

Testimony of

George W. Arnold

National Coordinator

For Smart Grid Interoperability

National Institute of Standards and Technology (NIST)

United States Department of Commerce

Before the

Subcommittee on Technology and Innovation
Committee on Science, Space, and Technology
United States House of Representatives

“Empowering Consumers and Promoting Innovation through
the Smart Grid”

September 8, 2011

Introduction

Chairman Quayle 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. I last testified about our progress and plans before the Subcommittee on Technology and Innovation on July 1, 2010.¹ Today, I would like to update you on our accomplishments, where we are going, and some of the key actions needed to ensure protection of consumer interests, including cost and privacy, while driving innovation within Smart Grid development.

The Smart Grid, which will modernize the United States electric power delivery system, is central to the Nation's efforts to increase the reliability, efficiency and security of the electric delivery system and also to help build the infrastructure that will facilitate clean energy sources to American homes and businesses. The Smart Grid utilizes advanced information and communications technologies to enable a two-way flow of electricity and information. This marriage of energy and information technologies will create capabilities to make the grid more efficient by reducing demand peaks and increasing capacity utilization and providing consumers with tools to reduce energy usage and potentially save money. It can also increase reliability, enable more widespread use of distributed and renewable energy sources, and facilitate electrification of vehicles.

The Smart Grid is an important contributor to the Administration's overall goal of fostering innovation and creating jobs in a clean energy economy through policies that catalyze private sector investments to modernize the nation's electrical infrastructure. NIST's mission - to advance innovation and U.S. industrial competitiveness - fits well with this goal, and we are committed to helping make that vision a reality. As former Commerce Secretary Gary Locke noted, "If we get this right ... if government and business can team up effectively ... we have an almost unprecedented opportunity to change how we use electricity, reduce greenhouse gas emissions, and create new jobs in an emerging industry."²

Modernizing and digitizing the nation's electrical power grid—the largest interconnected machine on Earth—is an enormous challenge and a tremendous

¹ Testimony of George Arnold before the House Committee on Science and Technology Subcommittee on Technology and Innovation United States House of Representatives, July 1, 2010, *available at* <http://gop.science.house.gov/Media/hearings/ets10/july1/Arnold.pdf>

² Commerce Secretary remarks at Jobs and Competitiveness Round Table, Durham, NC, June 13, 2011, *available at* <http://www.commerce.gov/news/secretary-speeches/2011/06/13/remarks-jobs-and-competitiveness-round-table-durham-north-carolin>

opportunity. Several years ago, the National Academy of Engineering described electric power and the electric grid as the greatest engineering achievement of the 20th century, and the largest industrial investment in the history of humankind.³ The basic structure of the present grid has changed little over its hundred-year history. The U.S. grid, which is operated by over 3200 electric utilities using equipment and systems from hundreds of suppliers, has historically not had much emphasis on interoperability or standardization, and thus has incorporated many proprietary interfaces and technologies that result in the equivalents of stand-alone silos.

The successful transformation of this infrastructure into an interoperable system would support the Administration's vision of a highly reliable electrical grid that uses a diverse suite of energy resources, including distributed and renewable resources, energy efficiency, and supports electric vehicles. This 21st century grid would be a significant engineering achievement with important economic and environmental impacts.

NIST's Standards Role: A Framework for Interoperability

A nationwide, interoperable and secure Smart Grid would optimally be harmonized with international standards. Under the Energy Independence and Security Act of 2007 (EISA), Congress assigned the NIST the "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of Smart Grid devices and systems..." [EISA, Section 1305]. That Act further specifies that the interoperability framework should be "flexible, uniform, and technology neutral." Congress instructed that the framework should accommodate "traditional, centralized generation and transmission resources" while also facilitating incorporation of new, innovative technologies, such as distributed and renewable energy resources and energy storage.

NIST is providing national and international leadership to drive the creation of interoperability standards needed to help make the Smart Grid a reality. We are engaging industry, government, and consumer stakeholders in an open and public process. We have published a first Release of a standards framework for the Smart Grid,⁴ are nearing the completion of a second Release, and, together with the private sector, have made significant progress in creating an ongoing public/private partnership that will provide a process for the continuing development and maintenance of Smart Grid standards needed to support the electric grid for decades to come.

³ Nat'l Acad. Eng., *Greatest Engineering Achievements of the 20th Century* (2003), available at <http://www.greatachievements.org>.

