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

Smart Grid: A Building – Utility Partnership

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The Electric Grid

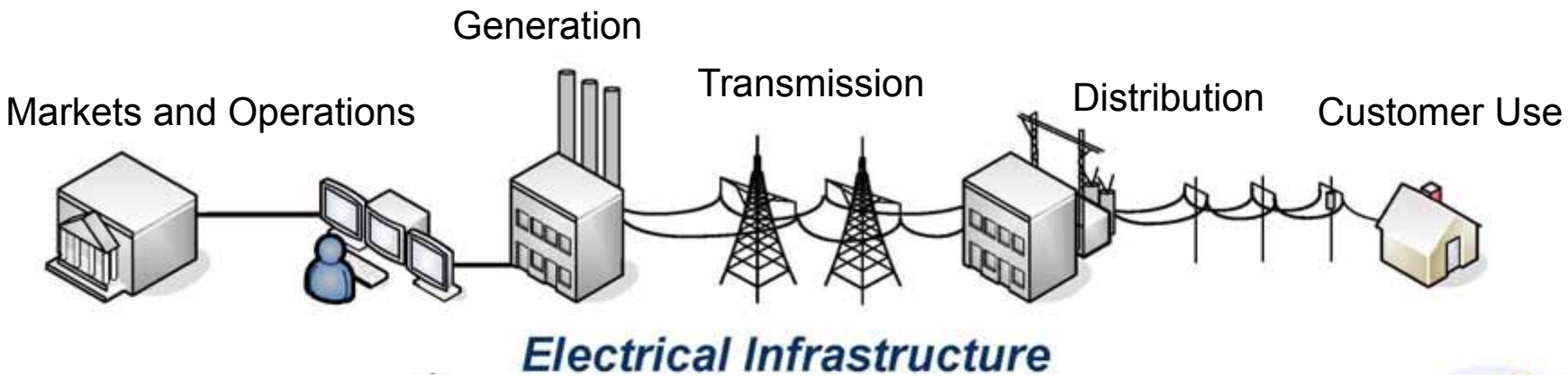
The Electric Grid 100 Years Ago

It's not too different today!

