CAISO Perspective on 33% Renewables and impact on Greenhouse Gas

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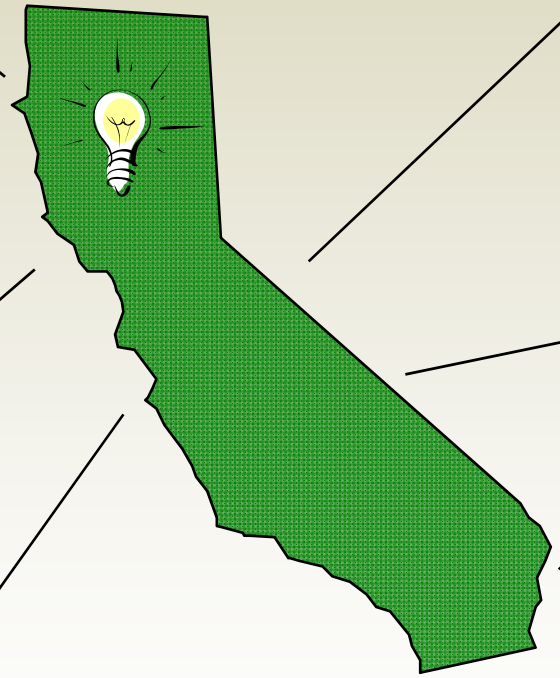
The power grid could make a dramatic transition over 2010 - 2020

- California has three major policy and regulatory drivers that will dramatically change the State's electric power system in the next 10 to 15 years:
  1. The increase of the State's Renewable Portfolio Standard (RPS) from 20% energy from renewable resources to 33% (and possibly beyond)
  2. AB32 reduction of Greenhouse Gas emissions to 1990 levels by 2020
  3. The retirement or repowering of Once Through Cooling (OTC) power plants between 2012-2021
- Additional technology and policy drivers that comprise the 2010- 2020 agenda: demand response, storage integration, PHEVs, Smart Grid

Into the Future: Accommodating the Climate Change Initiatives



- 20% of Energy Supply Renewable By 2010
- 33% of Energy Supply from Renewable Resources by 2020
- $ 1 Billion/Year Investment on Energy Conservation
- $5 Billion Investment on Smart Meters
- CO2 Emission Level Rolled Back to 1990 Level by 2020
- Ban Once-through Cooling Technology of all Coastal Plants by 20xx
- One Million Roof-Top Photo-Voltaic

Three major areas for the ISO's focus

- What transmission must be built to interconnect the renewable resouces and all generation in the interconnection queue?
- What will be the operational issues that must be solved to ensure grid reliability?
- Are there market issues, barriers, that must be address to handle large anounts of intermittent resources, energy storage and demand response?

Planned Enhancements to CAISO Markets

- Multi-stage generating unit modeling (2009)
- Scarcity pricing of ancillary services (2010)
- Convergence (virtual) bidding (2010)
- Integration of demand response and storage into energy and ancillary service markets (2009-2010)
- Evaluation of ancillary services products and pricing needed for renewable integration (2009 onwards)

The First Step: 20% Energy from Renewables by 2012 presents challenges but it is achievable

- Construction of 4000+ Megawatts of clusters of new wind generation facilities in Tehachapi, San Gorgonio, Solano and Altamont areas.
- An additional 1500 to 2000 MW clusters of solar and geothermal generation facilities will also be added in the San Luis Obispo, Mohave and Imperial Valley areas although environmental challenges are possible.
- The transmission plans to interconnect all of these facilities are either already approved and under construction or are in the final stages of review.
- The existing thermal and hydro generation facilities have sufficient flexibility to accommodate the variability of these new renewable resources.
- New tools and strategies are required to make it work in a reliable manner but it is **not a major change** in the fundamental design of the power grid.

Five Years Forward:
Market and Infrastructure Objectives for 2015

- Full integration of locational marginal pricing into power sector decision-making in California. Progress towards more efficient congestion management west-wide.

- Reliably and efficiently integrate 20-25% renewables through analysis of integration needs and providing appropriate guidance to State regulators (through evaluation of long-term procurement procedures) and the markets (through price signals).
  - As an integrated system, this can only be successfully accomplished through a robust and cooperative planning process throughout the West to ensure renewable integration (e.g. BPA joint work on wide area management, etc.)

- Establish level playing field for DR and storage technologies in the energy and ancillary service markets.

Market and Infrastructure Objectives for 2015

- Evaluate comprehensively ancillary service needs and pricing in the operating environment created by renewables and new non-generation market participants (and consistent with NERC/WECC requirements).

- Maximize flexibility of the existing and new generation fleet to ensure reliability while providing sufficient ramp, load following and Regulation capability for renewable integration.

- Support State agencies in implementing once through cooling regulations consistent with local and system reliability requirements and environmental policy needs, such as renewable integration and greenhouse gas reductions.

