California Independent System Operator (CAISO)

September 16, 2015

Virginia Thompson
Industry Affairs Manager
What is the ISO?

LEED Platinum certified building
What does the ISO do?

Three primary functions (focus on open and fair access):

- Reliability: Real Time grid management
- Infrastructure planning and resource interconnection
- Run the market for wholesale electricity
NERC regulates the North American grid through the adoption & enforcement of reliability standards.
Western Electricity Coordinating Council (WECC)

- CA is one of 14 states within WECC
California balancing authorities

- PacifiCorp
- California ISO
- Bonneville Power Administration (BPA)
- Balancing Authority of Northern California (BANC)
- Turlock Irrigation District (TID)
- NV Energy
- Los Angeles Department of Water and Power (LADWP)
- Western Area Lower Colorado (WALC)
- Imperial Irrigation District (IID)
Who oversees us today?

We are:

- governed by a governor appointed/Senate confirmed Five Member Board
- regulated by FERC Federal Energy Regulatory Commission
- compliant with NERC North American Electric Reliability Corporation
- part of WECC Western Electricity Coordinating Council
ISO coordination with state agencies

- Air Resources Board
  - Greenhouse gas regulations
  - ARB
- Water Resources Control Board
  - Once-through cooling
  - WRCB
- Energy Commission and Legislature
  - Renewable portfolio standard
  - Load forecasting
  - CEC & Leg.
- Public Utilities Commission
  - Resource adequacy
  - Generation procurement
  - PUC
ISO Organization Chart

Board of Governors

President & CEO

Market Monitoring

Board Committees
Audit Committee
Market Surveillance Committee
EIM Transitional Committee

Market & Infrastructure Development

Market Quality & Renewable Integration

Technology

Operations

General Counsel

Policy and Client Services
Before the ISO…
How the ISO fits in…

Transmission still owned by utilities, just operated by ISO

Utility owned generation

Independent Generators

Power Marketers

Scheduling Coordinators

Local utility

Customer

ISO

DRAFT
Reliability and real time

• For most of California and part of Nevada:
  – Responsible for electric system reliability, including constantly balancing supply and demand
  – Optimizes day-ahead electric system dispatch
  – Plans the transmission system to meet reliability requirements as well as economic and policy objectives
  – Manages generation interconnection

• Optimizes electric system dispatch every five minutes for most of California and parts of six additional states.

• Operates in furtherance of California energy and environmental goals.
The ISO has two 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

- 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
Challenges & Opportunities

- Current interconnection queue
- Variable Energy resources
- The “Duck Curve”
- Curtailment risk
- Energy Imbalance Market
- Regionalization
Current and projected renewable generation capacity in operation within the CAISO

*All online resources are included in the 2015 YTD amounts, including those yet to achieve full commercial operation.
Significant amount of energy storage projects entered the CAISO queue in 2014 & 2015

- CPUC procurement target for energy storage capacity by 2020
  - 1,325 MW, approximately 700 MW in transmission interconnected
- 79 projects totaling 8,076 MW currently in the CAISO queue
- 5,586 MW of stand-alone energy storage
- 2,490 MW combined with other generation technologies
- Technologies include battery, pumped storage, molten salt, flywheel and rail energy storage
Non-Flexible resources create oversupply conditions and potential for RPS curtailment

Oversupply may lead to curtailment because of dispatch limitations on some resources, such as:
- combined heat and power
- nuclear
- geothermal
- small hydro
- generation needed for reliability services

Operational requirements include:
- generation needed to meet ramping requirements
- Required standby generation, voltage support and other reliability services
- load following capability

- ISO has already seen the need to curtail generation in 2014
Renewable curtailment in 2024 at 40% RPS is significant

**Solutions**

- Target energy efficiency
- Increase storage and demand response
- Enable economic dispatch of renewables
- Decarbonize transportation fuels
- Retrofit existing power plants
- Align time-of-use rates with system conditions
- Diversify resource portfolio
- Deepen regional coordination
California can accelerate carbon reduction in the West by regionalizing the grid.

- Regional operation of the Energy Imbalance Market (EIM) is underway and growing.
- EIM is already saving consumers millions of dollars per year.
- A larger region benefits renewable integration
- PacifiCorp is evaluating whether to become a full participant in the ISO.
Energy imbalance market – key points

Without EIM:
Each BA must balance loads and resources within its borders

With EIM:
The market dispatches resources across BAs to balance energy

- Limited pool of balancing resources
- Inflexibility
- High levels of reserves
- Economic inefficiencies
- Increased costs to integrate wind/solar

- Diversity of balancing resources
- Increased flexibility
- Decreased flexible reserves
- More economically efficient
- Decreased integration costs
Summary of EIM benefits for the 1st Quarter 2015

<table>
<thead>
<tr>
<th>BAA</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO</td>
<td>$0.48</td>
<td>$0.49</td>
<td>$0.48</td>
<td>$1.44</td>
</tr>
<tr>
<td>PACE</td>
<td>$0.88</td>
<td>$0.83</td>
<td>$0.91</td>
<td>$2.63</td>
</tr>
<tr>
<td>PACW</td>
<td>$0.42</td>
<td>$0.49</td>
<td>$0.28</td>
<td>$1.19</td>
</tr>
<tr>
<td>Total</td>
<td>$1.78</td>
<td>$1.81</td>
<td>$1.67</td>
<td>$5.26</td>
</tr>
</tbody>
</table>

Benefits reflect:
- More efficient dispatch, both inter- and intra-regional
- Reduced renewable energy curtailment
- Reduced flexibility reserves needed in PacifiCorp BAAs

This report contains enhancements over the 2014 Q4 report:
- Benefit calculations include all fifteen minute market intervals
- Calculations used relevant prices including any corrections
- Calculations of avoided renewable curtailment
Considerations for non-California entities for becoming full grid participant (Pacificorp is currently analyzing this option)

ISO stakeholder processes:
- Greenhouse gas
- Transmission charges
- Full network model
- Resource adequacy

Multi-state engagement:
- Briefings
- Consultation
- Regulatory review

Implementation:
- Project design and development
- Testing
- Market simulation
- Readiness assessment

Regional Operations:
- Day-to-day operations
- Facilitate CARB enforcement of cap & trade compliance