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# Smart Grid Interoperability Framework

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# *The Electric Grid*

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One of the largest, most complex infrastructures ever built



In the U.S.:

- 3100 electric utility companies
- 10,000 power plants
- 157,000 miles of high-voltage lines
- 140 million meters
- \$800 billion in assets
- \$247 billion annual revenues

# 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 21<sup>st</sup> century energy economy, we need a 21<sup>st</sup> 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 Government Roles in Smart Grid

## Federal



Office of Science & Technology  
Policy; National Economic Council;  
& Council on Environmental Quality



Smart Grid Task Force /  
National Science &  
Technology Council

Other Federal  
Agencies



Smart Grid  
Subcommittee



Federal  
Energy  
Regulatory  
Commission

## State

FERC – NARUC

Smart Response Collaborative

Public Utility Commissions



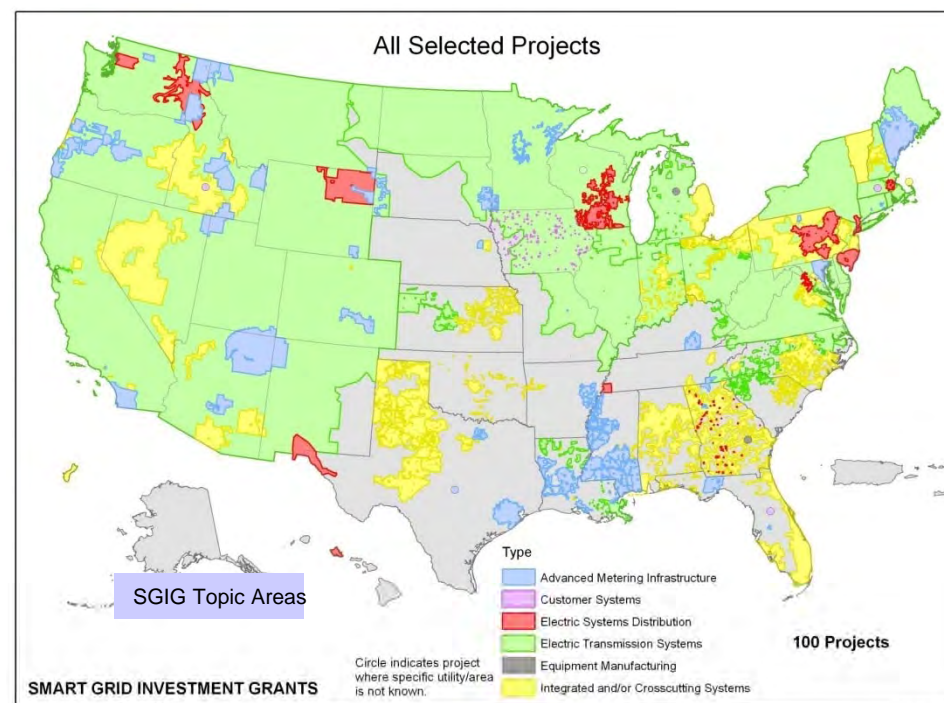


# Smart Grid Investment Grants

Category	\$ Million
Integrated/Crosscutting	2,150
AMI	818
Distribution	254
Transmission	148
Customer Systems	32
Manufacturing	26
Total	3,429