⁴ NIST Special Publication 1108, "NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0," January 2010, available at http://www.nist.gov/public_affairs/releases/upload/smartgrid_interoperability_final.pdf.

Our work to establish protocols and standards for the Smart Grid has been carried out with a great sense of urgency. Deployment of various Smart Grid elements, including smart sensors on distribution lines and smart meters in homes, and of distributed sources of renewable energy is already under way, and has been accelerated as a result of Department of Energy (DOE) Smart Grid Investment Grants and Smart Grid Demonstration Projects and other programs supporting renewable energy generation. Without standards, there is the potential for technologies developed or implemented with sizable public and private investments to become obsolete prematurely or to be implemented without measures necessary to ensure security.

While we are driving this program with a strong sense of urgency, we must also keep in mind that the foundation we lay with these standards likely will establish the basic architecture of the grid for decades. Any fundamental mistakes made at this stage may be difficult and costly to correct later. We especially cannot afford to make incorrect architectural choices or adopt weak standards that would compromise the security, reliability or stability of the grid. We need to work both quickly and carefully.

I would like to provide a brief overview of our efforts and accomplishments to date.

In April 2009, NIST announced a three-phase plan to carry out its EISA responsibilities. In May 2009, the Secretaries of Commerce and Energy convened a meeting of nearly 70 top executives from the power, information technology, and other industries, and asked those executives whether their organizations would commit to support the process established by NIST.

The NIST process had three phases:

- Phase 1, which took place from April 2009 to January 2010, engaged stakeholders in a participatory public process to identify applicable standards and requirements, gaps in the currently available standards, and priorities for additional standardization activities.
- Phase 2, which began in November 2009 and is ongoing, established a public/private partnership called the Smart Grid Interoperability Panel (SGIP) to continue development of interoperability standards and drive longer-term progress.
- Phase 3, which is also ongoing, is developing a testing and certification framework for Smart Grid standards.⁵

⁵ Opening Remarks of George Arnold, Smart Grid Interoperability Standards Technical Conference, held on 1/31/11 at FERC Headquarters *available at:* http://elibrary.ferc.gov/idmws/File_list.asp?document_id=13888084

The NIST plan has received broad support and active participation from industry. In a letter, the U.S. Chamber of Commerce commended NIST for its “willingness to reach out to the private sector on these issues.” The Chamber described the NIST-led process as “transparent and inclusive.”⁶

In January of 2010, the NIST-led process reached a major milestone with the publication of the Release 1.0 Framework and Roadmap for Smart Grid Interoperability (NIST Special Publication 1108).⁷ This document provides an initial foundation for an interoperable and secure Smart Grid and has been widely cited by the Smart Grid stakeholder community, both domestically and internationally. The Release 1.0 Framework described a high-level conceptual reference model for the Smart Grid, identified 75 existing families of standards that are applicable to the ongoing development of the Smart Grid, and specified 16 high-priority action plans to fill gaps in the standards portfolio with new or revised standards.

Another significant milestone in the development of the NIST framework was the publication of NIST Interagency Report (IR) 7628, “Guidelines for Smart Grid Cyber Security”, in September 2010.⁸ This three-volume document, which has also been widely cited by industry and regulators, provides the foundational requirements and guidance for efforts to ensure cybersecurity in the Smart Grid.

The Smart Grid Interoperability Panel (SGIP), established by NIST in November 2009, is a public/private partnership. The SGIP provides a mechanism for NIST to “solicit input and cooperation from private entities and other stakeholders,” as directed by EISA. In the long term, NIST envisions that the SGIP will mature into a permanent, stand-alone organization that will support the continuing evolution of the Smart Grid standards framework after NIST’s EISA-directed coordination role has been completed.

During its first two years of operation, the SGIP has focused its efforts on establishing processes and procedures for its work; overseeing and expediting the completion of the Priority Action Plans established in the NIST Release 1.0 Framework; creating additional action plans as needed; developing the cybersecurity guidelines for the Smart Grid including a methodology for reviewing the cybersecurity aspects of standards; and developing a testing and certification framework.

Membership in the SGIP has grown to over 680 organizations, including private companies, universities, research institutes, industry associations, standards setting

⁶ U.S. Chamber of Commerce’s Response to Notice requesting public comments on the second draft of NISTIR 7628, the Smart Grid Cyber Security Strategy and Requirements (75 Federal Register pages 18819-18823 at <http://edocket.access.gpo.gov/2010/pdf/2010-8415.pdf> Docket Number: 100202060-0143-01). Comments available at: <http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/NISTIR7628Draft2CommentsReceived>

⁷ *Supra*, note 3.

