?

Ms. HOFFMAN. Well, one of the technologies is, you actually can cycle the air conditioners through peak price signals. They can cycle some sort of incentive program for cycling the air conditioners, and that has been a common program.

Mr. DAVIS. And that works, because I just put like a 16 series in my house from propane to electricity and we just changed all of the light bulbs, so we are not talking about grid now, we are talking about actually efficiency and conservation.

Ms. HOFFMAN. And consumers' decisions. You can have the air conditioning running and there might be a price signal but the consumers may say okay, well, I am not going to start my dishwasher at this time, so you look at all the factors that pull together and not just the air conditioning.

Mr. DAVIS. Yes, Ms. Kelly.

Ms. KELLY. Thank you, Congressman Davis. FERC recently completed a study which the *Energy Independence and Security Act* asked us to do on assessing the national potential for demand response, and in that study we determined that in a perfect world, we could reduce peak 20 percent over the next 10 years. Those are the numbers I think that Ms. Hoffman was talking about. Now, that would be a perfect world but that perfect world would be all consuming entities having a smart meter and having that smart meter send the real-time price signals, dynamic pricing, and having the devices and appliances have smart chips in them that could automatically respond to the price. But that estimate, 20 percent, is very significant.

Mr. DAVIS. Yes.

Ms. KELLY. It would be 120 gigawatts. Today we consume on peak about 820 gigawatts, so it would be very significant.

Mr. DAVIS. At our home, it has reduced more than 20 percent the actual consumption of energy as a result of those two. So we are not necessarily talking about a grid that makes it smarter use, we are talking about customers who will be smarter users of the energy that we produce and that is a task for us.

Thank you, and I apologize for running over my time.

Chairman BAIRD. Thank you.

Mr. Rohrabacher.

POTENTIAL ENERGY SAVINGS

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. It has been a very educational hearing, and again, I agree with Mr. Ehlers that all of the panelists have contributed to our knowledge base on this issue which I consider to be vitally important because I think that in the future, our country will be relying on electricity. Electrifying America even more than it is is probably the answer to the pollution problems that we face, the challenges that we face today. I might add that those of us who don't believe that global warming is a problem caused by CO_2 are very concerned with pollution and very concerned with America's energy independence as well.

I would like to get back to the question that my colleague just brought up about how much energy we are talking about here. You guesstimated that with the smart grid, we would have 20 percent more efficiency in operating. What about today? How much of the electricity that is put into our system is dissipated in some way that wouldn't be dissipated if we were handling it in a smarter way? And I don't know, whoever can answer that. How about the guy from Southern California Edison? They know all that.

Mr. DE MARTINI. Thank you, Congressman. I don't have the exact number for our system but it is not unusual to have a system loss from the time it goes from generation down to the customer, somewhere in the neighborhood of maybe seven percent.

Mr. ROHRABACHER. Seven percent?

Mr. DE MARTINI. Yes.

Mr. ROHRABACHER. Okay. And so we are actually producing seven percent that never goes into some electric device in your home and things like that, that is just not used for the benefit that it could be used for?

Mr. DE MARTINI. That is right. That is through the losses in the transmission of the power over the power lines as well as through the transformer, so in the transformation from one higher voltage to a lower voltage we are stepping up in that transformation. And actually superconducting materials both applied to the conductors but we think that there is a lot of potential to apply it to the transformers and that is an area that we are putting a lot of focus on to see if we can't get some of that developed because that could be pretty easy to replace over the next decade.

FINANCIAL BENEFIT TO CONSUMERS

Mr. ROHRABACHER. So one of the goals of a smart system would be to bring that seven percent number down, which could pay for itself actually, when you think about what we are talking about here. And when we talk about smart meters and two-way meters, would a customer in the future be expected if he put solar power panels on his roof or finds a way of producing electricity with whatever method that would be, would that customer be expected to receive a financial benefit from that other than just the fact that he is not buying it? In other words, putting into the grid, would he receive some benefit? Is that what the goal is, or is that not the goal?

Mr. DE MARTINI. Yes, Congressman, that is what we mean by two-way flow of power.

Mr. ROHRABACHER. So what would that be? Would someone be able to receive payment back or credit for that would be in the same dollar amount as what it would cost him to take out—he or she?

Ms. KELLY. Congressman, it really depends on the nature of the marketplace that they are selling into. If it is a traditional regulated utility, then it would be an offset from the bill. If they are in an organized—we have seven organized markets within the United States, doesn't cover all of the United States but two-thirds of the consuming areas of the United States. If they sold into that organized market, they would get the clearing price of that market, the market price at the time they sold into it.

Mr. ROHRABACHER. So they get the market price, so if someone——

Ms. KELLY. They could get the market price.

Mr. ROHRABACHER. So if someone has like Dr. Bartlett here has a farm and he produces more electricity because he has got all the solar and the wind going, he would actually make the same amount of money as Southern California Edison in producing what he is producing. Is that right?

Ms. KELLY. Particularly if he sold it back on peak when the price is higher.

Mr. ROHRABACHER. Okay. Well, thank you very much. Again, this has been very educational. I appreciate your leadership, Mr. Chairman.

Chairman BAIRD. Mr. Tonko.

JOB CREATION AND WORKFORCE DEVELOPMENT

Mr. TONKO. Thank you, Mr. Chair. I apologize that I had to leave the hearing to go off to another meeting, so if I ask a question that has been asked, just tell me.

Workforce development as it relates to smart metering and in upgraded grid, has any discussion been had in that regard? Are there things you would advise this committee in terms of the human infrastructure that is required in order to do this in the most effective way, whether it is retraining workforces out there or entering some new, and what potential exists in the future? Are there career developments we should be doing as early as high school? In the State of New York, we have an operation that will deal with some of the developments of more trade-related aspects. Are there any comments that any of you would wish to share?

Ms. HOFFMAN. Let me start, Congressman. Thank you for the question. It is a very important question as we look at our aging workforce today. In the *American Recovery and Reinvestment Act* there is $100 million that is set aside for workforce training. The issues surrounding workforce training, I think as we look at putting more advanced technologies on the system, we will need to retrain workers that traditionally may do line work, but may have to also be able to handle solar cells on a pole on an electric system, as well as we need to have more sophisticated workforce coming into the electric industry as we start advancing power electronics. And as we look at cyber security, the information technology is probably not the way current line workers have utilized information technologies. There will be significant advancements with respect to computer use and information technology on electric systems that we need to make sure we advance the workforce in having them up to speed, and I think that—I believe that requires education at the high school level and at the starting point with respect to computers, mathematics and following that all the way through the two-year colleges.

Mr. TONKO. Anyone else?

Mr. DE MARTINI. Southern California Edison agrees, you know, with Ms. Hoffman. We believe this is actually one of the larger issues when we start to look at a smart grid. As Ms. Hoffman pointed out, there are fairly large challenges with the workforce that we have today. You know, the average age of our workforce is nearing retirement or already retirement eligible.

Mr. TONKO. And that is a pattern across the country, I think, especially in states where they deregulated?