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

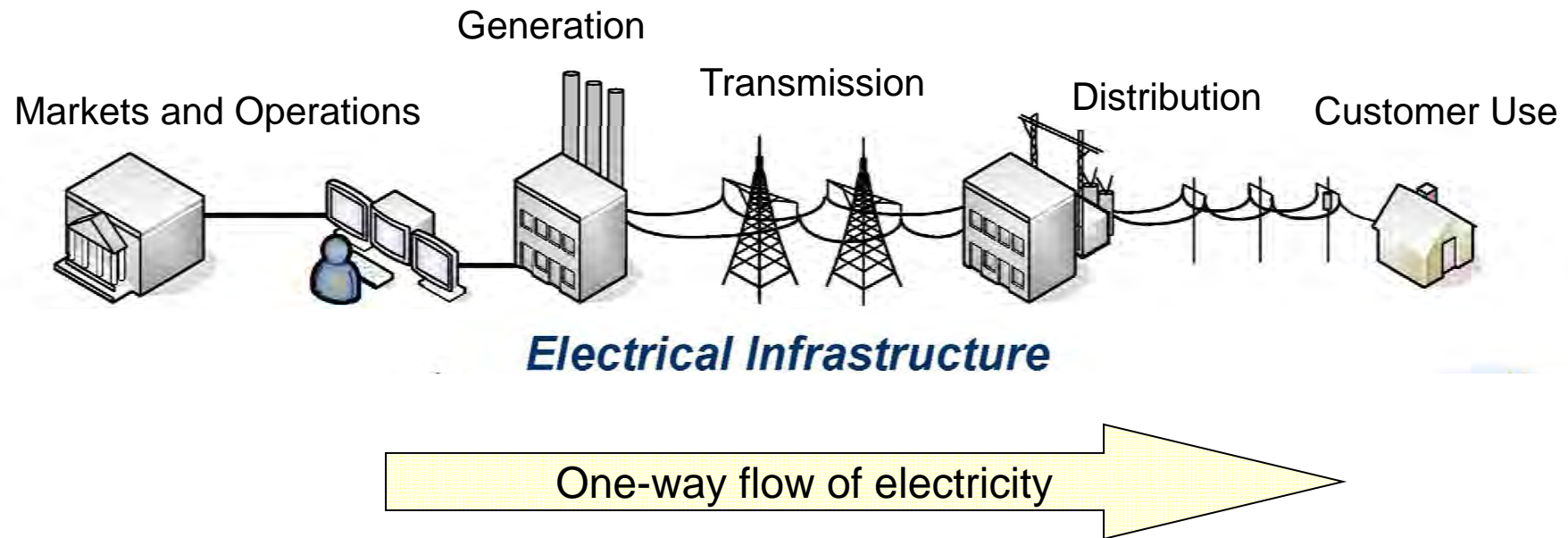
## Geographic Coverage of Selected Projects



Oct 21, 2009

# Today's Electric Grid

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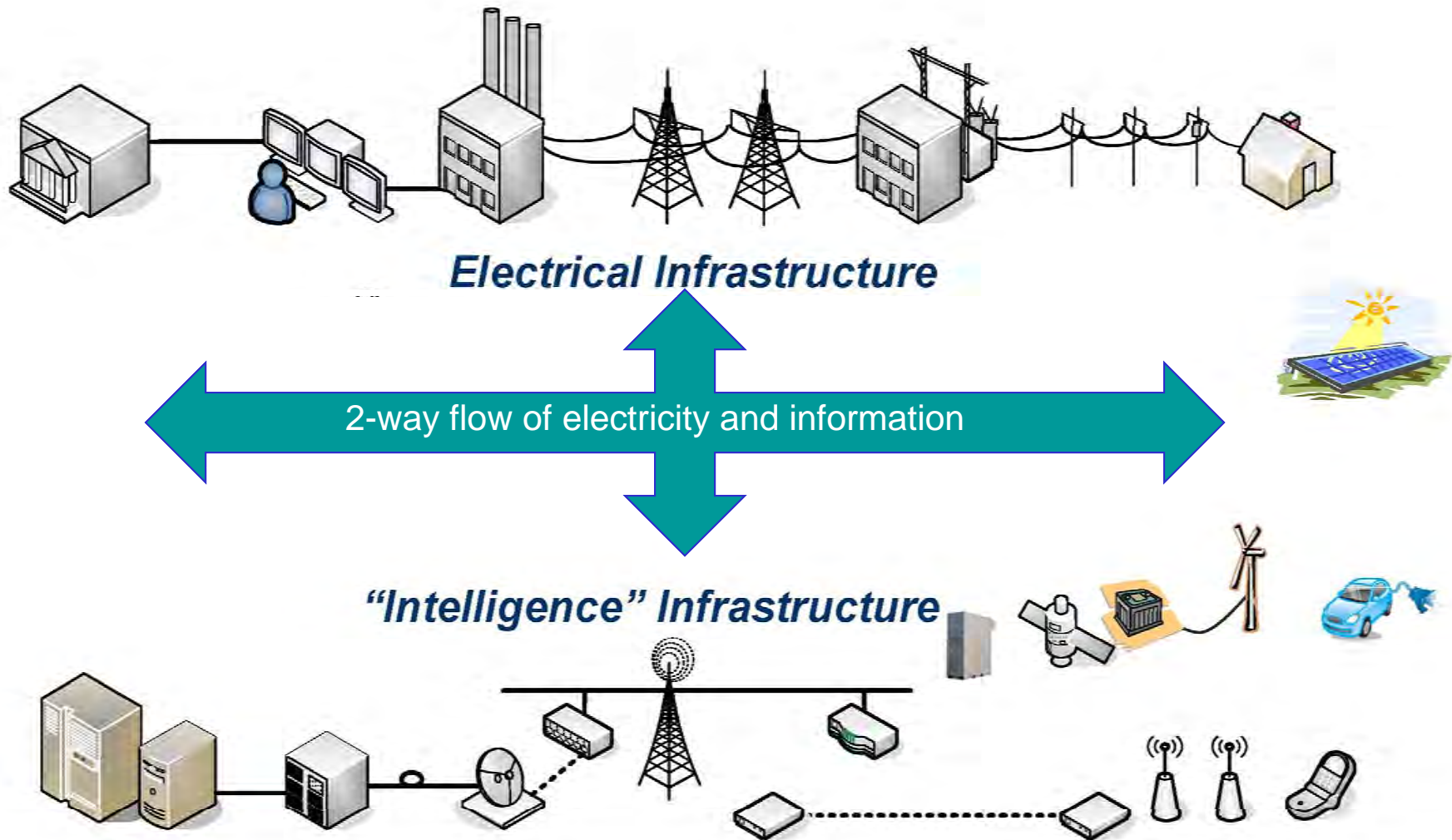
- *Centralized, bulk generation, mainly coal and natural gas in U.S.*
- *Responsible for 40% of human-caused CO<sub>2</sub> production*
- *Controllable generation and predictable loads*
- *Limited automation and situational awareness*
- *Lack of customer-side data to manage and reduce energy use*