Edison Pearl Street Station, 1882

Wall Street, 1913

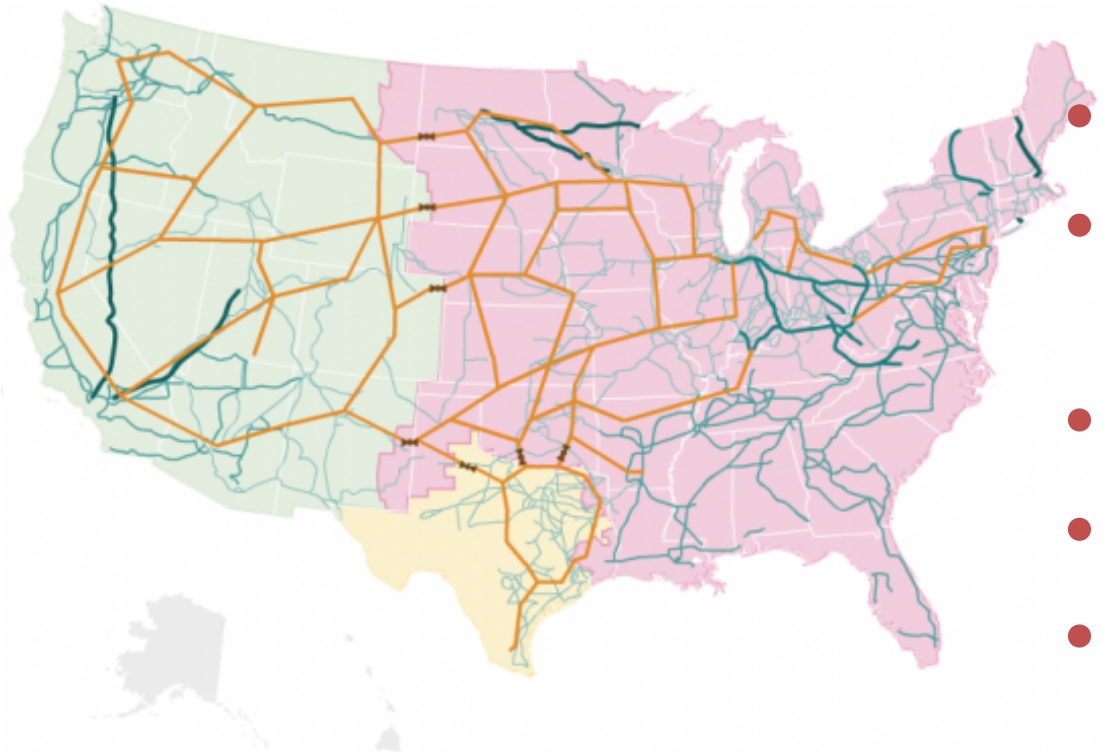
Today's Electric Grid



One-way flow of electricity

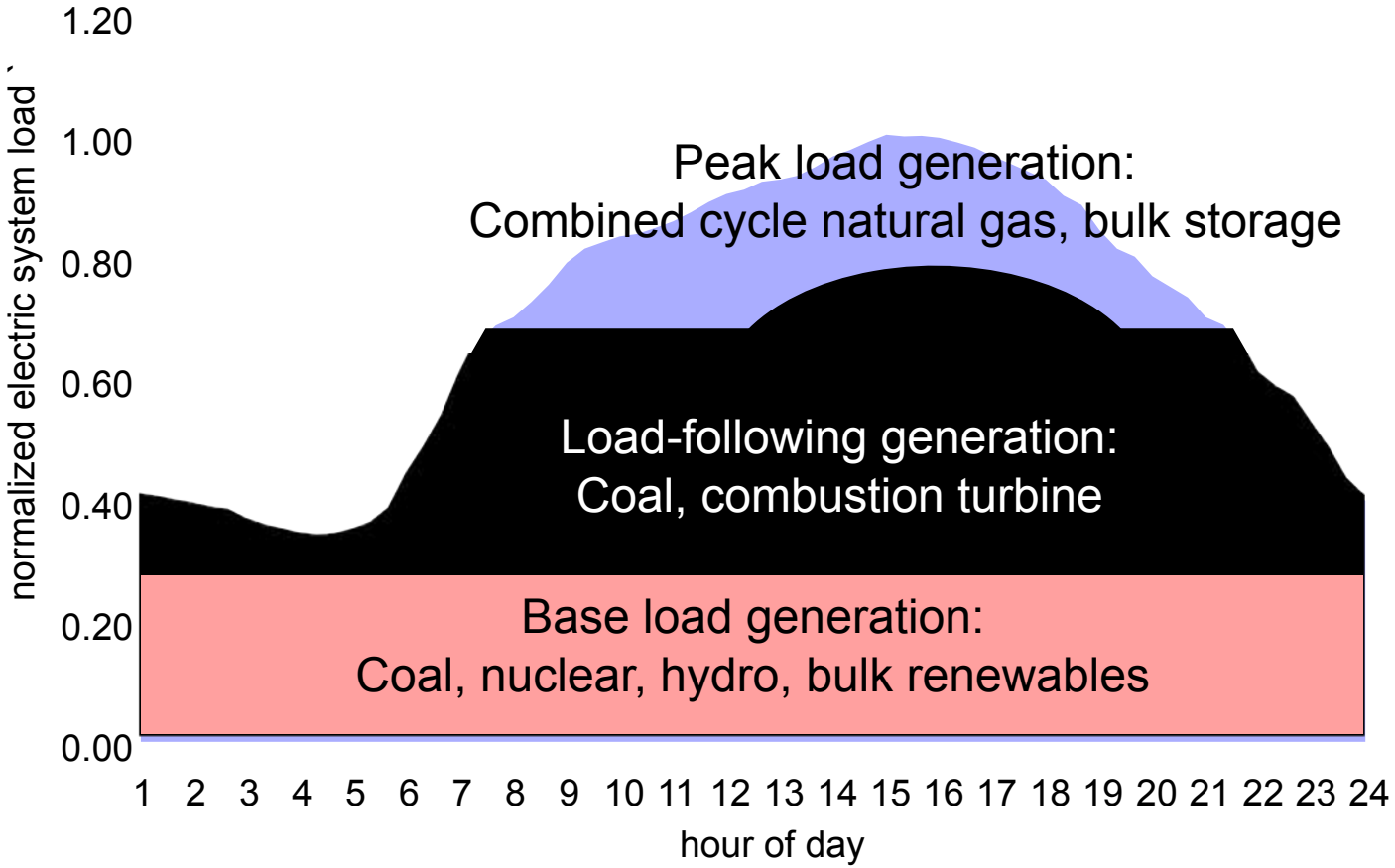
- *Centralized, bulk generation, mainly coal and natural gas in U.S.*
- *Responsible for 40% of human-caused CO_2 production*
- *Controllable generation and predictable loads*
- *Limited automation and situational awareness*
- *Lack of customer-side data to manage and reduce energy use*