Mr. DE MARTINI. Well, across the industry, so we are not unique in that regard, and one of the things that we have seen is that over the last 15 years when construction and growth of the electric industry slowed down after the 1980s, you know, the university systems largely dropped their power system certificate programs for the electrical engineering curriculum so there hasn't been a lot of graduates of electrical engineering programs specializing in power systems development. The other thing that we see clearly as we move forward, it is not just enough to reinstitute those curriculum because today a power system engineer also needs to understand computing systems. So we are working with a number of universities to try and reestablish the certificate programs and expand that to include computing systems, computing sciences as part of that. The line worker is a real challenge because most of our line workers and field workers are basically high school graduates and so they haven't had extensive, you know, sciences or certainly not electronics, and it isn't just the solar cells, although that would be a challenge as well. We are going to have a lot of power electronics out in the system, out on a circuit, as Mr. Stoessl highlighted. So as we have that, our folks need to understand, you know, electronics, which means that there is more education, so this is something we look at both with the labor unions in their development of their apprenticeship programs, community colleges we are reaching out to. This is a very large issue that the industry across the board is trying to——

Mr. TONKO. Is the planning element of that all structured enough or should the Feds step in or states step in and make certain that all this is getting accomplished in the most effective way?

Mr. DE MARTINI. I believe most utilities are very well aware of this, and we have been looking at this issue and starting to put in place plans to develop it. Obviously, you know, certain budgets and many of the locations across the United States for education are, you know, under pressure and so developing new programs can be quite challenging to be able to move this forward.

Mr. TONKO. Thank you. I had one second left, Mr. Chairman. I wanted to point that out.

Chairman BAIRD. Well done, Mr. Tonko.

Mr. TONKO. I am following our leader there.

Chairman BAIRD. Mr. Olson.

Mr. OLSON. Thank you, Mr. Chairman, for allowing me to participate in this hearing today. I greatly appreciate that.

I would like to follow up on my colleague from New York's questions about workforce development and specifically job creation. In April of 2009, Vice President Biden announced funding in the amount of $4 billion through the *American Recovery and Reinvestment Act* for smart grid initiatives. He did so under the premise of job creation. And that same day, a notice of intent was released by the Department of Energy which stated that job creation would be a primary criterion for ranking projects receiving funding under the program. However, revised guidance issued on June 26 has eliminated job creation as a primary criterion for funding. The funding opportunity announcement for smart grid initiative grants in the section entitled "frequently asked questions," it states that DOE remove the criterion on the extent of jobs creation and will now require applicants as stipulated within the Recovery Act to report quarterly on the number of jobs created and retained. And we were told during the debate we had on the Floor in the stimulus package that the urgency behind the measure was due to the need for job creation, and yet we have seen, it looks like the exact opposite is occurring, and so my question for you, Mrs. Hoffman, why the change in criteria?

Ms. HOFFMAN. The final funding opportunity announcement that came out recognizes that job creation is recognized throughout the solicitation. The major goals of the solicitation as listed in the introductory section says job creation is a goal. The proposers have to write towards those goals and recognize job creation as part of the proposals as well as the companies themselves must define the workers they require to implement projects in that solicitation, so we thought that—or we included job creation in almost every aspect of the technical requirements and the evaluation criteria of the proposal.

Mr. OLSON. I appreciate that answer, but let me read to you from the document that was issued on June 26. "The question is, will DOE use the number of jobs estimated to be created and/or retained as a criterion for rating a proposal on funding," and the answer is no. And then they downgrade it and say, "Although job creation is not included in the technical criteria used to rate proposals, it plays an important role throughout the grant process and grant recipients again are required to submit the numbers of jobs created and retained in their quarterly reports to DOErecovery.gov," and to me, that is a significant de-emphasis of job creation as part of the smart grids initiative.

And following up on that, Ms. Hoffman, if jobs creation, as you say, is still a factor driving the force behind these grants, how many jobs do you foresee will be created using the smart grid initiatives?

Ms. HOFFMAN. We are following the Council of Economic Advisors' methodology for job creation, and I don't have the number off the top of my head that they have quoted as part of their methodology.

[The information follows:]

INFORMATION FOR THE RECORD

We anticipate that the Smart Grid Investment Grant Program and the Smart Grid Demonstration Program will result in 36,712 and 6,685 job-years (full-time equivalents), respectively. These estimates were derived from the methodology provided by the President's Council of Economic Advisors, which prescribes that $92,000 of federal spending equates to one job-year.

Job creation was applied within our review process to determine relative merit. Based on our review of applications, we expect that the funding provided by these programs will produce highly skilled jobs within the engineering, information technology, and business analysis professions.

Mr. OLSON. I appreciate if you could get that to us. And a follow-up for you, Dr. Arnold, as well. In your testimony, you stated that smart grid is a critical piece of this Administration's overall goal of fostering and creating millions of jobs in the green economy, and again, how does that statement coincide with the shifting standard that I have been talking about?

Dr. ARNOLD. Well, I can talk about the role that standards play in that, and one aspect is enabling global market opportunities for U.S. manufacturers. And addressing Chairman Baird's question, we are working very actively with the key international bodies such as the International Electrotechnical Commission, the IEEE and others as a vehicle for promulgating standards that we are going to use in the U.S. smart grid. We are also engaging directly with other countries that are really following what we are doing. I would say we are in the lead in the world on this so that we can collaborate in the creation of international standards that will provide those global market opportunities for U.S. manufacturers.

Mr. OLSON. Thank you very much. I see my time is ending. I just want to encourage you all not to de-emphasize the jobs creation part of this. That is critical. If this is going to go forward, we need to create jobs and it appears it is being de-emphasized. And Mr. Chairman, I yield back my time.

Chairman BAIRD. I thank the gentleman. I am told by staff we may have votes in about 10 or 15 minutes. I know, Dr. Bartlett, you had a follow-up. I would like a brief follow-up. We will go ahead and start. I will try to shorten my time a little bit as well and ask colleagues to do the same.

INCORPORATING SOCIAL BEHAVIORAL ASPECTS

We had a markup in this committee this week earlier on a proposal to put social behavioral science program within DOE's work, and I am thinking about smart grid here and I am thinking, for goodness sake, please don't make this like programming my VCR or I am going to have a thermostat that flashes 12 constantly at me. The question really on a more serious note is, how are we working either at NIST or various companies here to incorporate the behavioral, cognitive, emotional even aspect of—I say "emotional" because my wife and I go round and round about what the heat should be in our home—of this technology? It is not a frivolous question at all. How do we incorporate that human behavior interface with smart grid work? Please, Mr. Stoessl.

Mr. STOESSL. If I may, I can give you one perfect example that one of the electric co-ops in Delaware has taken the lead on. They have a program called Beat the Peak, and it is going exactly to the behavioral element of this. They know and anticipate when peak costs are going to strike their membership, and they are looking for a simple in-home display. Right now, what the head of that utility does is literally send out an e-mail to his membership saying, we expect peak rates from 4 to 6 p.m. this afternoon, please curtail your usage, and his members do, and what we are now developing for him and what he is looking for is a simple in-home display, just a simple red-green kind of thing that when that light is red, please curtail usage, whatever you can do. Go ahead and run your air conditioner if you want, but if you can curtail, please do. And that simple indication, which will be triggered by communications through his meter and through his communication infrastructure, is a behavioral way of going at it. Very simple, no programming required, just be aware if that light is on and you can do something, please do it.

Chairman BAIRD. Are there other examples or comments?

