
Project: IEEE PES Discussion

Submission Title: SmartGrid Evolution and the Roll Standards will Play

Date Submitted: 15, May, 2009

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Abstract: The Obama administration is intending to invest close to 45 billion dollars to address renewal energy and a future "Smart Energy Grid" that will reduce our dependence on foreign oil. Chris will be discussing the "Smart Energy Grid" and what PG&E and the Technology Innovation Center are doing about it. He will provide insight as to how to think about the future of this project and what has been accomplished so far. He will also provide a road map related to the industry standards and technology that is required to address the challenges and gaps related to the future success of this project.

Purpose: Keynote

Notice: Release: The contributor acknowledges and accepts that this contribution becomes the property of IEEE

Chris Knudsen, PG&E

Agenda

- ▶ **Welcome and Safety**
- ▶ **A little about PG&E**
- ▶ **What is a Smart Grid?**
- ▶ **Why implement Smart Grid now?**
- ▶ **Why are standards so important and what is happening in industry today?**
- ▶ **What is PG&E Doing Relative to SmartGrid**
- ▶ **Q&A**



- **Emergency Phone Number**
 - 3-3622
- **CPR**
- **Evacuation Assembly Area**
 - Primary: Bechtel Plaza
 - Alternate: Justin Herman Plaza
- **Exit Strategy**
 - Stairs to Main
- **Earthquake Preparedness**
 - Duck and cover

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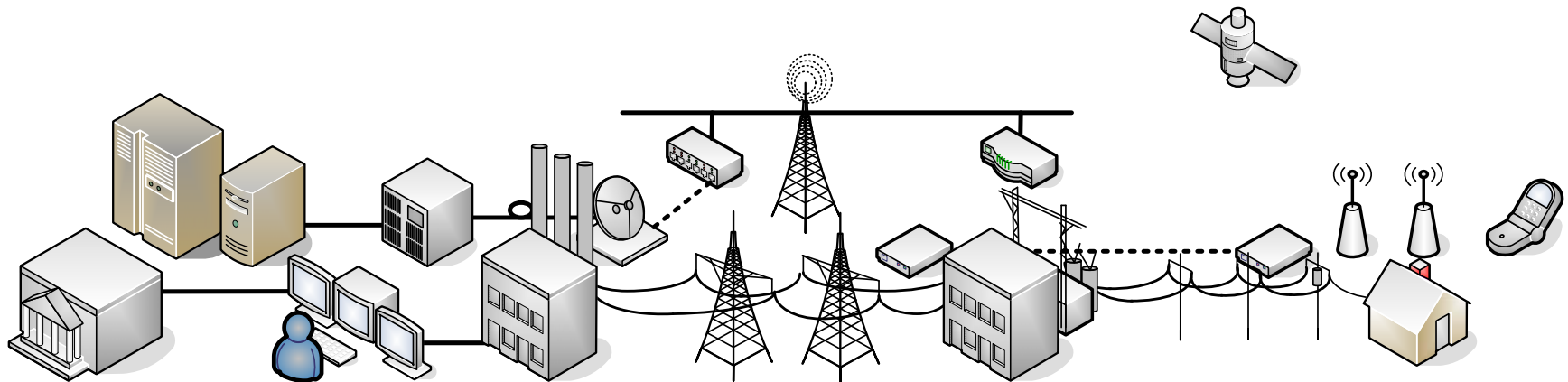
- ▶ **Q&A**

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The Smart Grid is an electric utility infrastructure system that integrates, coordinates, and prioritizes the advancement of both existing and new communications, computing, and advanced control technology to support the following concepts:

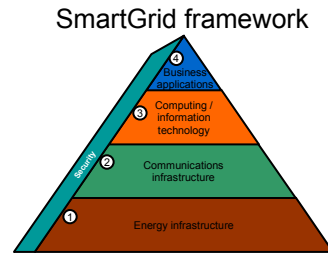
- ▶ Deployment and integration of intermittent and distributed energy resources
- ▶ Increased use of technology to dynamically optimize grid operations
- ▶ Optimized operation of appliances and significant loads, including PHEVs
- ▶ Cost-effective and environmentally beneficial demand-side management programs