# *What Will the Smart Grid Look Like?*

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- High use of renewables – 20% – 35% by 2020
- Distributed generation and microgrids
- “Net” 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”



**Standards Provide a Critical Foundation**



# *Smart Grid Interoperability*

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- Interoperability: The ability of 2 or more networks, systems, devices, applications, or components to communicate & operate together effectively, securely, & without significant user intervention
  - Communication requires agreement on a physical interface & communication protocols
  - Exchanging meaningful & actionable information requires common definitions of terms & agreed upon responses
  - Consistent performance requires standards for the reliability, integrity, and security of communications
  - Interoperability may include:
    - “Plug and play”: connect them & they work together
    - Interchangeability: Ability to readily substitute components

# *Benefits of Interoperability Standards*

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- Make it easy for consumers to use smart devices regardless of location & provider
- Protect privacy while enabling consumers to securely access information on their own energy consumption
- Prevent premature obsolescence, facilitate future upgrades, & ensure systems can be scaled up for larger deployments
- Provide for backward compatibility, integrating new investments with existing equipment
- Expand product markets & promote vendor competition: reducing costs, accelerating innovation, & increasing choice
- Ensure the security & enhance the reliability of the power grid

# *NIST Three Phase Plan*

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## **PHASE 1**

**Identify an initial set of existing consensus standards and develop a roadmap to fill gaps**

## **PHASE 2**

**Establish public/private Interoperability Panel to provide ongoing recommendations for new/revised standards**

## **PHASE 3**

**Testing and Certification Framework**

March                      2009                      September                      2010

# *White House Meeting May 2009*

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- Chaired by Secretaries of Energy and Commerce
- 66 CEOs and senior executives, federal and state regulators

- Commitment to accelerate development of a roadmap



## *Open, Public Process*

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- Three public workshops
- More than 1500 participants
- Hundreds of companies, organizations, agencies
- Online collaboration wiki
- White House-sponsored blog
- Federal Register Notices
- Web conferences
- All information publicly available on-line





