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National Institute of Standards and Technology
U.S. Department of Commerce

Standards Framework for a National Interoperable and Secure Smart Grid

Smart Grids Week Linz 2011

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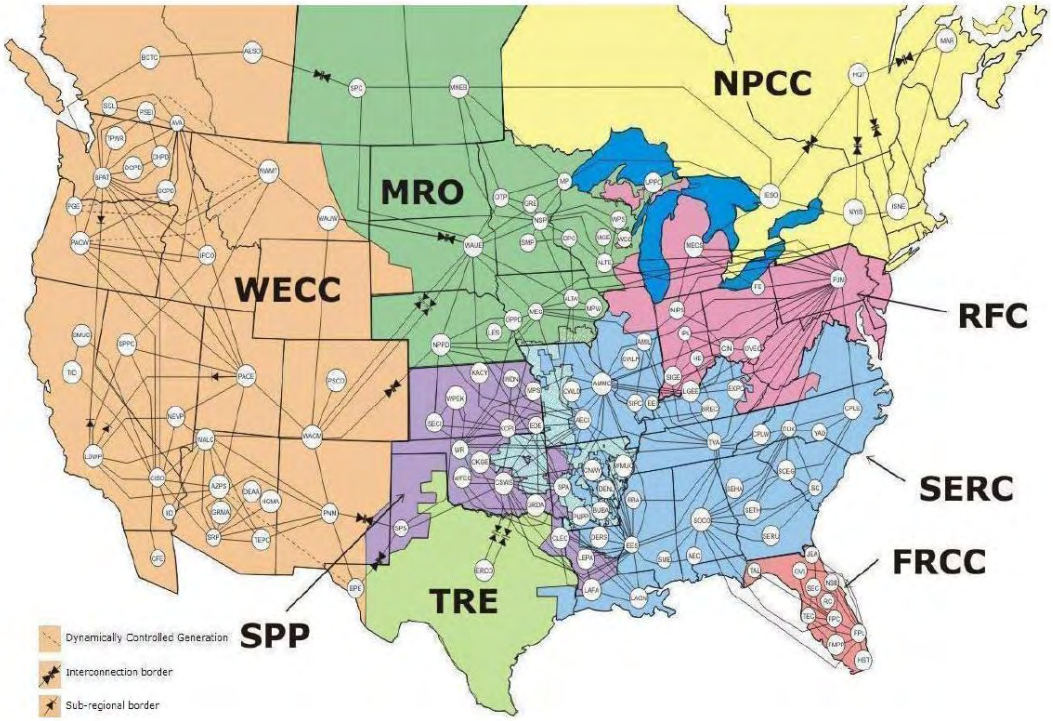
National Institute of Standards and Technology
25 May 2011

The Electric Grid

Example: North American Electric Grid

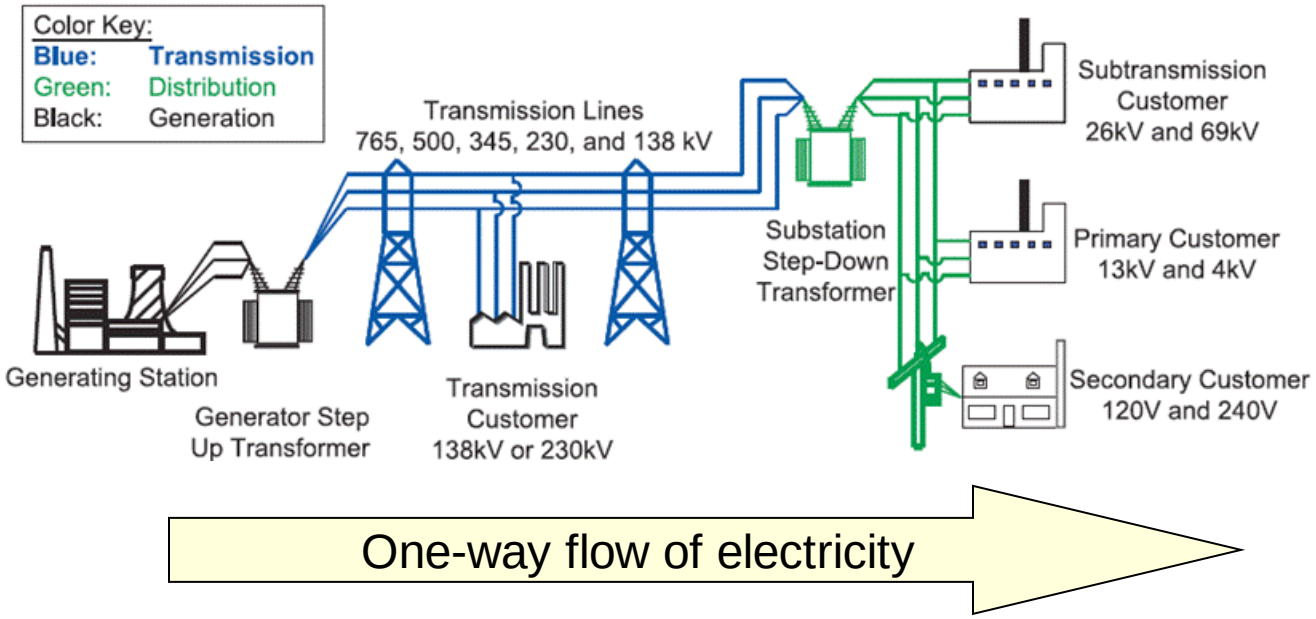
US figures:

- 22% of world consumption



- 3,200 electric utility companies
- 17,000 power plants
- 800 gigawatt peak demand
- 165,000 miles of high-voltage lines
- 6 million miles of distribution lines
- 140 million meters
- $1 trillion in assets
- $350 billion annual revenues

Today's Electric Grid



- *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*

What is the Smart Grid?