U.S. Electric Grid



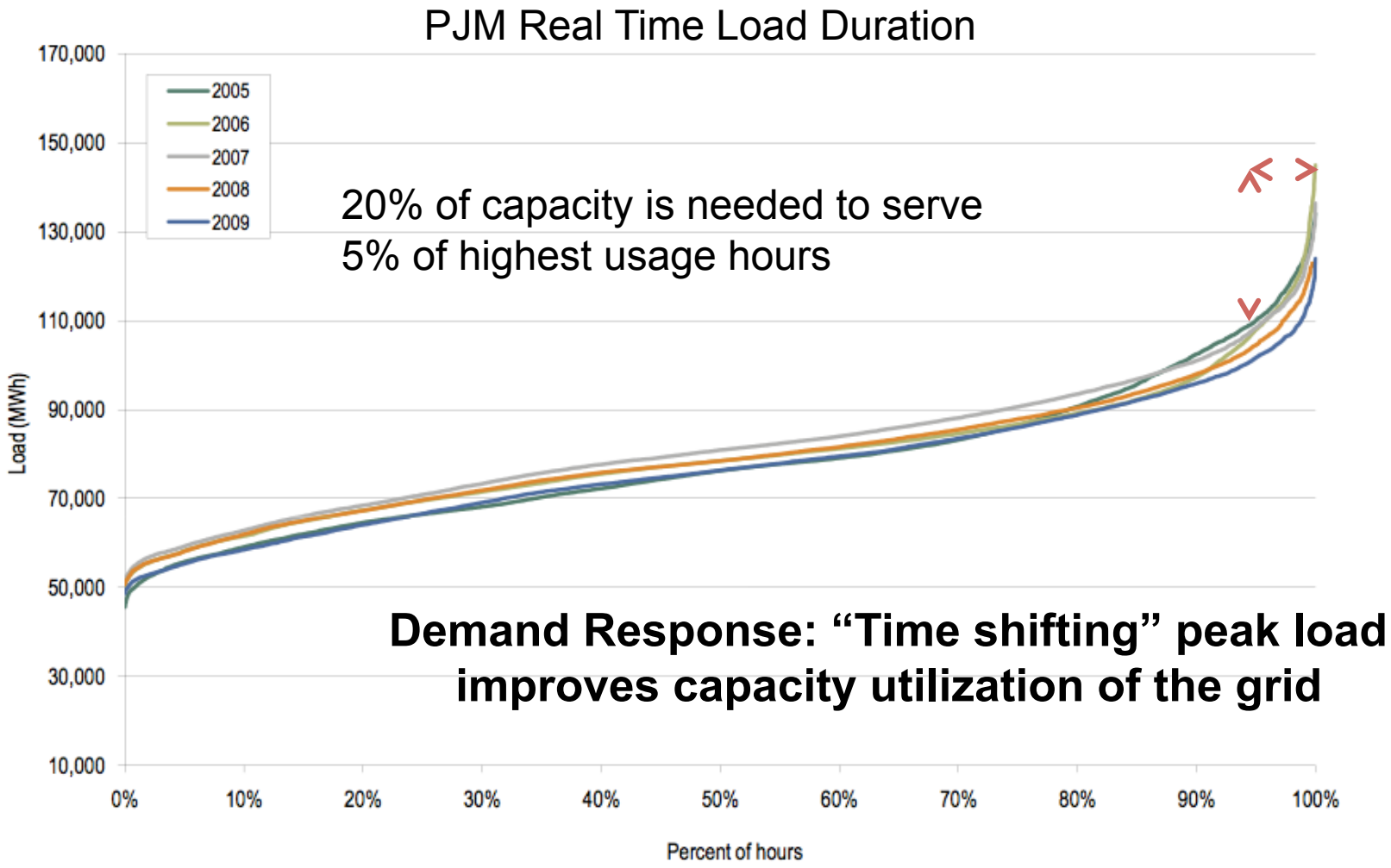
- 3,100 electric utility companies
- 10,000 power plants
- 157,000 miles of high-voltage lines
- 140 million meters
- $800 billion in assets
- $247 billion annual revenues

Load and Generation in Today's Grid



Why Do We Need Smart Grids?

Current Grid is Inherently Inefficient



Source: PJM (a Regional Transmission Organization part of the Eastern Interconnection grid)

Why Do We Need Smart Grids?

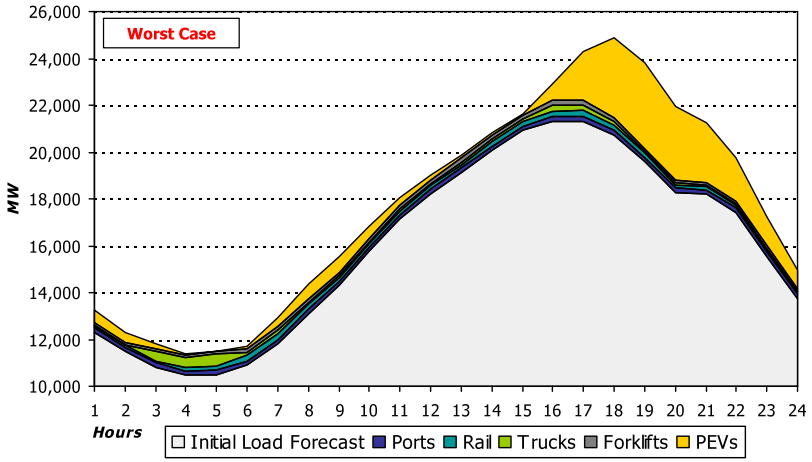
Integration of Electric Vehicles

Electrification of transportation could:

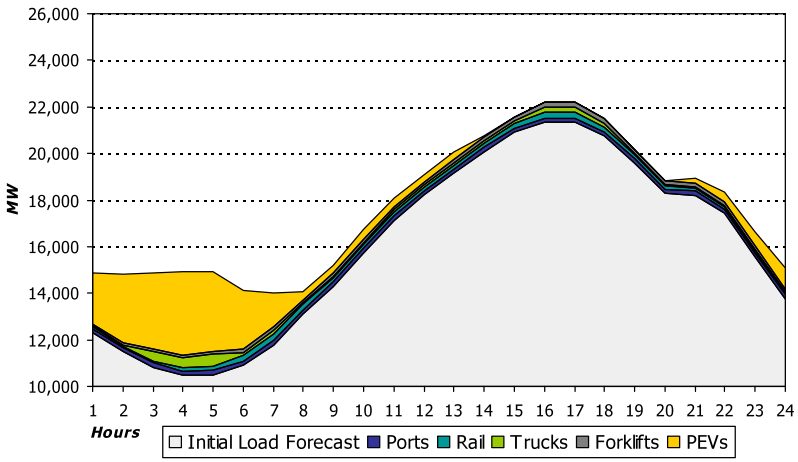
- Displace US oil imports
- Reduce CO_2 emissions
- Reduce urban air pollutants
- Idle capacity of the power grid could supply 70% of charging needs
- Batteries in EVs could provide power during peak electricity demand