## *Priorities for Standardization*

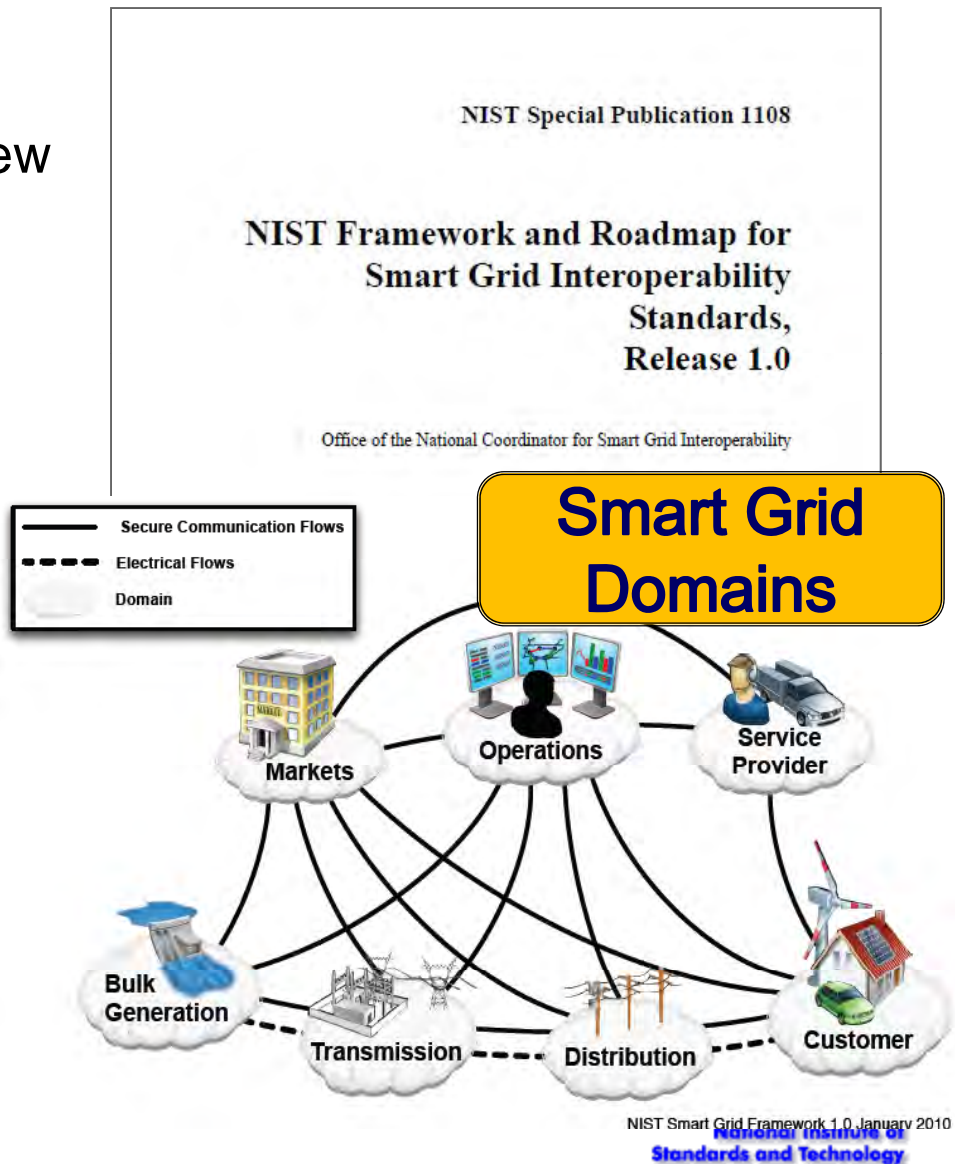
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- Demand Response and Consumer Energy Efficiency
- Wide Area Situational Awareness
- Electric Storage
- Electric Transportation
- Advanced Metering Infrastructure
- Distribution Grid Management
- Cyber Security
- Network Communications