Source: Summarized from PG&E CPUC OIR submission

PG&E Smart Grid of the Future

Detail on next page

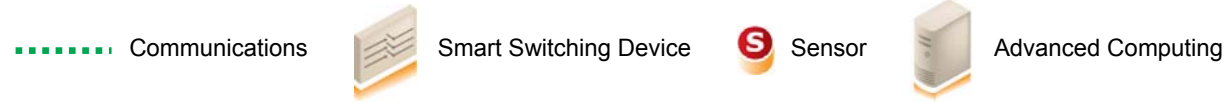
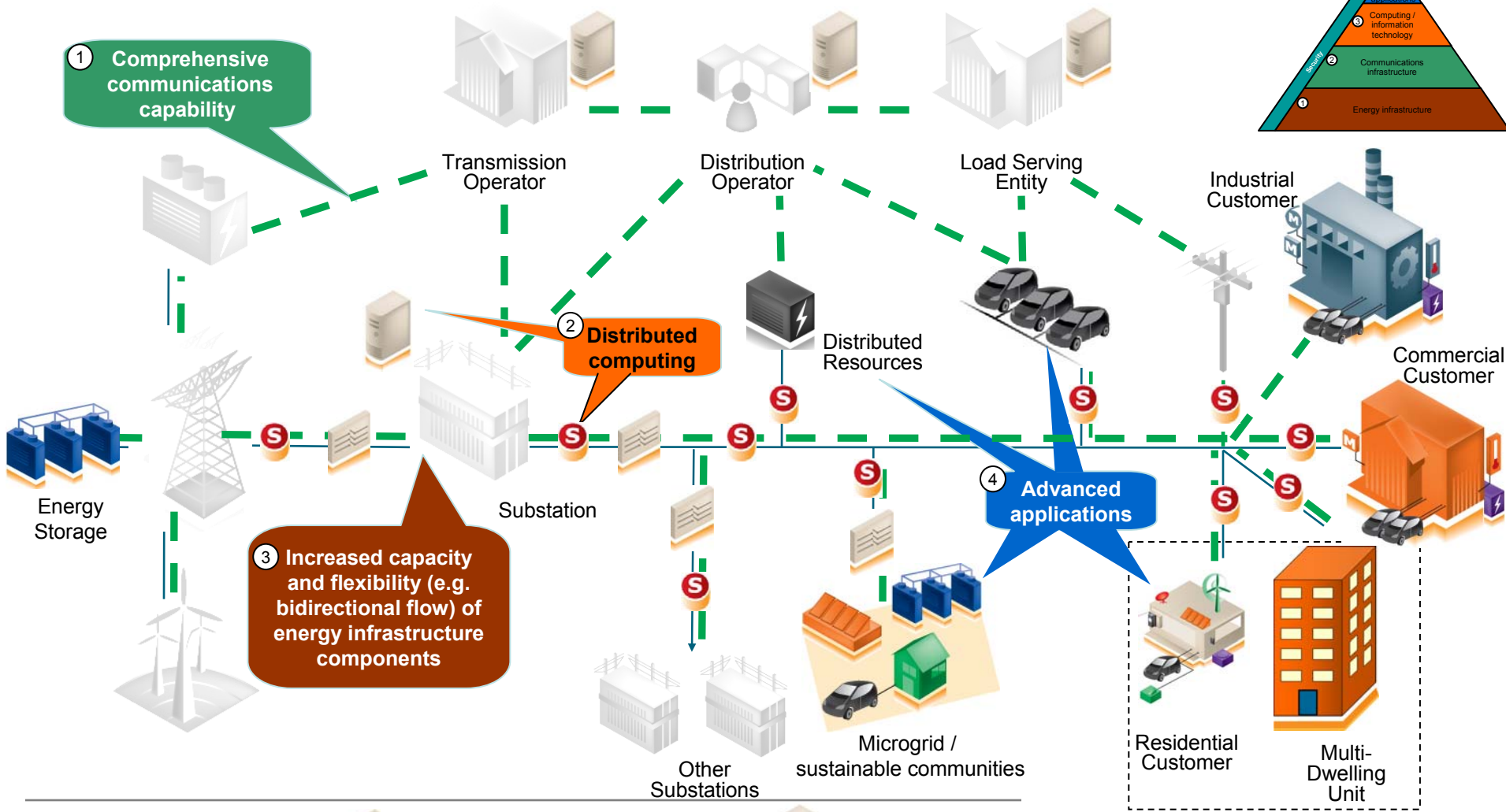


1 Comprehensive communications capability

2 Distributed computing

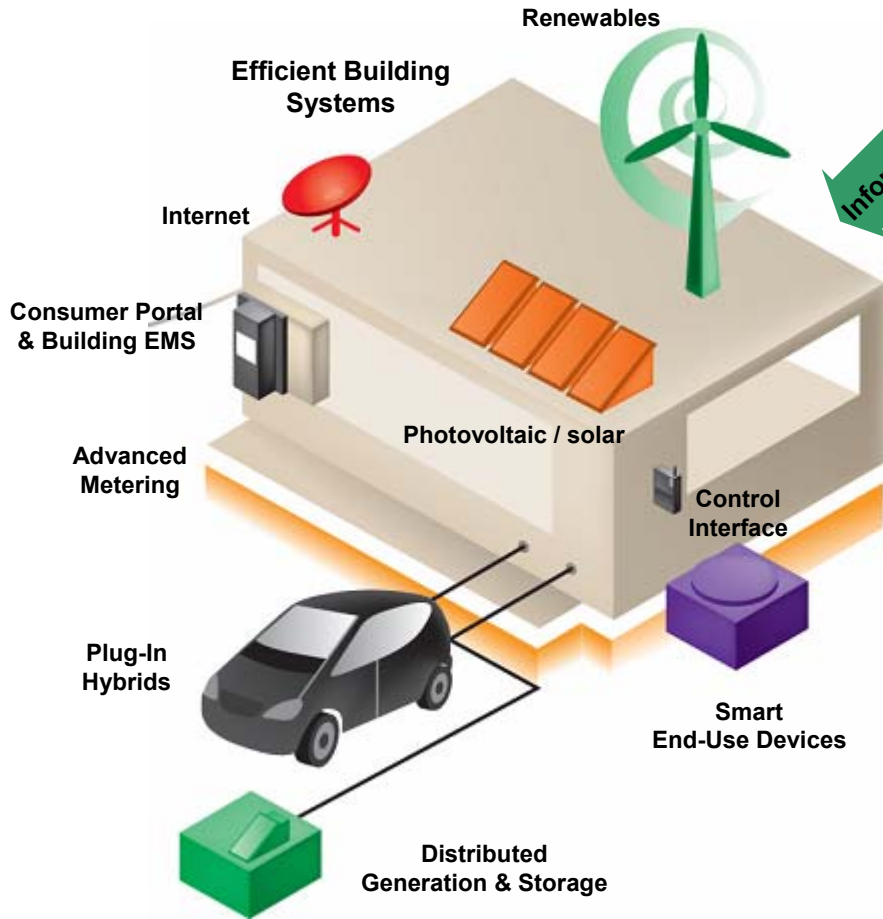
3 Increased capacity and flexibility (e.g. bidirectional flow) of energy infrastructure components