California Forecasted EV Charging Load

2020 SUMMER LOAD IMPACT – NO UTILITY INVOLVEMENT*



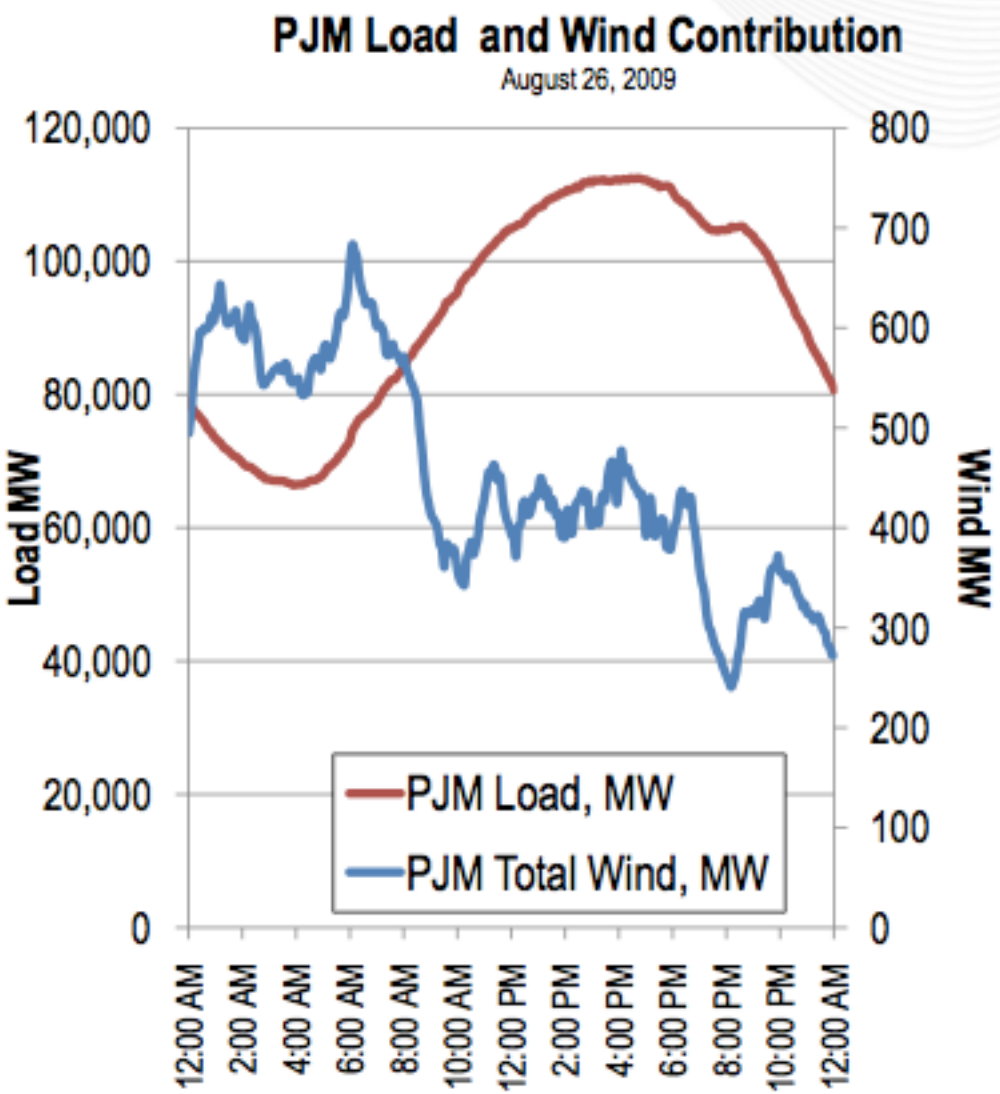
2020 SUMMER LOAD IMPACT – WITH UTILITY INVOLVEMENT*



*Based on predicted 1.6 million EVs on the SCE grid

Why Do We Need Smart Grids?

