

smart grid

NIST and the Smart Grid



NIST's Smart Grid and Cyber-Physical Systems Program Office is housed in the Engineering Laboratory, and draws on expertise from across the NIST organization, including the Physical Measurement Laboratory and the Information Technology Laboratory. The Office leads, coordinates, and manages the national public/private partnership effort to develop interoperability standards for the smart grid, fulfilling NIST's statutory responsibility under the Energy Independence and Security Act of 2007 (EISA). The Office also provides programmatic leadership for NIST measurement science research supporting the evolving and ongoing modernization of the nation's electric grid.

For further information:

Dr. Chris Greer
Director, Smart Grid and Cyber-Physical Systems Program Office and National Coordinator for Smart Grid Interoperability
National Institute of Standards and Technology
100 Bureau Drive, Stop 8200
Gaithersburg, MD 20899-8200
301-975-5987 (Telephone)
301-975-4091 (Facsimile)
smartgrid@nist.gov (E-mail)

Smart Grid Web Site:

www.nist.gov/smartgrid

Engineering Laboratory (EL)

Dr. Howard Harary, Acting Director

Information Technology Laboratory (ITL)

Dr. Charles H. Romine, Director

Physical Measurement Laboratory (PML)

Dr. Joseph L. Dehmer, Director

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Standards and Technology
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Introduction

The electric power grid and electric power industry are undergoing a dramatic transformation. By linking information technologies with the electric power grid—to provide "electricity with a brain"—the power grid of the 20th century is evolving into the 21st century's smart grid.

Consumers, manufacturers, and utilities are already seeing new benefits from the emerging "smart grid version 1.0." As work proceeds on version 1.0, the cycle of innovation and evolution will continue to advance toward versions 2.0, 3.0, and beyond, promising a bright energy future.

The National Institute of Standards and Technology (NIST) plays a key role in grid modernization—bringing together manufacturers, consumers, energy providers, and regulators to accelerate development of secure interoperable standards. NIST coordinates the standards process that will allow the many pieces of "the world's largest and most complex machine" to work together.

In addition, NIST performs vital research supporting the nation's electrical industry and infrastructure. Drawing on its scientific, technical, and engineering expertise, NIST characterizes and measures many of the critical elements that make up the smart grid.

Since its establishment in 1901, NIST's mission has been to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST's Smart Grid Program will carry that mission forward in the coming decades.



Smart Grid Benefits

The electric grid ecosystem—from power generators and utilities to equipment manufacturers and consumers—will realize benefits from the smart grid: a "system of systems" that integrates an end-to-end, advanced communications infrastructure into the electric power system. For consumers, the smart grid will offer up-to-the-moment information on their energy usage, enable smart appliances and devices to be programmed to run during off-peak hours to lower energy bills, and open up a wider range of electricity pricing plans.

A more intelligent grid will also:

- increase grid reliability and reduce the frequency of power blackouts and brown-outs by giving utilities wide-area situational awareness, which includes monitoring, analysis, and decision-making;
- increase grid resiliency by providing detailed information to enable utilities to more quickly restore power after outages;
- reduce inefficiencies in energy delivery, lowering generation requirements;
- facilitate efficient and cost-effective charging of electric vehicles;
- integrate the sustainable resources of wind and solar energy more fully into the grid; and
- improve management of distributed energy resources, including microgrids and storage.

Standards Coordination, Interoperability, & Cybersecurity

As outlined in the "The Energy Independence and Security Act of 2007"

(Public Law 110-140, or EISA), NIST

has been given

"primary

responsi-

bility to

coordinate

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framework that

includes protocols

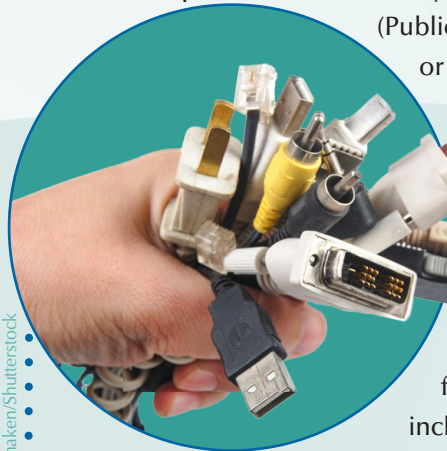
and model standards

for information management to achieve interoperability of smart grid devices and systems."

"Interoperability" refers to the capability of different systems and devices to communicate and operate effectively with one another. Devices that are fully interoperable are often described as having "plug and play" characteristics (i.e., connect them and they work together).