Ms. HOFFMAN. Just one comment, sir. The way the technology should be developed has to keep consumer behavior in mind and consumer sophistication, and I think that is not a one-size-fits-all. We must tailor the technology to the customer, so if a customer just wants to know a price and have it automated on the system, we should be able to do that, whereas if a sophisticated customer that wants to go in and manipulate things just like he is sophisticated, say, on the stock market, we need to tailor the technology to meet the needs of the customer.

Chairman BAIRD. Is that being incorporated in the work being done by DOE for NIST, et cetera?

Ms. HOFFMAN. I am hoping we will see it as part of the projects that are proposed.

Dr. ARNOLD. Chairman Baird, I would say that standards also play a key role in this and creating a standard for customer access to energy usage information. The standard I referred to earlier for communicating pricing information will enable the creation of software tools that can put this information in formats, you know, on a web browser or what have you that are easy for customers to see or even a simple red light-yellow indicator for customers who don't want to be that sophisticated.

Chairman BAIRD. We go crazy over a 50 percent discount on cereal boxes at the grocery store, you know, you save your coupons and all this stuff. If somebody said you can run your dishwasher now but it is going to cost you much more now if you run it, and back to this peak issue, it would help a great deal. Ms. Kelly, did you want to comment?

Ms. KELLY. I was going to say that a follow-up to that is something that the collaborative is excited about, and that is the DOE clearinghouse of information. Any of the demonstration projects that receive stimulus funds will have to report information to the clearinghouse, and it is one of our goals that the consumer acceptance, which I think is another way of describing what you are talking about, is something that will have to be monitored and followed and reported so that we can understand what kind of consumer interfaces work well as well as which ones don't work.

Chairman BAIRD. That is encouraging.

Mr. ROSS. Mr. Chairman.

Chairman BAIRD. Yes, please.

Mr. ROSS. I was just going to add that there has been a lot of work done in this area that can be translated from Internet and telecommunications technologies, and I think what you are seeing now is a lot of companies that for a long time have been developing new and innovative products in those areas moving into energy management systems. And there is a lot of work to be done there. There are some studies that have shown that, you know, programmable controllable thermostats, about 70 or 80 percent of people don't actually bother to go ahead and program them, and so the new types of devices that are coming out are either portals for people to use online, in-home displays or some are even developing it through television interfaces. What they are finding is with just simple information, rather than waiting until the end of the month on the utility bill, people are reducing their energy consumption 10 to 20 percent.

Chairman BAIRD. I would suggest we take a page out of the behavioral economics retirement investment models which suggest that if you preextract people's retirement 401(k) match, you have a much greater participation than if you wait for people to opt in, and let us ship the thermostats with preset things and adjust that to some easily, you know, wireless clock reset, and then if they want they can go with the default, it is a lot easier. So thank you for the insightful answers.

Mr. Inglis.

Mr. INGLIS. Mr. Chairman, I have no further questions.

Chairman BAIRD. Mr. Bartlett.

ELECTROMAGNETIC PULSES

Mr. BARTLETT. Thank you very much. I was genuinely pleased at the panel's knowledge of EMP. I would just like to note that the usual things that we say that give us some comfort probably aren't relevant here, the mutually assured destruction. An EMP blast over North Korea would have little or no effect on North Korea. They just don't have any infrastructure that would be affected by EMP. As Vladimir Lukin said, with no fear of retaliation, if it comes from the ocean, how do you know from where it came? Two days ago, the Secretary of Defense was here and he made the observation that they were counting on deterrents to protect us from EMP, and I said Mr. Secretary, that is not going to work, because as Vladimir Lukin said, with no fear of retaliation. You know, we keep watching for whether North Korea or Iran has a missile which will reach us. That is irrelevant. Neither of them—I have been to North Korea. I spent three or four days there. They may be evil. They are not stupid. They are not going to launch a missile from their soil. It is going to come from the ocean, and all one needs is a tramp steamer, $100,000 to buy a Scud launcher and a crude nuclear weapon. You couldn't shut down the whole country with that but you could shut down all of New England with that. And, you know, if you missed by 100 miles, it is as good as a bull's eye because it really doesn't matter.

You know, this is really a tough thing, but unless we protect ourselves against that—Mr. De Martini, you mentioned that it took two or three years to get these big transformers, and that is the kind of thing that Vladimir Lukin was referring to when he said it would shut down our grid and our communications for six months or so. Indeed, we don't even make those in our country, do we? You order them from overseas. So some of the smaller ones, maybe 18 months or so, and some of the larger ones that long a time. And in a cascading collapse of the grid, we would expect a number of these to be destroyed, would we not?

Mr. DE MARTINI. In a very large—you know, depending on the altitude that as I understand it in terms of where it would be exploded, it could impact a much wider area as you described and so yes, smaller distribution transformers, we actually have a lot of those in stock and those can be done relatively quickly. It is the very large high-voltage transformers that are essentially custom made. Those would be longer and most of that manufacturing is not done in our country.

Mr. BARTLETT. It is all done overseas and you order one and they will make one for us because these are on nobody's shelf including the manufacturer's shelf. They make them when you order them. This is such an incredible consequence that you just shy away from it. You know, it is the old saying if it is too good to be true, it is probably not true, and this is so horrible that maybe it is not true, but the reality is that it could be true. As a matter of fact, there is a new book out called One Second After, and the movie rights have already been sold to the book and it looks at what happens in our country to a—and their story is probably true to what will happen if it happens, and we hope it does not. And by the way, if we are immune to it, it is less likely to happen. Vulnerability invites attack. But the launch comes from the ocean and then the ship is sunk. There are no fingerprints. What do you do? In any event, what do you do when they have simply shut down your computers? And that is what it will do, just fry everything that is microelectronics. And do you then vaporize their grandmothers and their babies because they did that? It is a very difficult thing. You know, if we really are prepared, it won't happen because if we are not vulnerable, there will be no benefit in doing it. So thank you very much for your knowledge of this and hope you take it into account. Thank you very much.

Chairman BAIRD. Dr. Bartlett, my strategy in that eventuality is to come to your place.

Mr. BARTLETT. Thank you, sir. You will be welcome.

Chairman BAIRD. Mr. Tonko.

SUPERCONDUCTION

Mr. TONKO. The application of superconductive cable and the promises that it might hold for dealing with some of our delivery system, our transmission systems primarily, any vision as to when we might be up and ready with the superconductive application?

Mr. DE MARTINI. The discussions we have been having with manufacturers in terms of both cable and transformers in particular, it looks like, you know, the technology is getting to a point where we can start to look at demonstrations within three to five years, particularly on transformation. We think that is a real opportunity to focus on in the near term, and which could lead to products being, you know, put into production into our service, you know, within a decade. So we see a lot of promise there. We already have today superconducting full current limiter that we have put in our system earlier this year. It is one of the first in the country, and we are working with actually American Superconductor.[6] This was part of the award that was announced by Secretary Chu this week, a transmission-level superconducting full current limiter that will be going in our system in 2012. So we see the technology evolving and certainly over the decade we expect to see more of this going into service.

Mr. TONKO. It seems to me we have trouble with the siting of many lines oftentimes which traverses several communities, expectedly. If we can do that with far greater capacity and the same dimension of cable, that we should really speed our investment in R&D, and I know that in New York State there are those companies who are breaking their own records in terms of development of the superconductive opportunity. Thank you.

Chairman BAIRD. Mr. Tonko, thank you.

Dr. Ehlers.