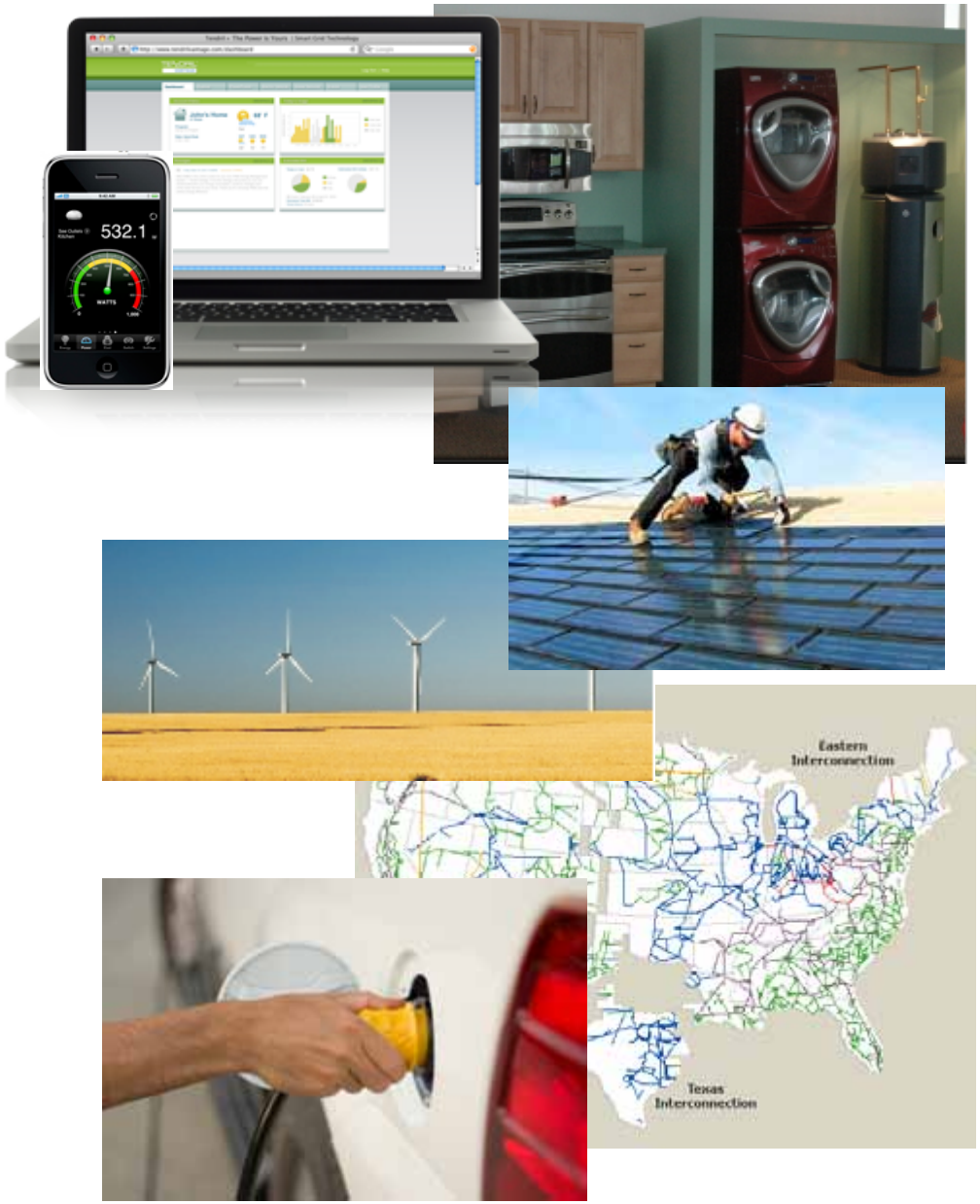
Integration of Renewables



Renewable sources have their own challenges

- Intermittency
- Need for storage
- Need for power conditioning, quality, conversion systems
- Not all renewables are equally “green”