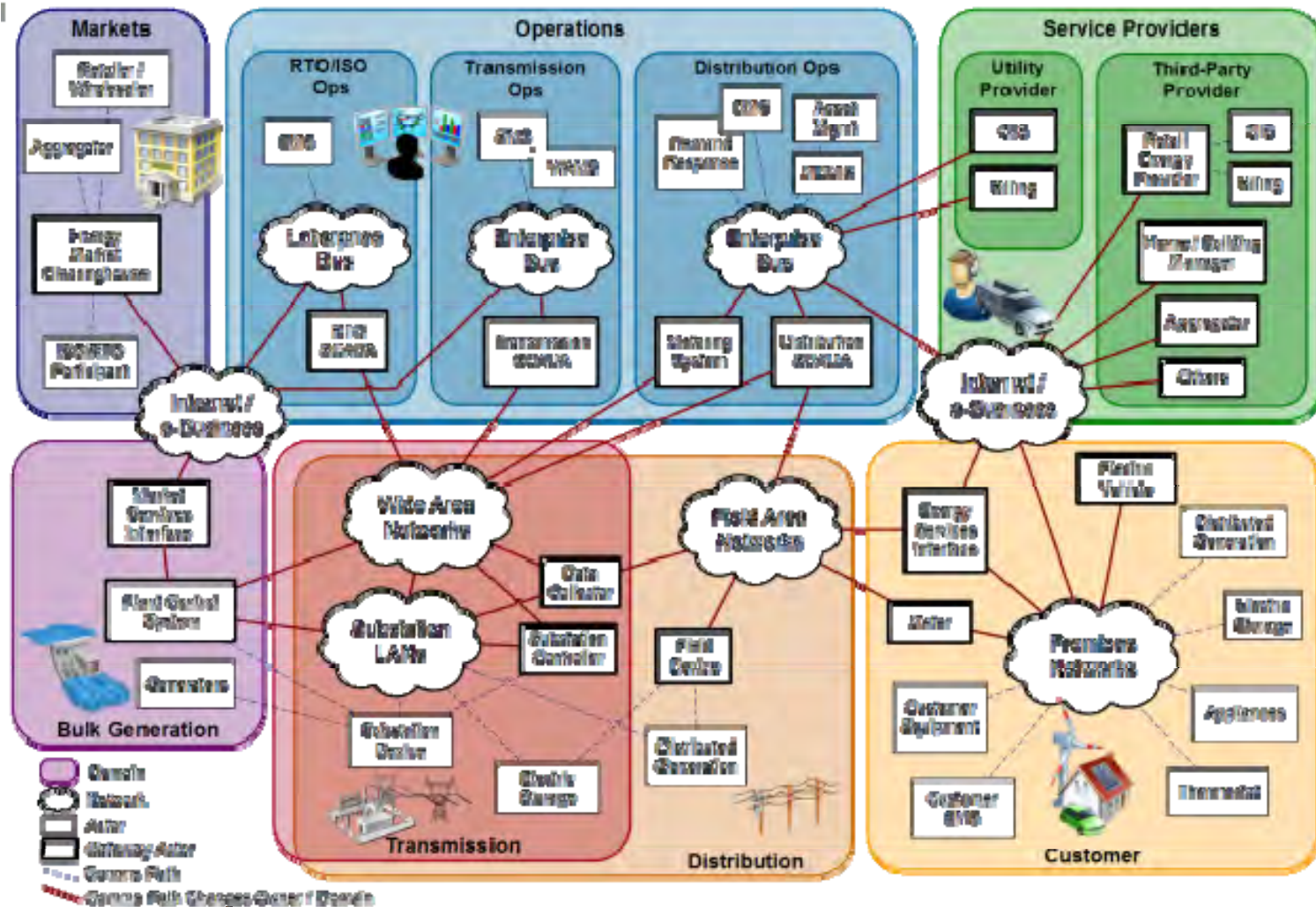
# Smart Grid Framework and Roadmap 1.0

- 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/>



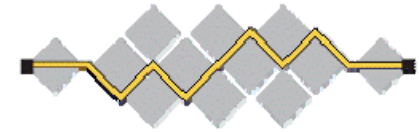
# Smart Grid Reference Model



# *Standards Come From Many Sources*

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International



**I E T F**<sup>®</sup>



**SAE** *International*<sup>™</sup>

Global  
Consortia



**OGC**<sup>®</sup>  
Open Geospatial Consortium, Inc.

**OASIS** 

Regional and  
National



*American National Standards Institute*

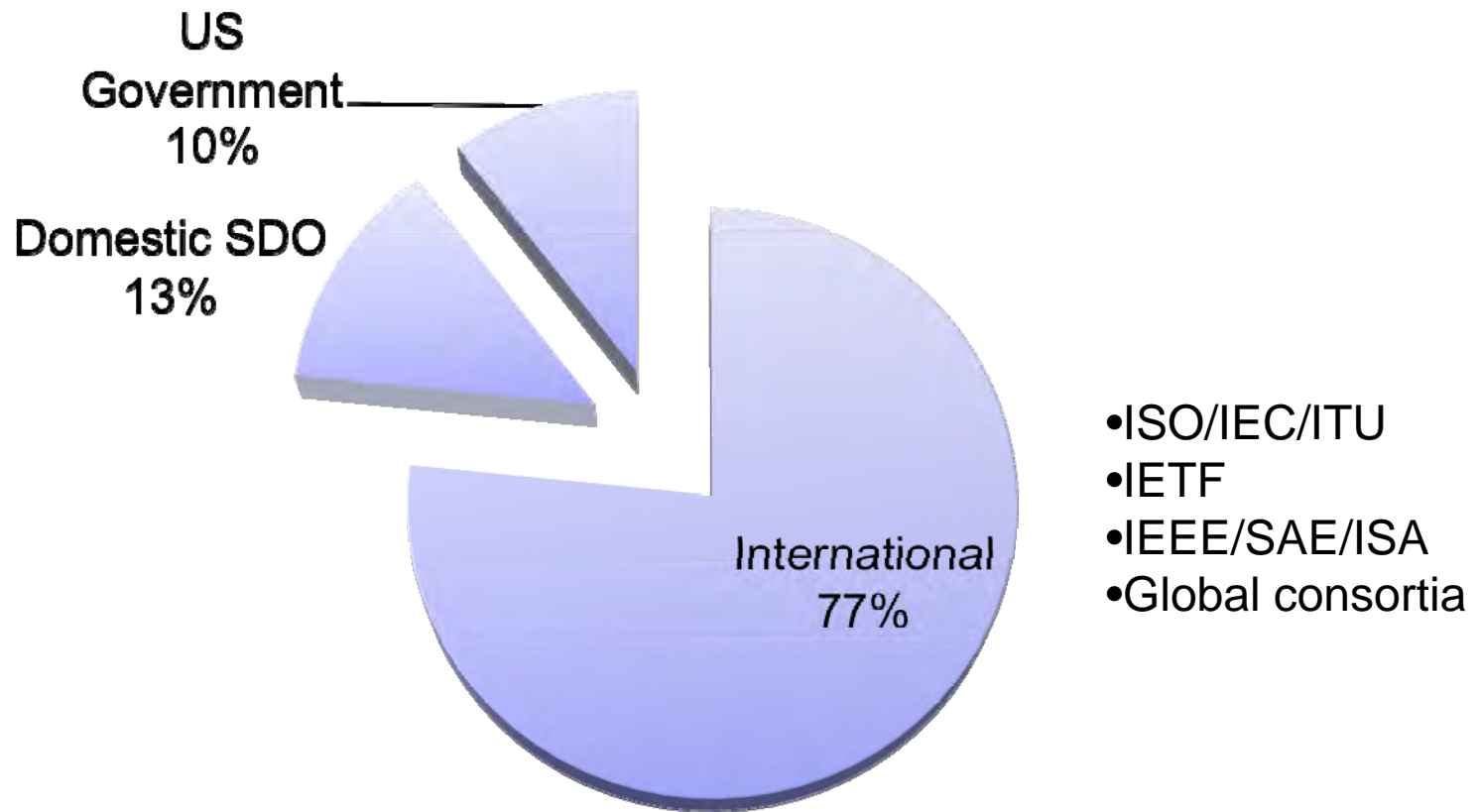