The Smart Grid integrates information technology and advanced communications into the power system in order to:

- Increase system efficiency and cost effectiveness
- Provide customers tools to manage energy use
- Improve reliability, resiliency and power quality
- Enable use of innovative technologies including renewables, storage and electric vehicles

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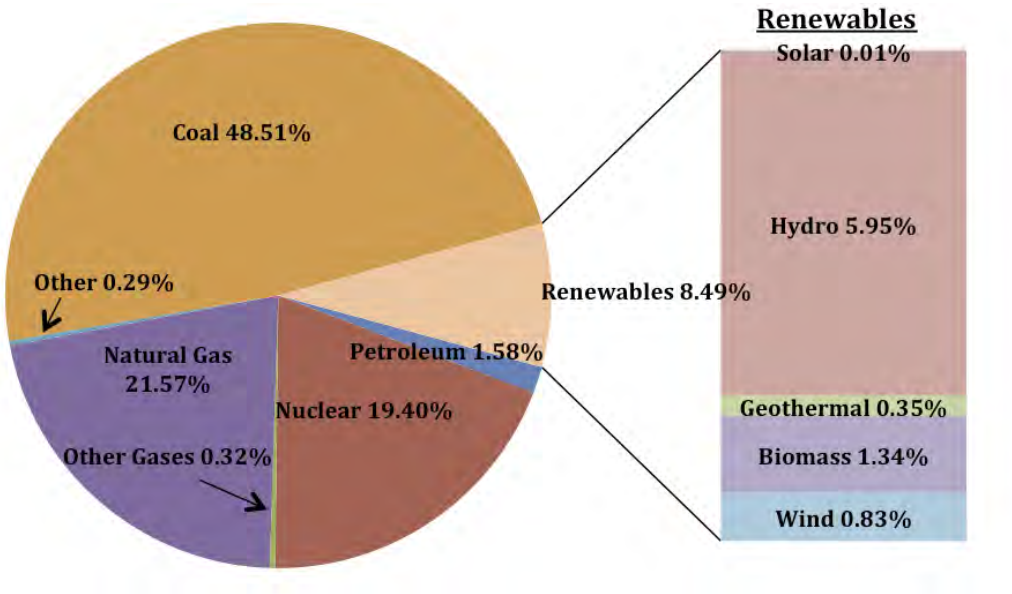
Increasing Efficiency is a Key Priority

2007 Generation by Source

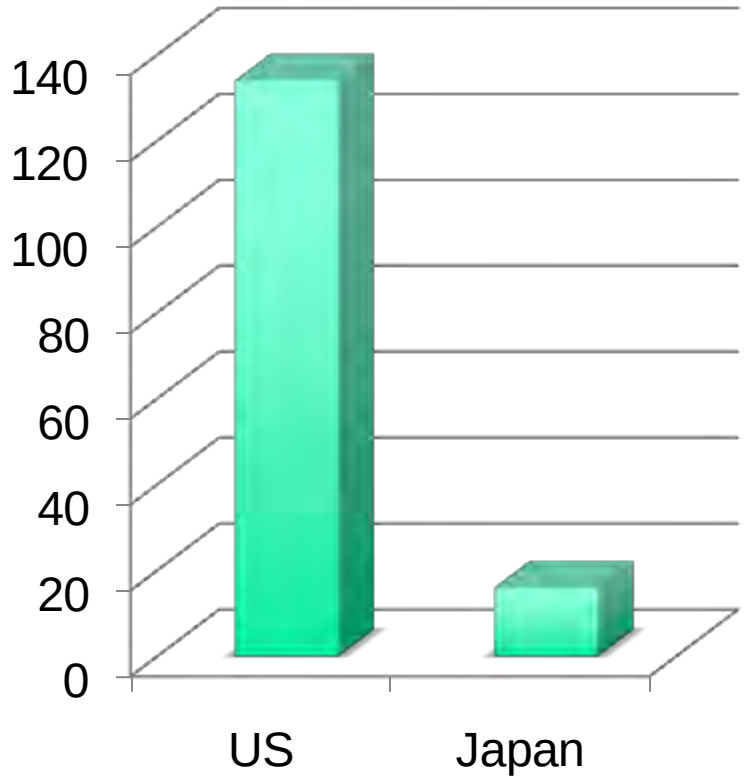


Sources:
(1) DoE EIA
(2) Brattle Group

- Half of U.S. coal plants are > 40 years old
- Average substation transformer age > 40 years
- Projected investment in modernization and expansion: ***$1.5 - $2 trillion*** by 2030
- Smart grid helps utilities reduce delivery losses and customers reduce both peak and average consumption – thus reducing investment otherwise required
  - US per capita annual electricity usage = 13000 kWh
  - Japan per capita annual usage = 7900 kWh