⁸ Available at <http://csrc.nist.gov/publications/PubsNISTIRs.html#NIST-IR-7628>.

organizations, testing laboratories, and government agencies at the Federal, state and local levels. Almost 1800 individuals participate in the committees, working groups, and priority action plan teams working under the panel, representing these hundreds of organizations. An elected 27-member governing board, representing 22 different stakeholder groups, including electric utilities, electric equipment manufacturers, building automation providers, information and communications technology companies, state regulators, and venture capital firms, oversees the SGIP.

While the vast majority of participants in the SGIP are from the private sector, members of NIST's technical staff and management also play a role as technical contributors and leaders in the various boards and committees of the SGIP, working alongside their private sector counterparts. The NIST participants bring to the SGIP technical expertise in standards and measurement science in the areas of power engineering, information technology, industrial control systems, building energy management, communications, and cybersecurity.

The international partnerships that NIST has built with the governments of other countries have resulted in global recognition of SGIP's role. The SGIP provides a forum for international collaboration on smart grid standards development. The number of international participants in the SGIP has increased significantly over the last year and these efforts are designed to reduce barriers to trade in smart grid technologies and services around the world. International coordination on smart grid standards will help drive international trade and investment in this fast growing sector and U.S. exporters of smart grid products will benefit as a result.

The SGIP has achieved many significant accomplishments since its formation. I would like to highlight a few.

The SGIP has been executing 19 priority action plans to fill standards gaps (three were added to the original 16 identified in the Release 1.0 NIST framework). These action plans have resulted in a number of key standards deliverables, which include:

- A Smart Meter Upgradeability Standard, published by National Electrical Manufacturers Association, that will ensure that many of the large number of meters to be installed over the next several years can be upgraded to accommodate anticipated updates to metering standards.
- Internet Engineering Task Force Request for Comments (RFC) 6272, which specifies the various Internet protocols to be used in the Smart Grid.
- Publication of NIST IR 7761, which provides guidelines for utilities and their suppliers to assess wireless communications standards for use in various Smart Grid applications.
- A customer energy usage information data standard, published by the North American Energy Standards Board (NAESB), that enables entrepreneurs to

develop third party applications to help customers to monitor their energy usage and save money.

- The selection of three standards published by Society for Automotive Engineers (SAE) International to support electric vehicle charging.
- Publication of an “SEP 1.x to 2.0 Transition and Coexistence” guideline, which will ensure that millions of meters that have already been deployed using early versions of the Zigbee Smart Energy Profile (SEP) will be able to interoperate with future IP-based home area networks. This is especially important to states like Texas that have pioneered in the early deployment of smart meter technology.

Another key early deliverable from the SGIP is the Catalog of Standards,⁹ containing descriptive information about standards deemed relevant to the Smart Grid through the SGIP’s consensus process. This catalog will provide key input to future releases of the NIST framework.

A critical element of the SGIP’s process is a cybersecurity review of each standard considered for inclusion in the catalog. The SGIP Cybersecurity Working Group, which is chaired by a NIST staff member, reviews each candidate standard against the requirements in NIST IR 7628 to identify potential vulnerabilities and necessary mitigation actions.

Phase 3 of the NIST plan is the development of a testing and certification framework for the Smart Grid. In December 2010, the SGIP Testing and Certification Committee, which is co-chaired by a NIST staff member, published the “Interoperability Process Reference Manual, Release 1,”¹⁰ providing an important foundation for this phase of the plan. This document specifies the structure and processes for testing and certification programs relevant to the Smart Grid. To date, five private sector organizations have announced testing and certification programs conforming to this guide. The most recent such program, established by a consortium of four industry alliances to test and certify using the Smart Energy Profile 2.0 protocol, will certify interoperability of consumer appliances with the Smart Grid to reduce or delay energy usage when the grid is overloaded.

NIST is in the process of updating the Smart Grid framework based on work carried out since Release 1.0 was published in January 2010. NIST has posted a draft of Release 2.0¹¹ and invited public comments, and we anticipate publication of Release 2.0 by the end of 2011.

⁹ Available at <http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIPCoSStandardsInformationLibrary>

¹⁰ SGIP Interoperability Process Reference Manual, Version 1.0, available at: http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGTCCIPRM/SGTCC_IPRM_Version_1.0_Updated.pdf.