**NEMA**

**NIST**  
National Institute of  
Standards and Technology

# *Smart Grid Will Use International Standards*

## **Source of Standards in NIST Roadmap**





# *Why Do We Need Standards?*

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## **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

# *Why Do We Need Standards?*

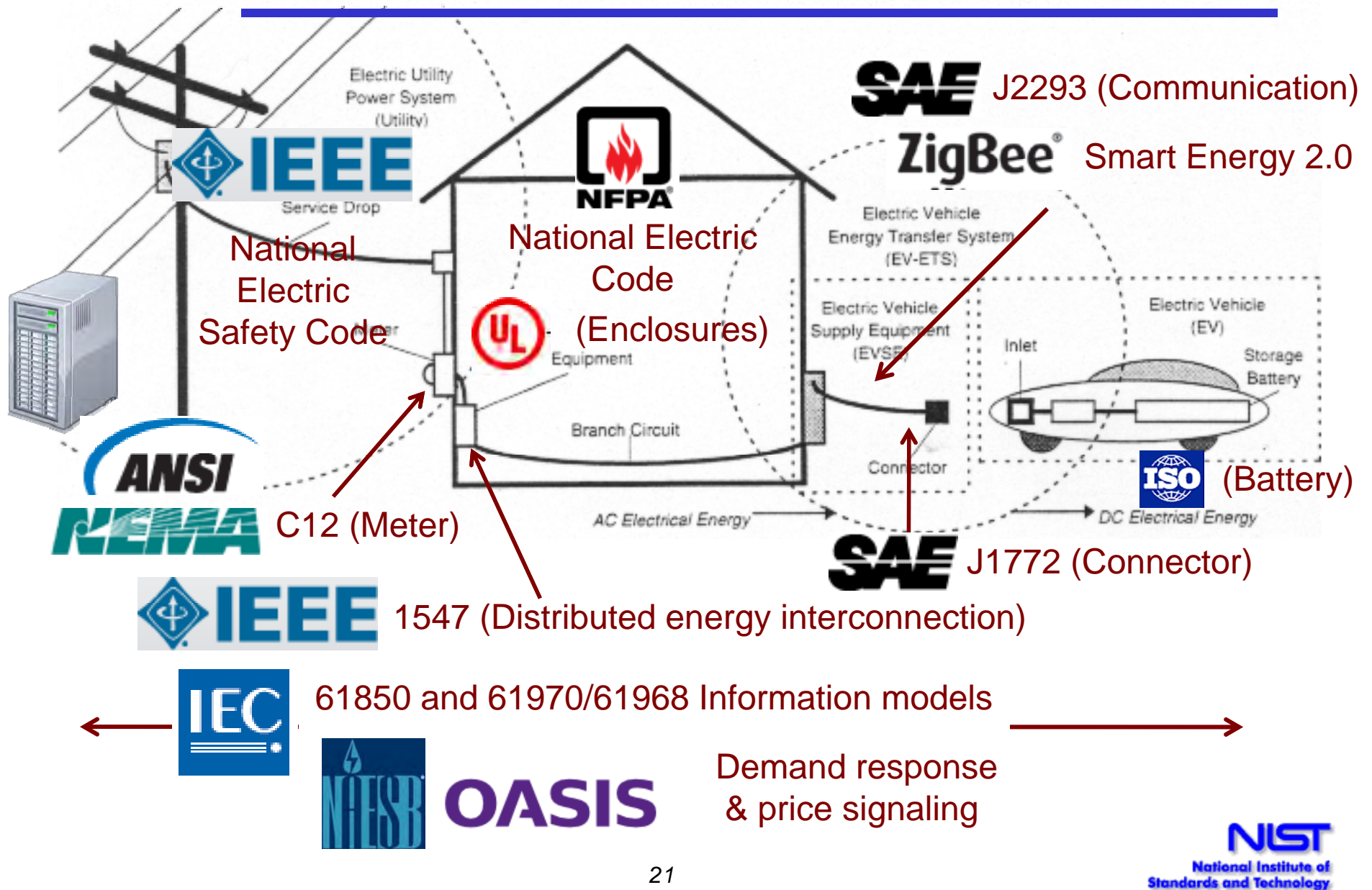
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**Whirlpool Corporation To  
Produce One Million Smart  
Grid-Compatible Clothes  
Dryers by the End of  
2011...**

