Interoperability Standards for the Smart Grid

World Smart Grid China Focus 2010

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National Coordinator for Smart Grid Interoperability
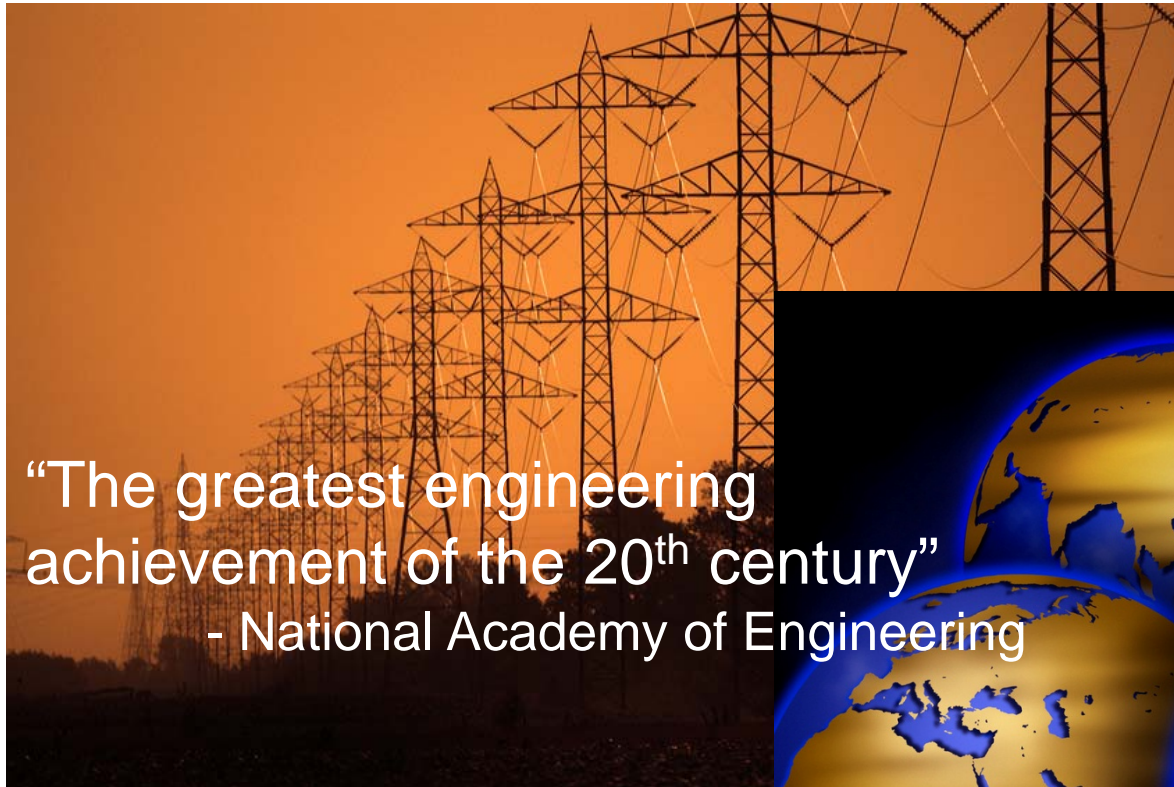
National Institute of Standards and Technology

October 28, 2010

The Electric Grid

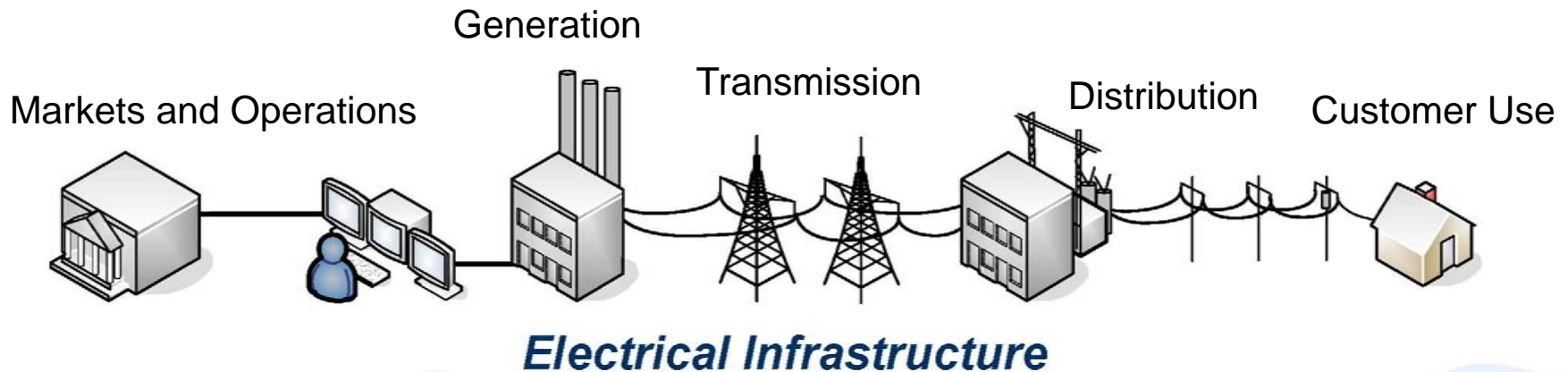One of the largest, most complex infrastructures ever built