¹¹ Available at <http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/IKBFramework>.

NIST's work on the Smart Grid has been enabled by funding from both the American Recovery and Reinvestment Act of 2009¹² (Recovery Act) and NIST's annual appropriations. The Recovery Act funds totaled \$17 million, including \$12 million provided by DOE and an additional \$5 million from Recovery Act funds appropriated directly to NIST. More than half of NIST's work through the end of FY11 was supported by the Recovery Act funds, which will have been completely expended by the end of this fiscal year.

To support the NIST Smart Grid program, Congress has appropriated a total of \$2.3 million in FY09, \$5 million in FY10, and \$8.3 million in FY11. The FY12 President's Budget sustains NIST's Smart Grid efforts by providing funding to accelerate development of needed standards through priority action plans, establish the testing and certification framework, and ensure smart grid cybersecurity standards and guidelines stay ahead of evolving threats.

A significant portion of NIST's Smart Grid budget has been used to fund private sector contractors that support the administration and operation of the SGIP. In the long term, our vision is for the SGIP to mature into an independent organization, funded primarily by the private sector that will continue to support the evolution of the Smart Grid standards framework after NIST's EISA coordination role is complete. However, it will take several years for the SGIP to develop a business model and private sector funding sources that are self-sustaining.

To guide future planning for NIST's work on the Smart Grid, NIST established a Smart Grid Federal Advisory Committee in September 2010. The first report of this committee is expected in November of 2011, and it will provide important input to guide the longer-term direction for NIST's Smart Grid work.

Engagement with Regulators

EISA directs FERC to "institute a rulemaking to adopt such standards and protocols as may be necessary to insure smart-grid functionality and interoperability in interstate transmission of electric power, and regional and wholesale electricity markets" at any time after NIST's work has led to "sufficient consensus" in the Commission's judgment.

The development and adoption of standards for the Smart Grid is an unprecedented, complex undertaking. In the past, few, if any, interoperability standards have been adopted in regulation for national infrastructures such as the electric grid, the telecommunications system, or the Internet. The vast majority of standards in these and many other industries are used on a purely voluntary basis, without government regulatory action. Similarly, voluntary consensus interoperability standards may be sufficient in many cases to insure the functionality and

¹² Pub. L. No. 111-5, available at <http://www.gpo.gov/fdsys/pkg/PLAW-111publ5/pdf/PLAW-111publ5.pdf>.

interoperability of the Smart Grid in interstate power transmission and regional/wholesale electricity markets, without government regulation.

In the first exercise of its type under EISA, NIST notified FERC in October 2010 that it had identified five families of existing voluntary consensus standards as ready for consideration by regulators.¹³ To invite public discussion of whether there were sufficient consensus to institute a rulemaking proceeding, FERC hosted a Technical Conference on January 31, 2011, followed by a supplemental notice on February 16, 2011 soliciting written comments from interested parties.¹⁴

On July 20, 2011, FERC issued an Order,¹⁵ in which it found that there was insufficient consensus to institute a rulemaking proceeding at that time to adopt the initial five families of standards. At the same time, FERC's Order expressed support for the NIST process:

“We believe that the best vehicle for developing smart grid interoperability standards is the NIST interoperability framework process, including the work of the SGIP and its committees and working groups. . . . The Commission recognizes and appreciates the comprehensiveness of the smart grid interoperability framework process developed by NIST. . . . Therefore, we encourage utilities, smart grid product manufacturers, regulators, and other smart grid stakeholders to actively participate in the NIST interoperability framework process to work on the development of interoperability standards and to refer to that process for guidance on smart grid standards.”¹⁶

NIST believes that FERC's action is consistent with NIST's public comments to the Commission that it can send appropriate signals to the marketplace by recommending use of the NIST Framework.¹⁷

FERC's decision is also consistent with the Administration's "Policy Framework for a 21st Century Grid,"¹⁸ released on June 13, 2011, which recommended to FERC that in

¹³ NIST letter to FERC Chairman Jon Wellinghoff, October 6, 2010, *available at*: http://www.nist.gov/public_affairs/releases/upload/FERC-letter-10-6-2010.pdf

¹⁴ Federal Energy Regulatory Commission (FERC) Notice of Technical Conference re Smart Grid Interoperability Standards under RM11-2. December 21, 2010, *available at*: http://elibrary.ferc.gov/idmws/File_list.asp?document_id=13875396

¹⁵ 136 FERC ¶ 61,039, Order, "Smart Grid Interoperability Standards," Docket No. RM11-2-000, issued July 19, 2011, *available at*:

http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20110719-3029.