PUBLIC EDUCATION

Mr. EHLERS.—secondary schools both before I got here and after I got here, and it continues to amaze me, I meet parents who say well, I don't see why it is necessary, Johnny already has enough math, he just doesn't—but this is a good example. If you are going to as I suggested earlier put digital devices on every appliance showing what the rate of energy usage is and you have a smart grid where you can also indicate the cost, you also have to have people who know how to use it and who program their thermostats and so forth, and there just has to be a basic level of intelligence and training of the American public if we are really going to make this work. I think also it is very important for the utilities. I think you mentioned that, Mr. De Martini, of trained workers, and I had an experience just in the past six months which surprised me. My wife and I came home, turned on a few lights and she started preparing dinner, and suddenly some lights dimmed, a couple went out and others were working fine. And I said aha, we have lost one phase of our three-phase electricity. So I called the power company, and the first question, she said are your lights out, and I said well, some are, some aren't, and I explained to her that we obviously had lost one phase of the electricity. She had no idea what I was talking about. She says well, we don't send trucks out immediately on a rush unless all your lights are out, and I tried to explain to her again what was going on. I just got nowhere and so I went out of the house, went up and down the street knocking on neighbors' doors and said please call in. She had told us that the more—if they got more calls, then they would send a truck out. And so I knocked on neighbors' doors and said please call this number and tell them your electricity is out, and as a result we got the truck there quicker than we would have before. But it just struck me that an employee of a power company would not, especially when dealing with the public, would not understand someone calling in like that. So at every level we have to have better training includ-

[6] American Superconductor Corporation

ing the general public, but especially your employees in the utilities.

I thank you, Mr. Chairman. That is the end of a very good hearing and I thank you for calling it and thank the panel for being here.

Chairman BAIRD. Thank you.

INTERAGENCY COORDINATION

I do have one last question, and it sort of integrates much of what has been discussed and it is this. It seems to me there is, hopefully, a positive synergy with the team that we see here, but you represent a much broader spectrum, and it is this. So you have got NIST working on standards, private sector working on innovative tools, electrical companies and distribution companies putting all that in place, DOE doing research. Are you comfortable in FERC regulating so much of this? Are you all comfortable that you are working together well enough? In other words, is there cross-pollination and cross-coordination? How is it going?

Ms. HOFFMAN. In my opinion, in working on several programs within the Department of Energy, this has been one of the best working groups I have had to work with.

Chairman BAIRD. Ms. Kelly.

Ms. KELLY. We are very, very satisfied with the way things have been working.

Dr. ARNOLD. The teamwork has been incredible with both the other agencies, federal and State level, and the private sector.

Mr. DE MARTINI. I think for utilities, we have all come together, not just regionally but also across the Nation and working very well with DOE, the regulatory agencies and NIST and this current effort and obviously with our suppliers in terms of these new products and innovations that are coming to the market.

Mr. ROSS. I would just reinforce what the other panelists have said. There seems to be a great deal of coordination among the federal agencies that are involved, and I think there is increased cooperation and participation in and among industry and with the utilities.

Mr. STOESSL. And I will echo with the panel. I think there has always been good cooperation from the utilities and suppliers but with this particular issue with the government involvement that there has to be, there has been very, very good interaction and NEMA (National Electrical Manufacturers Association) has stepped in to really help pull industry together to give us one voice when we are interacting with the various councils, various standard bodies.

Chairman BAIRD. Government, private sector, industry working together. Not a bad way to close the hearing. Thanks very much. Have a great day.

[Whereupon, at 12:09 p.m., the Subcommittee was adjourned.]

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Appendix 1:

ANSWERS TO POST-HEARING QUESTIONS

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ANSWERS TO POST-HEARING QUESTIONS

Responses by Patricia Hoffman, Acting Assistant Secretary, Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy

Question submitted by Chairman Brian Baird

Q1. This May, the House passed the "Waxman-Markey" bill (H.R. 2454) to regulate carbon emissions and promote energy efficiency and renewable energy sources. How does the system of allowances and credits established therein, particularly in the cap-and-trade carbon system, relate to incentives or disincentives for industry to promote smart grid technologies?

A1. Smart grid technologies do not directly cause or reduce emissions of carbon or other greenhouse gases. Thus, the cap-and-trade carbon proposal with its allowances and credits does not provide either incentives or disincentives for smart grid technologies. Smart grid technologies are information and control technologies that can enable more efficient operation of the electricity system from generation to delivery and encourage customers to reduce their electricity consumption, particularly during times when power is relatively expensive. Smart grid technologies can also facilitate the integration of new renewable sources into the grid, thus indirectly supporting the goals of cap-and-trade.

Questions submitted by Representative Daniel Lipinski

Q1. The National Association of Regulatory Utility Commissioners has reported that the most effective place for initial investment in Smart Grid improvements is on the electric grid itself, where energy and costs savings are immediate and do not rely upon changes in customer behavior and do not need customers to purchase and install in-home energy savings devices. During hearing questions, you and Ms. Kelly indicated that you felt that improvements upstream of the customer are worthwhile, other parts of the smart grid are at least as important.

Can you qualify the potential energy savings and costs associated with these two categories of smart-grid technologies? Which will result the greatest savings for residential customers?

A1. The costs associated with upgrading customer systems (meters and load management applications) for integration with a smart grid were estimated at $62 billion, based on a 2004 industry report by the Electric Power Research Institute (EPRI). This estimate, although a bit outdated, fell within an order of magnitude with a 2009 estimate of $40 billion for nationwide implementation of smart meters (Faruqui and Sergici with the Brattle Group, "Household Response to Dynamic Pricing of Electricity—a Survey of the Experimental Evidence," funded in part by Edison Electric Institute/EPRI). The benefits from implementing smart meters with pricing programs with and without in-home energy saving devices are documented in the 2009 report after analyzing the results from the most recent 15 pricing pilot programs. The study concluded that, "Across the range of experiments studied, time-of-use rates induce a drop in peak demand that ranges between three to six percent and critical-peak pricing tariffs induce a drop in peak demand that ranges between 13 to 20 percent. When accompanied with enabling technologies (programmable thermostats), the latter set of tariffs lead to a drop in peak demand in the 27 to 44 percent range." Thus, the peak demand reduction and associated energy savings from customer systems are highly significant, reflecting a non-zero price elasticity of demand for electricity.

The net costs associated with upgrading the transmission and distribution (T&D) grid for smart-grid readiness were estimated to be $165 billion (not including those concurrent investments needed for meeting load growth and correcting deficiencies), from the same 2004 EPRI report. The $165 billion in T&D modernization included a portion of the $62 billion for customer systems above; however, the exact portion was not known. Although the report concluded with an overall benefit to cost ratio of 4:1 to 5:1, the benefit breakdown used a different set of attributes, not those of peak demand reduction and energy savings.

These industry studies evaluate the potential benefits of smart grid technologies deployment based on limited pilots. As part of its *American Recovery and Reinvestment Act* efforts, the Office of Electricity Delivery & Energy Reliability is developing a consistent cost/benefit analysis methodology to be applied to all smart grid projects to assess a broader experience. All cost/benefit data will be stored in the Smart Grid Information Clearinghouse to allow direct, comparative analysis, which will also address the question of what investment would benefit the residential customer most.

Q2. What percentage of the stimulus funds that DOE is awarding goes toward smart grid technologies that improve the efficiency of the electric grid itself, as compared to technologies that produce savings only when consumers change their behavior?