Market and Infrastructure Objectives for 2015

- Support transmission planning for renewables in California and the West to ensure efficient expansion decisions are based, over time, on market price signals. This includes establishing a coordinated planning participation by publicly-owned utilities with the ISO and IOUs.

- Leverage market tools to conduct “state-of-the-art” reliability and economic evaluations of all proposed transmission projects.

- Transform CAISO planning functions to better integrate wholesale market information and evaluate on equal basis transmission, generation and non-generation resource investments.

Market and Infrastructure Objectives for 2015

- Evaluate deficiencies of State Resource Adequacy program and assist state in reforming Resource Adequacy mechanisms to be more market-based and centralized. This will entail careful evaluation of the capacity value of wind and solar resources, so as to ensure sufficient backup of dispatchable capacity.

- With the implementation of scarcity pricing in 2010, there may be opportunities to better leverage scarcity pricing, diminishing the funding role of capacity contracts, but State will likely be reluctant to terminate RA requirements.

- Support efficient development of the smart grid, based on wholesale locational price signals.

Ten Years Forward:
Market and Infrastructure Objectives for 2020

All of the above, plus:

- Reliably and efficiently integrate 33% renewables and have prepared ISO for potentially for higher levels of renewables in subsequent years.

- Prepare for system and market operations with increased penetration of distributed resources.

- Increased penetration of renewables coupled with GHG restrictions by 2020 could lead to early retirements of thermal generation. Evaluate implications for Resource Adequacy pricing and requirements.

More Detail on Renewable Integration

- Generation mix in 2020 and implications for variability
- Steps towards improved wind forecasting and enhanced operational capabilities
- Steps to increase flexibility of resource mix

33% Energy from Renewables is a game changer

The 33% RPS goal and other initiatives will require fundamental changes to the power system.

- A significant amount (3000+ MWs) of the new renewable generation will no longer be installed in discrete clusters but could be Distributed Generation and Photovoltaic panels on a million rooftops, backyards and over parking lots.
- The Renewable Electric Transmission Initiative (RETI) has identified 29 Competitive Renewable Energy Zones (CREZ) but there is a significant amount of new generation planned that is not in the CREZ areas.
- It seems clear that substantial amounts of future generation will not be located in clusters but will be spread throughout both the transmission and distribution systems.

33% Energy from Renewables is a game changer

- The elimination of OTC power plants will further disperse generation and potentially reduce the amount of large generation resources close to large load centers.
- New Energy Storage facilities with 5 to 6 hours of energy absorption or delivery and located in strategic areas will be useful.
- Demand Response will provide flexibility in matching loads to available generation resources.
- GHG reduction requirements will put major pressure on elimination of many thermal power plants.

33% RPS will challenge new transmission

- Current plans call for the planning, permitting, design and construction of six to seven new major transmission lines in the next 10 years to interconnect all the new renewables.
  - **Pallning, Approving, Permiting and Construction will be a major challenge**
- Links to major renewable clusters in Southern California, Nevada, Arizona, Wyoming, New Mexico, Mexico and Pacific Northwest will require upgrades or new lines.
  - **Regional transmission planning will be essential**
- Increased utilization of existing transmission will be key
  - **Voltage and dynamic stability limits on ties must be improved**

Three major renewables integration issues

1. Identification of the new renewable generation resources that will be built to meeting the 33% RPS goal and agreement on the transmission and distribution plan to interconnect these resources to the grid to deliver the energy to customer loads.
2. Creation of new computer models and study tools that accurate represent the characteristics of the power system of the future. What resources will be required to make the system work in a reliable and cost effective manner?
3. What investment in new technology such as the Smart Grid and Energy Storage and Demand Response programs will be essential to integrate all the components in the grid of the future?

Key Operational Issues that CAISO has begun to assess to address Variability associated with Wind and Solar

- Increased ramps in morning and evening
- Increased load following requirements
- Increased requirements for Regulation
- Potential increase in operating reserves and need for supplemental reserves
- Increased frequency of overgeneration
- Increased stresses on generation fleet from ramping, cycling
- Increased concerns with sufficient system inertia

Operational Tools to Support Wind Integration

- Objectives
  - Develop visualization tools to help operators deal with renewable integration. The team includes BPA, CAISO, WAPA, MISO, New England ISO, and PJM
  - Integration with Market Systems
- Ramp
  - 24-hours look ahead – peak & off-peak
  - 2-3 hours look ahead with 5-minute resolution
  - Provide probabilities of expected ramps
  - Forecast the impacts of unpredicted wind ramps
- Timeline
  - Production tool by December 2009

KEMA study of generation fleet

- Modeling of all generators and energy storage facilities
- Pick 4 days – different seasons for modeling
- 24 hour dispatch with import
- Includes handling of significant generator tripping
- Goal is to verify fleet operation in future dates
- Develop new dispatch algorithms

CAISO's goal is to implement the renewables programs and ensure grid reliability

Questions ?