4 Advanced applications

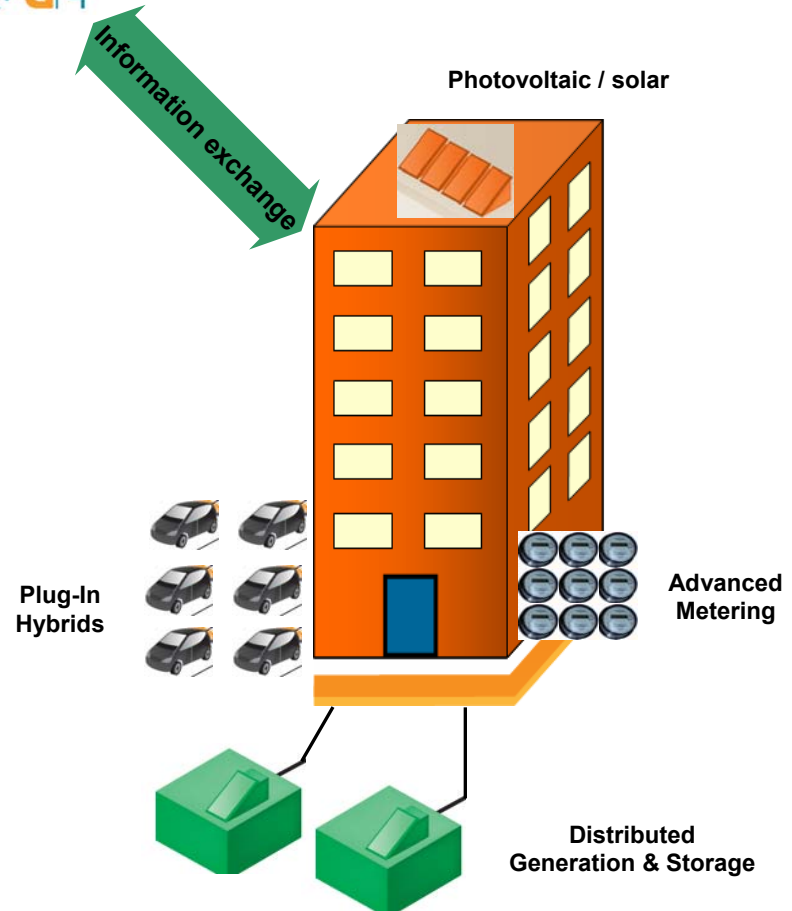


Smart Grid Enables Customer Options

Single home example

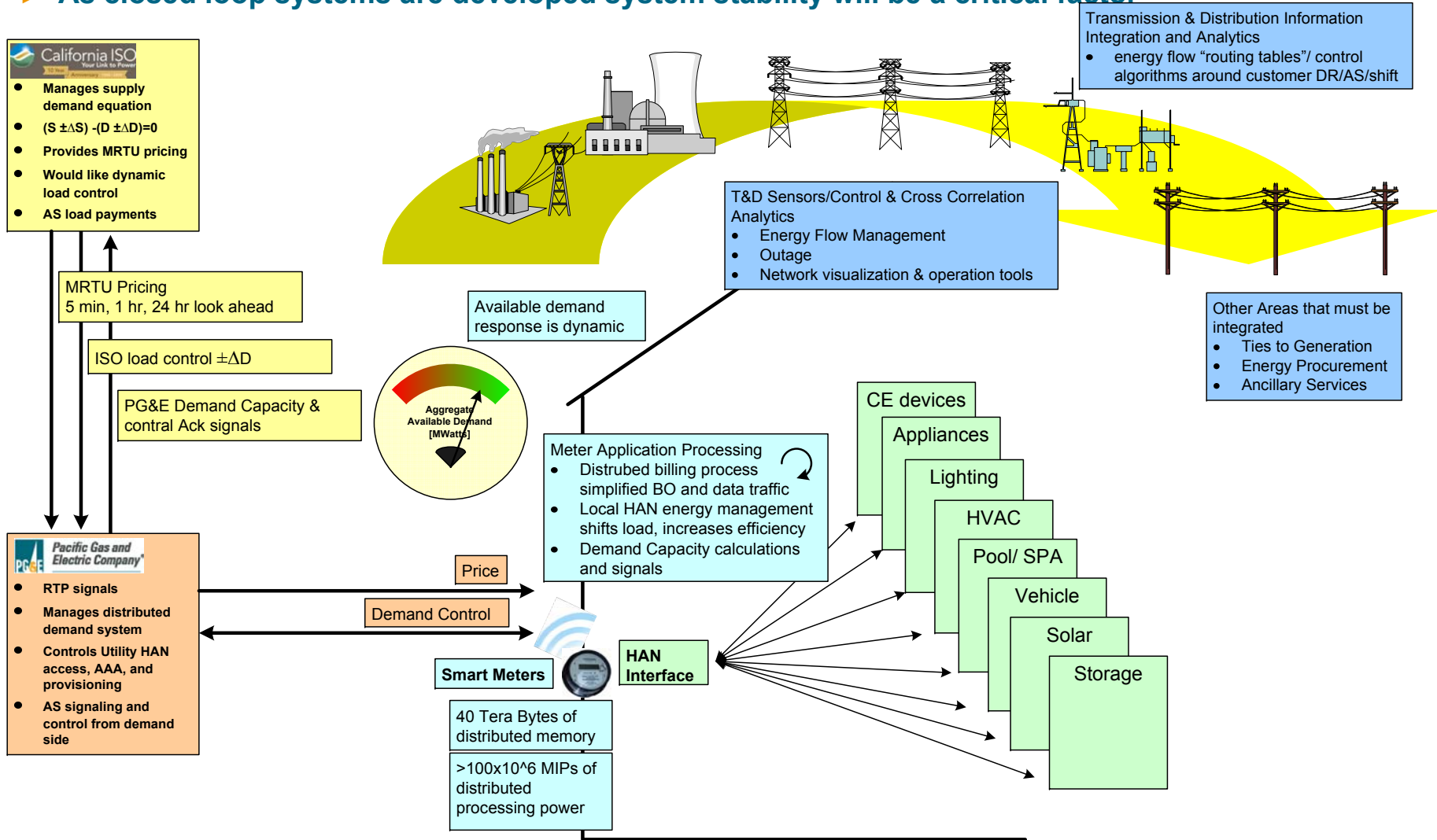


Multi-Dwelling Unit example



The Complete System Must be Stable

- ▶ All systems are interdependent. New systems must consider how they need to communicate across systems in a distributed way
- ▶ As closed loop systems are developed system stability will be a critical factor

