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# NIST Coordination and Acceleration of Smart Grid Standards

Tom Nelson

National Institute of Standards and Technology

8 December, 2010



# *The Electric Grid*

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One of the largest, most complex infrastructures ever built



“The greatest engineering achievement of the 20<sup>th</sup> century”  
- U.S. National Academy of Engineering



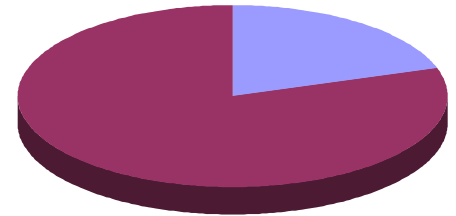
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- **NIST is Providing National and International Leadership to Coordinate and Accelerate Smart Grid Documentary Standards**
    - Leverages NIST technical expertise, industry connections, independent reputation
    - Expanded role for NIST to address 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

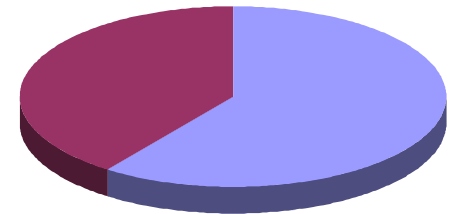
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- Modern life relies on significant energy use
- Energy use has implications (climate, geopolitical, ...)
- **Electricity is a key part of solution**
  - Infrastructure exists almost everywhere, transportable, reliable, cost effective, ...
  - Electric 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)

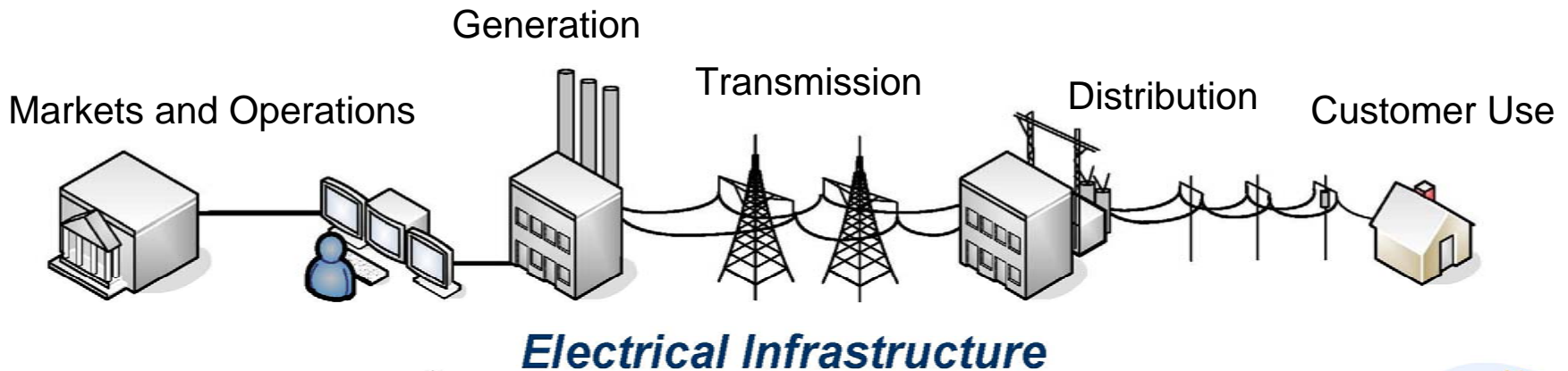


1950 - 20%



2008 - 60%

# Today's Electric Grid



One-way flow of electricity

- *Centralized, bulk generation, mainly coal and natural gas*
- *Responsible for 40% of human-caused CO<sub>2</sub> 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 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