Improving Reliability for 21st Century

Power outages
Minutes/year/customer

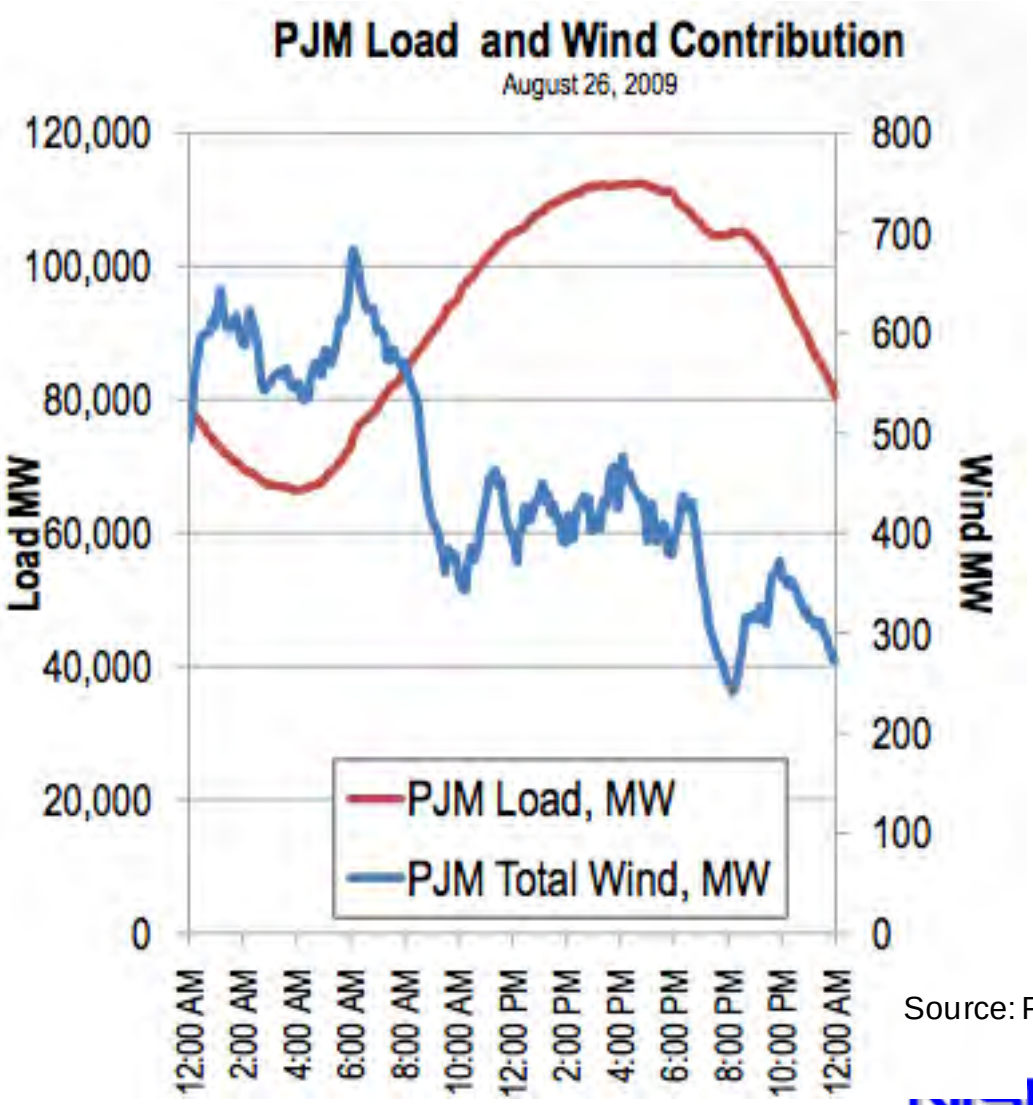


- $80 billion/year cost to US economy
- Smart grid sensors and automated controls will improve reliability

Sources:
(1) IEEE Benchmarking 2009 Results Distribution Reliability Working Group
(2) Japan Ministry of Economy Trade and Industry 2010
(3) Lawrence Berkeley National Laboratory

Enabling Greater Use of Renewables

- Electricity generation accounts for 40% of human-caused CO_2
- Greater use of wind and solar requires more dynamic grid control and storage



Source: PJM

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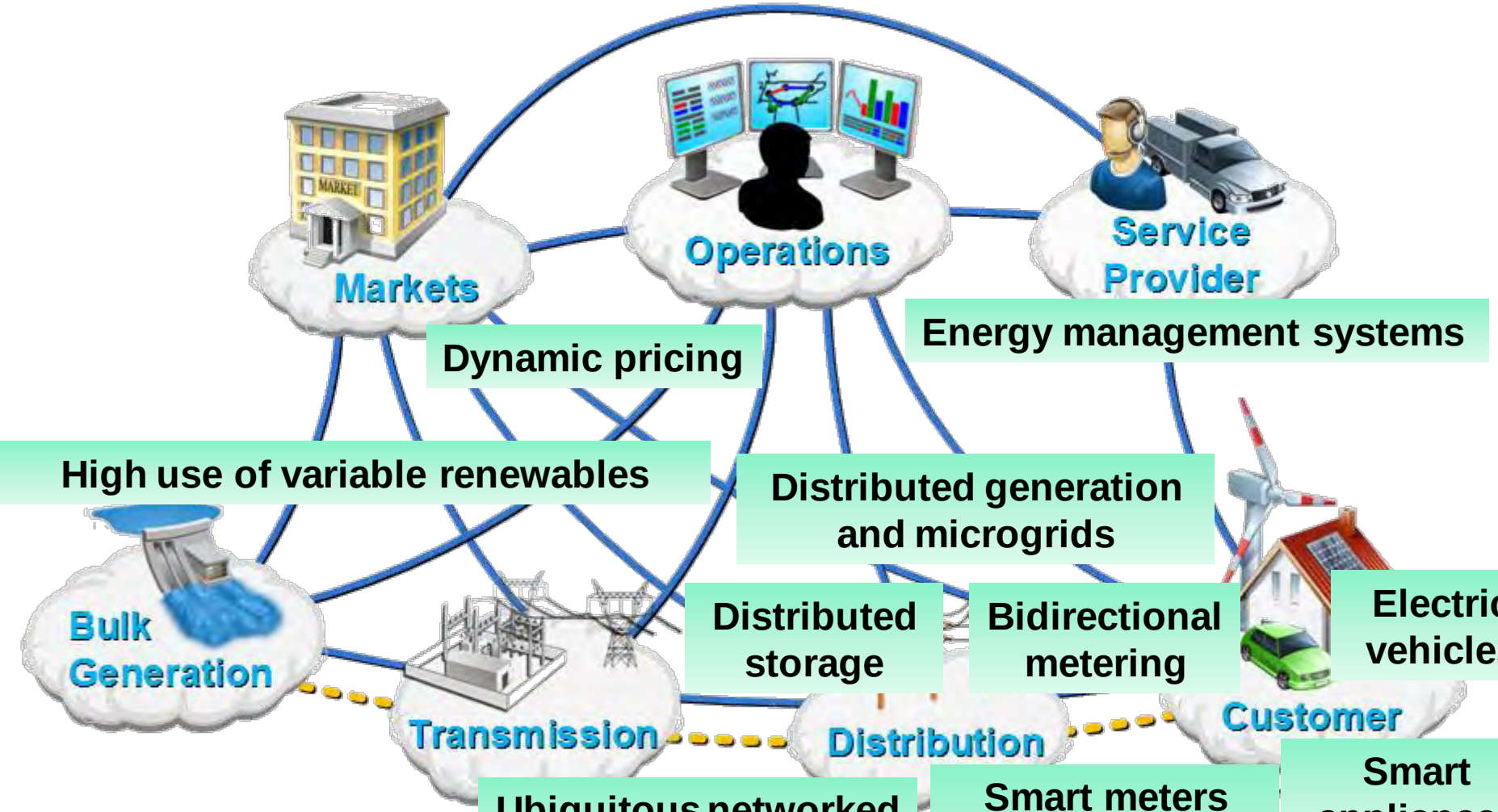
Enabling Reduced Dependence on Oil

- Idle capacity of the power grid could supply 70% of energy needs of today's cars and light trucks
- Displace half of US oil imports
- Reduce CO_2 20%
- Reduce urban air pollutants 40%-90%
- Batteries in EVs could provide power during peak demand

What Will the Smart Grid Look Like?



