NIST Coordination and Acceleration of Smart Grid Standards

IEEE PES ISGT
Tom Nelson
National Institute of Standards and Technology
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The Electric Grid

One of the largest, most complex infrastructures ever built

“The greatest engineering achievement of the 20th century”
- U.S. National Academy of Engineering
• NIST is Providing National and International Leadership to Coordinate and Accelerate Smart Grid Documentary Standards
  – Leverages NIST technical expertise, industry connections, independent reputation
  – Expanded role for NIST to address U.S. National Priority
  – NIST is coordinating standards development, not writing new standards
  – Consistent with U.S. Standards System

• Research/Calibration Support for the Smart Grid
Energy use

• Modern life relies on significant energy use
• Energy use has implications (climate, geopolitical, …)

**Electricity is a key part of solution**

– Infrastructure exists almost everywhere, transportable, reliable, cost effective, …
– Electric grid connects supply and demand
  • Electricity must be used or stored when produced
  • Bidirectional communications are needed in future to match variable distributed generation with load
  • Consumers must be engaged to modify energy use
– New needs and capabilities anticipated
  • Example: Electric vehicles, with storage potential

% of US economy (GDP) dependent on electricity (Manhattan Institute, 2008)

1950 - 20%
2008 - 60%
Today’s Electric Grid

**Electrical Infrastructure**

- One-way flow of electricity

- Centralized, bulk generation, mainly coal and natural gas
- Responsible for 40% of human-caused CO$_2$ production
- Controllable generation and predictable loads
- Limited automation and situational awareness
- Lots of customized proprietary systems
- Lack of customer-side data to manage and reduce energy use
**Smart Grid – A National Priority**

- “We’ll fund a better, smarter electricity grid and train workers to build it…”
  
  President Barack Obama

- “To meet the energy challenge and create a 21st century energy economy, we need a 21st century electric grid…” Secretary of Energy Steven Chu

- “A smart electricity grid will revolutionize the way we use energy, but we need standards …”
  
  Secretary of Commerce Gary Locke

**Smart Grid Enables:**

- Higher Penetration of Renewables
- Smart Charging of Electric Vehicles
- Consumers to Control Energy Bills
- Efficient Grid Operations & Reduced Losses
- Reduced Distribution Outages
- Improved System Reliability & Security
### US Smart Grid Investment Grants

#### SGIG Topic Areas

<table>
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<tr>
<th>Category</th>
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<tr>
<td>Integrated/Crosscutting</td>
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<tr>
<td>AMI</td>
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<td>Distribution</td>
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<td>Customer Systems</td>
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<td>Manufacturing</td>
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<td><strong>Total</strong></td>
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#### Geographic Coverage of Selected Projects

- 18 million smart meters
- 1.2 million in-home display units
- 206,000 smart transformers
- 177,000 load control devices
- 170,000 smart thermostats
- 877 networked phasor measurement units
- 671 automated substations
- 100 PEV charging stations
What Will the Smart Grid Look Like?

- High use of renewables – 20% – 35% by 2020
- Distributed generation and microgrids
- Bi-directional metering – selling local power into the grid
- Distributed storage
- Smart meters that provide near-real time usage data
- Time of use and dynamic pricing
- Ubiquitous smart appliances communicating with the grid
- Energy management systems in homes as well as commercial and industrial facilities linked to the grid
- Growing use of plug-in electric vehicles
- Networked sensors and automated controls throughout the grid
Smart Grid: The “Energy Internet”

Electrical Infrastructure

2-way flow of electricity and information

“Intelligence” Infrastructure

Standards Provide a Critical Foundation
Standards are Essential

Example: Smart Meters

- Key element of smart grids
- 40 million to be deployed in the next several years in US
- Rapid technology evolution
- Absence of firm standards
AMI Metering

- Smart meters that provide near-real time usage data
- Time of use and dynamic pricing
- Ubiquitous smart appliances communicating with the grid
- Energy management systems in homes as well as commercial and industrial facilities linked to the grid
- Growing use of plug-in electric vehicles
Advanced Metering Interface -AMI

Power Usage to Personal Activity Mapping

Peak = 7.18 kW
Mean = 0.49 kW
Daily load factor = 0.07
Energy consumption = 11.8 kWh
Priorities Areas

• Demand Response and Consumer Energy Efficiency
• Wide Area Situational Awareness
• Electric Storage
• Electric Transportation
• Advanced Metering Infrastructure
• Distribution Grid Management
• Cyber Security
• Network Communications
Smart Grid Framework and Roadmap 1.0