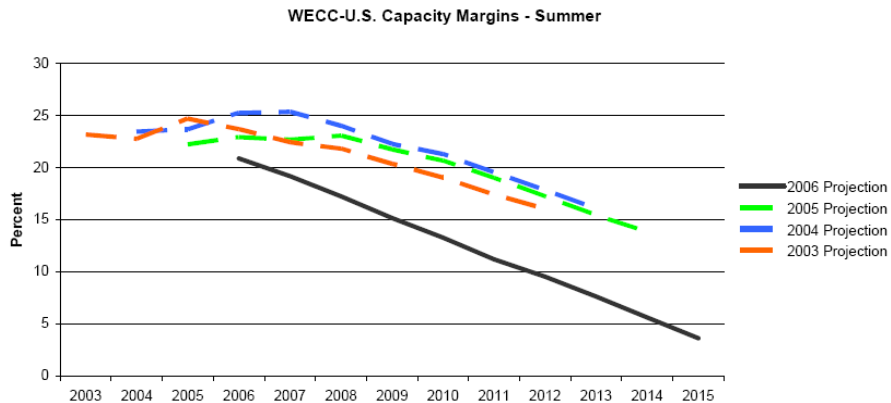


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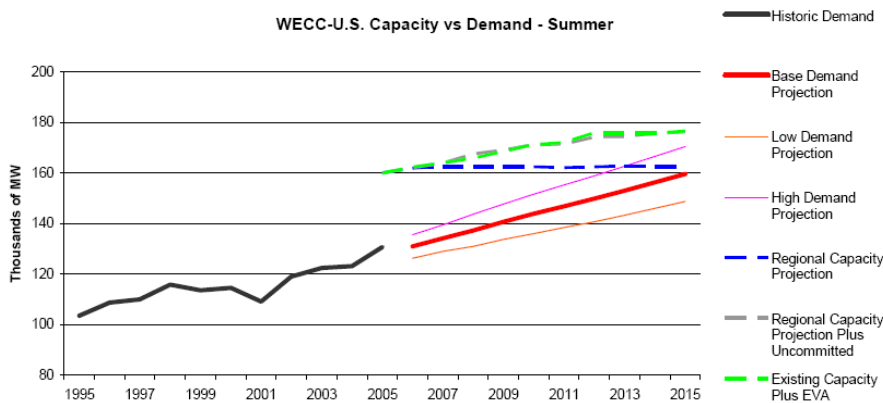
The US Macro Energy problem

Figure 50: WECC-U.S. Capacity Margins — Summer

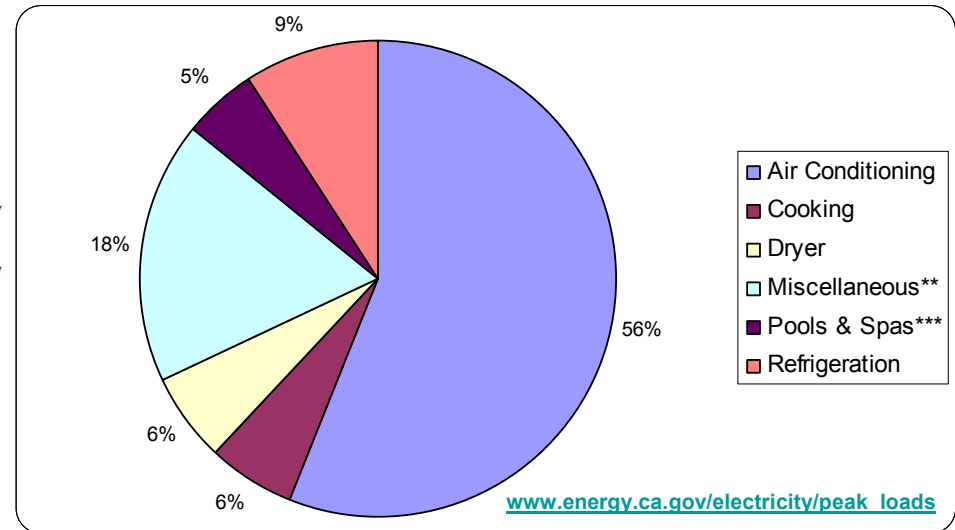


- ▶ The US is on a trajectory of declining bulk energy margin
- ▶ There is no good supply side solution
- ▶ The solution is a dynamic distributed demand side energy efficiency and load control system
- ▶ Reasonable reductions can dramatically improve our peak energy position