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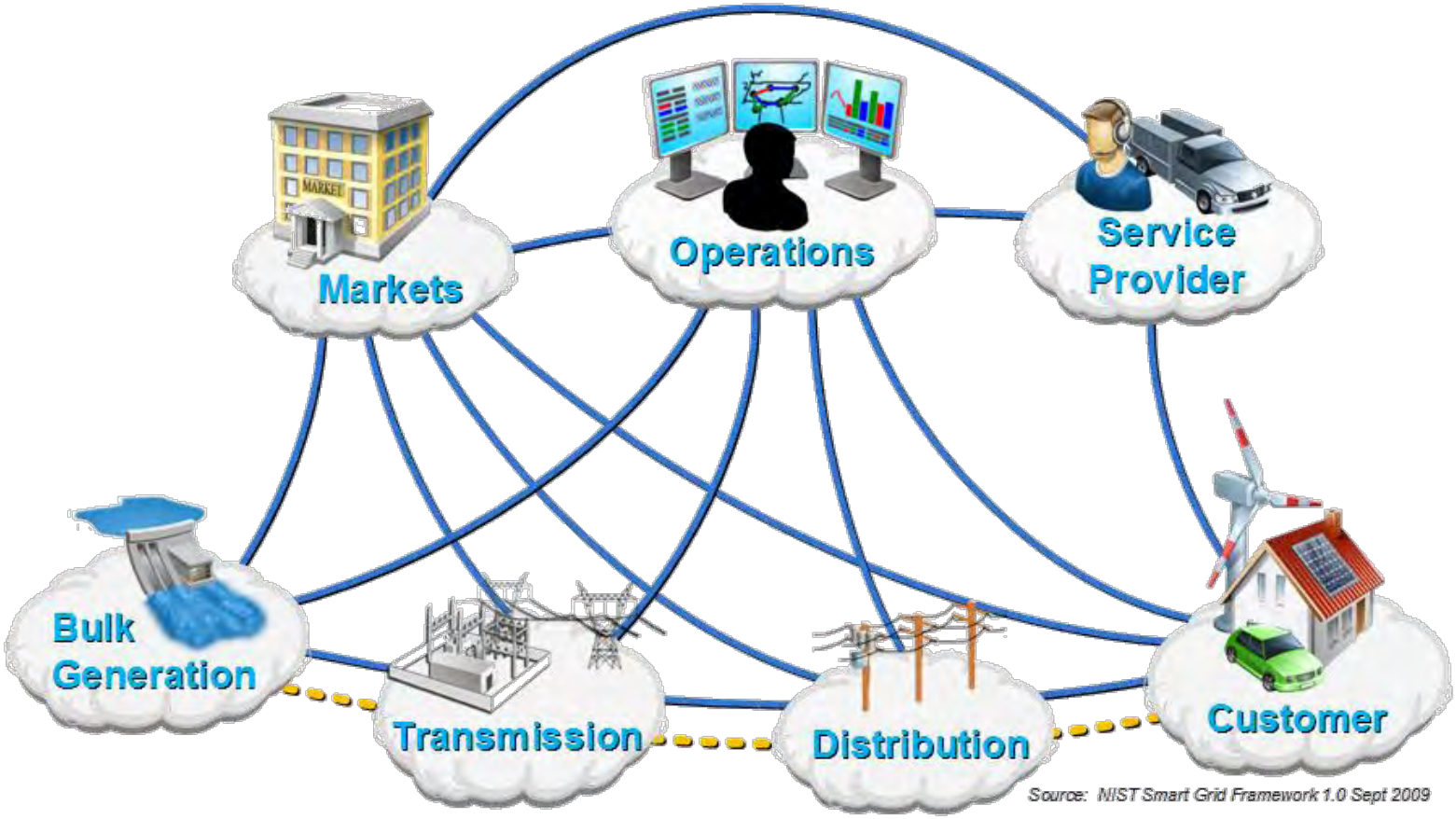
Architecture and Standards



Standardized architectural concepts, data models and protocols are essential to achieve interoperability, reliability, security and evolvability

Smart Grid – A U.S. National Policy

"It is the policy of the United States to support the modernization of the Nation's electricity [system]… to achieve…a Smart Grid." Congress, Energy Independence and Security Act of 2007

"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

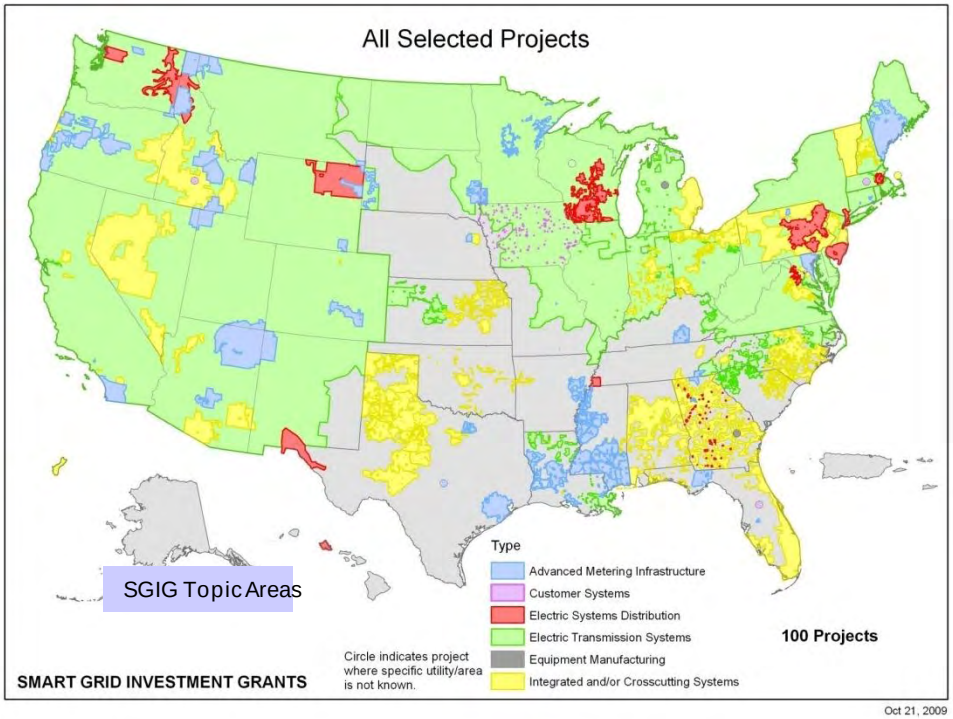
"A smart electricity grid will revolutionize the way we use energy, but we need standards …" Secretary of Commerce Gary Locke