"The greatest engineering achievement of the 20th century"
   - National Academy of Engineering

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Today's Electric Grid

Markets and Operations · Generation · Transmission · Distribution · Customer Use
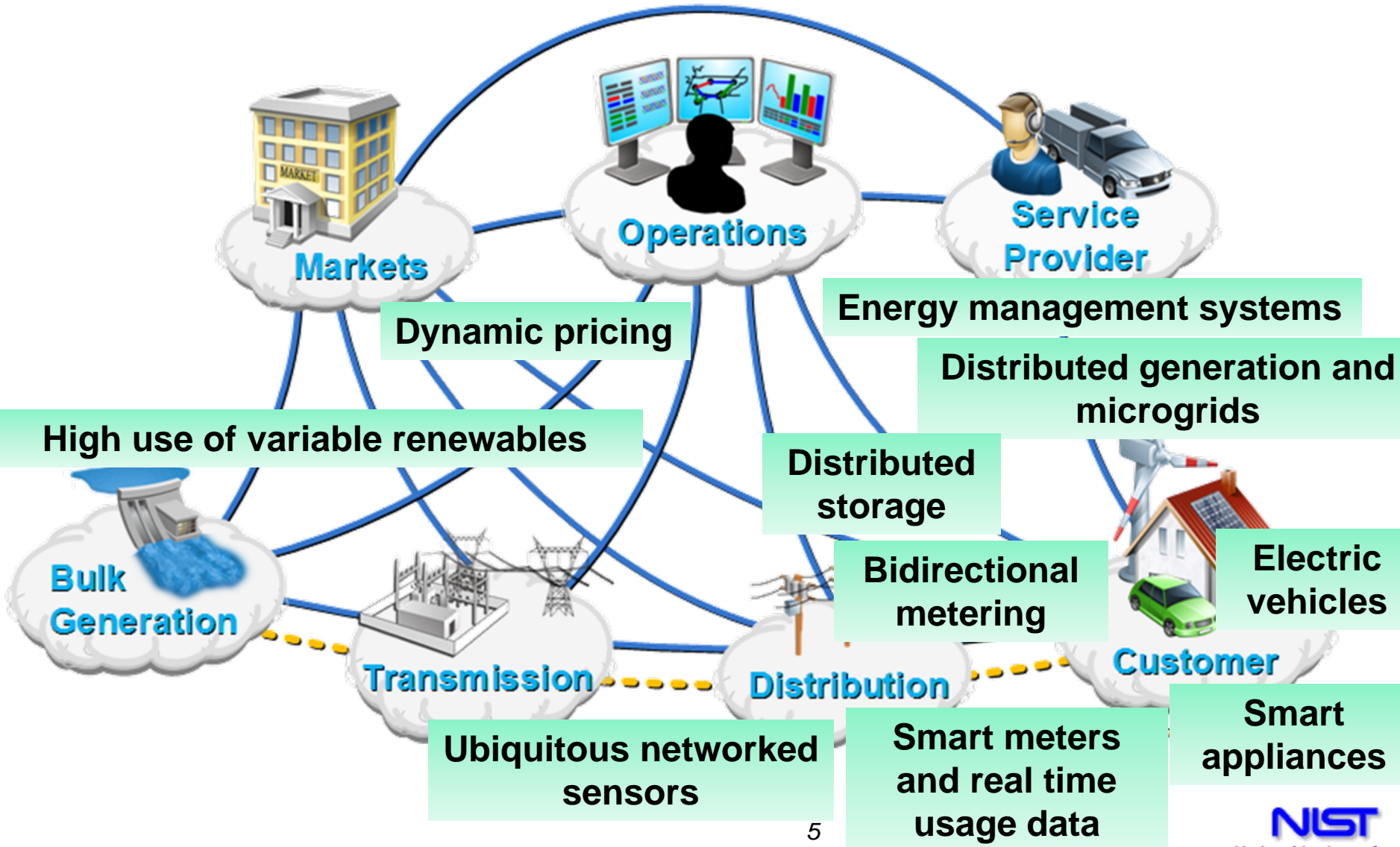
Electrical Infrastructure