¹⁶ *Id.*

¹⁷ Comments of US National Institute of Standards and Technology in response to the Commission's Supplemental Notice Requesting comments under RM11-2, April 7, 2011, *available at*: http://elibrary.ferc.gov/idmws/File_list.asp?document_id=13909438

¹⁸ White House. "A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future." June 13, 2011, *available at*: <http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc-smart-grid-june2011.pdf>

order “to enable the development and implementation of smart grid standards, merely embracing the standards as best practices in the field—rather than as mandatory ones—is sufficient....” FERC’s support of the NIST Interoperability Framework could encourage utility companies looking for smart grid solutions to rely on the framework for guidance, but leave it to individual utilities to decide how to best comply.

NIST believes that FERC’s decision did not close the door to the possibility of future rulemaking if it is determined that adoption of certain standards is necessary to ensure their deployment to ensure interoperability.

Testimonies, comments and reply comments received from the FERC technical conference were valuable sources of input to NIST and the SGIP. Based on our evaluation of this input, several steps are being taken to improve NIST and SGIP processes. For example, SGIP has initiated a task group to consider how to add reviews of reliability and implementation issues within the SGIP.

Ensuring Protection of Consumer Interests

Let me conclude with a discussion of critical actions being taken to ensure protection of consumer interests, highlighted in the Administration’s “Policy Framework for a 21st Century Grid.”

Regulators and utilities need to ensure that their investments in a Smart Grid are cost-effective to keep electricity affordable. The standards being developed through the NIST program play a critical role in this respect. They will help ensure that present investments in new technologies will generate future value for rate-payers by facilitating interoperability and upgradeability. These standards will also reduce market fragmentation and help create economies of scale, providing consumers greater choice and lower costs. They will help promote healthy vendor competition that will result in lower costs for utilities and, ultimately, for consumers.

Policymakers should ensure that residential and small business consumers have access to a portfolio of easy-to-use Smart Grid programs, technologies, and policies that empower them to manage their energy use effectively. The standards being developed through the NIST program will help enable timely consumer access to data that can help them control their energy usage. The standards will encourage the development of innovative third-party applications to help consumers save energy and encourage development of a market for smart appliances that can reduce energy usage during peak demand periods. The standards will also offer policymakers a solid framework for protecting consumer data privacy.

Finally, the Federal government must continue to facilitate the development of rigorous, open standards and guidelines for cybersecurity through public- private cooperation. Cooperation between stakeholders can help identify and address the diversity of cyber risks the electric power sector faces. The Federal government will

work with the private sector to provide the appropriate level of support for the continuing evolution of those standards and guidelines, to keep pace with the evolving threat. The three-volume report, NIST IR 7628, Guidelines for Smart Grid Cyber Security,¹⁹ presents a framework that organizations should use to develop effective cybersecurity strategies tailored to their particular combinations of Smart Grid-related characteristics, risks, and vulnerabilities. Volume 2 of NIST IR 7628 is devoted to privacy guidelines for Smart Grid data, and NAESB is in the process of developing a business practice standard for data privacy consistent with the NIST guidelines. Organizations in the diverse community of Smart Grid stakeholders - from utilities to providers of energy management services to manufacturers of electric vehicles and charging stations - can use the methods and supporting information presented in the report as guidance for assessing and mitigating risks. This approach recognizes that as the Smart Grid comes online, the electric grid will rapidly change from a relatively closed system to a complex, highly interconnected environment. Each organization's cyber security requirements should evolve as technology advances and as threats to grid security inevitably multiply and diversify.

Conclusion

The Smart Grid, with the unique investment opportunity afforded by the Recovery Act, represents a great opportunity to renew and modernize one of the Nation's most important infrastructures. NIST is proud to have been given an important role in this initiative, and is committed to achieving the Administration's vision of a cleaner, more reliable, more efficient and effective electricity grid that creates jobs and helps reduce our dependence on oil.

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.

¹⁹ *Supra*, n. 7.



George W. Arnold

George Arnold was appointed National Coordinator for Smart Grid Interoperability 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 Vice President-Policy for the International Organization for Standardization (ISO) in 2006-2009.

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.