US 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



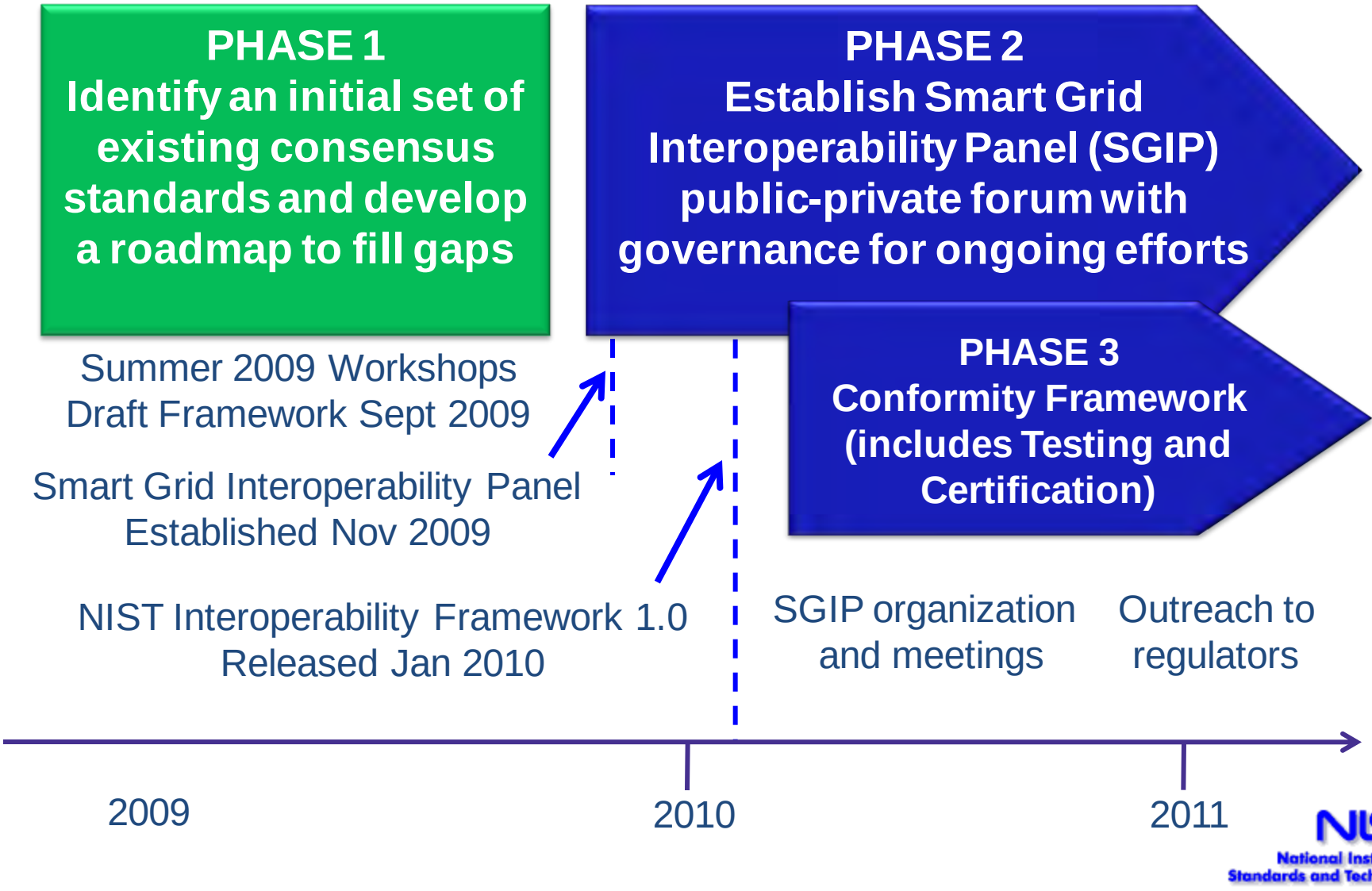
Standards – Key Aspect of US Policy

The Energy Independence and Security Act gives NIST

"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…"

- Congress directed that the framework be "flexible, uniform, and technology neutral"
- Use of these standards is a criteria for federal Smart Grid Investment Grants
- Input to federal and state regulators

NIST Three Phase Plan for Smart Grid Interoperability



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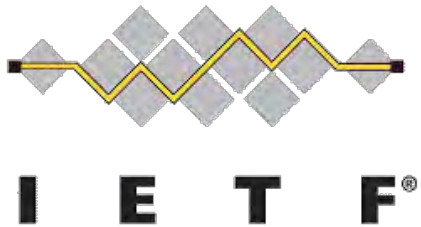
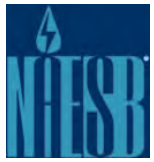
Standards Come from Many Developers