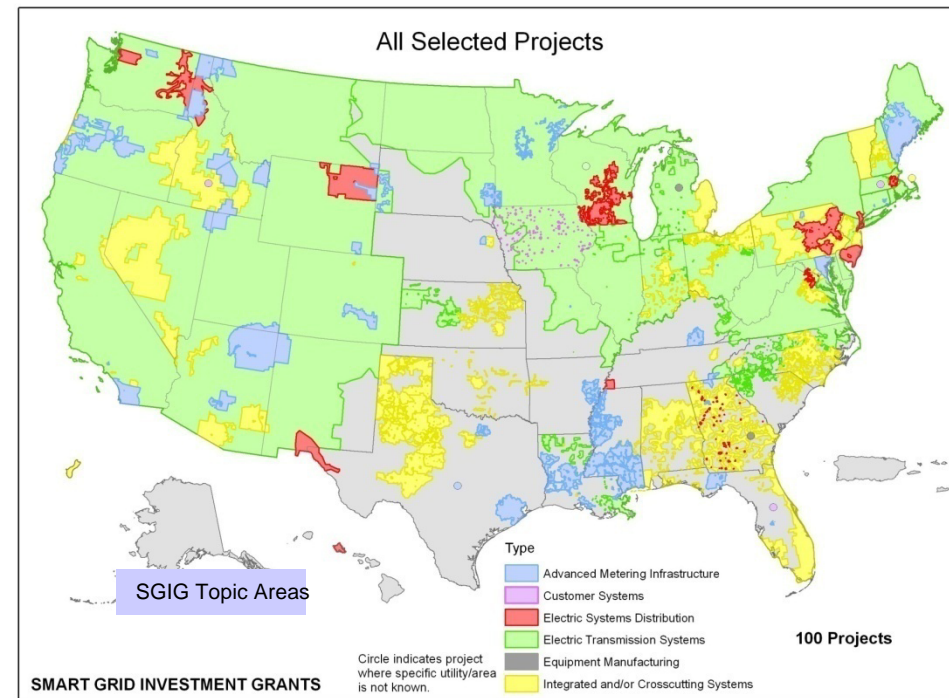


# US Smart Grid Investment Grants

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



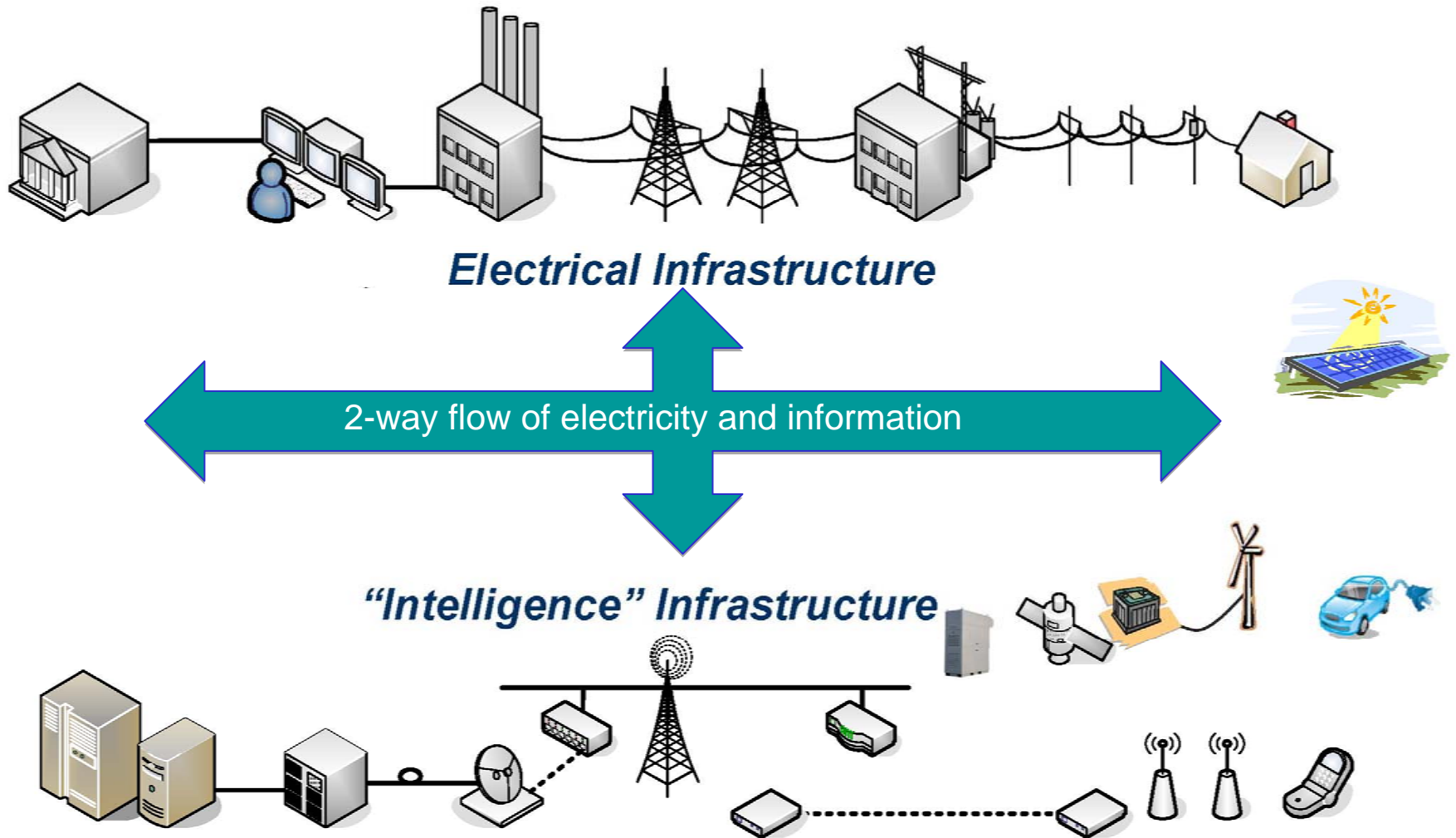
# *What Will the Smart Grid Look Like?*

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- 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”



**Standards Provide a Critical Foundation**

# *Standards are Essential*

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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