A2. The $3.4 billion in the Recovery Act Smart Grid Investment Grant (SGIG) funding opportunity covers six topic areas: smart grid equipment manufacturing; customer systems; advanced metering infrastructure; electric distribution system; electric transmission system; and integrated and/or crosscutting systems (i.e., covering two or more of the preceding topic areas). The SGIG does not prescribe a funding range for each topic area; rather, all proposals will be evaluated based on their respective merits, including costs and benefits (economic, reliability and power quality, environmental, and energy security) and other performance merits. The selection of these proposals is still under way. The portion of the funding that will be allocated to programs that affect customer behavior, such as dynamic pricing, is not known at this time.

In regard to the approximately $615 million in Recovery Act funds for new Smart Grid Demonstrations, $415 million of the total will support regional demonstrations and the balance will fund grid-scale energy storage demonstration projects. All proposals are still being evaluated, in accordance with the merit-review criteria including savings benefits. Again, it is too early to tell what portion of the $415M will be allocated to dynamic pricing programs.

Question submitted by Representative Lincoln Davis

Q1. During the re-hearing, we discussed the potential savings in power production that could be realized with smart grid deployment. Can you please provide EERE's numbers on this potential savings at peak load or otherwise?

A1. The Federal Energy Regulatory Commission (FERC) issued a report in June 2009 that assessed demand response potential. The study projects that the peak demand in 2019 could be reduced by 44 GW, 100 GW, and 150 GW under the expanded business-as-usual, achievable participation, and full participation scenarios, as compared to the base scenario of business-as-usual. The differences among these scenarios are defined by varying deployment levels of smart grid technologies and practices (advanced metering infrastructure, dynamic pricing offering, enabling technologies, and customer participation in the above). The 150 GW of peak demand reduction in 2019 under a full-participation scenario is equivalent to elimination of the need for 2,000 peaking power plant operations (based on 75 MW of output by a typical peaking power plant) or represents 16 percent of peak demand in 2019.

Peak demand reduction from modernization of the T&D grid will be tracked by DOE through its data collection/analysis efforts to be implemented on all smart grid projects funded under the Recovery Act.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Suedeen G. Kelly, Commissioner, Federal Energy Regulatory Commission

Questions submitted by Chairman Daniel Lipinski

Q1. The National Association of Regulatory Utility Commissioners has reported that the most effective place for initial investment in Smart Grid improvements is on the electric grid itself, where energy and costs savings are immediate and do not rely upon changes in customer behavior and do not need customers to purchase and install in-home energy savings devices. During hearing questions, you and Ms. Hoffman indicated that you felt that while improvements upstream of the customer are worthwhile, other parts of the smart grid are at least as important.

Can you quantify the potential energy savings and costs associated with these two categories of smart-grid technologies? Which will result in the greatest savings for residential customers?

A1. There are significant opportunities for potential energy savings and other benefits that would be enabled by smart grid investments both on the transmission and distribution grid level (that do not involve any actions by customers) as well as on customer premises. It is, however, difficult to quantify these benefits with precision and, therefore, to identify whether one is greater than the other. However, there is evidence that shows that the installation of new systems and devices at customer locations can potentially produce significant energy savings. At the hearing, I cited a recent report by the Commission that estimated that pervasive installations of smart meters and other enabling technologies such as smart thermostats could lead to as much as a twenty percent reduction in peak demand.[1] At the recent GrldWeek 2009 conference, a senior researcher from the Pacific Northwest National Lab reported preliminary results of an ongoing study showing that overall energy savings could be as high as twelve percent.[2] In addition, savings that result from smart grid investments upstream of the customer will likely also be substantial. I therefore believe that both types of investments should be pursued in order to maximize the efficiency of the Nation's transmission and distribution system.

[1] Commission Staff Report, *A National Assessment of Demand Response Potential*, at 27–28 (June 2009), available at *http://www.ferc.gov/legal/staff-reports/06-O9-demand-response.pdf*

[2] See Rob Pratt, PNNL, *Potential Energy and Carbon Benefits of a Smart Grid*, at 3 (Sept. 2009), available at *http://www.pointview.com/data/2009/09/31/pdf/Rob-Pratt-4771.pdf*

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ANSWERS TO POST-HEARING QUESTIONS

Responses by George W. Arnold, National Coordinator for Smart Grid Inter-operability, National Institute of Standards and Technology, U.S. Department of Commerce

Questions submitted by Chairman Brian Baird

Q1. During the hearing, I noted the need for international compatibility with electric appliances. How is NIST coordinating with other nations to ensure global standards for consumer goods and power plugs and sockets?

Q1. NIST recognizes the importance of international compatibility for the various elements of the Smart Grid. The use of internationally accepted standards will enable U.S. manufacturers supplying components to the Smart Grid to access foreign markets on an equitable basis. Extensive use of internationally accepted standards will also help reduce the cost of procurement, while increasing choices for customers looking to source products, components and assemblies for the Smart Grid in the U.S. The lack of common standards can significantly increase the cost for U.S. manufacturers, who would be forced to adapt their products for different countries.

As you have noted, the existing electric infrastructures throughout the world use a variety of voltage levels, plugs and sockets, so there is a need for appliances to have different physical and electrical connections. Unfortunately such differences will continue to exist since it is not practical to rewire plugs and sockets built into the legacy physical infrastructure. However, it is possible to achieve international harmonization of the communications and information management aspects of smart grid applications and products, which are independent of electrical voltage levels and electrical plugs and sockets.

NIST is working closely with relevant international standards organizations, such as the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO), and the International Telecommunication Union (ITU) to ensure that communications and information management standards for smart appliances are internationally harmonized wherever possible. The NIST effort is also engaging many other standards developing organizations domiciled in the U.S. which develop international standards, such as the Institute of Electrical and Electronics Engineers (IEEE), the Internet Engineering Taskforce (IETF), Open Geospatial Consortium (OGC), and others. Numerous multinational companies that have an inherent interest in the adoption and use of international standards are directly involved in the NIST process. Many standards identified in the draft NIST roadmap are international standards that are already used around the world (e.g., BACNet ANSI ASHRAE 135–2008/ISO 16484–5 for Building Automation, IEC 61850 for Substation Automation and Protection, IEEE 1547 for Physical and Electrical Interconnections between Utility and Distributed Generation, ISO/IEC 18012 providing guidelines for product inter-operability, and ITU Recommendation G.9960 covering in-home networking over power lines, phone lines and coaxial cables, etc.).

Recognizing the importance of collaboration with other countries, NIST is also engaged in bilateral discussions with counterparts in other countries and regions about Smart Grid standards. NIST is partnering with the American National Standards Institute (ANSI) to engage the national committees of key countries (China, India, Japan, Russia, Germany) and the European standards body CENELEC in discussions about Smart Grid at the International Electrotechnical Commission (IEC) General Assembly in Tel Aviv, in October 2009. NIST is partnering with its sister DOC bureau, the International Trade Administration, to initiate a dialogue about Smart Grid standards with the European Commission and its relevant offices. Dr. George Arnold, the National Coordinator for Smart Grid Inter-operability, will provide a key note address at the Latin American Smart Grid Forum, in Brazil, and the Smart Grids Asia conference in Singapore in November 2009.

Q2. This May, the House passed the "Waxman-Markey" bill (H.R. 2454) to regulate carbon emissions and promote energy efficiency and renewable energy sources. How does the system of allowances and credits established therein, particularly in the cap-and-trade carbon system, relate to incentives or disincentives for industry to promote Smart Grid technologies?