To achieve interoperability, diverse stakeholders must agree on technical standards and on procedures and protocols for testing and conformance. Interoperability benefits consumers through easier-to-use, more reliable systems with lower life cycle costs.

As information technologies expand on the electric grid (and to other cyber-physical systems, such as those dealing



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with natural gas and water), cybersecurity becomes a critical priority. NIST plays a central role in working with industry to develop appropriate guidance for protecting these systems from cyber attacks.

Research

NIST has been involved in measurement research and standards development related to the electric grid for over a century. More recently, NIST has played a key role in the development of synchrophasor technology, power electronics, and metering standards. NIST's smart grid effort gained momentum with the EISA legislation, and the Smart Grid and Cyber-Physical Systems Program Office now sponsors a broad program to support grid modernization and extend lessons learned into other cyber-physical systems. The NIST smart grid team includes experts from disciplines spanning the physical sciences, information science, and engineering—from physics and electrical engineering to information networks and computer security.

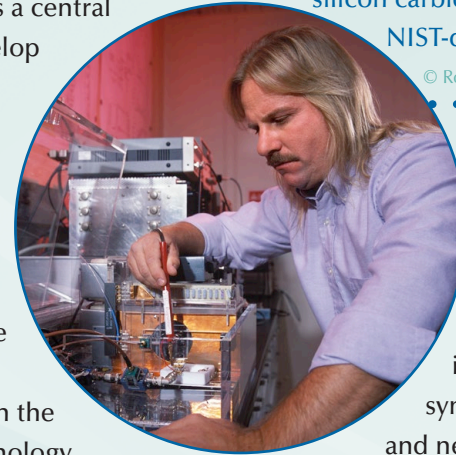
NIST's systems engineers are studying how the many systems which make up the smart grid are organized and integrated into a larger "system of systems." NIST researchers

Team members discuss the network performance of mobile communication systems, which can be used for smart grid communications



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Team member performs high-speed, high-voltage silicon carbide device characterization using NIST-developed, specialized equipment



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are also investigating measurements under field environment conditions, as well as dynamic measurements of smart grid parameters. Research and testing involves a variety of testbeds, including those for electrical meters, synchrophasors, timing, smart buildings, and net-zero energy housing. An integrated, combined testbed is currently under development.

Partnerships & Publications

The NIST Smart Grid Program, on behalf of the federal government, serves as a convener—building partnerships and bringing together stakeholders from across industry, government, and academia.

As an example, to help carry out its EISA-assigned coordination role and help organize the smart grid community, NIST established the Smart Grid Interoperability Panel (SGIP) in November 2009. The SGIP transitioned in 2013 into a self-sustaining private sector not-for-profit corporation that continues its partnership with government. It has developed an international reputation as the forum where a diverse cross-section of technical leaders can interact to coordinate, accelerate, and harmonize new and emerging standards for the smart grid.

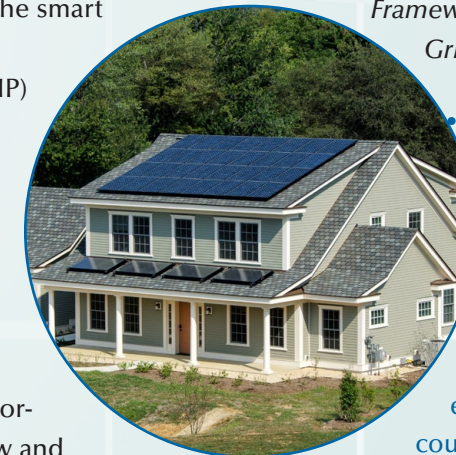
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NIST Director Pat Gallagher and SGIP 2.0 Chair John McDonald shake hands after signing the official MOU with SGIP 2.0

NIST's Smart Grid Program partners with sister organizations around the world. By working internationally to coordinate and harmonize grid modernization efforts and standards, NIST is helping open up a multi-billion dollar global market for smart grid-related products and services.

NIST's Smart Grid Program coordinates with a number of federal agencies and with state regulators, and it produces and publishes information resources that serve a range of audiences, including the *NIST Framework and Roadmap for Smart Grid Interoperability Standards*.



Resembling a typical suburban single-family home, the Net-Zero Energy Residential Test Facility at NIST's Gaithersburg, MD campus is designed to produce as much energy as it consumes over the course of a year. It will serve as a testbed for new home-scale energy technologies, including smart grid

Credit: NIST