CAISO View of Smart Grid

What Does the Smart Grid Enable?
A Utility and Grid Operator’s Perspective

Smart Grid mini series – Stanford University

Jim Detmers
Vice President, Operations

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Grid Operators View

Leverage smart grid policies to:

- Increase demand-side participation in the CAISO market,
- Support renewable resource integration,
- Support development of communications standards for a robust, secure communications network, and
- Enhance grid efficiency and reliability.
Smart grid strategies also provide greater visibility of the loads and resources throughout the system.

5.1 million electric customers

4.9 million electric customers

1.4 million electric customers

It is critical to know how much load is being covered by local generation, such as solar photovoltaic generation, so the CAISO can ensure reserves are available to replace the variable energy resources if required.
Increasing Demand-side Participation in the CAISO’s Markets

- Smart meter give customers visibility of their energy consumption and options to control their energy costs.
- New “smart” appliances and smart buildings will have loads that can respond to energy prices.
- Customers will be able to modify their consumption based on dispatch commands and pricing signals.
- Future tariffs to encourage PHEV to charge during off peak periods – a win for the customers, grid asset utilization, cleaner air and a match with off peak wind generation.
Achieving peak demand reduction requires a Smart Grid and dynamic pricing.

- **Light blue:** reductions through dynamic pricing
- **Dark blue:** reductions through Smart Grid technology

Source: FERC, June 2009 National Assessment of Demand Response Potential
Integrating Renewable Resources

- Smart grid systems will be to lower the barriers to interconnection of renewable generation at all levels of the grid.
- Smart grid will help make the distribution system robust enough to maintain power quality and acceptable voltages even with the interconnection of renewables on the distribution circuits.
- Smart substations will monitor the loads and resources in their area and provide both real-time data and potential short term energy forecasts for their area.
Solar energy sources are highly variable

Alamosa, CO - 5min. System Output
September 4, 2008

81% drop in 5 minutes

Output from an 8MW solar PV panel in Colorado on 9/4/08

High variability due to clouds
Wind energy is a challenge to forecast
2013 - Wind + Solar
4000 MW Solar and 6000 MW WIND Nameplate Capacity
Support development of communications standards for a robust, secure communications network

A smart grid will require many different parts of the electric system to communicate with each other.

The development of common communications and security standards will be vitally important to the success of the smart grid.

- NIST - National Institute of Standards and Technology
- NAESB - North American Energy Standards Board
- OASIS - Organization for the Advancement of Structured Information Standards
The shape of grids to come?

Conventional electrical grid
Centralised power stations generate electricity and distribute it to homes, factories and offices.

Energy internet
Many small generating facilities, including those based on alternative energy sources such as wind and solar power, are orchestrated using real-time monitoring and control systems.

Offices or hospitals generate their own power and sell the excess back to the grid. Hydrogen-powered cars can act as generators when not in use. Energy-storage technologies smooth out fluctuations in supply from wind and solar power.

Distributing power generation in this way reduces transmission losses, operating costs and the environmental impact of overhead power lines.

Sources: The Economist; ABB
Enhancing Grid Efficiency and Reliability

Achievement of high standards for grid efficiency and reliability requires data and information from all levels of the electric system as well as a regional view.

Key strategy is the deployment of a high speed Synchrophasor network for the western interconnection and expansion of the phasor network in California

- New data points at key stations and renewable generation
- New visualization tools
- Research and deployment of new controls for damping grid oscillations and enhancing grid stability
Phasor Measurement Units in North American Power Grid

Legend:
- Networked
- Installed
- Aggregators

With information available as of March 3, 2009
Goal: sensor-based operations and dynamic modeling

Frequency and response to system events

Grid stress - Angle separation
Reliability Issues and Examples

**Issues**

- Frequency Excursions
- Frequency Response
- Lack of Wide-Area Visibility
- System Dynamic Monitoring
- Standards Compliance Monitoring
- Dynamic Voltage Response

**Declining Reliability Performance Trend**

**Recent Large Frequency Excursions With Changes Over 3,000 MW**

**Lack of Visibility and Situational Awareness Led to Aug. ’03 Blackout**

- Normal Phase Angle is approx. -25°

Notes:
- Angles are based on data from blackout investigation.
- Angles are calculated from a Power flow Simulation.
- Angle reference is Browns Ferry.
Visualization – In Use at CAISO

Visualization Tiers – Dashboard, Interconnection, Reliability Coordinator, Local Area

Real Time Alarms within ALL RTDMS Client Applications

GAUGE
Quantifies the worst performing metric

LOCATION INDICATOR:
Provides information for specific locations or jurisdictions

TRAFFIC LIGHTS:
Provide status of specific Metrics across the entire interconnection
What is the Smart Grid going to do for us?

Technologies

- **Integrated Communications**
  Integrated communications connect components to an open architecture for real-time information and control, to allow every part of the grid to both “talk” and “listen.”

- **Sensing and Measurement**
  Sensing and measurement technologies support faster and more accurate response, such as remote monitoring, time-of-use pricing and demand-side management.

- **Advanced Components**
  Advanced components apply the latest research in superconductivity, fault tolerance, storage, power electronics and diagnostics.

- **Advanced Control Methods**
  Advanced control methods monitor essential components, enabling rapid diagnosis and precise solutions appropriate to any event.

- **Improved Interfaces and Decision Support**
  Improved interfaces and decision support amplify human decision-making, transforming grid operators and managers into knowledge workers.

Benefits

- **Reduced Disruptions**
  Near-zero wide–area blackouts and greatly reduced local interruptions.

- **Improved Reliability**
  High-quality power for sensitive electronics and complex computer applications.

- **Greater Consumer Control**
  Options for consumers to manage their electricity use and costs.

- **Access to Market**
  The plug and play integration of renewables, distributed resources and control systems.

- **Enhanced Security**
  Improved resilience to attack, natural disasters and operator errors.

- **Stronger Economy**
  Annual savings of tens of billions of dollars from reduced interruptions, reduced congestion and reduced need to build expensive plants and lines.