# *AMI Metering*

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- 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

# *Priorities Areas*

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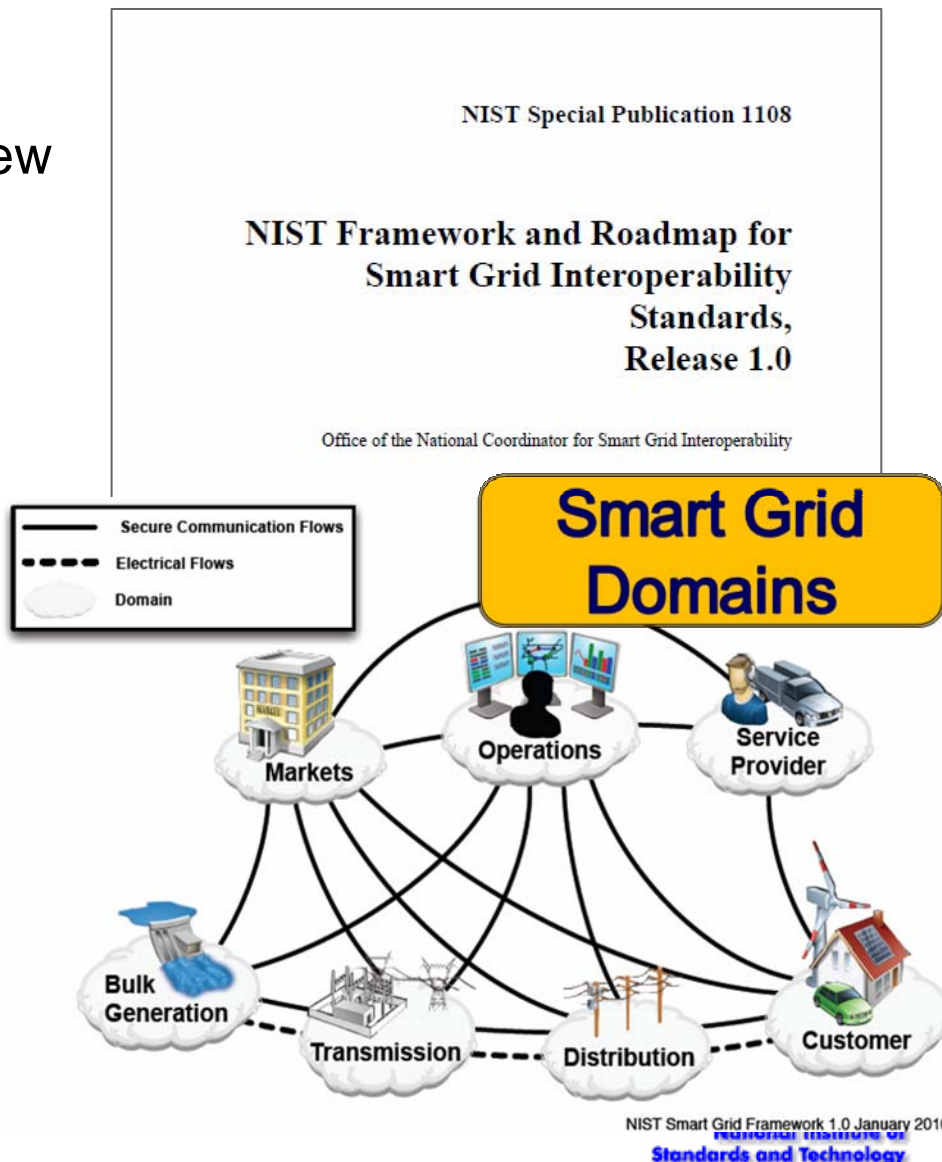
- Demand Response and Consumer Energy Efficiency
- Wide Area Situational Awareness
- Electric Storage
- Electric Transportation
- Advanced Metering Infrastructure
- Distribution Grid Management
- Cyber Security
- Network Communications