International

Global Consortia

Regional and National

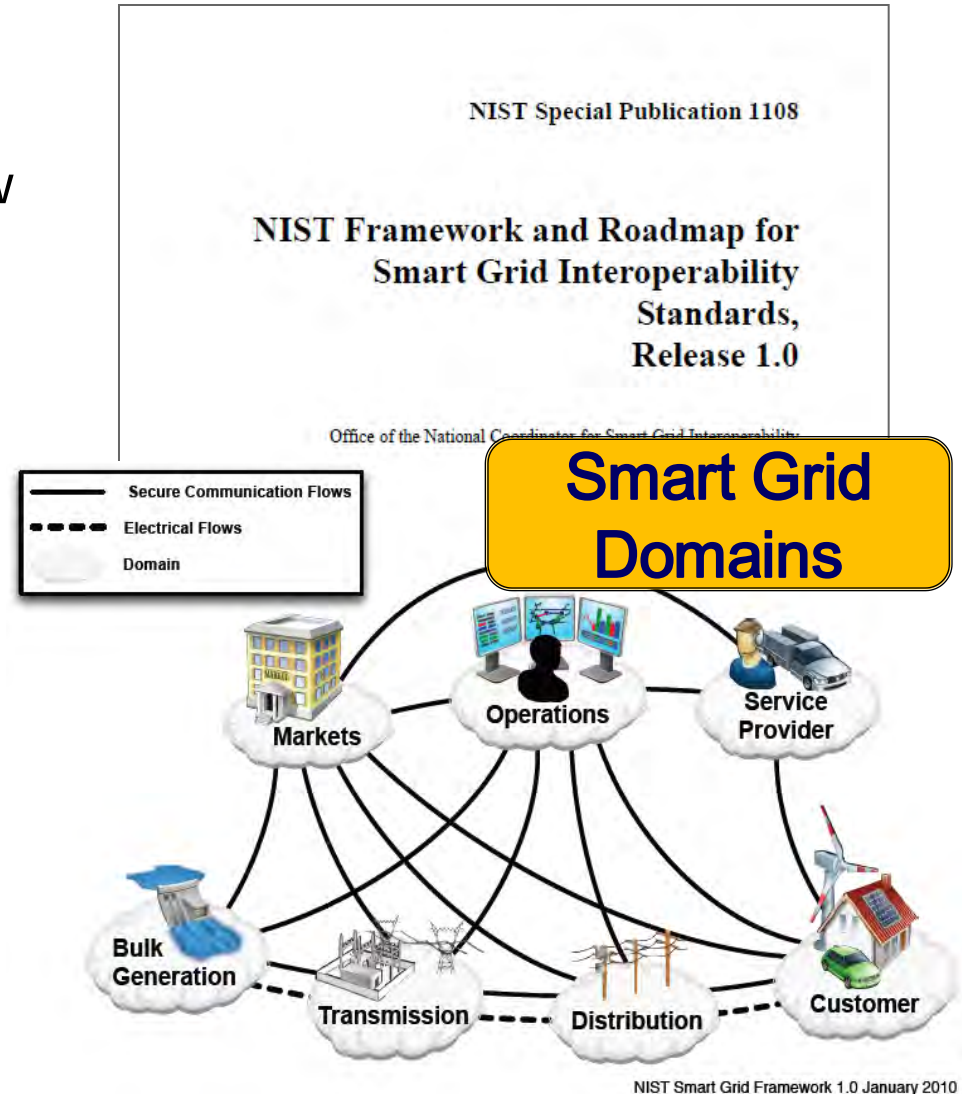




NIST Smart Grid Framework and Roadmap 1.0

- 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/



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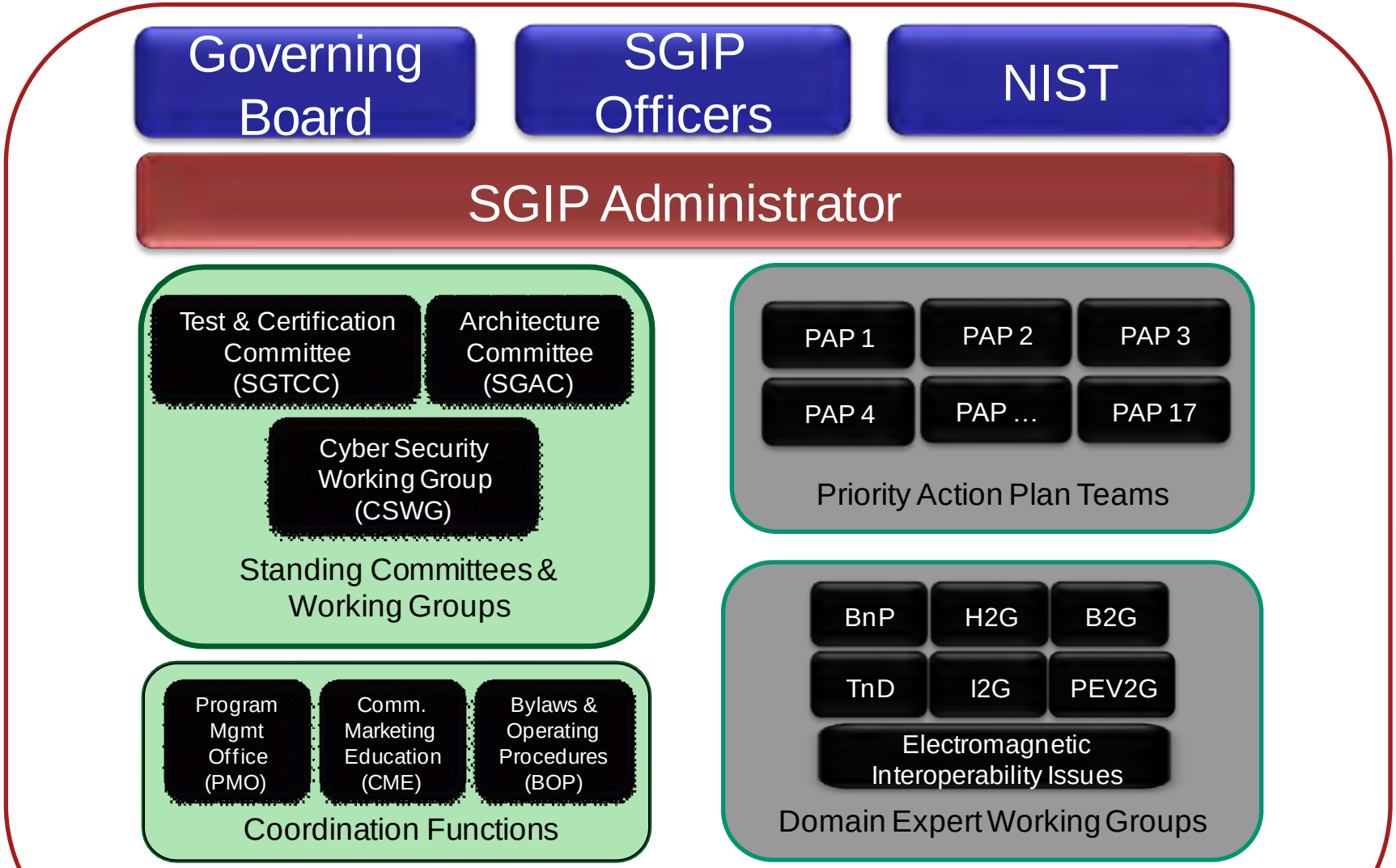
Smart Grid Interoperability Panel

- Public-private partnership created in Nov. 2009
- 664 member organizations
- Open, public process with international participation
- Coordinates standards developed by Standards Development Organizations (SDOs)
  - Identifies Requirements
  - Prioritizes standards development programs
  - Works with over 20 SDOs including IEC, ISO, ITU, IEEE, …
- Web-based participation