A2. As outlined in the *Energy Independence and Security Act* (EISA) of 2007 (Public Law 110–140), the National Institute of Standards and Technology (NIST) is responsible for developing a framework for protocols and standards to achieve the inter-operability of Smart Grid devices and system. Inter-operability—the ability of diverse systems and components to work together—is vitally important to both the performance of the Smart Grid and the development of Smart Grid technologies. Given this focused, well-defined role, NIST does not have a position on how the system of allowances relate to the incentives or disincentives for industry.

That said, H.R. 2454 does promote the development of Smart Grid technologies in a number of areas:

- State regulatory authorities and utilities will establish standards and protocols for integrating plug-in electric drive vehicles into the electric grid, including Smart Grid systems.
- Inclusion of Smart Grid technologies and capabilities in the Energy Star program.
- Inclusion of Smart Grid capabilities and potential energy savings information on appliance Energy Usage labels.
- Appliances with Smart Grid features will be eligible for rebates under the Appliance Rebate Program outlined in the *Energy Policy Act of 2005*.

Appendix 2:

ADDITIONAL MATERIAL FOR THE RECORD

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STATEMENT OF KATHERINE HAMILTON
PRESIDENT
THE GRIDWISE® ALLIANCE

Chairman Baird, Ranking Member Inglis, Members of the Subcommittee, thank you for allowing me to submit testimony for your hearing *"Effectively Transforming Our Electric Delivery System to a Smart Grid."* On behalf of the GridWise Alliance, I would like to thank you for your support and attention to our vision and goals, including crafting the Smart Grid Title XIII in the *Energy Independence and Security Act of 2007* (EISA), enacting the *American Recovery and Reinvestment Act* with significant funds for smart grid, and recently passing the *American Clean Energy and Security Act of 2009* which provides incentives for smart grid deployment.

The GridWise Alliance is a coalition of 95 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, manufacturers, consultants, investors, 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, along the distribution lines, and all the way to the meter and appliances and equipment that consume electricity. A smart grid is dynamic and interactive. The smart grid has monitoring, control, and optimization capabilities that manage assets and demand, integrate distributed resources, and route power flows to maximize operation efficiency. All stakeholders on a smart grid can participate and make informed energy choices. Two-way communication allows system operators to observe what is happening on the grid and adjust operations to increase grid reliability while improving delivery and use efficiency. Smart grid technologies can provide increased functionality and intelligence to existing distribution devices. A smarter grid will include a variety of technologies and solutions, depending upon the regional and local systems, as well as the goals of the system.

The GridWise Alliance thinks of a smarter grid as a means to an end—not an end unto itself. A smart grid can increase reliability, improve 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 benefits of wind, solar, geothermal, hydropower, and biomass power. Smart grid technologies can provide more dynamic power flow control, increased bulk transfer and improved system efficiencies.

The GridWise Alliance believes that critical issues for deployment of the smart grid through the Recovery Act funds includes establishing: 1) clear guidelines for funding projects, ensuring the incorporation of the language of EISA as amended in the Recovery Act; 2) an expedited contracting process consistent with the Office of Management and Budget Initial Implementing Guidance for the Recovery Act; 3) a rational approach that fully respects both preexisting Intellectual Property rights and new intellectual property that emerge from the deployment of existing intellectual property in research and development, demonstration or investment projects ; 4) 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) a transparent, but not onerous, process for monitoring allocations among different types of smart grid endeavors and altering new allocations to secure balance as appropriate in light of the overall Recovery Act and EISA objectives.

Since the purview of this committee includes National Institute of Standards and Technology (NIST) oversight, the GridWise Alliance agrees that the Recovery Act appropriately funded development and harmonization of critical inter-operability standards framework through NIST. In EISA, NIST was given an unfunded mandate to develop a framework for smart grid standards; the Department of Energy (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 inter-operability that could be used as a foundation in developing standards. While some of the groundwork had begun before the Recovery Act was passed, the generous funding and aggressive support of the NIST process has been critical.

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 transfer easily to smart grid inter-operability standards with the funding in place. Dr. George Arnold, the National Coordinator for Smart Grid Inter-operability, is fully engaged in the process and the GridWise Alliance believes that NIST is on the right track in developing this standards process. The Alliance has participated by attending the meetings as well as providing detailed comments from the industry perspective.

The inter-operability process will benefit from and be accelerated by stimulus funding for projects. Since utilities and others deploying smart grid technologies want to reduce the risk of stranded asset investments, they are driving early inter-operability standards development in domain expert work groups that feed into the NIST process. They are also designing deployments such that firmware and software could be revised, usually remotely, rather than change out entire equipment investments. This is common practice in other industries and is an effective means of driving deployment without excessive redeployment cost once the standards are finalized. Finally, the industry recognizes that standards should be applied where they are relevant, cost effective and appropriate to the intended function of the system. Too many times, we tend to assume all standards apply everywhere. Through the many industry domain working groups, the industry has established standards that are applicable for certain uses. Additional work will be needed to assess the cost effectiveness of those standards during deployment. It may be in the best interest of energy costs to phase in additional standards over time rather than replace legacy systems to accommodate new standards.

The GridWise Alliance prefers open standards and protocols so that all players are enabled equal accessibility to compete in the market. Because of the increased scrutiny on cyber security and data privacy issues, certain criteria in developing technologies are critical. Industry has been collectively engaged in this process 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 advance of the NIST standard setting process. We do not want to hold up these efforts that can, among numerous other benefits, stimulate the economy, by waiting for standards to be developed and adopted.

We agree that cyber security issues are paramount and should be carefully addressed 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 and operational IT to ensure grid reliability. Strong access control, secure authentication, confidentiality, integrity, monitoring and non-repudiation mechanisms have existed for many years and can be applied to securing the smart 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 have already been installed in many transmission substations; smart grid investments will serve to upgrade cyber security for these systems. The GridWise Alliance supports the coordination of the Federal Energy Regulatory Commission (FERC), North American Electric Reliability Corporation (NERC), and the National Association of Regulatory Utility Commissioners (NARUC) with the Department of Homeland Security and industry efforts as critical to the development of cyber security standards.

Smart grid can be implemented differently in different places. The design and implementation of a smart grid can vary 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 allow consumers to make energy choices and to allow utilities to have 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 and in what order the various applications are to be developed to meet strategic roadmap objectives.

The GridWise Alliance believes that implementing smart grid technologies on the current grid will provide a multitude of benefits—from helping alleviate congestion and integrating distributed renewable energy, more efficiently managing both the transmission and distribution systems, and engaging consumers with information exchange and new pricing programs. 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. New transmission coupled with smart grid applications like dynamic forecasting and energy storage can enhance the ability to deploy renewable energy and distributed generation sources onto our grid.

While the electric grid has the same basic mechanical 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 need for distribution system monitoring and control because of radial nature of their systems. A municipal utility may need to contain costs and have consumers adjust demand using rate incentives and smart meter technologies. A data center may require redundancy and increased 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 offices, and Department of Energy Industrial Assessment Centers. Many universities—like Florida State, George Mason University, Northern New Mexico College, University of Colorado, Washington State University, and North Carolina State University, as well as many community colleges and trade centers—have smart grid technology research and education programs. Edison Electric Institute has worker training centers as does the International Brotherhood of Electrical Workers (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, efficient, more reliable, and freer of carbon.