Standards for data  
communication,  
price information,  
schedules, demand  
response signals



# Electric Vehicles Require Many Standards





# ***Smart Grid Interoperability Panel***

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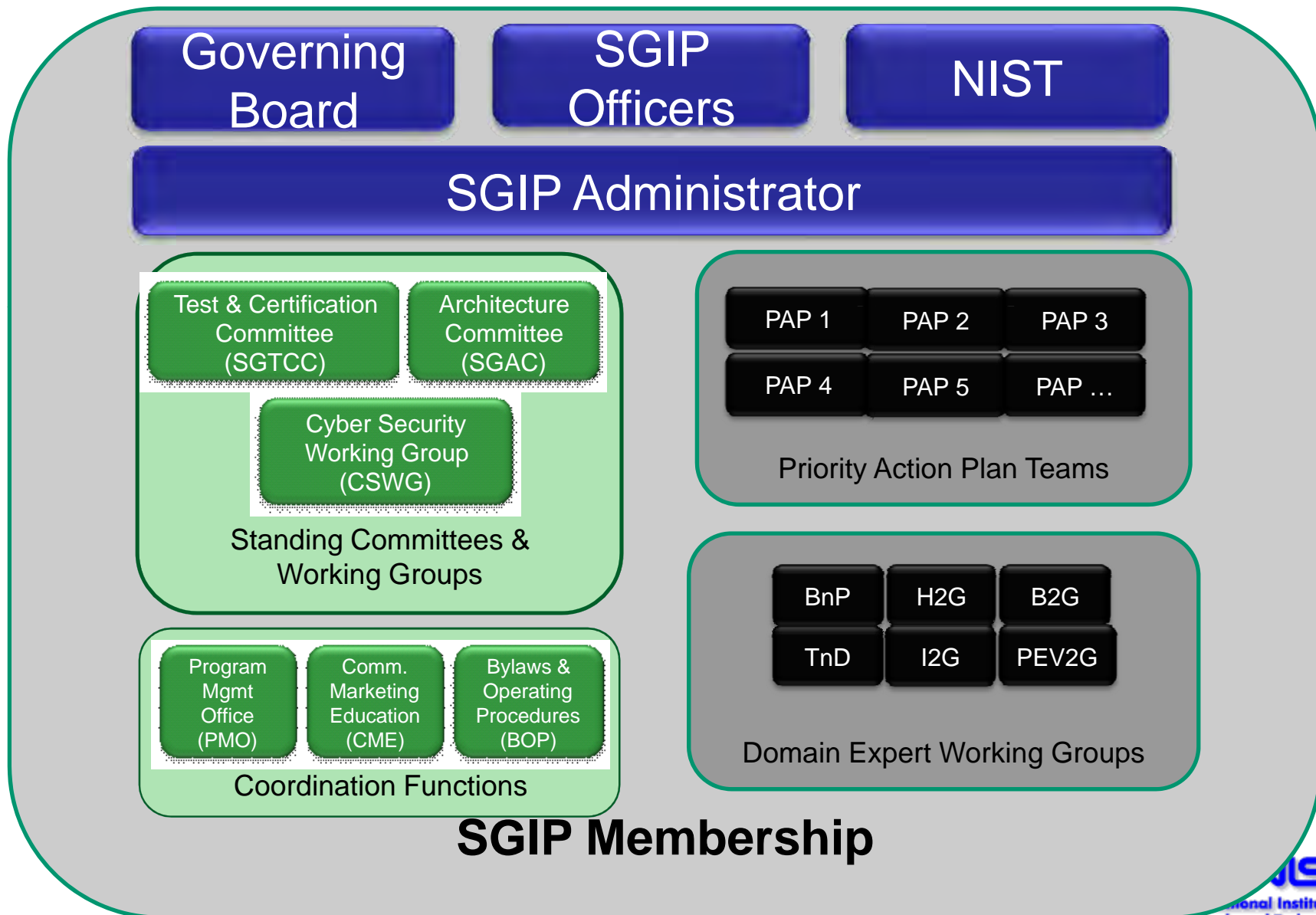
- Public-private partnership created in Nov. 2009
- Broad range of stakeholders in SGiP developing consensus about standards needed to build a smarter grid
  - Nearly 600 member organizations (with over 50 international organizations) & over 1700 participants from 22 stakeholder categories
- Coordinates 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>