Smart Grid Goals

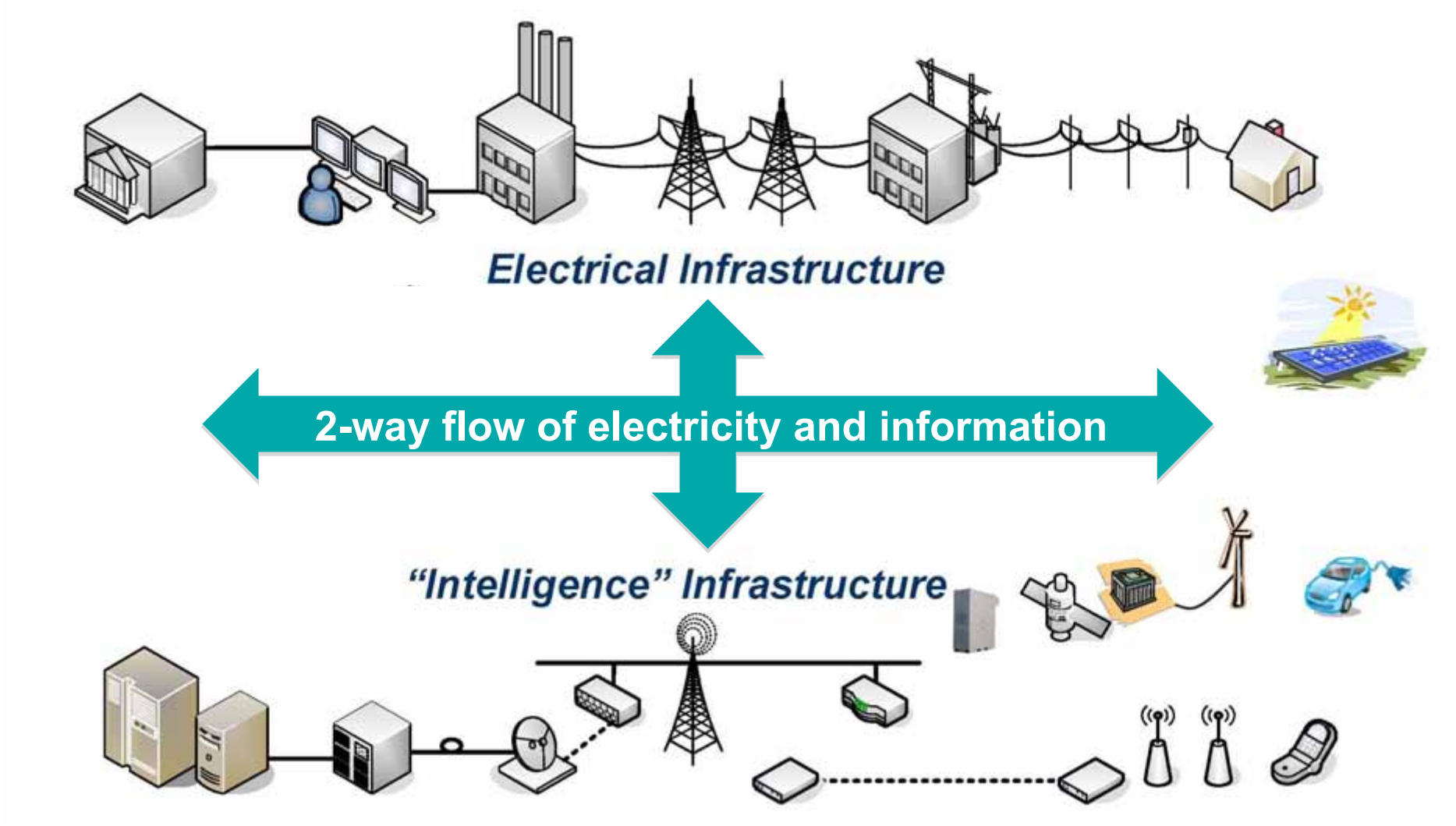


- Enable customers to reduce average and peak energy use
- Increase use of renewable sources
- Improve reliability and security
- Facilitate infrastructure for electric vehicles

What Will the Smart Grid Look Like?

- High use of **renewables** – some jurisdictions as high as 35% by 2020
- **Distributed generation** and microgrids
- Bidirectional 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 grid
- Energy management systems in homes as well as commercial and industrial facilities linked to the grid
- Growing use of plug-in **electric vehicles**: Million in US by 2015
- Networked **sensors and automated controls** throughout the grid

Tomorrow's "Smarter Grid"



There is no Smart Grid without Smart Buildings!

- 72% of electricity is consumed in buildings (40% commercial, 32% residential)
- As we approach national goals of net-zero energy buildings, renewable generation sources connected to buildings will become increasingly important
- As the nation migrates to electric vehicles, they will be plugged in to buildings

Buildings will no longer be a dumb load at the end of the wire. They will become an integral part of the grid.

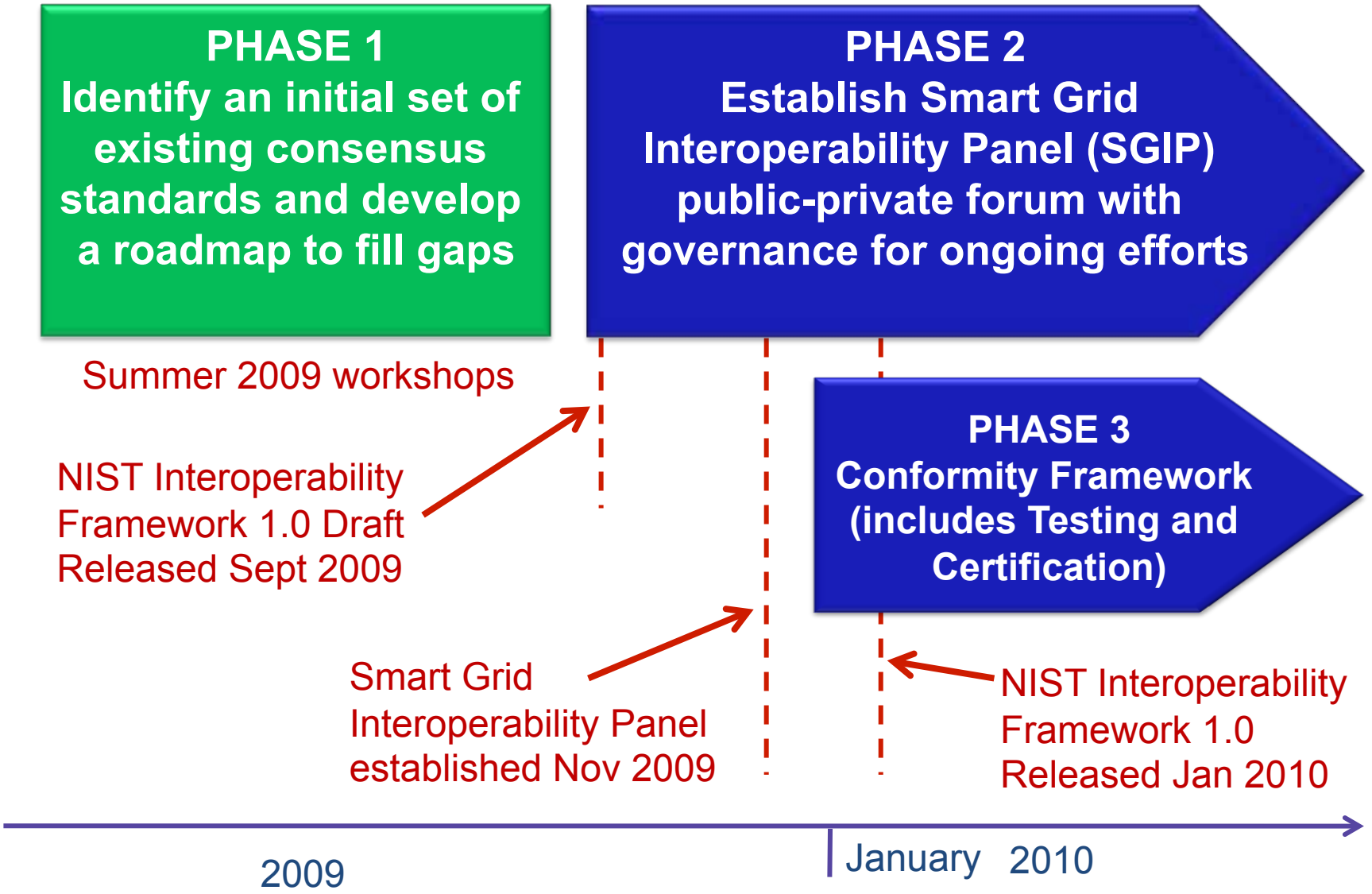
NIST Role

- Under Title XIII, Section 1305 of EISA, NIST has

  "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 DoE Smart Grid Investment Grants
- Input to FERC and state PUC rulemaking