# 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

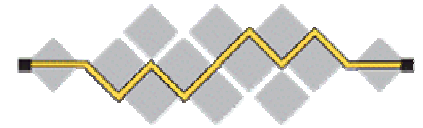
<http://www.nist.gov/smartgrid/>



# *Standards Come From Many Sources*

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International



**I E T F<sup>®</sup>**



**SAE** *International*

Global  
Consortia



**ZigBee<sup>®</sup>**  
**Alliance**

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

**OASIS** 

Regional and  
National



*American National Standards Institute*

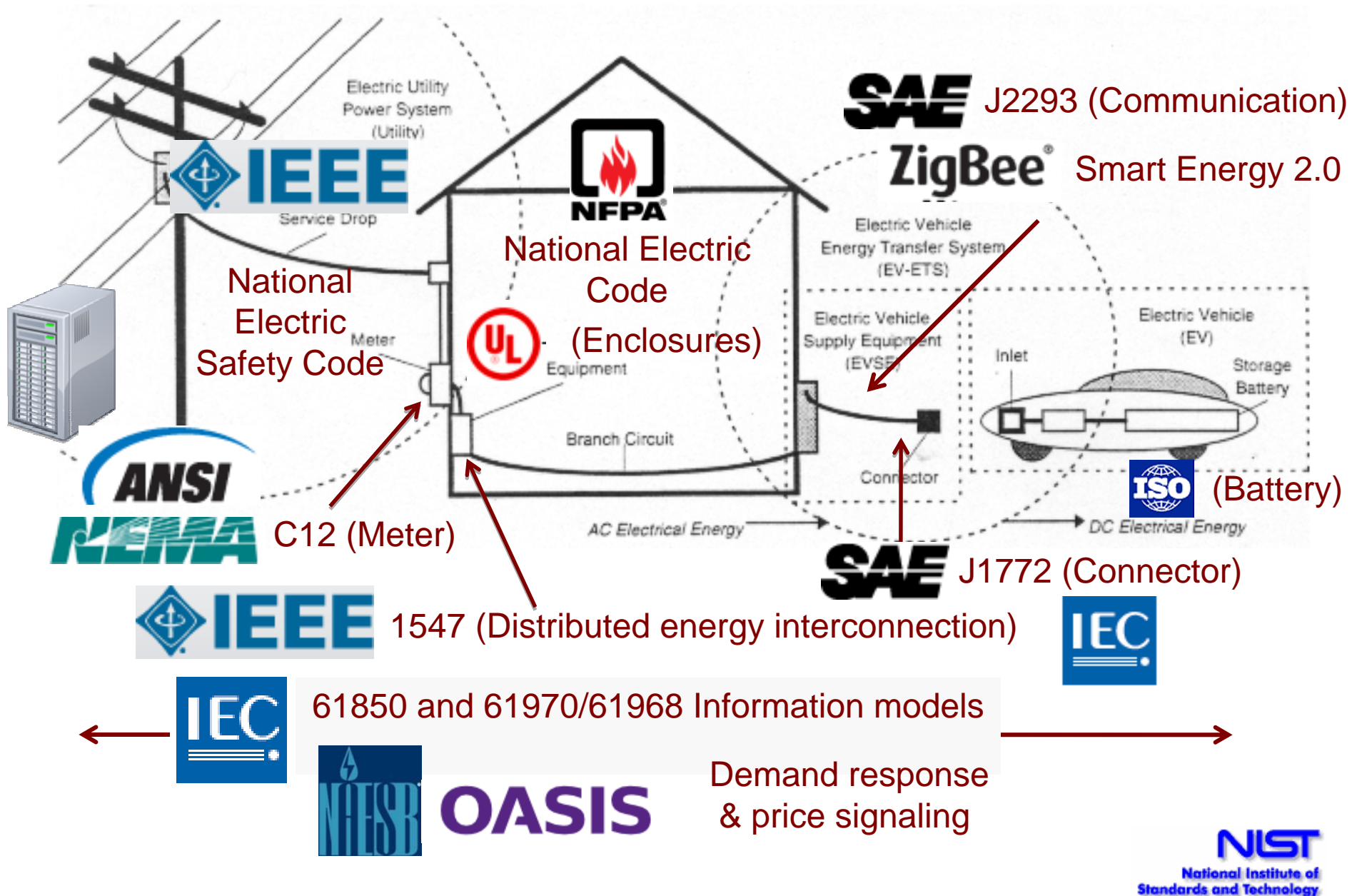


**NEMA**

**NIST**  
National Institute of  
Standards and Technology



# Example: 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
  - 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***

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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



# *Priority Action Plans (PAPs)*

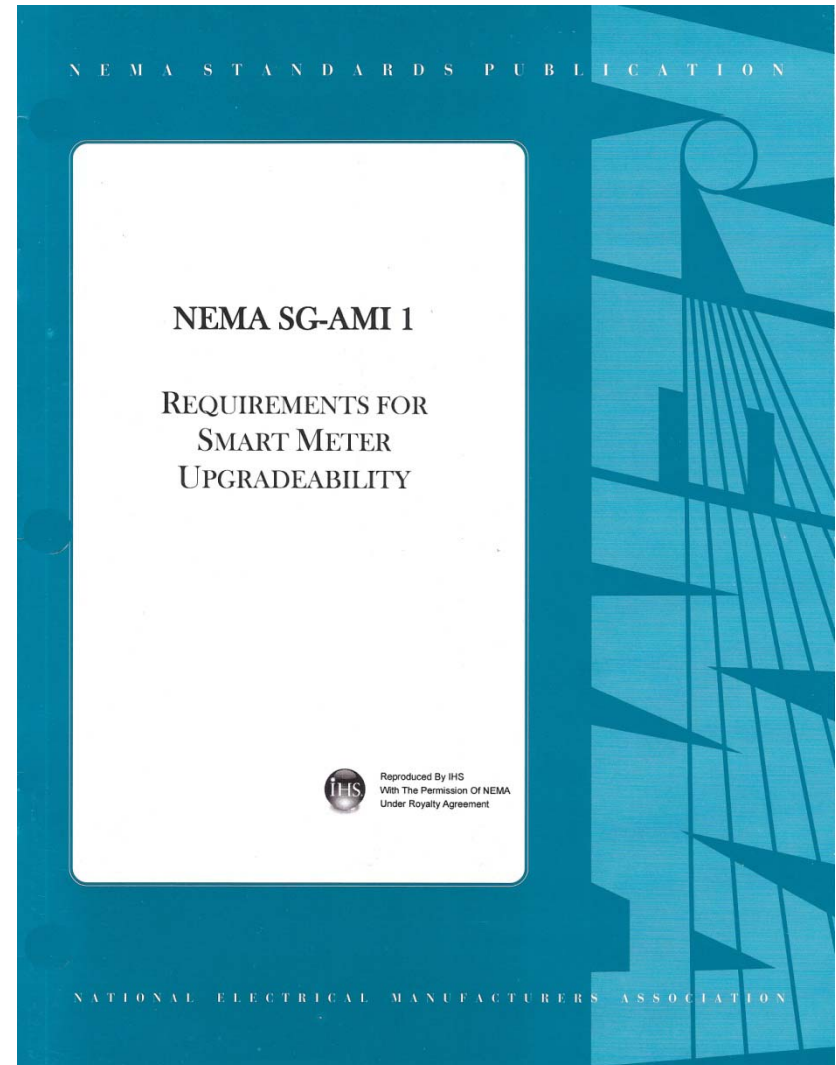
- Created to address gaps in Smart Grid standards