Figure 51: WECC-U.S. Capacity Versus Demand — Summer

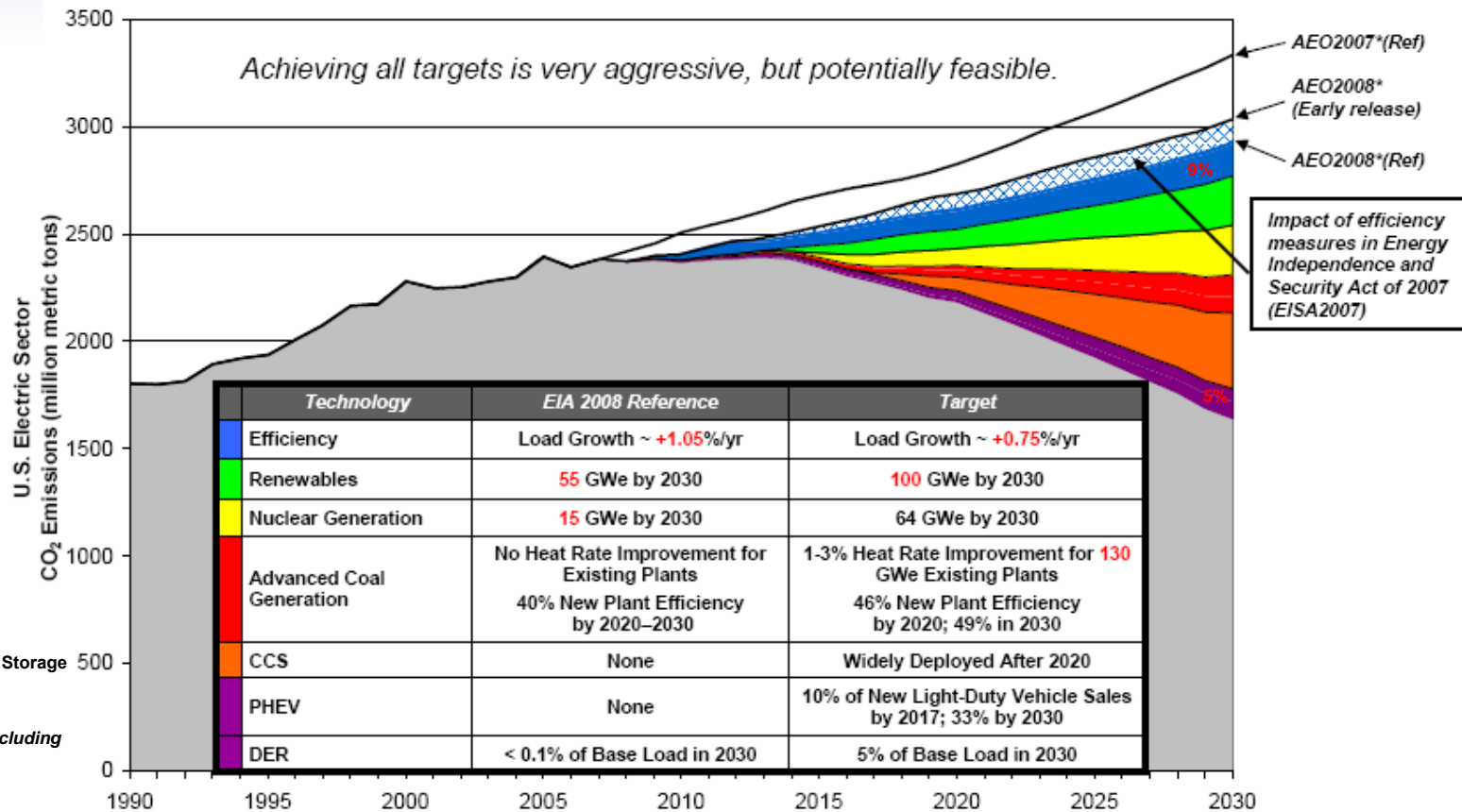


Source: NERC 2006 Long-Term Reliability Assessment



California Residential Peak Load

2008 Prism...Technical Potential for CO₂ Reductions



*Energy Information Administration (EIA) Annual Energy Outlook (AEO)

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

Why Smart Grid Now?

- ▶ EISA 2007 Legislation has mandated the regulation of interoperable standards for Smart Grid
- ▶ The CPUC is also tasked to address Smart Grid in the EISA legislation and is presently considering its approach
- ▶ NIST is undertaking a mapping of relevant industry standards for Smart Grid implementation
- ▶ The recently signed Economic Stimulus Package provides funding for Smart Grid projects



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Standards: some general comments

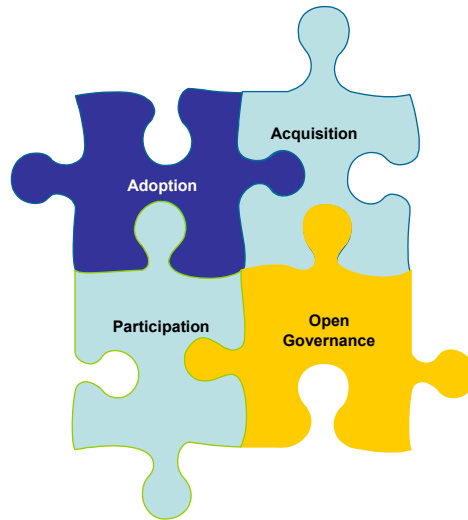
- ▶ A big challenge is explaining the absolute profound impact that standards will have on the utility industry long-term
 - ▶ The scale, priority, energy, and momentum is easy to see if you are engaged and highly opaque if you are not. There is a huge wave over the horizon that will significantly impact how Utilities select and adopt technology
 - ▶ Sec Commerce and Sec Energy view standards as a top priority
 - ▶ Standards are a critical milestone to achieve SmartGrid interoperability
- ▶ Security standardization and DER (load included) regulations will go all the way to the customer, it is only a matter of time until a regulatory body drives compliance to the meter and beyond. Current issues/ barriers are jurisdictional and will have to arbitrate FERC and states rights.
 - ▶ Since security transcends all elements of our systems, regulated standards and compliance will also extend to all elements of our systems
- ▶ Utilities are highly engaged and helping to lead much of the standards work
 - ▶ UCA OpenSG representing >27% US meters and growing with a well accepted body of work and work in process. It is quickly becoming accepted as the utilities technical requirements voice of the industry
 - ▶ Actively aligning with EEI, UTC, EPRI, and NIST
- ▶ My high level definition of SmartGrid is all inclusive, (clarifying as there are many segmented views)
 - ▶ it is everything, it is Generic, it is analogous to “the Internet”, it includes AMI, DER, DA, Gen, Tx, Dist, Markets, Customer, External Services, ...

Open Standards are an Absolute Requirement for Interoperability

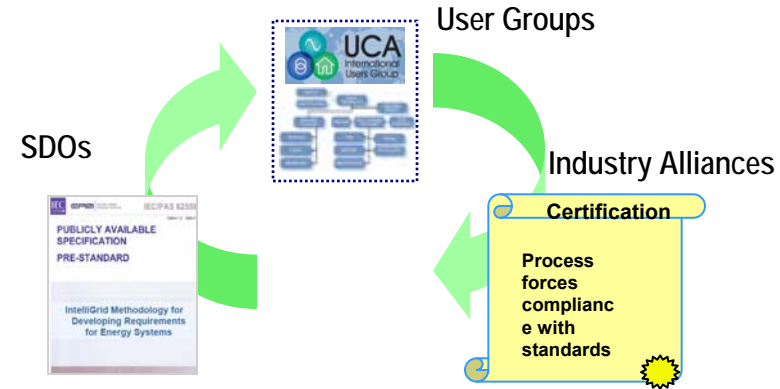
- ▶ A set of interoperable standards will be regulated at the federal level (DOE)
 - ▶ FERC is mandated to regulate under EISA 2007
- ▶ Without open standards a SmartGrid will not be achieved
- ▶ Without an industry compliance program an interoperable SmartGrid will not be achieved
- ▶ The industry is highly engaged on creating open SmartGrid standards
 - ▶ The top world wide standards organizations and technologists
 - ▶ NIST, EPRI, IEEE, IEC, IETF, UCA OpenSG, others
- ▶ An ever increasing number of Utility rate cases will depend on these emerging standards
- ▶ The only way to execute efficiently is to have technical depth in the new technologies
 - ▶ Awareness and knowledge comes from standards engagement,
 - ▶ Standards work levers peer resources and knowledge
- ▶ Vendors can not solve the problems or drive the technology to maturity alone
 - ▶ Utilities are critical as only Utilities implement the full end to end system