NIST's Three Phase Plan



Standards are Critical: Smart Grid Interoperability Panel

- Public-private partnership created in Nov. 2009
- >700 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, CEA, IEEE, …
- Web-based participation

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

ASHRAE NEMA

FSGIM

Facility Smart Grid Information Model

SPC 201P

PURPOSE: The purpose of this standard is to define an abstract, object-oriented information model to enable appliances and control systems in homes, buildings, and industrial facilities to manage electrical loads and generation sources in response to communication with a “smart” electrical grid and to communicate information about those electrical loads to utility and other electrical service providers.

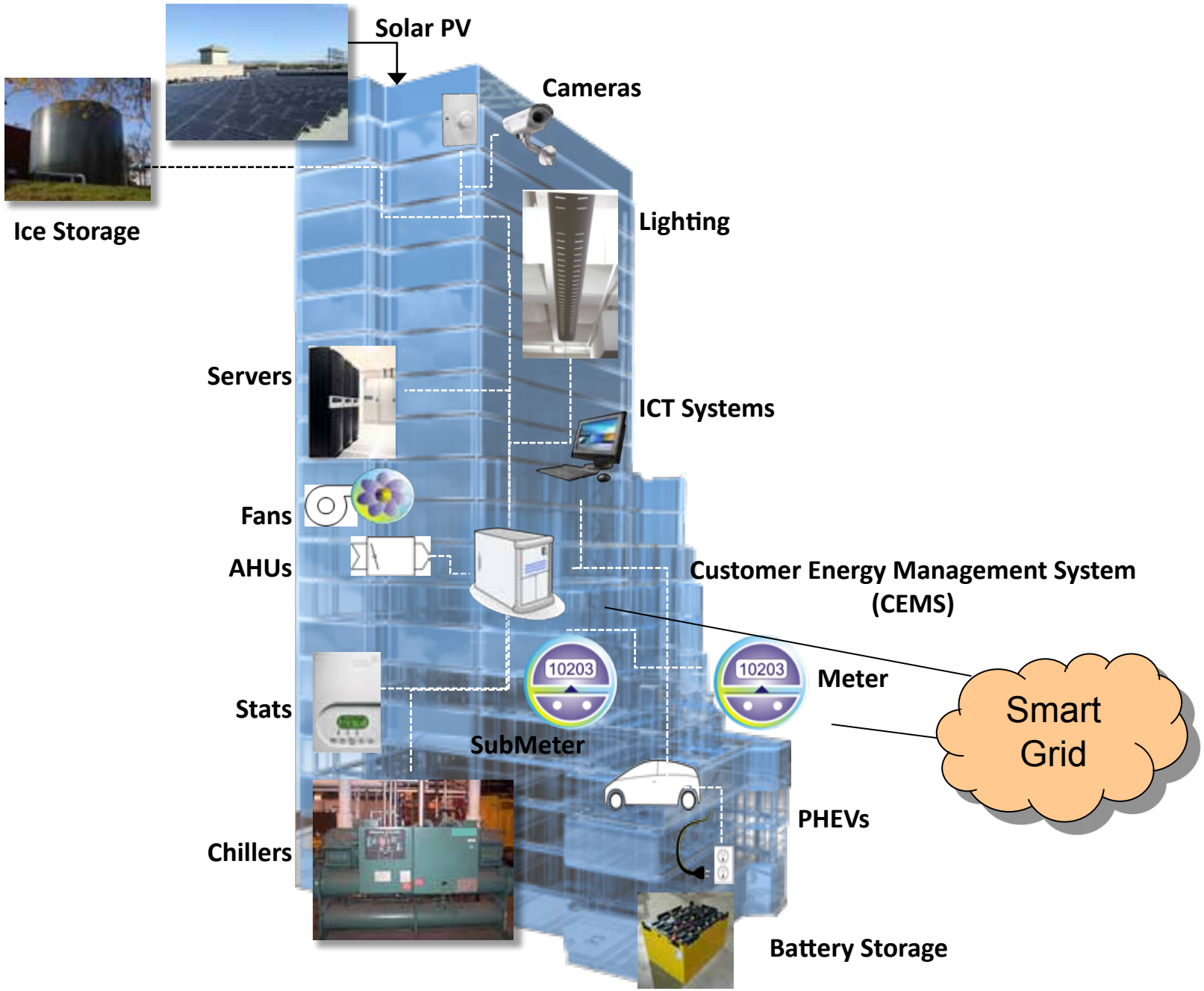
This standard will be used by standards development organizations to develop or enhance protocol specific implementations of the model, e.g., BACnet.