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 available today that creates benefits for our grid, we can continue to enhance these applications through research and development and demonstration. Research and development does not end when commercialization begins, but can continually improve performance, price, and other benefits from any given technology. Smart grid demonstration projects can serve to both spur widespread investment in these technologies and, as well as to provide greater clarity of the need for any additional research and development. Certainly continued robust funding for this research beyond the stimulus funds will be important to the continued development of new technologies for our grid.

The full benefits of a smart grid will not be realized without allowing the consumers to make 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 energy consumption information or price signals, education, and technological assistance. Because our electric system is so ubiquitous and robust, we take it for granted when we flip the light switch on the wall. Electricity has become an integral part of our lives and a necessity for our nation's economic growth, prosperity, and our personal lifestyles and well-being. Most people do not 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 in states like California and Texas 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.

There are many knowledge gaps the GridWise Alliance has identified in the implementation of a smart grid that perhaps House Science Committee could take under consideration.

- One such gap is an understanding of how consumers respond to continuous requests to curtail demand and how a multitude of participants on the grid will figure into implementing smart grid technologies;
- Another gap is in understanding how transmission and distribution markets will establish a common basis for regulatory innovation to support smart grid deployment;
- We will need to have an ability to quantify smart grid benefits in order to demonstrate economic benefits, energy efficiency, and operational flexibility as well as customer service, outage management and enhanced emergency operations;
- We will need to understand the framework for system inter-operability between new smart grid communications and markets and existing systems;

- We will need measurements to understand how demand side controls impact the supply side during outages;
- We also need to know what regulatory support will be necessary to provide meaningful demand response as renewable generation increases;
- Another gap exists in understanding what is needed to protect customer data privacy in a two-way communications system; and,
- Finally, we will need more research to understand new digital transmission monitoring systems evolve into control systems and how these smart grid monitoring systems allow for lower reliability risks at the interconnection level.

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. We also expect that the projects will be spread around the country to see how smart grid differs by location. These projects should stimulate economic growth—by helping utilities retain jobs, by spurring offshoot industries, and by increasing jobs through installation of clean energy technologies. These projects are also expected to further technological advancement and spur greater investment in grid modernization and automation. 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 in legislation that involves our electricity system, as they were in the *American Clean Energy and Security Act.* We will work with the House Science 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 included in energy and climate legislation will help those goals to be met. The House Science Committee is uniquely qualified to ensure that the research and development process for our evolving grid is managed in a way that can transform the way in which we think about and use energy. Our Alliance is always available to help define what policies are important to the deployment of smart grid and we can provide expert guidance as you move forward with your policy initiatives. We thank you for allowing our voices to be taken into consideration; we look forward to working closely with this committee.

STATEMENT OF GORDON W. DAY, PH.D.
2009 PRESIDENT,
THE INSTITUTE OF ELECTRICAL AND
ELECTRONICS ENGINEERS—UNITED STATES OF AMERICA
(IEEE–USA)

On behalf of nearly 210,000 engineers, scientists and allied professionals who are IEEE's U.S. members, which includes many who are responsible for designing, building and operating the Nation's electric delivery system, IEEE–USA appreciates the opportunity to provide input to the Subcommittee for its hearing to highlight the critical issues involved in transforming the electric power delivery system into a Smart Grid. Our comments will focus on the overall needs and opportunities associated with this transformation, with a specific focus on associated workforce, cyber security and standards issues.

Why the Smart Grid Transformation is Essential

Today, the U.S. electric grid is a network of 10,000 power plants, 150,000 miles of high-voltage (>230 kV) transmission line, millions of miles of lower-voltage distribution lines, more than 12,000 substations and millions of customers. Our national electric power system is comprised of two key infrastructures:

- An electric infrastructure—that generates and carries the electric energy in the power system, and
- An information infrastructure that monitors, controls, and exchanges information between the utility and the customer.

Over recent decades, the grid has been severely stressed by increases in electric demand and a declining rate of new investment. Since 1982, growth in peak demand for electric power has exceeded growth in transmission capacity by almost 25 percent every year. The result is grid congestion and higher transmission losses, which can result in higher rates for electricity and lower reliability. The Department of Energy recently estimated that the cost of power outages ranges from $25 billion to $180 billion annually. The increasingly complex and competitive bulk power market is also adding additional stresses to the grid. Inadequate capacity, control and reliability are impediments to the deployment of new sources of alternative energy and limit our ability to increase the use of electricity in transportation.

Transforming the existing electric power system into a Smart Grid is essential to mitigating these problems and promises several important political, economic, and environmental benefits for the Nation:

- By supporting the interrelated goals of price transparency, clean energy, efficiency, grid reliability and vehicle/transportation electrification, a Smart Grid will help reduce the Country's dependency on imported oil.
- Enabling the real-time pricing of electricity will allow consumers to make informed decisions about their energy usage and reduce their energy costs.
- Providing the information and control needed to better manage electrical demand will help facilitate the integration of alternative energy sources by providing a means to help mitigate the variability caused by their intermittency, as well as enabling increasing electrification of our transportation sector including the integration of plug-in hybrid electric vehicles into the grid.
- Greatly expanding the connection of end-user loads to grid information and control will facilitate energy efficiency improvements.
- Adding intelligence (including sensors, communications and software systems) to our electric grid will enhance the ability of systems operators to detect and address problems before they become widespread grid disturbances, limiting the effects of disruptions and significantly improving the system's overall efficiency and reliability.

There are also likely to be numerous benefits of having a Smart Grid that are difficult to quantify at present. Examples include the flexibility to accommodate new requirements, the ability to accommodate advances in grid and electric generation technology, and the ability to support innovative new regulatory concepts, all without major replacement of existing equipment.

Congress and the Administration recognized Smart Grid's potential by passing the *Energy Independence and Security Act* (EISA) of 2007 into law. Title XIII of the EISA Act mandates a Smart Grid that is focused on modernizing and improving the information and control infrastructure of the electric power system. The Smart Grid encompasses the information and control functionality that will monitor, control, manage, coordinate, integrate, facilitate, and enable achievement of many of the benefits of innovations envisioned in national energy policy.

Making an Effective Transformation

In our 2009 National Energy Policy Recommendations (*http://www.ieeeusa.org/policy/positions/energypolicy.pdf*), IEEE–USA outlines the following Smart Grid-related recommendations for governmental action, which we believe are essential to make the transition to a stronger and smarter electrical energy infrastructure:

- Fully funding previously authorized EISA legislation to support the Smart Grid development effort.
- Supporting development of reference implementations (field test) of Smart Grid standards to help rapidly resolve technical issues and ambiguities either prior to or immediately following adoption by Standards Developing Organizations (SDOs).
- Working with Standards Developing Organizations to help them address issues that delay development of Smart Grid standards or act as barriers to their widespread deployment.
- Working with State regulators, the National Association of Regulatory Utility Commissioners, and the Federal Energy Regulatory Commission Smart Grid Collaborative to resolve issues of ratepayer involvement, especially for standards having benefits focused on national security and energy independence issues.
- Providing R&D funding to address issues regarding implementation of Smart Grid functionality by technologically or economically challenged residential customers. Some Smart Grid technologies may require residential customers to acquire and use relatively sophisticated devices. R&D will be needed to design user-friendly devices, minimize their cost, and identify Smart Grid concepts that best match the capabilities of users of all capabilities.
- Coordinating Smart Grid development efforts with advanced broadband deployment. Coordination of these efforts is essential to insure that the evolving broadband infrastructure is available and can support Smart Grid communication requirements.
- Devoting necessary attention and adequate resources to the issue of cyber security for Smart Grid control systems and software. Increasing our reliance on the Smart Grid's information infrastructure also increases the risk of malicious cyber attack and potentially increases the consequences of a successful attack. Examples of potential attackers include hostile foreign governments, organized crime, terrorists, market manipulators, and disgruntled employees. In recent years, cyber security in electric power systems has received increased attention at the federal level. The North American Electric Reliability Corporation (NERC) has adopted Critical Infrastructure Protection (CIP) standards enforceable under the 2005 *Energy Policy Act*. EISA 2007 mandates cyber security throughout the Smart Grid. A high level of continued focus on cyber security is warranted.