Key Principles of Standards Strategy

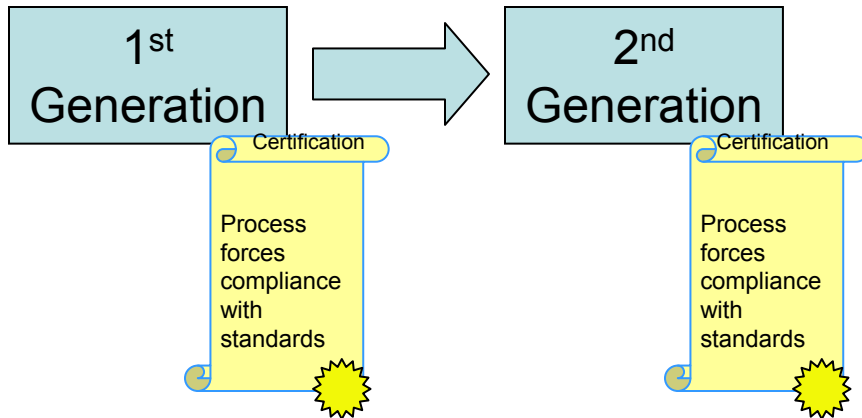
1. Openness



2. Separation of Duties



3. Generational Compliance



4. Loose Coupling



Benefits of Open and Interoperable Standards



- 50% savings in integration costs
- Avoid re-inventing the wheel
- Learn from industry best practices
- Specify requirements more easily
- Prevent single vendor “lock-in”
- Vendors share a much larger market
- Reduced maintenance and training costs
- Reduced development costs
- Security and network management requirements better understood

- ▶ NIST has been appropriated \$10M to drive a standards roadmap and is highly engaged with competent leadership.
 - ▶ George Arnold: Bell Labs (VP standards & IP), Lucent, president IEEE-SA, ANSI COB
 - ▶ Under extreme pressure to create an interim roadmap for SmartGrid Standards
 - ▶ EPRI has been contracted to develop the initial RoadMap
 - ▶ Rel 1.0 targeted May 28th, 2.0 – Aug 15th, 3.0 Dec
 - ▶ NIST 1st 2 day workshop in DC 4/28-29 (500 attended)
 - ▶ NIST 2nd 2 day workshop 5/19-20 (expect > 700 attendees)
- ▶ Our job is to help NIST to be successful.
 - ▶ Success is defined by creating enough of a framework and an initial roadmap such the industry can move into a more traditional standards process

NIST Current list of “low-hanging fruit” standards

Standard	Application
AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and Smart Grid end-to-end security
ANSI C12.19/MC1219	Revenue metering information model
BACnet ANSI ASHRAE 135-2008/ISO 16484-5	Building automation
DNP3	Substation and feeder device automation
IEC 60870-6 / TASE.2	Inter-control center communications
IEC 61850	Substation automation and protection
IEC 61968/61970	Application level energy management system interfaces
IEC 62351 Parts 1-8	Information security for power system control operations
IEEE C37.118	Phasor measurement unit (PMU)communications
IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
IEEE 1686-2007	Security for intelligent electronic devices (IEDs)
NERC CIP 002-009	Cyber security standards for the bulk power system
..NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system
Open Automated Demand Response (Open ADR)	Price responsive and direct load control
OpenHAN	Home Area Network device communication, measurement, and control
ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model

<http://collaborate.nist.gov/twiki-sggrid/bin/view/ SmartGridInterimRoadmap/SGR1Standards>

