Making Sense of U.S. Energy Markets

National Conference of State Legislators
Task Force on Energy Supply

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Two-thirds of the United States is served by independent system operators (ISO/RTOs)

Core ISO functions:

- A balancing authority area operator
- A transmission & infrastructure grid planner and operator
- A facilitator of competitive wholesale power markets
California has multiple Balancing Area Authorities
ISO coordination with California state agencies

**Air Resources Board**
- Greenhouse gas regulations

**Water Resources Control Board**
- Once-through cooling

**Energy Commission and Legislature**
- Renewable Portfolio Standard
- Policy driven transmission

**Public Utilities Commission**
- Resource Adequacy
- Generation Procurement
- Transmission sighting/permitting
The ISO facilitates a market for suppliers/purchasers
The ISO has two pricing markets

**Day-Ahead Energy Market**

**Enables**

Parties to schedule contracted supply/demand

Suppliers to offload excess supply in the form of energy or ancillary services

LSEs the ability to secure pricing for load due to
- changes in load forecasts or
- incremental changes in demand

**Real-Time Energy Market**

**Composed of**

Hour-ahead scheduling for intertie resources

15-min market supports renewable integration

5-min market intended to meet instantaneous demand

**Includes**

- ISO Balancing Authority Area
- EIM Balancing Authority Areas
Components of the locational marginal price

Energy

The price at which supply and demand curves meet

Congestion

A situation in which the lowest-priced electricity can't flow freely to a specific area due to heavy use of the transmission system

Caused by: Lack of transmission capacity, Outages

Losses

Energy lost in transmission

Magnitude: is dependent on the location of supply and demand

Locational marginal price

GHG

* LMP for EIM entities also contains a GHG component
ISO Nodal Pricing

Resources are paid the nodal price at their location

Load pays the weighted average price of all load nodes in the service territory

Imports and Exports are paid or pay the price at the scheduling point
Resource procurement

Renewables Portfolio Standard (RPS) and other legislative mandates
Requires investor-owned utilities (IOUs), electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 50% of total procurement by EOY 2030

Long Term Procurement & Integrated Resource Plans
CPUC proceeding to conduct a 10-year look ahead and consider all of the Commission’s electric procurement policies and programs to ensure most of California has a safe, reliable, and cost-effective electricity supply

Resource Adequacy
CPUC adopted policy framework to ensure the reliability of electric service for all Load Serving Entities (LSEs) within the CPUC’s jurisdiction; ISO requires reporting from all LSEs in the system that reflect adequacy
Current resource mix of ISO

Total installed capacity 73,306 MW
as of 11/02/2016

- 56.4% natural gas
- 0.4% oil
- 0.7% coal
- 1.1% nuclear
- 3.14% large hydro
- 11.6% renewables
- 27% renewables

renewables breakdown

- 46% solar
- 30.7% wind
- 6.7% biofuels
- 6.6% small hydro
- 9.8% geothermal
- 0.2% storage battery
- 1.1% other

15,755 MW = Maximum import capacity at summer peak for the ISO
California continues to add renewable resources (predominately Solar PV)

*All online resources that are not in test mode are included in the 2016 YTD amounts, including those yet to achieve full commercial operation.  **Approximate.
Solar and wind production is significantly reducing the need for conventional resources on peak demand days.

**Net Demand**
The net demand curve depicts the variability in demand and wind and solar supply that the ISO must meet to maintain grid reliability. Net demand is calculated by taking the actual demand and subtracting the electricity produced by wind and solar resources that are directly connected to the ISO grid.
Oversupply and ramping: A new challenge as more renewables are integrated into the grid

- ISO has already seen the need to curtail generation
- Oversupply may lead to curtailment because of dispatch limitations on some resources, such as
  - geothermal
  - nuclear
  - small hydro
  - combined heat and power

Typical Spring Day

Net Load 11,663 MW on May 15, 2016

Actual 3-hour ramp 12,960 MW on December 18, 2016
Renewable curtailment in 2024 at 40% RPS is significant.

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<thead>
<tr>
<th>Solutions</th>
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<tr>
<td>Target energy efficiency</td>
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<td>Increase storage and demand response</td>
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<tr>
<td>Enable economic dispatch of renewables</td>
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<tr>
<td>Decarbonize transportation fuels</td>
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<tr>
<td>Retrofit existing power plants</td>
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<tr>
<td>Align time-of-use rates with system conditions</td>
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<td>Diversify resource portfolio</td>
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<td>Deepen regional coordination</td>
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Majority of western states have an RPS. A regional ISO can transform the electricity sector to a low-carbon energy delivery system.

Regional market integration can:
- Reduce customer costs
- Enhance coordination and reliability
- Facilitate renewable resource integration
- Reduce emissions
- Enhance regional system planning

Successful market integration requires:
- Change in California state statute to amend governance
- Approval by PacifiCorp state regulatory bodies and the FERC
- Approval by FERC on changes to PacifiCorp and ISO tariffs
Carbon and cost benefits increase with a regional market.

- Increases development of renewable generation in California and the region
- Optimizes what power plants are turned on ahead of time
- Increases development of new transmission to enhance reliability, lower costs, and achieve policy objectives
- Improves reliability by providing greater visibility and load/resource diversity across the region

- State-of-the art technology that balances supply and demand every five minutes
- Dispatches the use of the lowest cost generation available in real-time
The ISO western Energy Imbalance Market (EIM) continues to expand

Advanced ISO market systems automatically balance electricity every five minutes

The market systems choose low cost resources to reliably meet demand
Scope of the Studies required by SB350

Legislative Requirement:

- 359.5. (a) It is the intent of the Legislature to provide for the transformation of the Independent System Operator into a regional organization..., and that the transformation should only occur where it is in the best interests of California and its ratepayers.

- The ISO will conduct studies of the impacts of a regional market, including:
  1. Overall benefits to California ratepayers
  2. Emissions of greenhouse gases and other air pollutants
  3. Creation or retention of jobs and other benefits to the California economy
  4. Environmental impacts in California and elsewhere
  5. Impacts in disadvantaged communities
  6. Reliability and integration of renewable energy resources

- The modeling, including all assumptions underlying the modeling, shall be made available for public review.
2020 and 2030 Hypothetical Regional Footprints

WECC currently consists of 38 individual Balancing Authorities

- **2020 Footprint**: Regional ISO to consist of only CAISO and PacifiCorp: denoted as “CAISO+PAC”

- **2030 Footprint (and 2020 Sensitivity)**: Expanded Regional ISO to consolidate all balancing areas in the U.S. WECC except the Federal Power Marketing Agencies (U.S. WECC w/o PMAs)
Regional market improves the California economy

- Regionalization (Scenarios 2 and 3) can create **9,900–19,400 more jobs** than Current Practice in California, primarily by making electricity more affordable
  - Higher statewide household real disposable income due to more affordable energy
  - Higher statewide Gross State Product, real output, state revenue, and employment
  - Disadvantaged households benefit more because utility costs are higher portion of income

**Statewide Jobs Created by 2030**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Geothermal</th>
<th>Wind</th>
<th>Solar</th>
<th>Indirect Jobs</th>
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<tr>
<td>Current Practice</td>
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<tr>
<td>Regional 2</td>
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<td>Regional 3</td>
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<td>100,200</td>
<td>9,500</td>
<td>9,500</td>
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