The Importance of Standards and IEEE's Role

A key focus of the Smart Grid effort will be to identify the requirements for the new information and communications infrastructure needed to support the Smart Grid and to define a body of compatible (inter-operable) standards to be used in its implementation. From an operational perspective, standards will be needed to enable the Smart Grid to meet a variety of new requirements, including integrating renewable energy sources, supporting new market concepts, helping improve energy efficiency, and accommodating new uses of electricity such as plug-in hybrid electric vehicles. Multiple standards stakeholder organizations are being leveraged to help define these key infrastructure requirements, which will enable a successful Smart Grid implementation by industry and regulatory authorities.

IEEE is active in supporting the technologies and setting the standards necessary for the evolution and deployment of the Smart Grid. IEEE was identified as a key organization in the EISA 2007 and has been part of the NIST Smart Grid standards effort since its 2008 initiation. IEEE experts have been continuously involved in the NIST workshops and will lead multiple breakout sessions including Electric Storage Interconnection and Wireless Communications for the Smart Grid during the 3–4 August NIST workshop.

IEEE is uniquely positioned to support the Smart Grid program because:

- IEEE leverages the global expertise and synergy of its broad spectrum of organizational resources. IEEE integrates 44 technical societies and councils supporting technology development, education, publication, in synergy with a global standards community.
- IEEE Standards Association enables technology integration across a spectrum of fields, necessary for a forward looking platform, e.g., power, communications, digital information management controls technology, networking, security, reliability assessment, interconnection of distributed resources including renewable energy sources to the grid, sensors, electric metering, broadband over power line, and systems engineering.

As part of its new technology development effort, IEEE has mobilized its various constituencies into a coordinated Smart Grid effort, which includes a spectrum of activities and initiatives such as technical publications (i.e., "IEEE Transactions on Smart Grid"), conferences, education, and industry recognized standards.

In March of this year, a new project focused on the smart grid was approved by the IEEE Standards Board: IEEE P2030, Guide for Smart Grid Inter-operability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads under the leadership of Dick DeBlasio and the sponsorship of a cross IEEE Standards Coordinating Committee (SCC21). This project addresses a body of IEEE 2030 standards supporting functional, inter-operability, and testing for verification of Smart Grid attributes and end use applicability. This project will leverage the work NIST is conducting in developing a standards framework. The first meeting was held in June 2009 involving over 300 participants, both on-site and remote. This program is projected to support the NIST September Smart Grid report. More information is available at the following web site: *http://grouper.ieee.org/groups/scc21/2030/2030_index.html*

The "NIST-Recognized Standards for Inclusion in the Smart Grid Inter-operability Standards Framework Release 1.0," incorporated several IEEE standards and standards series:

- IEEE C37.118 Phasor measurement unit (PMU) communications
- IEEE 1547 Physical and electrical interconnections between utility and distributed generation (DG)
- IEEE 1686–2007 Security for intelligent electronic devices (IEDs).

Other IEEE standards and standards projects are referenced in the EPRI "Report to NIST on the Smart Grid Inter-operability Standards Roadmap," e.g., the IEEE 802™.

The Workforce Component

The U.S. engineering and technician workforce is not yet prepared for planning, building, operating and maintaining a Smart Grid. This will make it difficult to realize the promised benefits of a Smart Grid soon. The aging workforce is a major concern. Nearly 50 percent of engineers and technicians currently employed in the electric utilities and over 40 percent of the university power engineering faculty is eligible to retire in the next five years. Increased and effective efforts are needed to attract young people to power and energy careers, and to becoming our next generation of educators.

The vision is that Smart Grid technologies will become widely implemented in our nation's electricity delivery system. As a result, federal policies must support education and training in the electricity delivery field:

- to prepare an engineering and skilled trades workforce that has the necessary knowledge and skills to design, plan, construct, operate, and maintain a modern electricity delivery system, including power system infrastructure , and information systems, as well as to manufacture the necessary components of that system,
- to enable retraining that will allow unemployed and under-employed workers in other fields to find new job opportunities in electricity delivery, and
- to enhance, build and sustain the education infrastructure at accredited educational institutions, including community colleges and universities, offering credit and non-credit education in electric power and energy.

A Smart Grid is transformative technology for the electric power industry. Our nation's educational institutions have to be transformed to respond to this technology advance. The Smart Grid will require engineers, computer scientists, and technicians among others who possess new and enhanced skill sets in information technology, communications, alternative energy resources, cyber security and other relevant technical fields. This workforce also must be prepared to be highly innovative. Most of the benefits of a Smart Grid will come through new applications that are not yet envisioned or developed.

Appropriate curricula need to be developed. To develop those curricula effectively, a comprehensive study is needed to identify the new workforce skills for successful deployment of a Smart Grid and the training needed to equip the workforce with those skills. New and innovative ways of delivering these curricula need to be developed to meet the wide-ranging needs of learners. Support is also needed to increase access to these new education programs through increased financial assistance, and through effective and widespread communication of training opportunities throughout the Nation.

The *American Reinvestment and Recovery Act* (ARRA) of 2009 (P.L. 111–5) anticipated the need for preparing the workforce for a Smart Grid by appropriating $100 million for "worker training activities" related to electricity delivery and energy reliability funded through the Department of Energy. These funds should be used for putting in place the critical education infrastructure that supports job creation, professional development, career advancement, and workforce mobility. IEEE–USA's recommendations for the use of these funds can be found at *http://www.ieeeusa.org/policy/positions/electricityworkforce.pdf*

Conclusion

The engineers, computer scientists and associated technical professionals responsible for creating the Smart Grid will do their part to ensure the Smart Grid is designed, built and operated to maximum advantage.

The Federal Government can ensure an effective transition by bringing key stakeholders and participants together as needed to ensure consensus and collaboration on key decisions, by encouraging the development of the needed standards, and by supporting research and development needed to develop necessary technology, address user needs, and ensure the security of the system. New standards will provide the foundation on which the Smart Grid must be built. To make sure that a well-trained engineering and technical workforce is available to build and sustain the Smart Grid, targeted investments should be made in education and training on the Smart Grid combined with broad support for STEM workforce development.

IEEE, through its standards, technical publications, conferences and members will play a key role in supporting efforts to create Smart Grids in the United States and in other countries around the world. Working through IEEE–USA, we stand ready to assist Congress and the Administration with information and advice as you wrestle with Smart Grid-related issues for the Nation.

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