#	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



# ***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 data from smart meters)
- Timely usage information changes consumer energy choices
- Will enable many innovative products and services



**Google Powermeter;  
also Microsoft Hohm**



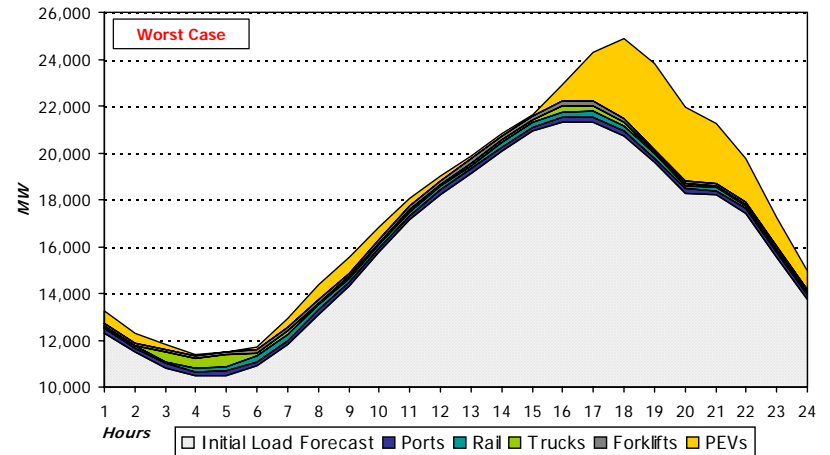




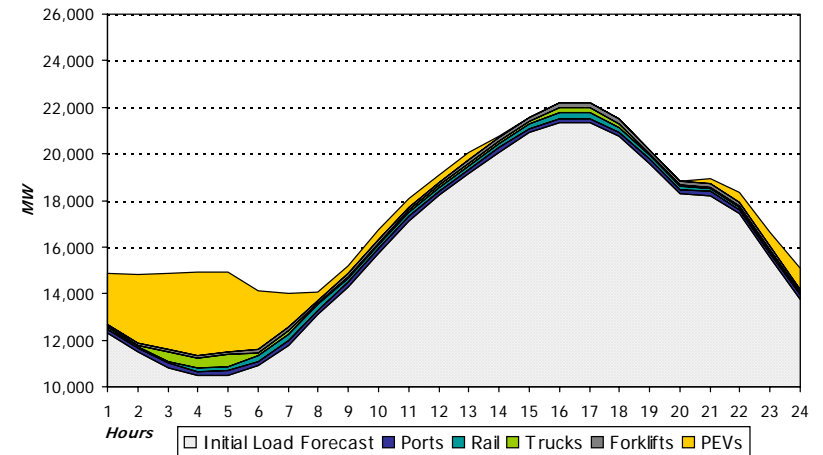
# PAP11: Electric Vehicle Charging

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

2020 SUMMER LOAD IMPACT – NO UTILITY INVOLVEMENT\*



2020 SUMMER LOAD IMPACT – WITH UTILITY INVOLVEMENT\*





# ***Standards for Appliance-to-Grid Communication***

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- 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.

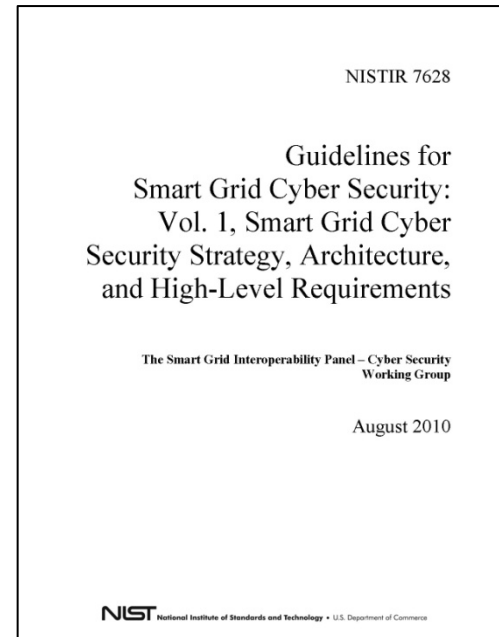


Whirlpool will release smart laundry appliances in 2011.