Smart Grid Standards Mapping

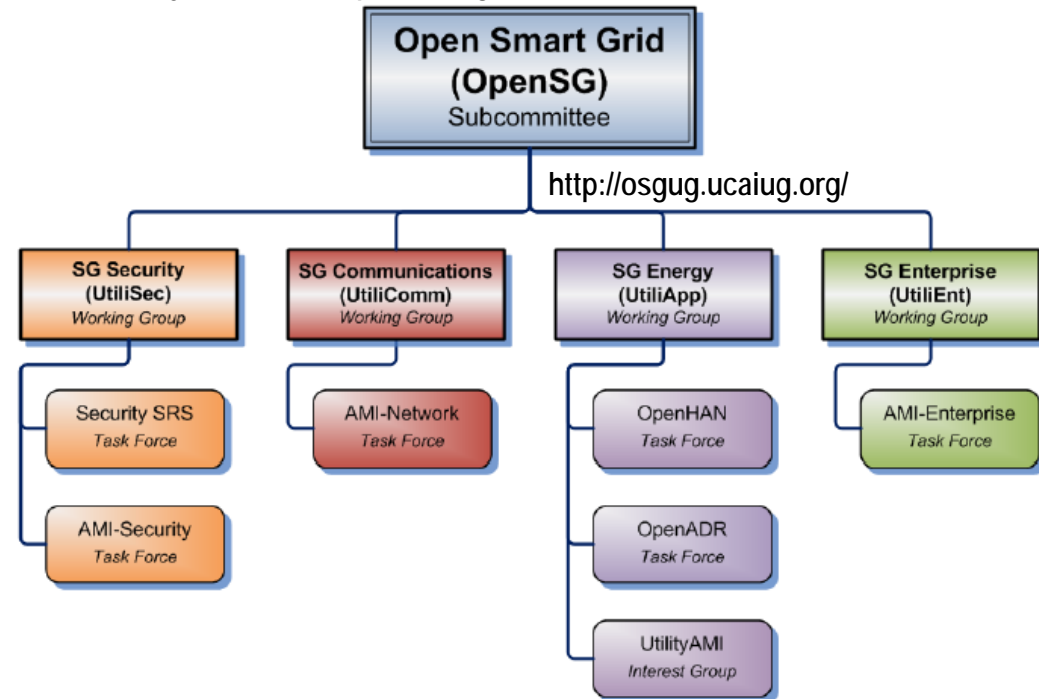
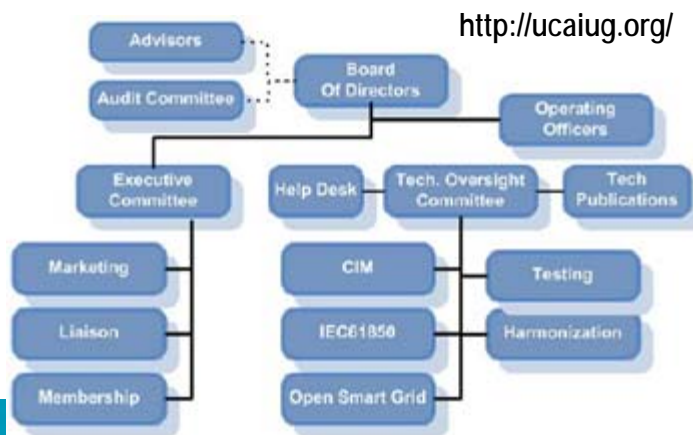
<u>Type of Organization</u>							<u>Areas of Focus or Attention</u>
National Organizations	NIST	NERC FERC	NEMA	ASHRAE	CEA EIA	SAE	NIST is a key Focus is NIST, SAE
User Groups	UCA OpenSG	EPRI/EEI USGE WG	IEC 61970/68 CIM Users	DNP Users Group	BACnet Users	AEIC Meter Group	Focus is UCA, EPRI/EEI & IEC
Industry Alliances & Consortia	GWA GWAC	ZigBee+Hom ePlug (ZBHP)	ZigBee Alliance	HomePlug Alliance	AHAM	Z-Wave Alliance IPSO	Focus is ZigBee & ZBHP
SDOs	IEC	IETF	IEEE	ISO	ANSI		Focus is IETF, IEC and IEEE
Standards Material Sources	CEC Projects	DOE Projects	EPRI projects yellow/blue	Utility Projects	DOD Projects yellow/gray	Other Projects (NIST, ...)	Focus is CEC/DOE

- ▶ We focus our energies on the green (others are also highly valuable, this is just where we prioritize our resources on the emerging standards for now)
- ▶ UCA is our lead Users Group
- ▶ Home Plug and Zigbee are key alliances now, more to come with Grid
- ▶ IEEE, 802.15.4, P1901, C37.x, IEC 61850, 61968/70, IETF

Utility Communication Architecture Iug

- ▶ The mission of the UCA International Users Group is to enable utility integration through the deployment of open standards by providing a forum in which the various stakeholders in the utility industry can work cooperatively together as members of a common organization to:
 - ▶ Influence, select, and/or endorse open and public standards appropriate to the utility market based upon the needs of the membership.
 - ▶ Specify, develop and/or accredit product/system-testing programs that facilitate the field interoperability of products and systems based upon these standards.
 - ▶ Implement educational and promotional activities that increase awareness and deployment of these standards in the utility industry.

Led by 10 Utilities representing 27% of all US residential electric meters



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SmartGrid is a Journey, Not an End State

- ▶ Following the principles of best practices to take emerging technologies to scale
- ▶ There are no shortcuts



▶ Testing facilities

- ▶ PG&E employs end to end laboratories to enable rapid prototyping and testing of smart-grid technologies
- ▶ Accelerates technology development and ensures standards compliance early on



▶ Pilots

- ▶ PG&E focuses on pilots to evaluate the viability of technology and resolve technical issues
- ▶ Partnerships spanning the smart-grid ecosystem ensure that insights are scalable

▶ Standards definition

- ▶ PG&E plays a broad role in shaping and accelerating the standards that will underlie future smart-grid implementations



