ISO Energy Market

Planning for a 100% Renewable New Mexico Coalition for Clean Affordable Energy

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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 (reliability)
- A transmission & infrastructure grid planner and operator (reliability)
- A facilitator of competitive wholesale power markets (market operations)
The primary function of an ISO is to ensure that the grid is operating reliably and efficiently

- **Reliability** – Fluctuating conditions and power dynamics require high-tech forecasting tools, competitive market outcomes and real-time precision

- **Efficiency** - Operators optimize available resources every 4 seconds

- **Innovation** - Support deployment of clean technologies such as demand response and aggregated distributed resources

- **Transparency** – Structured organized markets provide transparent pricing
ISO coordination with California state agencies

**Air Resources Board**
- Greenhouse gas regulations

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

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

**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
Responsibilities of a vertical integrated utility shift when joining an ISO

<table>
<thead>
<tr>
<th>ISO</th>
<th>Utility</th>
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<tbody>
<tr>
<td>• Balancing Authority Area responsibilities</td>
<td>• Resource planning &amp; procurement</td>
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<td></td>
<td>• Generation Operation</td>
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<td></td>
<td>• Distribution level generation interconnections</td>
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<tr>
<td>• Transmission level generation interconnections</td>
<td>• Distribution planning &amp; service to customers</td>
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<tr>
<td>• Generation Dispatch</td>
<td>• Load interconnection</td>
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<tr>
<td>• Transmission Planning</td>
<td>• Load metering</td>
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<td>• Transmission access service</td>
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Shared: Transmission Operation
California continues to add renewable resources (predominately Solar PV)

- Unspecified 50% RPS**
- Solar Thermal
- Solar PV
- Wind
- Biofuel
- Small Hydro
- Geothermal

Renewable Capacity (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>Existing Generation</th>
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<tbody>
<tr>
<td>2014</td>
<td></td>
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<tr>
<td>2015</td>
<td></td>
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<tr>
<td>2016 YTD*</td>
<td></td>
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<td>2016</td>
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<td>2017</td>
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<td>2019</td>
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<td>2020</td>
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<tr>
<td>2030</td>
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(Existing generation)

*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
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 8,507 MW on May 14, 2017

Actual 3-hour ramp of 12,960 MW on December 18, 2016
A suite of solutions are necessary

<table>
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<tr>
<th>Storage – increase the effective participation by energy storage resources.</th>
<th>Western EIM expansion – expand the western Energy Imbalance Market.</th>
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<tbody>
<tr>
<td>Demand response – enable adjustments in consumer demand, both up and down, when warranted by grid conditions.</td>
<td>Regional coordination – offers more diversified set of clean energy resources through a cost effective and reliable regional market.</td>
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<td>Time-of-use rates – implement time-of-use rates that match consumption with efficient use of clean energy supplies.</td>
<td>Electric vehicles – incorporate electric vehicle charging systems that are responsive to changing grid conditions.</td>
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<td>Renewable portfolio diversity – explore procurement strategies to achieve a more diverse renewable portfolio.</td>
<td>Flexible resources – invest in fast-responding resources that can follow sudden increases and decreases in demand.</td>
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The evolution of the grid includes the western energy imbalance market (EIM)

- Advanced ISO market systems automatically balance electricity every five minutes
- The market systems choose low cost resources to reliably meet demand
- Four EIM entities now in the implementation phase
- Entities exploring future entry
  - Salt River Project, Los Angeles Department of Water & Power (LADWP), Northwestern Energy, CENACE in Baja, CA
Carbon and cost benefits increase with a regional market.

Full Participation Benefits

- 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

Energy Imbalance Market Benefits

- 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
Regionalization

What is regionalism?
• ISO expanding its balancing area and market operations to other states in the west

What does regionalism offer?
• Enhanced grid optimization
• Efficiently integrated renewable resources

What are the benefits?
• Increased system reliability
• Reduced GHG emissions
• Estimated savings of many millions of dollars every year
• Reduced curtailment of renewables
• Improved regional system planning
• Enhanced risk mitigation
In 2016, representatives from 77 countries came to the ISO to discuss renewable integration and grid modernization.