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
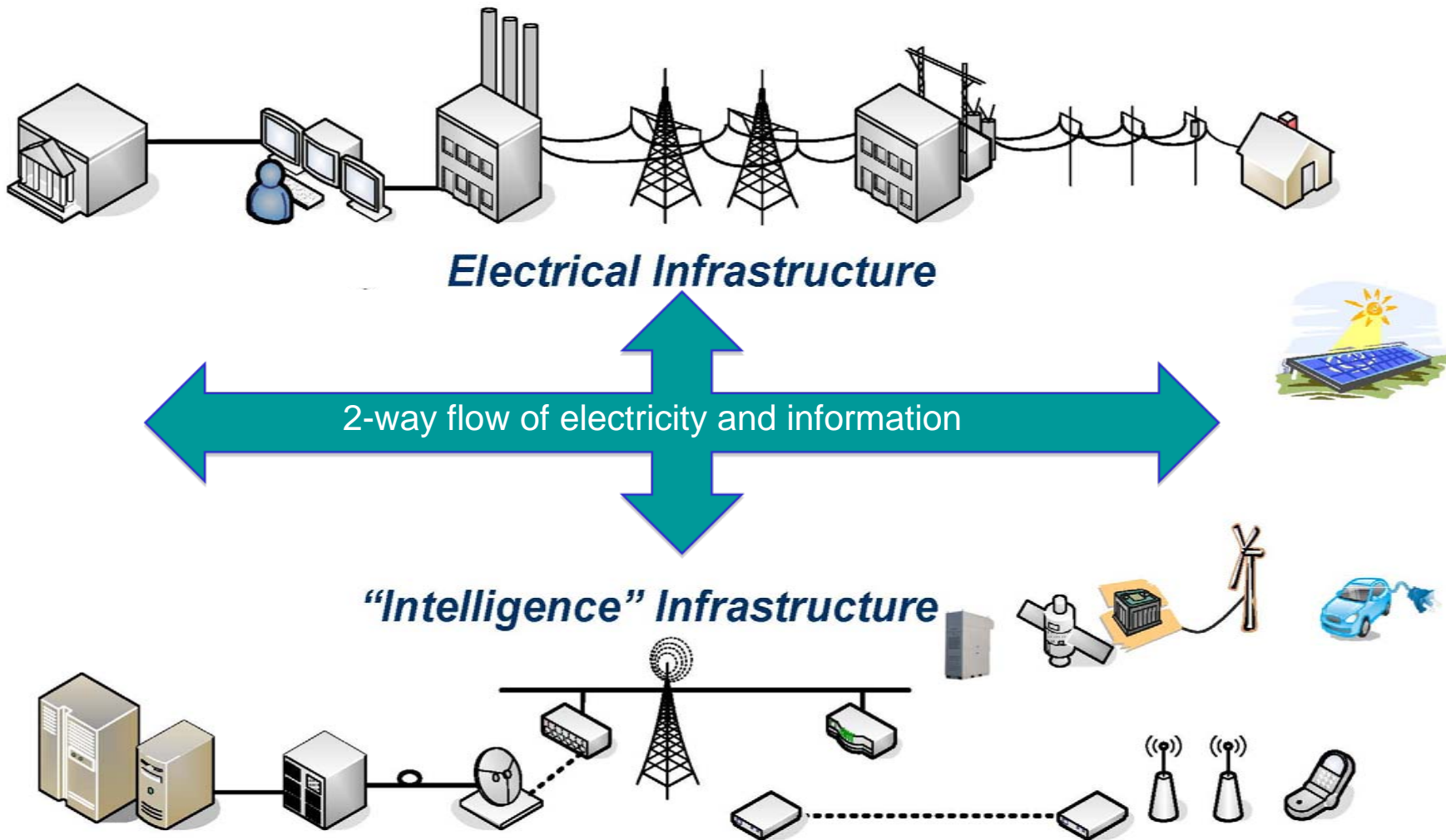
Smart Grid Goals
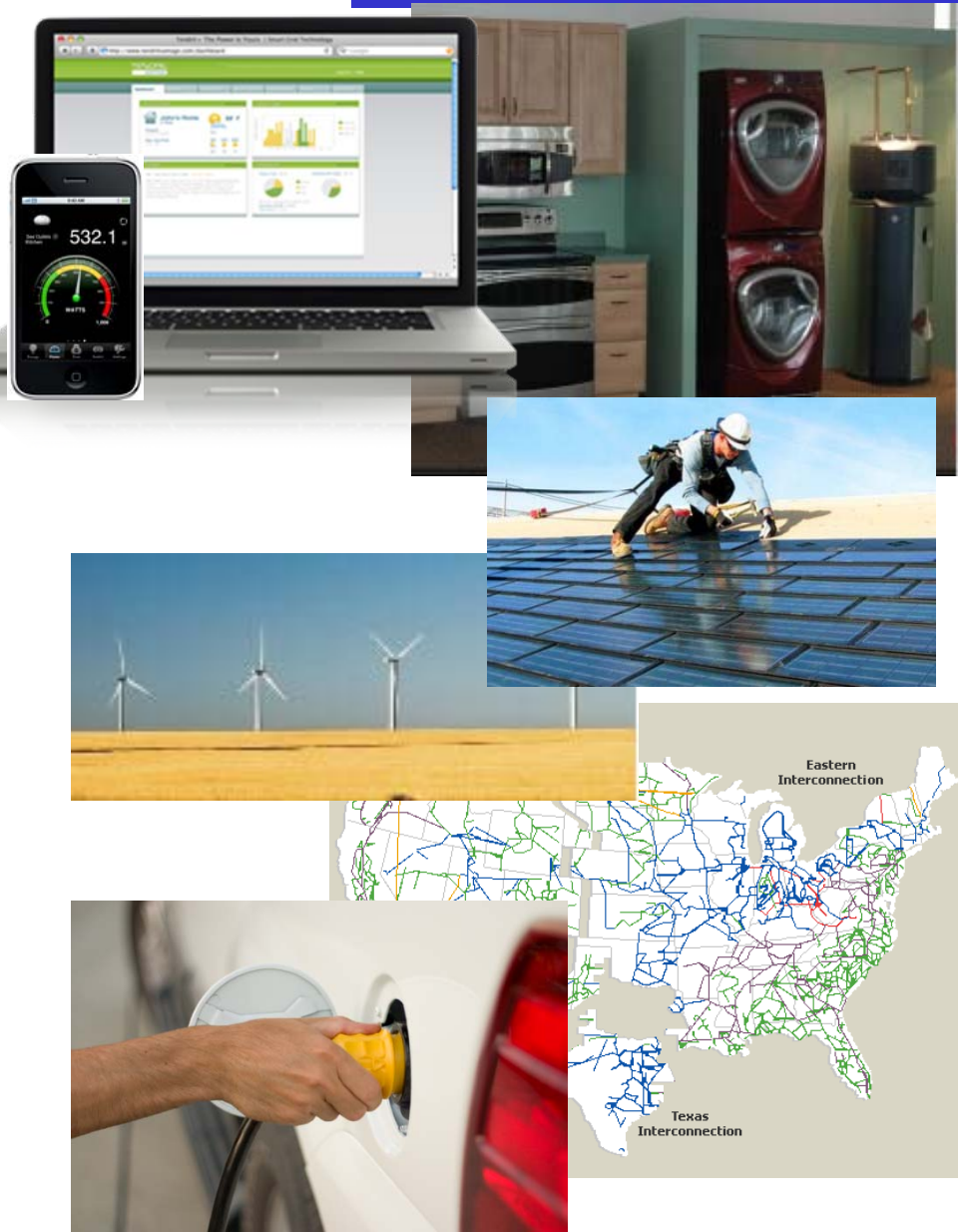
- Enable consumers to manage and reduce energy use