▶ PG&E's service area in California

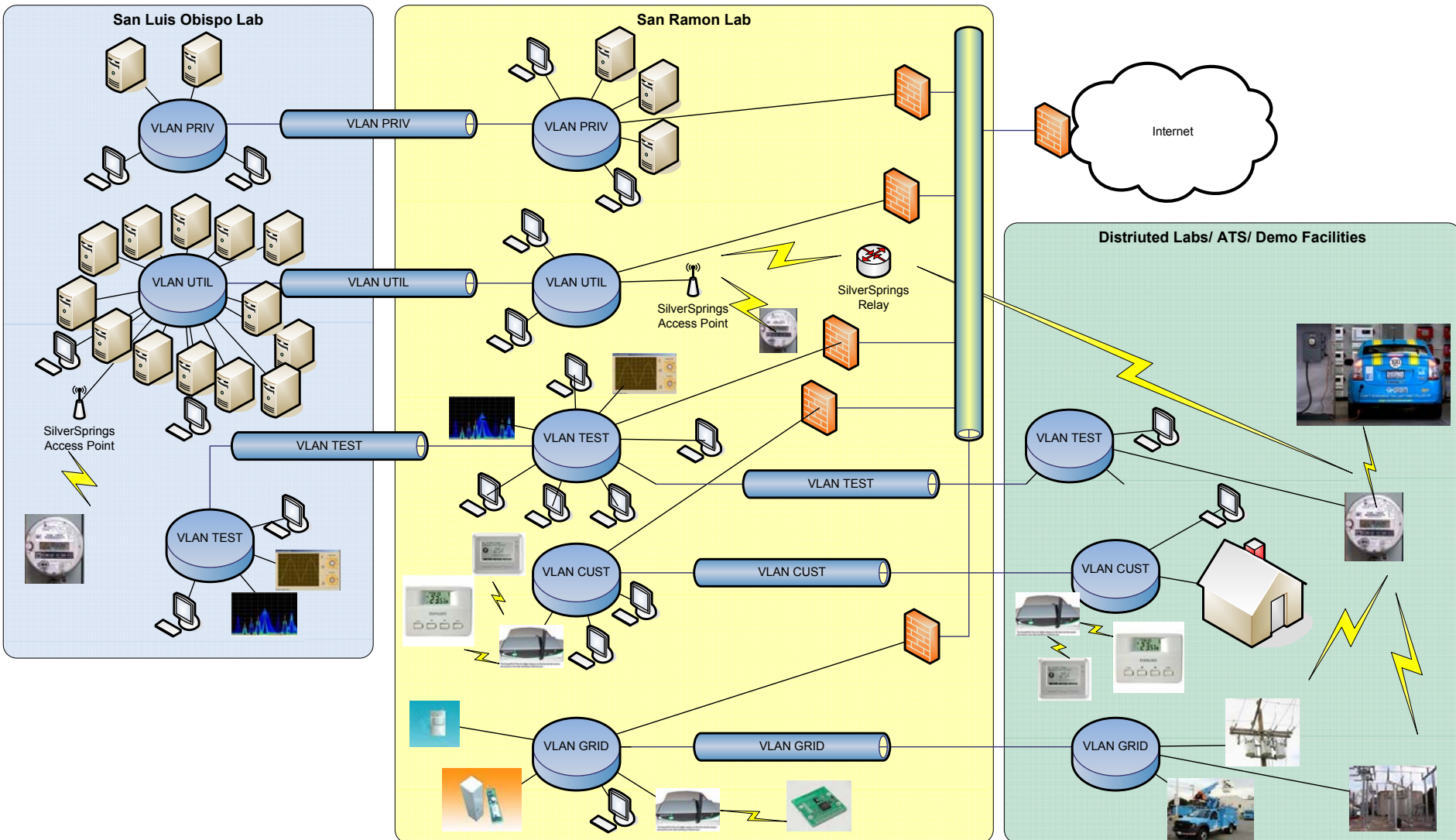
Full customer deployment

- ▶ pilots extend to full-scale roll-out, assuming benefits are proven
- ▶ PG&E's industry-leading smart-meter deployment allows it to be at the leading-edge of other smart-grid technology deployments
- ▶ Insights are used to feed the next cycle of the technology deployment cycle

A Distributed SmartGrid Lab is the Foundation

Technology Innovation Center – Logical Networks

Revised: 02/20/2009



San Luis Obispo – Network Applications Lab

Server (19) and Storage (51 TB) racks



The NAL focuses on applications and network level testing.

This including hosting and performance testing the SilverSprings SmartMeter back office application, databases and web servers for lab projects across the labs.

Additionally, HAN networking project work is performed.

HAN Demonstration



Linux workstations

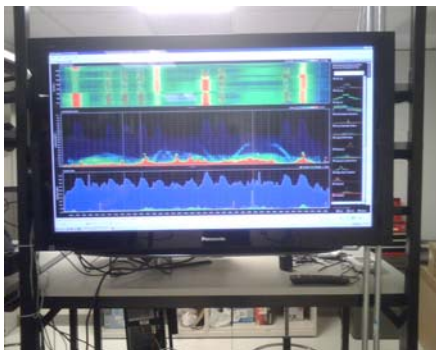


Electronics test bench



Electronics work bench

Radio Frequency Monitoring



RF Shield Room



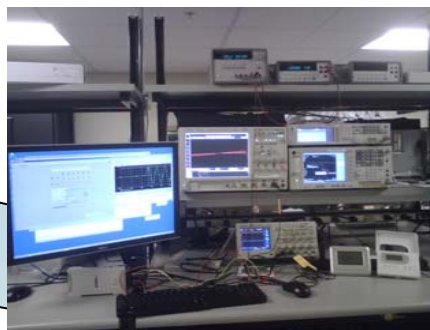
The CASL focuses on communications and sensor (device) testing.

This including Radio Frequency interference, coverage and capacity testing.

Devices used for HAN and SmartGrid must follow standardized communications protocols and device interoperability testing is also performed in the CASL.



SSN HAN Prototype

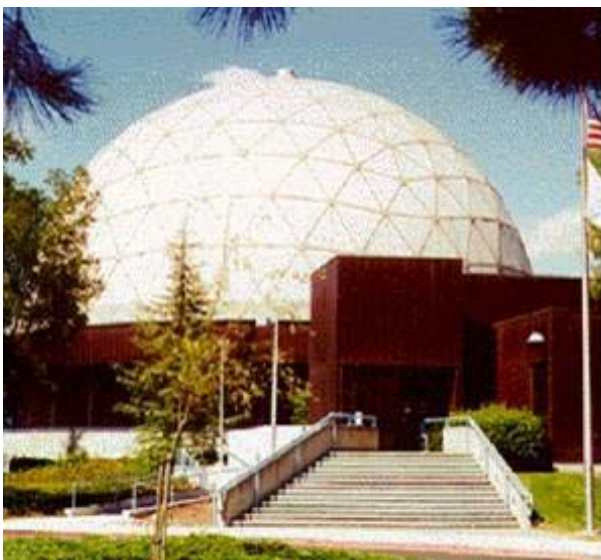


Device Test Bench



SmartMeter Testing

San Ramon Technology Center



1 PG&E San Ramon Technology Center
(includes TLS)
3400 Crow Canyon Road

2 San Ramon Conference Center
2211 Camino Ramon

The SR Technology Center provides the power engineering based facilities to install, operate, measure and test the electrical components of the Smart Grid.



Key Takeaways to Today's Discussion

- ▶ Industry Standards are the primary, critical, component necessary to build an interoperable SmartGrid
- ▶ Standards must be developed in an open process. Failure to do so will impair the ability to deploy a SmartGrid
- ▶ Certification can not be achieved without standards but certification is even more critical than standards
- ▶ There is a tremendous amount of new, highly interesting and highly beneficial work to be done!



Questions?