SGIP Twiki:

http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIP

SGIP Organization



SGIP Membership

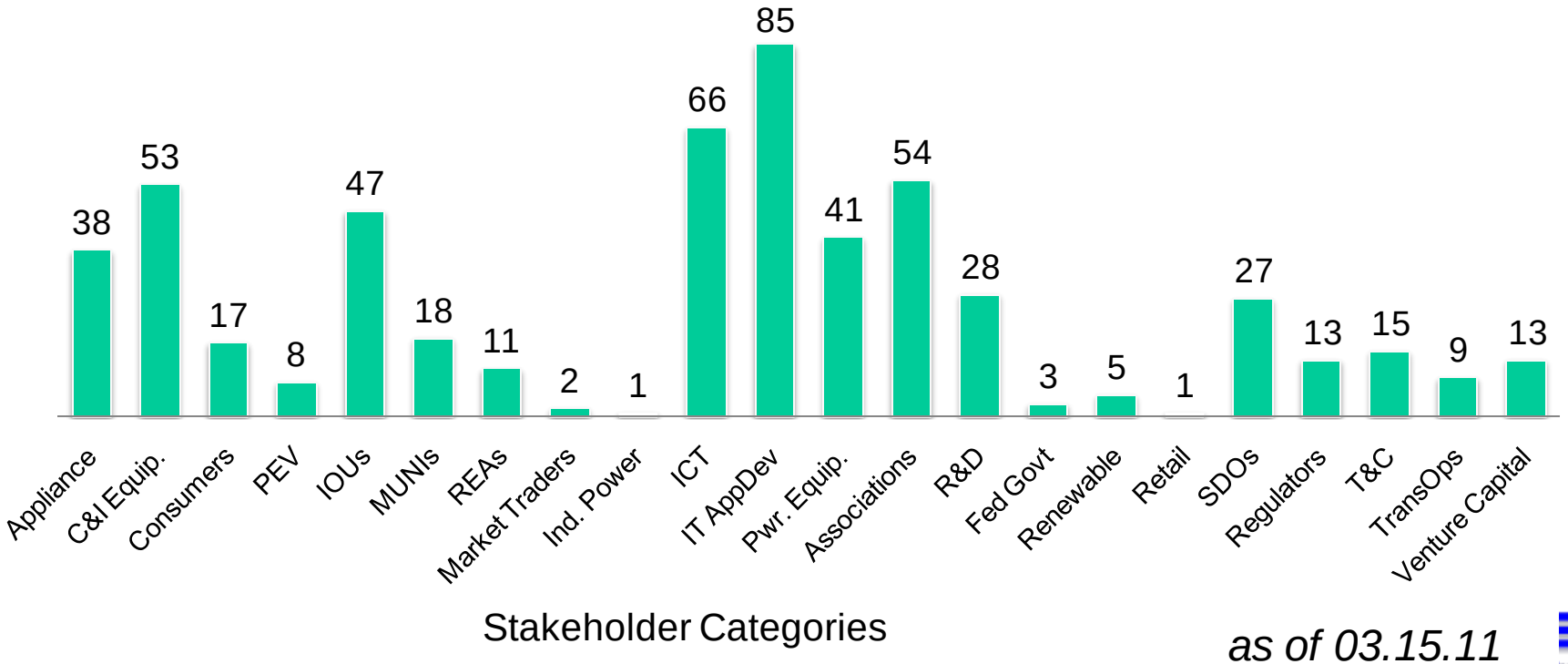
SGIP Membership

- **Total # of Member Organizations: 664**
  - # of Participating Member Organizations: 555
  - # of Observing Member Organizations: 109
  - # of Organizations who joined in Q1 2011: 19
- **Total # of Individual Members*: 1,708**

# of Organizations by Country

- USA: 592
- Europe: 21
- Asia: 16
- Oceania: 4
- North America (non-US): 29
- South America: 1
- Africa: 1

# of Participating Member Organizations by Declared Stakeholder Category

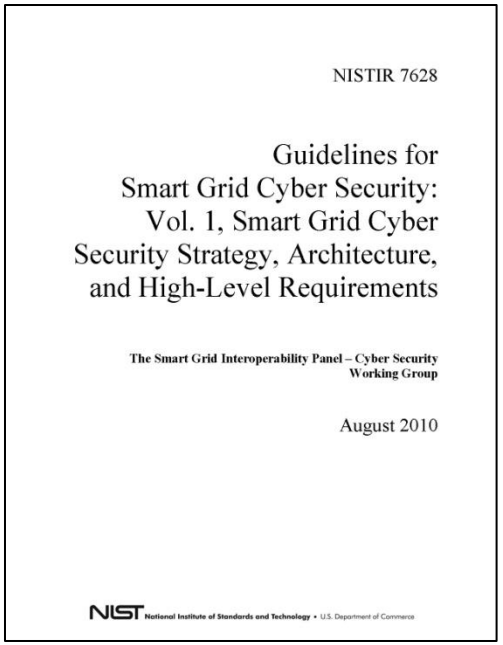


as of 03.15.11

** Omits non-active Signatory Authorities.*

Cyber Security Working Group

- Building cyber security in from the start has been a paramount concern
- Permanent Working Group
  - Over 575 public and private sector participants
- August 2010 NIST publishes: *Guidelines for Smart Grid Cyber Security*
- Guideline includes:
  - Risk assessment guidance for implementers
  - Recommended security requirements
  - Privacy recommendations


NISTIR 7628

Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements

The Smart Grid Interoperability Panel – Cyber Security Working Group

August 2010

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Filling Gaps in the Standards

Priority Action Plans

#	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 61850 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	Facility Smart Grid Information
		18	SEP 1.x to SEP 2.0 Transition and Coexistence