- Increase use of renewable sources

- Improve reliability and security

- Facilitate infrastructure for electric vehicles

4

What Will the Smart Grid Look Like?

Markets

Operations

Service Provider

Dynamic pricing

Energy management systems

Distributed generation and microgrids

High use of variable renewables

Distributed storage

Bulk Generation

Bidirectional metering

Electric vehicles

Transmission

Distribution

Customer

Ubiquitous networked sensors

Smart meters and real time usage data

Smart appliances

5

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Smart Grid: The "Energy Internet"

Electrical Infrastructure

2-way flow of electricity and information

"Intelligence" Infrastructure

Standards Provide a Critical Foundation

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Benefits of Interoperability Standards

- 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

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Smart Grid Interoperability Panel

- Public-private partnership created in Nov. 2009
- 620 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, …
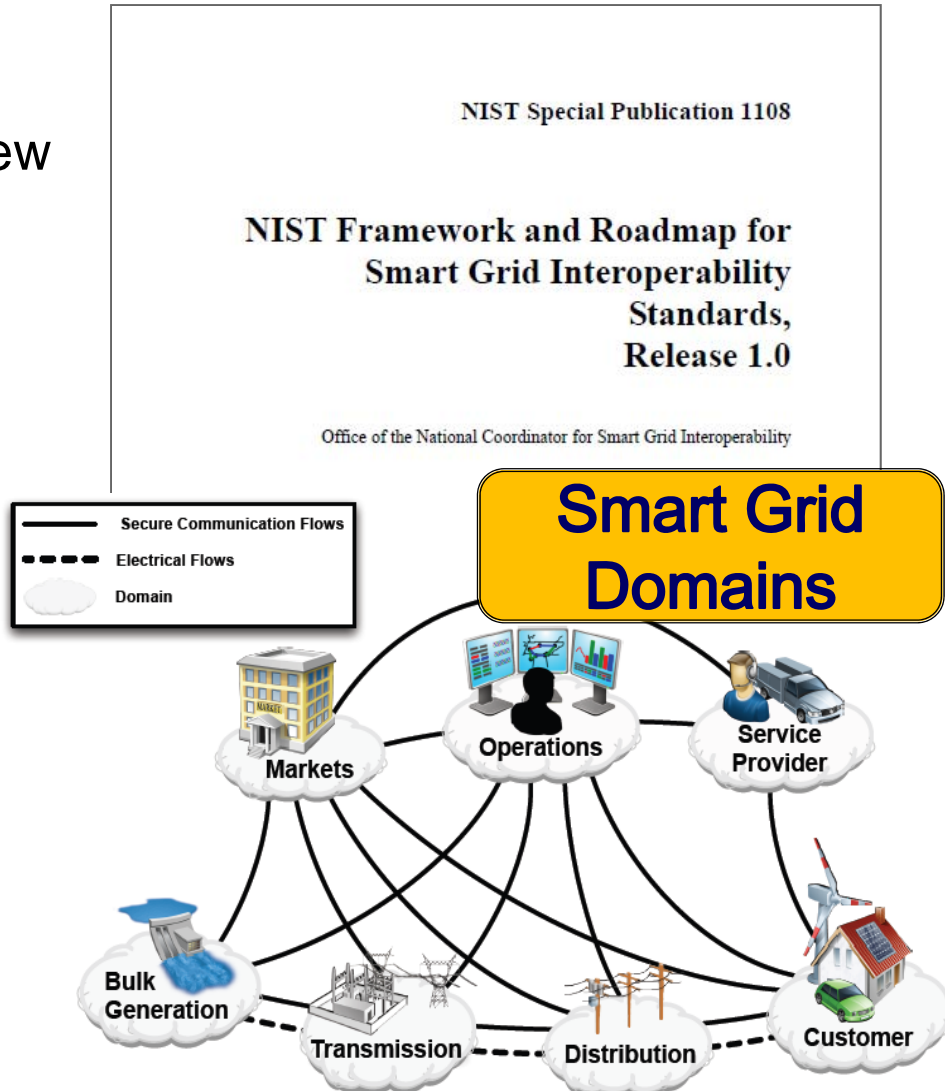- Web-based participation

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

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Stakeholders in the Process

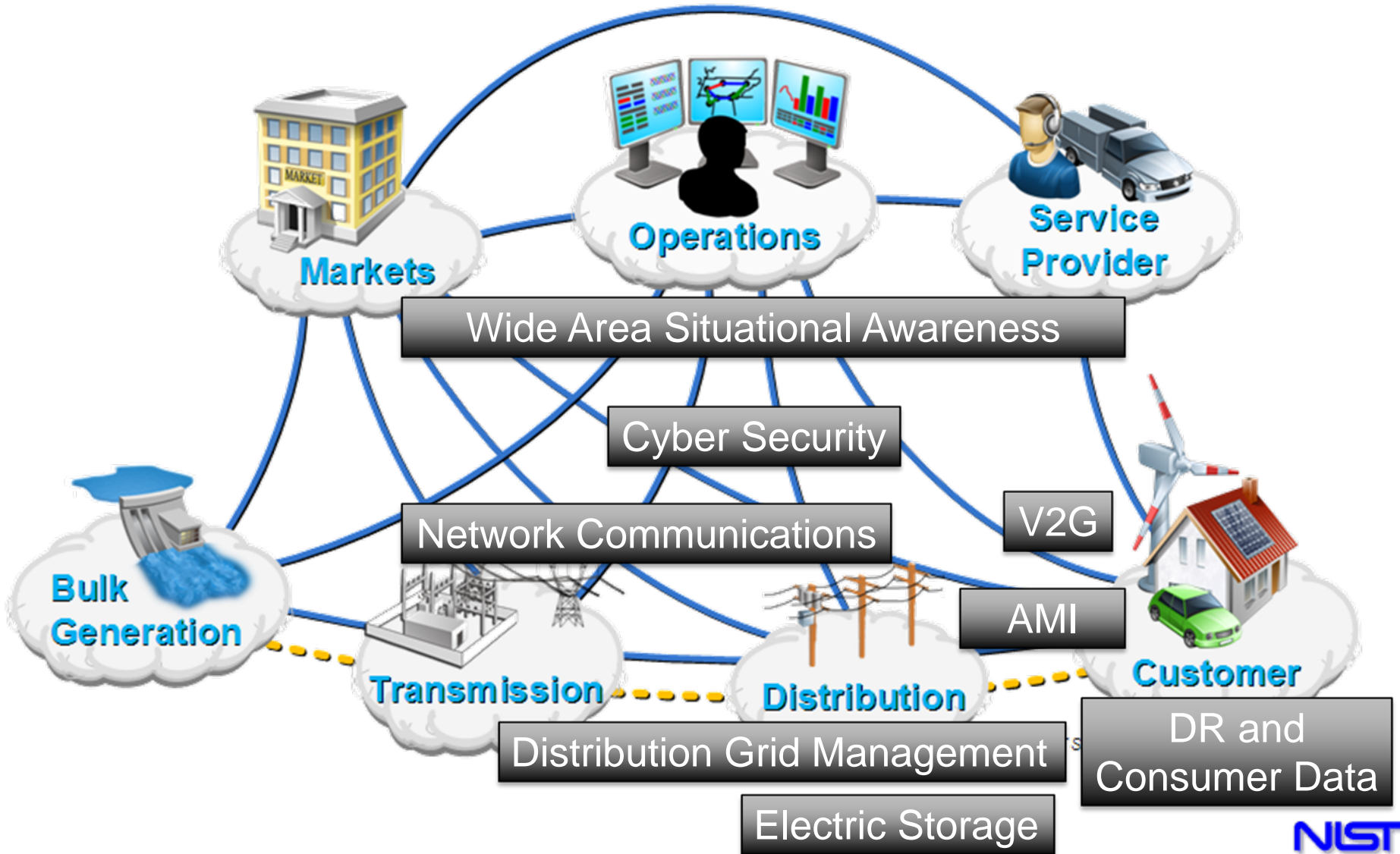|				
1	Appliance and consumer electronics providers		12	Power equipment manufacturers and vendors
2	Commercial and industrial equipment manufacturers and automation vendors		13	Professional societies, users groups, and industry consortia
3	Consumers – Residential, commercial, and industrial		14	R&D organizations and academia
4	Electric transportation industry Stakeholders		15	Relevant 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

