Smart Grid
Utility Challenges in the 21st Century

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Balancing Competing Priorities

Reliable Service

Environmental Sustainability

Reasonable Cost

Smart Grid
Challenges for the 21st Century Utility

Key Utility Challenges:
- Keep electricity flowing reliably
- Integrate increasing amounts of distributed and intermittent resources
- Maintain a balanced system
Traditional End-to-end Utility Network Balances Supply and Demand

- Natural Gas Generators
- Nuclear Power Plants
- Hydro power plants
- Transmission Lines
- Distribution Substations
- Customers

Smart Grid functionality restores the balance.
Large-scale Renewables and Distributed Resources Impact Supply and Demand Unpredictably…

… Driving the Need for a Smarter Grid
A Smart Grid

Overlay with an “Intelligent” Infrastructure

- Pervasive sensing and measurement devices
- Pervasive control devices
- Advanced data communications
- Computing and information management

Smart

Power Plants  Transmission Networks  Substations  Distribution Networks  Consumers
Utility-scale Storage Resources

- **Pumped Hydro**
- **Compressed Air**
- **Sodium-Sulfur (NAS) Battery**
- **Zinc Bromine Flow Batteries**
- **Flywheel**
Renewable Resource Integration

Today:

- Clean, flexible, natural gas-fueled resources are currently necessary to back up intermittent resources
- Significantly improved air emissions profile than retiring plants, but still fossil-fueled

Tomorrow:

- Utility-scale distributed storage backs up intermittent resources and time-shifts resource availability to coincide with demand
- Distributed generation and distributed storage create a similar capability at the customer premise
Smart Grid Foundation: Largest US Smart Meter Deployment

- Ubiquitous automated meter reading
  - 10 million meter upgrades by 2012
  - 3.5 million deployed to date

- Frequent meter reads
  - daily for gas
  - hourly or 15 minute intervals for electric

- Embedded in-premise network gateway device unlocks new opportunities
  - Customer energy management
  - Demand-side management
  - SmartCharging for PEVs
Paradigm Shift: Customer Energy Management

Time-shifting Electricity

Typical Summer Demand

Time of Day

In-premise Network
AMI / Smart Grid
Online Energy Use Information

- Secure customer access through PGE.com
- Displays energy use by billing cycle, month, or week
- Displays daily hourly electric use
- Customer service reps able to view same graphs online
In-premise Network: Increasing Levels of Sophistication

**Basic**
- Simple high-low indicator

**Enhanced**
- More comprehensive in-home displays (usage, cost, time)
- Programmable Communicating Thermostat (PCT)

**Advanced**
- Fully automated intelligent energy management system
- Other automated/programmable appliances
- Electric vehicle charging
- Distributed generation
- Electric storage
Targeting Dependable Reductions in Electric Demand

Results from PG&E Auto-Demand Response Event, Summer 2008
PEV Impact on Utility Operations will be Significant

Larger number of BEVs coming to market

BEV 22
PHEV 15

# of models announced
BEV=(full) battery electric vehicle; PHEV=plug-in hybrid electric vehicle

BEVs have extended range

100 miles
BEV
40 miles
PHEV
24 kWh
BEV
8 kWh
PHEV

Electric mileage
Battery size (usable)

BEVs require higher charging capability

20 hours
1.4kW
9 hours
3.3kW
4 hours
6.6kW
Rate of charge

Most BEVs will come with the ability to charge at 6.6 kW

They represent substantial impact on the grid

SF 2.0
San Ramon 6.5
Fresno 6.2
Vacaville 5.3
Rocklin 6.3
Berkeley 3.4

PHEVs
Hours Load (kW)
~6 1.4
~3 3.3
~1 6.6
~20 1.4
~4 6.6

Expected charging profile

Avg. residential peak (summer, kW)
PEVs Charge On-peak

- Ample generation in overnight periods
- Most people return home during peak
- TOU pricing may not be enough to incent behavior
  - We estimate only 3% of all electric vehicles in California are on TOU rate

* Source: Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels and the DOE/GSA Federal Automotive Statistical Tool (FAST).
HEV Density “2004-08” – A Tale of Two Cities

Fresno CA:
- New Registrations: 83K
- HEV Registrations: 2K
- 2.4% of light duty purchases HEVs
- HEV zip code median: 11

Berkeley CA:
- New registrations: 14K
- HEV registrations: 2.5K
- 18% of light duty purchases HEVs
- HEV zip code median: 212

= 25 HEVs
SmartPort Network Architecture

Intelligent Sub-meter
- Charging profile
- Demand response
- CO2 credit calculation
- Highway usage tax

AMI Smart Grid
- ZigBee
- PLC – Homeplug

HAN
- ZigBee
- PLC – Homeplug

Smart Garage
- ZigBee
- PLC – Homeplug

Cord
- SAE
- J1776

xEV
- SAE
- J2836
At PG&E,
We Are Committed To Sustainability