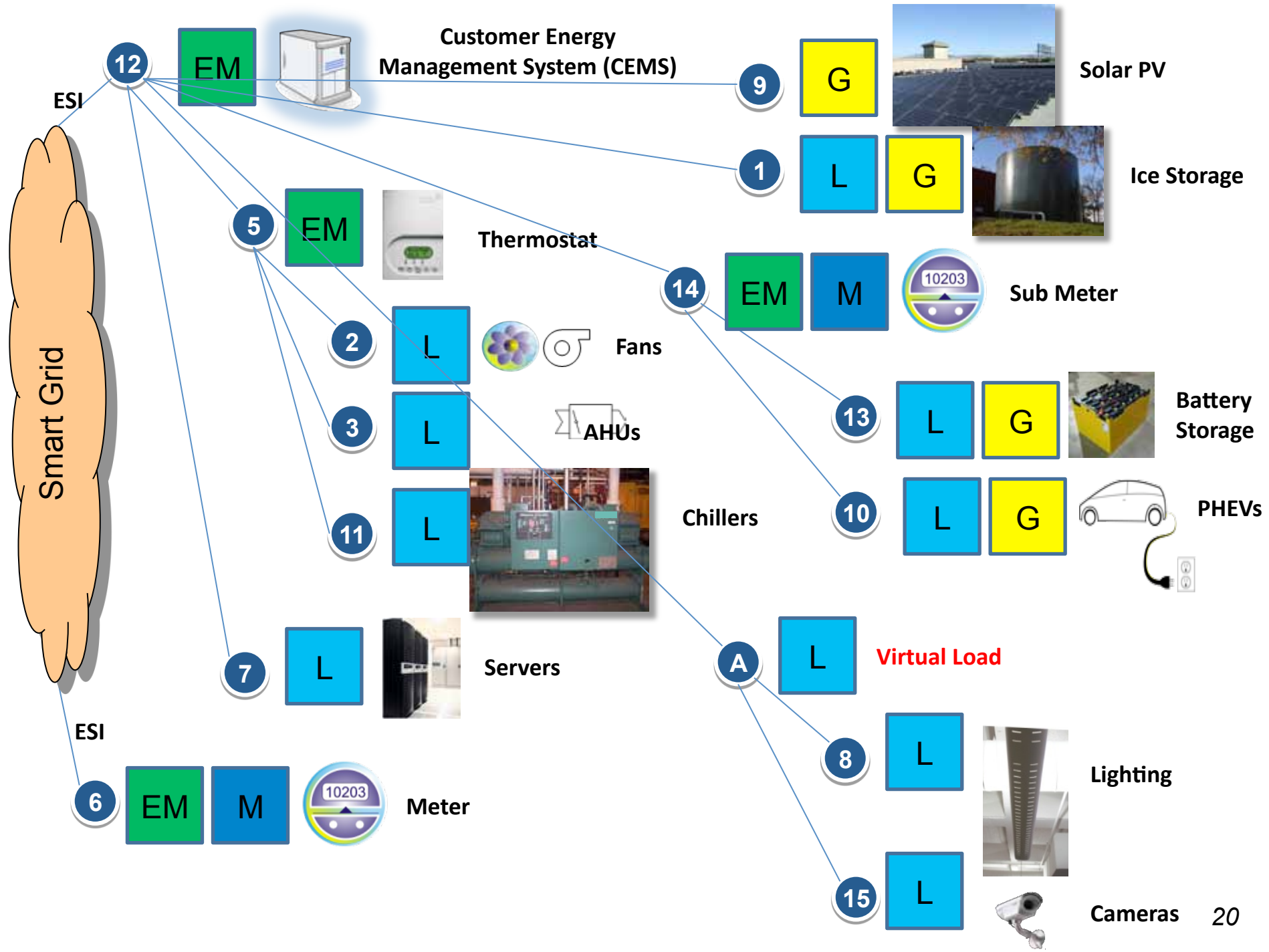
Participants in the Process

- Commercial/Institutional/Industrial Producers
- Appliance, Residential Automation, and Consumer Electronics Producers
- Consumers — Residential, Commercial, and Industrial
- Utility
- General

44 voting members
5 non-voting members
1 consultant
Many other active participants

A Physical Example of SPC 201P Energy Objects




Customer Energy Management System (CEMS)
ESI
12
EM
Smart Grid
ESI
6
EM
M
10203
Meter
5
EM
Thermostat
2
L
Fans
3
L
AHUs
11
L
Chillers
7
L
Servers
9
G
Solar PV
1
L
G
Ice Storage
14
EM
M
10203
Sub Meter
13
L
G
Battery Storage
10
L
G
PHEVs
A
L
Virtual Load
8
L
Lighting
15
L
Cameras

ASHRAE NEMA

FSGIM

Facility Smart Grid Information Model

SPC 201P

The model will support a wide range of energy management applications and electrical service provider interactions including:

(a) on-site generation,
(b) demand response,
(c) electrical storage,
(d) peak demand management,
(e) forward power usage estimation,
(f) load shedding capability estimation,
(g) end load monitoring (sub metering),
(h) power quality of service monitoring,
(i) utilization of historical energy consumption data, and
(j) direct load control.

ASHRAE NEMA FSGIM
Facility Smart Grid Information Model
SPC 201P

SPC 201P Development Timeline

- SPC formed August 2010
- 1st meeting August 2010
- Working groups meeting in parallel with regular (weekly) teleconferences
- Monthly full SPC meetings in person or by webinar
- Public review draft expected very soon
- International participation welcome

Goal: Published Standard in 2012

Further Information

- NIST Web portal: http://www.nist.gov/smartgrid
- ASHRAE SPC 201P http://spc201.ashraepcs.org/