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/

NIST Special Publication 1108

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0

Office of the National Coordinator for Smart Grid Interoperability

Secure Communication Flows
Electrical Flows
Domain

Smart Grid Domains

Markets
Operations
Service Provider
Bulk Generation
Transmission
Distribution
Customer

NIST Smart Grid Framework 1.0 January 2010

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The Standards Address…

Standards Come from Many Developers

International

Global
Consortia

Regional and
National

Foundational Standards for the SG

Current TC57 Reference Architecture
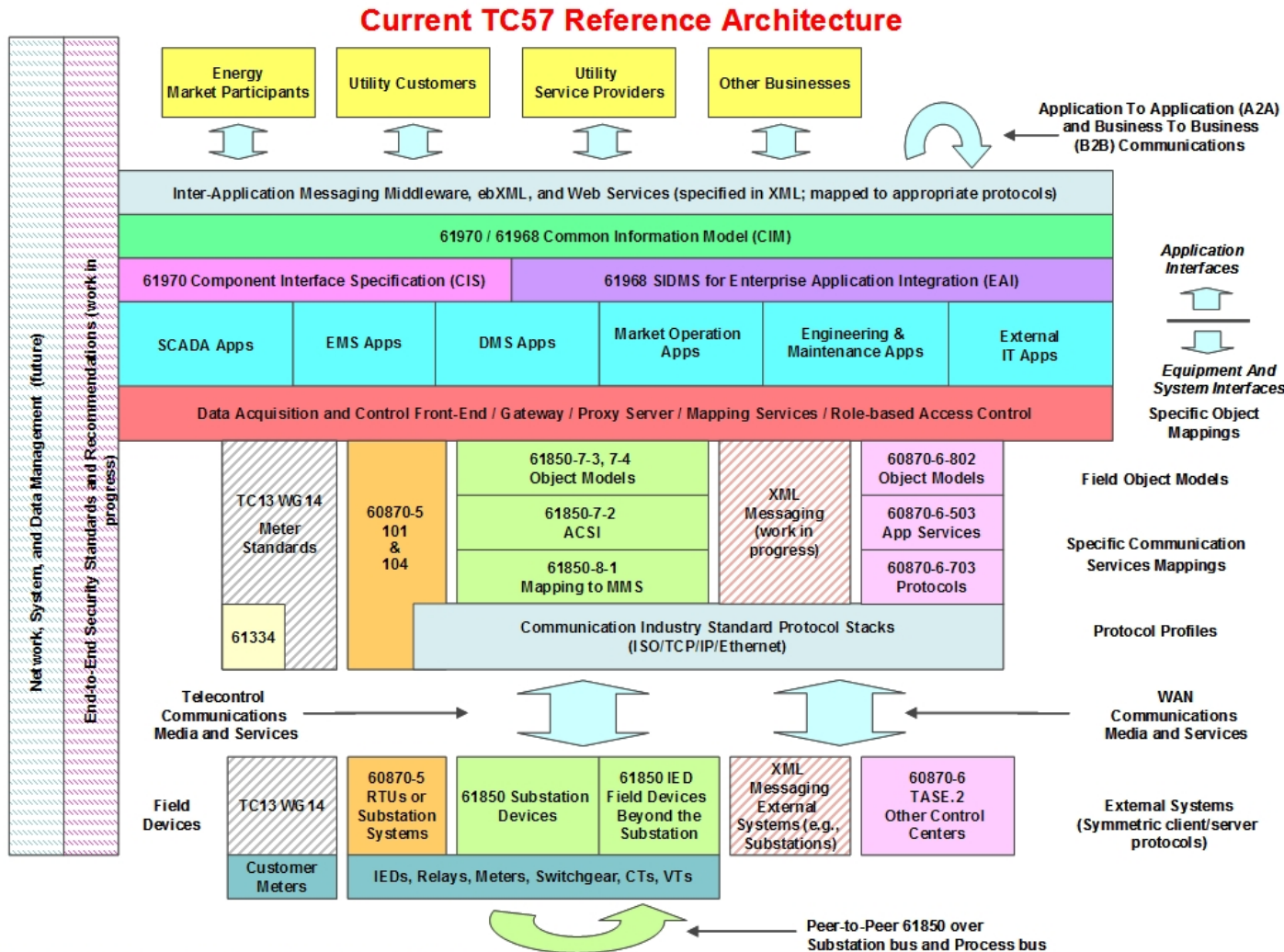
- IEC 61970/61968 Common Information Model for Transmission and Distribution
- IEC 61850 Common data format for substation automation
- IEC 60870-6 Inter-control center communication
- IEC 62351 Cybersecurity