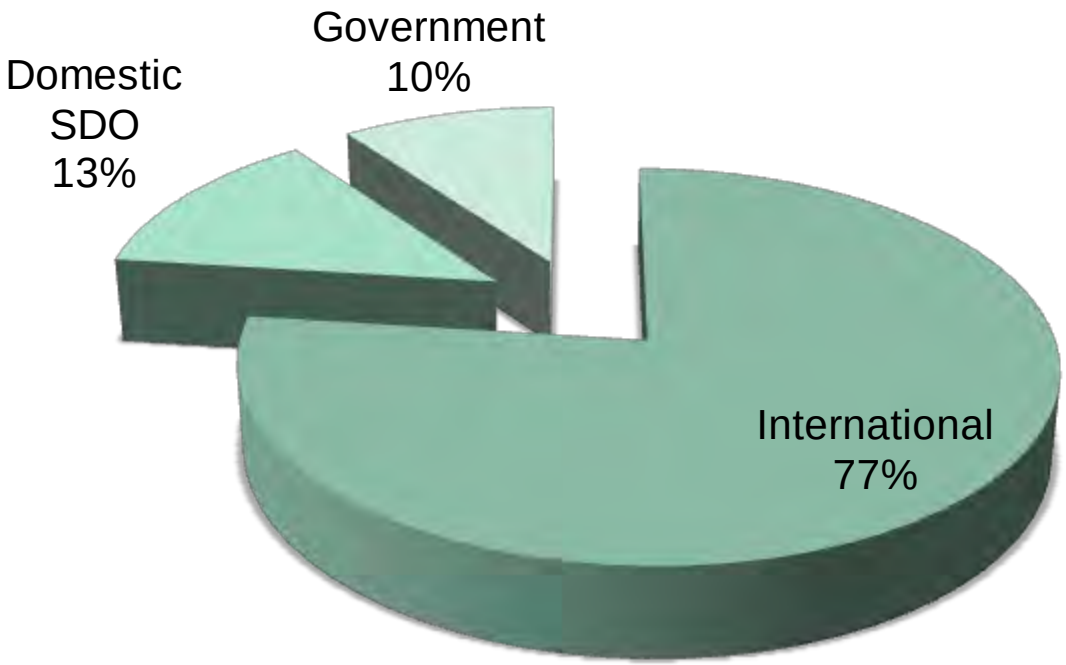
How to Participate in the NIST Process

- We encourage participation in the NIST Process through the SGIP
- Different types of participation
  - SGIP Plenary Meetings
    - Governance and oversight of work
  - Priority Action Plans (PAPs)
    - Detail technical work
  - SGIP Committees
    - Architecture
    - Testing and Certification
  - SGIP Working Groups
    - Cyber security
    - Electromagnetic compatibility

Global Collaboration is Key to Success

- The laws of physics do not differ from country to country – the electric grid must obey them!
- There are many technical challenges to solve – sharing knowledge helps all
- Global standards avoid unnecessary adaptations for different markets, resulting in lower costs and greater innovation

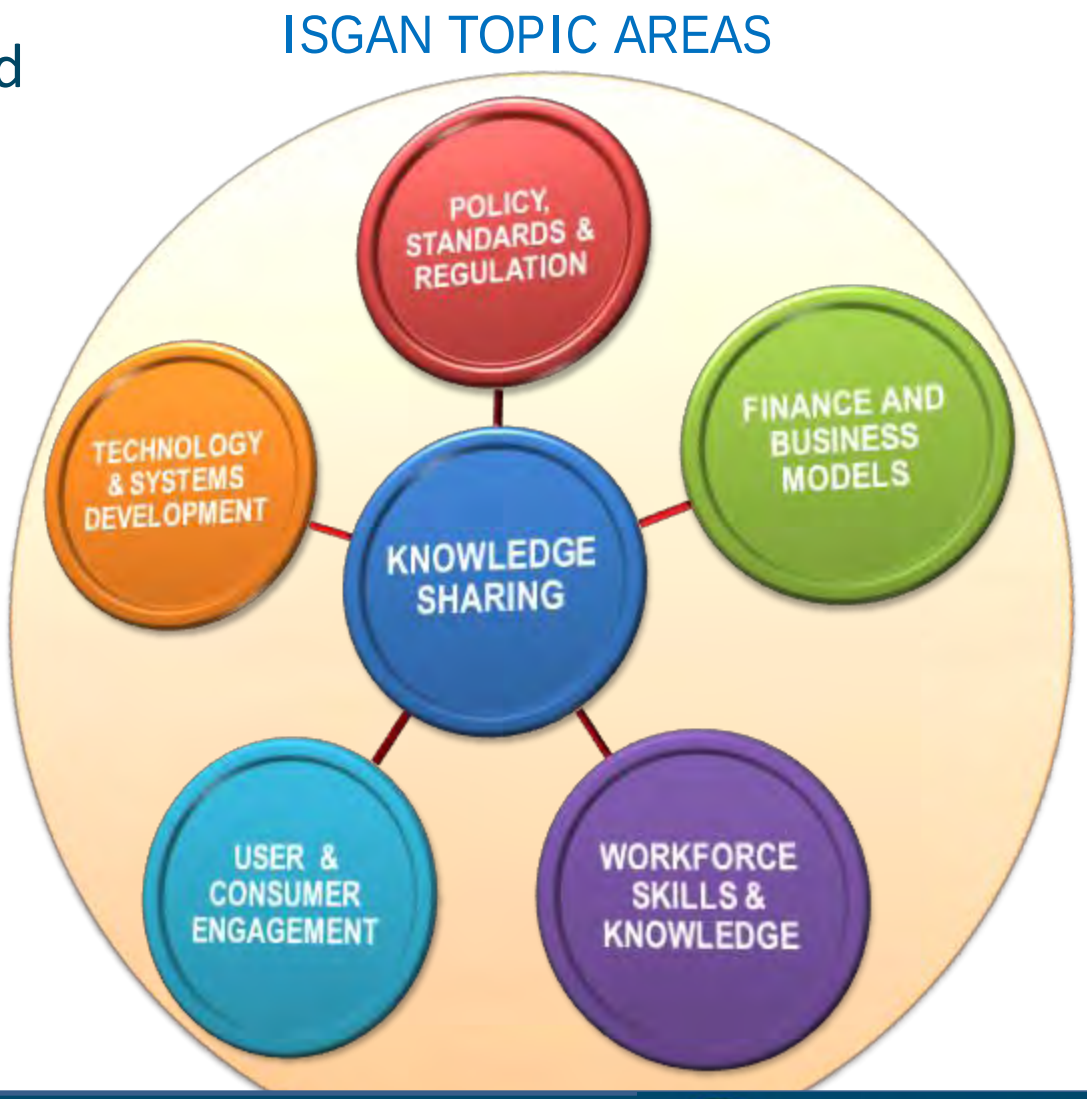
Source of Standards in NIST R1 Framework



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

Smart Grid – International Smart Grid Action Network (ISGAN)

- Multilateral cooperation to advance the development and deployment of smart grid technologies and systems globally
- **Five key topic areas** with knowledge sharing at core:
- **Four foundational projects** underway:
  - Global Smart Grid Inventory
  - Smart Grid Case Studies
  - Benefit-Cost Analyses and Toolkit Development
  - Synthesis of Insights for Decision Makers



CLEAN ENERGY MINISTERIAL

Further Information

- Web portal: http://www.nist.gov/smartgrid
- Contact:
  - Dean Prochaska, National Coordinator for Smart Grid Conformance
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