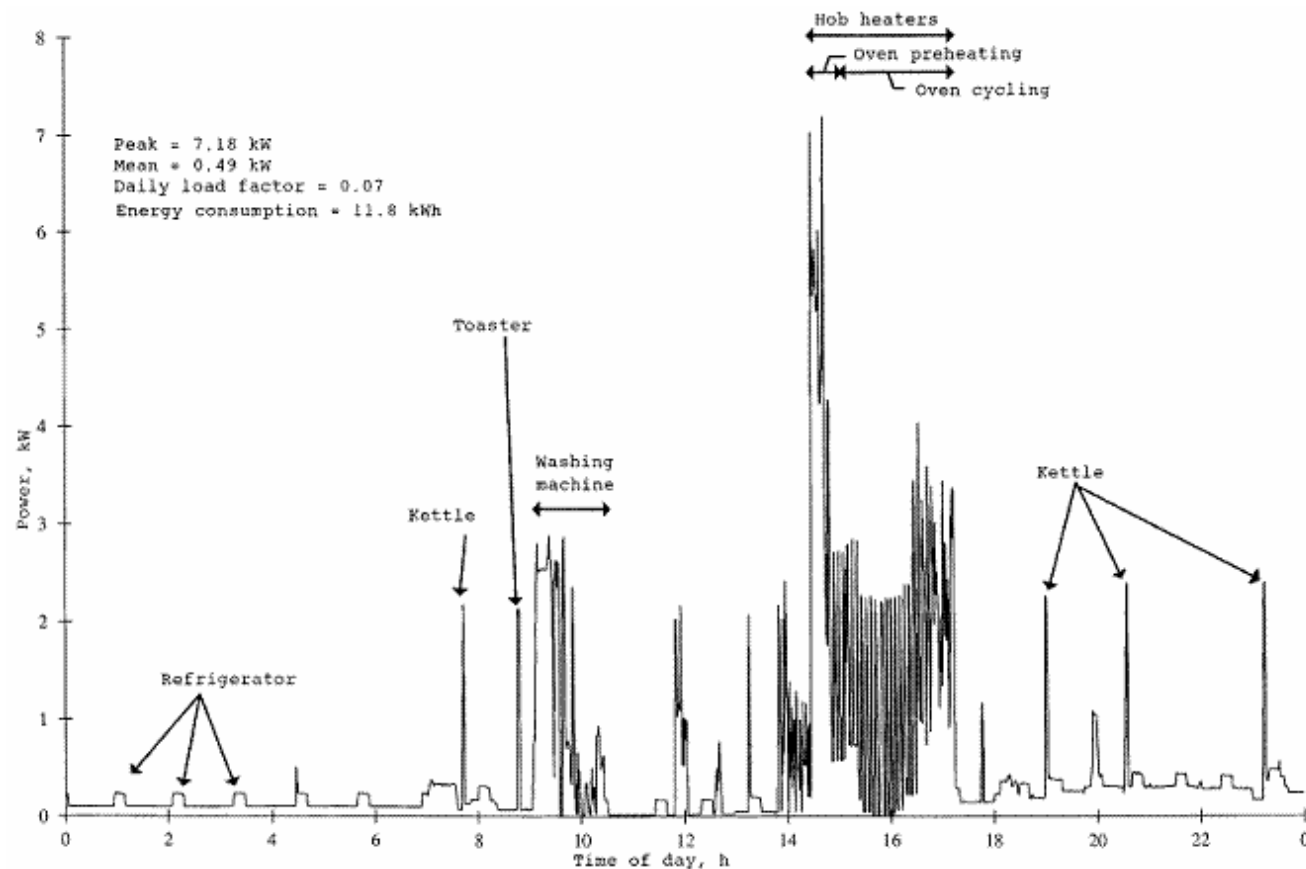


# Cyber Security Working Group

- 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



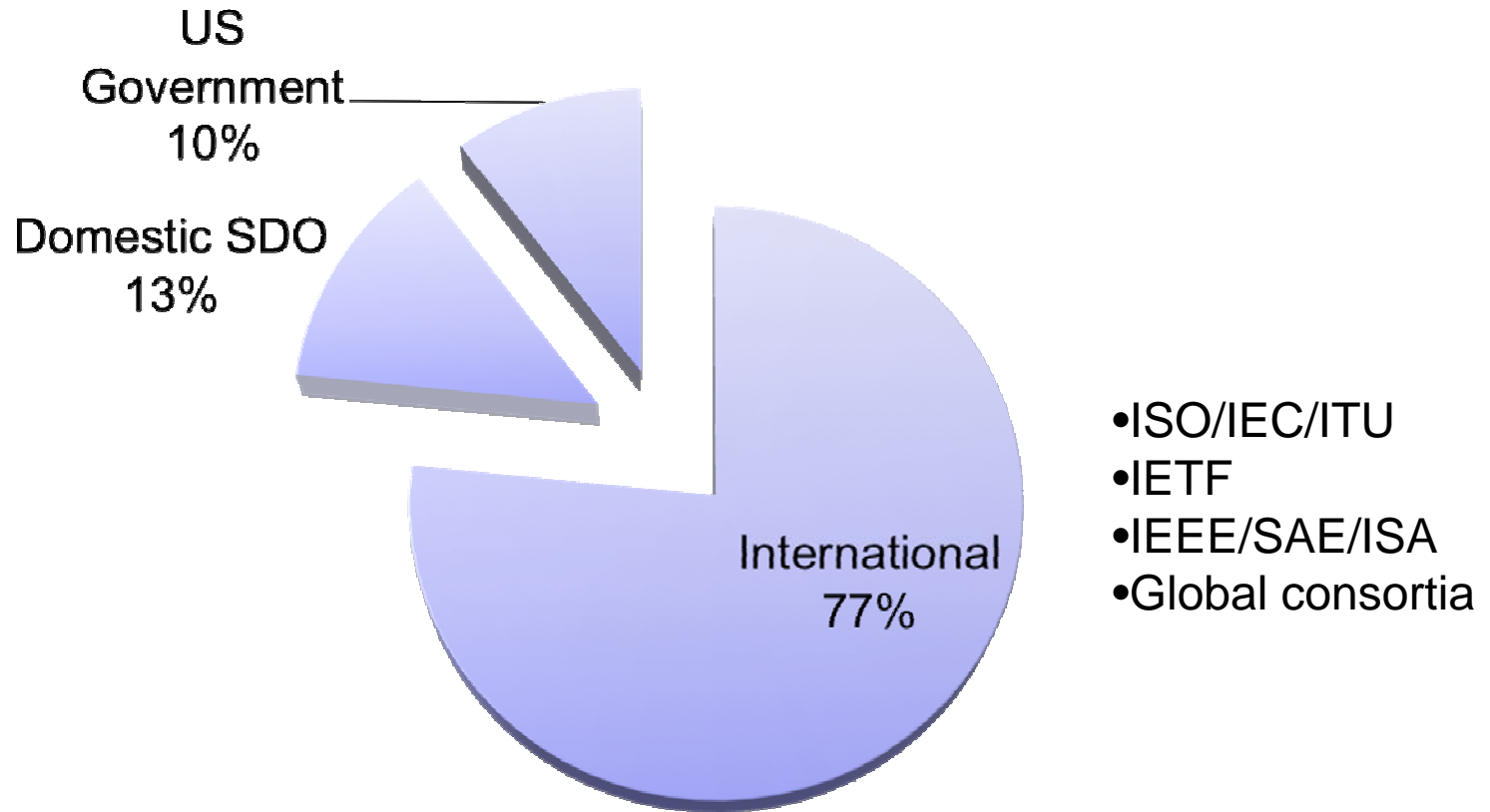
# Advanced Metering Interface -AMI



Power Usage to Personal Activity Mapping

# *Smart Grid Will Use International Standards*

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



# *Further Information*

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- 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](mailto:thomas.nelson@nist.gov)
  - Telephone: +1.301.975.2986