Notes: 1) Solid colors correlate different parts of protocols within the architecture.
2) Non-solid patterns represent areas that are future work, or work in progress, or related work provided by another IEC TC.
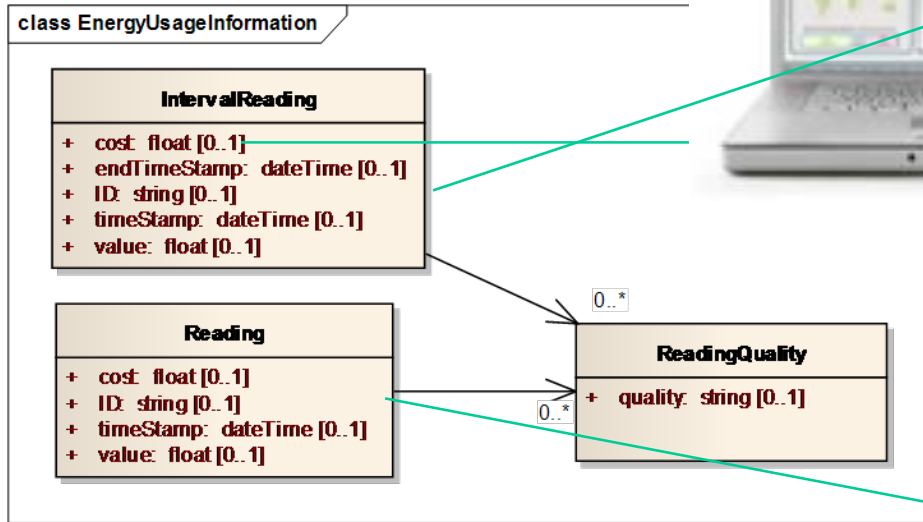
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Filling Gaps in the Standards

- ## Priority Action Plans

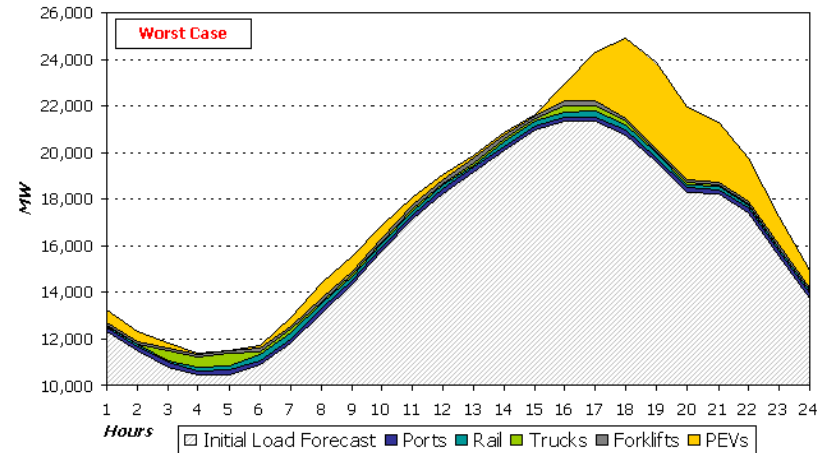| #	Priority Action Plan	#	Priority Action Plan
0	Meter Upgradeability Standard	9	Standard DR and DER Signals
1	Role of IP in the Smart Grid	10	Standard Energy Usage Information
2	Wireless Communication for the Smart Grid	11	Common Object Models for Electric Transportation
3	Common Price Communication 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