# Smart Grid Stakeholders

1	Appliance and consumer electronics providers	12	Power equipment manufacturers and vendors
2	Commercial and industrial equipment manufacturers and automation vendors	13	Professional societies, users groups, and industry consortia
3	Consumers – Residential, commercial, and industrial	14	R&D organizations and academia
4	Electric transportation industry Stakeholders	15	Relevant Federal Government Agencies
5	Electric utility companies – Investor Owned Utilities (IOU)	16	Renewable Power Producers
6	Electric utility companies - Municipal (MUNI)	17	Retail Service Providers
7	Electric utility companies - Rural Electric Association (REA)	18	Standard and specification development organizations (SDOs)
8	Electricity and financial market traders (includes aggregators)	19	State and local regulators
9	Independent power producers	20	Testing and Certification Vendors
10	Information and communication technologies (ICT) Infrastructure and Service Providers	21	Transmission Operators and Independent System Operators
11	Information technology (IT) application developers and integrators	22	Venture Capital



# SGIP Organization





# ***SGiP Standing Committees***

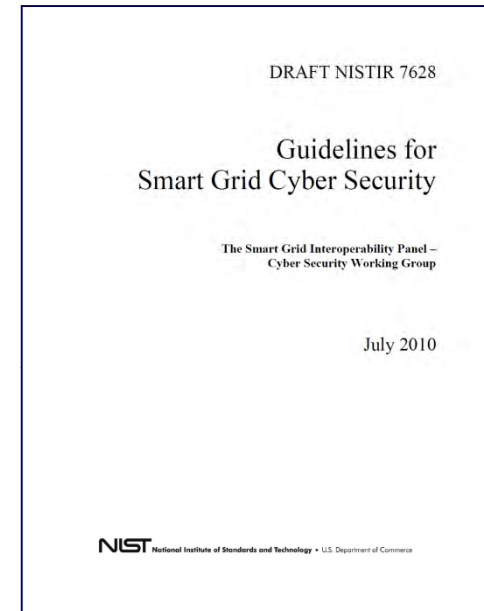
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- Smart Grid Architecture Committee (SGAC)
  - Creates & refines SG Conceptual Reference Model, including lists of the standards and profiles necessary to implement the Smart Grid.
- Testing & Certification Committee (SGTCC)
  - Creates and maintains 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





## ***Priority Action Plans (PAPs)***

- Created to address gaps in Smart Grid standards

#	Priority Action Plan	#	Priority Action Plan
0	Meter Upgradeability Standard	9	Standard DR and DER Signals
1	Role of IP in the Smart Grid	10	Standard Energy Usage Information
2	Wireless Communication for the Smart Grid	11	Common Object Models for Electric Transportation
3	Common Price Communication Model	12	IEC 61850 Objects/DNP3 Mapping
4	Common Scheduling Mechanism	13	Time Synchronization, IEC 62850 Objects/ IEEE C37.118 Harmonization
5	Standard Meter Data Profiles	14	Transmission and Distribution Power Systems Model Mapping
6	Common Semantic Model for Meter Data tables	15	Harmonize Power Line Carrier Standards for Appliance Communications in the Home
7	Electric Storage Interconnection Guidelines	16	Wind Plant Communications
8	CIM for Distribution Grid Management	17	Customer Facility Smart Grid Information

# *SDOs Participating in SGIP PAPs*

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## International

- IEC
- ISO
- ITU-T
- IEEE
- IETF
- ISA
- SAE

## Consortia

- OASIS
- Zigbee
- HomePlug
- CAL Connect
- FIX Protocol
- OSCRE
- OGC

## US/Canada

- ASHRAE
- ATIS
- CSA
- NAESB
- NEMA
- NERC
- TIA
- UL



# *NIST Bilateral Exchanges on SG Standards*

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## Asia

- Japan
- Korea
- China
- Singapore
- Australia
- India
- Pakistan

## EMEA

- EC
- France
- Germany
- Denmark
- Austria
- Poland
- Israel

## Americas

- Canada
- Mexico
- Brazil

## *Further Information*

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- Web portal: <http://www.nist.gov/smartgrid>
- Contact:
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