- Published January 2010
  - Extensive public input and review
  - Completed in Less than 1 year
- Smart Grid Vision & Reference Model
- Identified 75 existing standards
- 16 Priority Action Plan Projects are filling key gaps
- Companion Cyber Security Strategy

http://www.nist.gov/smartgrid/
Standards Come From Many Sources

International

Global Consortia

Regional and National
Example: Electric Vehicles Require Many Standards

- 1547 (Distributed energy interconnection)
- J1772 (Connector)
- 61850 and 61970/61968 Information models
- Demand response & price signaling
- J2293 (Communication)
- Smart Energy 2.0
- C12 (Meter)
- National Electric Code (Enclosures)
- National Electric Safety Code
- ANSI NEMA
- IEEE
- IEC
- SAE
- ZigBee
- ISO (Battery)
- National Institute of Standards and Technology
Priority Action Plans (PAPs)

- Created to address gaps in Smart Grid standards

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<thead>
<tr>
<th>#</th>
<th>Priority Action Plan</th>
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<td>Meter Upgradeability Standard</td>
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<td>Standard DR and DER Signals</td>
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<td>Role of IP in the Smart Grid</td>
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<td>Standard Energy Usage Information</td>
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<td>Wireless Communication for the Smart Grid</td>
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<td>Common Object Models for Electric Transportation</td>
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<td>Common Price Communication Model</td>
<td>12</td>
<td>IEC 61850 Objects/DNP3 Mapping</td>
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<td>Common Scheduling Mechanism</td>
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<td>Time Synchronization, IEC 62850 Objects/ IEEE C37.118 Harmonization</td>
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<td>Standard Meter Data Profiles</td>
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<td>Transmission and Distribution Power Systems Model Mapping</td>
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<td>Common Semantic Model for Meter Data tables</td>
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<td>Harmonize Power Line Carrier Standards for Appliance Communications in the Home</td>
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<td>Electric Storage Interconnection Guidelines</td>
<td>16</td>
<td>Wind Plant Communications</td>
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<td>CIM for Distribution Grid Management</td>
<td>17</td>
<td>Customer Facility Smart Grid Information</td>
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</table>
PAP 00: Smart Meter Upgradeability Standard

- NEMA Smart Grid Standard AMI 1-2009, Requirements for Smart Meter Upgradeability

- Start of work to approved standard: 90 days!
PAP10: Energy Usage Information

- Data information model for usage (monthly bill to near-real-time)
- Timely usage information changes consumer energy choices
- Will enable many innovative products and services

Google Powermeter; also Microsoft Hohm
• Data model
• Information exchange protocols
• Fast charging connector standard
Standards for Appliance-to-Grid Communication

• Price, schedule, demand response signals for appliance-to-grid communications

• Home Area Network Communications Protocols

Whirlpool Aims for Smart Appliances in 2011

Smart appliances will need home control systems to store user preferences.

May 12, 2010 — by Steven Castle

Whirlpool says by 2011 it will have "smart" appliances that can connect to smart meters and the smart grid.

Whirlpool representatives at the Alliance to Save Energy’s EE (Energy Efficiency) Global Forum in Washington, D.C. say the company will have its Energy Smart water heater, with an external hookup for connection to a smart meter, available by the end of 2010.

The company also says smart laundry appliances will be available in 2011.
Smart Grid Interoperability Panel

- Public-private partnership created in Nov. 2009
- Broad range of stakeholders in SGIP developing consensus about standards needed to build a smarter grid
  - 620 member organizations (with over 50 international organizations) & over 1700 participants from 22 stakeholder categories
- Coordinates the development of standards by Standards Development Organizations (SDOs)
  - Identifies Requirements
  - Prioritizes standards development programs
  - Works with over 20 SDOs including IEC, ISO, ITU, IEEE, …
- Open, transparent & inclusive process
  - SGIP Twiki: http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIP
SGIP Standing Committees

• Smart Grid Architecture Committee (SGAC)
  – Creates & refines SG Conceptual Reference Model, including lists of the standards and profiles necessary to implement the Smart Grid.

• Testing & Certification Committee (SGTCC)
  – Creates and maintains the documentation and organizational framework for compliance, interoperability and cyber security testing and certification related to Smart Grid standards
  – Develops & implements certification criteria by which compliance can be verified through testing of vendor products and services
Cyber Security Working Group

- Building cyber security in from the start has been a paramount concern
- Permanent Working Group
  - Over 460 public and private sector participants
- August 2010 NIST publishes: *Guidelines for Smart Grid Cyber Security*
  - Reflects Comments on Sept 2009 and Feb 2010 Draft *Smart Grid Cyber Security Strategy and Requirements*
- Guideline includes:
  - Risk assessment guidance for implementers
  - Recommended security requirements
  - Privacy recommendations
Smart Grid Will Use International Standards

Source of Standards in NIST Roadmap

- US Government: 10%
- Domestic SDO: 13%
- International: 77%

- ISO/IEC/ITU
- IETF
- IEEE/SAE/ISA
- Global consortia
Further Information

• Web portal: http://www.nist.gov/smartgrid/
• Twiki: http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WebHome
• Contact:
  – Tom Nelson
  – Email: thomas.nelson@nist.gov
  – Telephone: +1.301.975.2986