Energy Usage Information Standards

class EnergyUsageInformation

IntervalReading
+ cost: float [0..1]
+ endTimeStamp: dateTime [0..1]
+ ID: string [0..1]
+ timeStamp: dateTime [0..1]
+ value: float [0..1]

Reading
+ cost: float [0..1]
+ ID: string [0..1]
+ timeStamp: dateTime [0..1]
+ value: float [0..1]

ReadingQuality
+ quality: string [0..1]

0..*

0..*

Standardizes data elements available to consumers or authorized 3rd party application providers

NAESB PAP10 Kickoff: Straw Model

Electric Vehicle Charging Standards

2020 SUMMER LOAD IMPACT – NO UTILITY INVOLVEMENT*

- Data model
- Information exchange protocols
- Fast charging connector standard

2020 SUMMER LOAD IMPACT – WITH UTILITY INVOLVEMENT*

Appliance-to-Grid Communication

- Price, schedule, peak period 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.

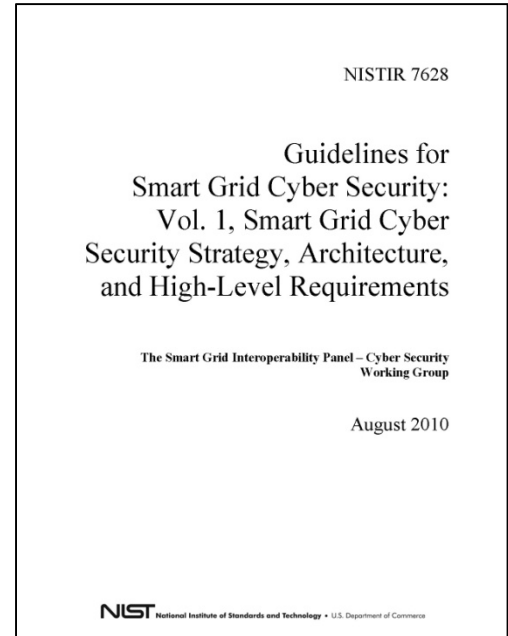The company also says smart laundry appliances will be available in 2011.

Whirlpool will release smart laundry appliances in 2011.

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

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

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

Benefits of Global Standards

- **Avoid unnecessary adaptations for different markets**
- **Promote supplier competition**
- **Encourage innovation**
- **Lower costs for suppliers**
- **Lower costs for utilities**
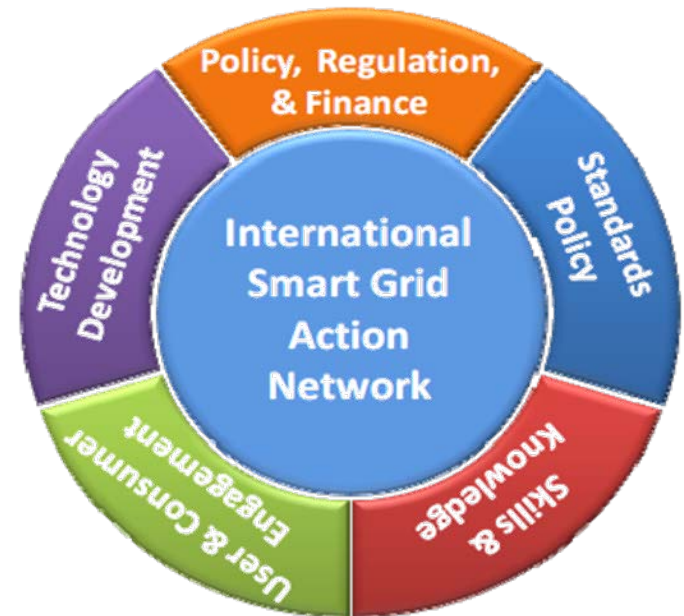- **Lower costs to end customers**

International Smart Grid Action Network

Purpose: To accelerate development and deployment of smarter electric grids around the world

- Announced at the first meeting of the Clean Energy Ministerial (CEM) in July 2010

International Smart Grid Action Network

- Policy, Regulation, & Finance
- Standards Policy
- Skills & Knowledge
- User & Consumer Engagement
- Technology Development

Further Information

- Web portal: http://www.nist.gov/smartgrid

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