

Testimony of

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“Effectively Transforming Our Electric Delivery System to
a Smart Grid”

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Introduction

Chairman Baird, Ranking Member Inglis, and Members of the Subcommittee, I am George Arnold, the National Coordinator for Smart Grid Interoperability 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 interoperable 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A Smart Grid would replace the current, outdated system and employ real-time, two-way communication technologies to allow users to connect directly with power suppliers.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

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

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 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.

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

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 interoperability 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 interoperability 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 1 - 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 1 began in April and will conclude in September with the publication of Release 1.0 of the NIST Interoperability 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 Interoperability 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 interoperability 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.

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

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 Interoperability 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 interoperability standards, including cyber security; an initial set of standards to support implementation; and plans to meet remaining standards needs.

Phase 2 - 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, 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 Interoperability Standards Panel to serve this function.

Phase 3 - 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 interoperability 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 interoperability 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 interoperability 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 interoperability 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 interoperability 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 interoperability. 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 Interoperability 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 International⁴ is developing the standards for the connector on the vehicle and the associated charging system; IEEE⁵ 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

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.

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 lifecycle 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 cannot 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 interoperability. I would be happy to answer any questions you may have.