



California ISO



ISO PUBLIC

What we stand for

□ ***Our Vision***

- Operate the world's most reliable, cost-effective and environmentally sustainable power system.



□ ***Our Strategy***

- Reliably and efficiently integrate new resources by proactively upgrading operational capabilities
- Strengthen resource adequacy and meet California's SB100 goals through long-term transmission planning and effective coordination with state agencies
- Build on the foundation of the Western Energy Imbalance Market to further expand Western market opportunities
- Provide highly responsive and inclusive stakeholder engagement and customer service
- Create a flexible and adaptive work environment that retains and attracts a highly skilled and engaged workforce

Shaping the industry

The ISO, a nonprofit public benefit corporation, maintains the constant and reliable flow of electricity for the health, safety and welfare of consumers.

How?

- Delivering **224.8 million megawatt-hours** of electricity annually
- Facilitating **fair and transparent** wholesale electricity market
- Performing comprehensive **transmission planning**
- Clearing the way for **clean, green resources** to access the grid



California ISO

Within its balancing authority area, the California ISO:

- Maintains reliability on the grid
- Manages the flow of energy
- Oversees the transmission planning process
- Operates the wholesale electric market

For much of the western U.S., the ISO:

- Operates the Western Energy Imbalance Market (EIM)
- Serves as Reliability Coordinator (RC West)



California ISO facts

As a federally regulated nonprofit organization, the ISO manages the high-voltage electric grid California and a portion of Nevada.

52,061 MW record peak demand
(Sept. 6, 2022)

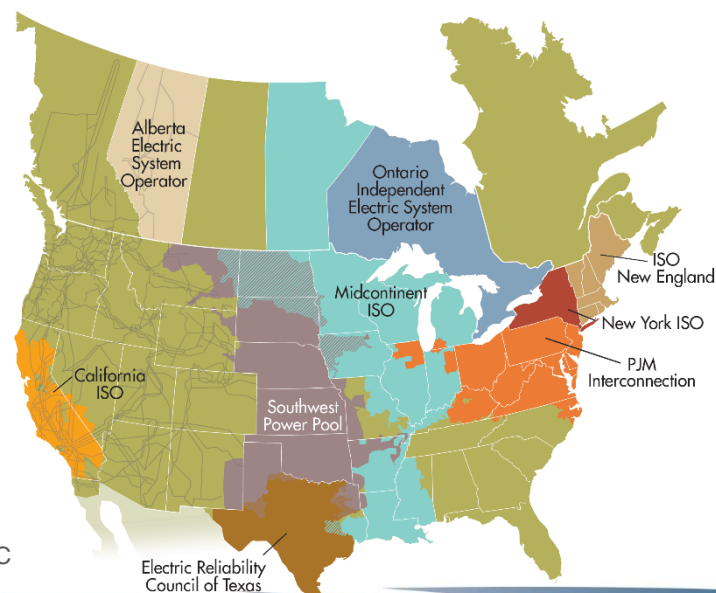
224.8 million megawatt-hours of electricity delivered
(2020)

75,747 MW power plant capacity
Source: California Energy Commission

1,119 power plants
Source: California Energy Commission

32 million people served

One of **9** ISO/RTOs in
North America



California ISO oversight

Comply with

NERC

North American Electric
Reliability Corporation

Regulated by

FERC

Federal Energy
Regulatory Commission

The ISO is regulated by the federal government because management of interstate transmission lines falls under federal jurisdiction.

Part of

WECC

Western Electricity
Coordinating Council

Governed by a

FIVE

member board
Governor appointed,
Senate confirmed

North American Grid

The three high voltage power grids in North America include the eastern, western and Texas interconnections.

The North American Electric Reliability Corporation (NERC) is the organization that regulates the North American grid through the adoption and enforcement of reliability standards. NERC is under the regulatory jurisdiction of the Federal Energy Regulatory Commission



NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

ISO/RTO Council

The California ISO is one of 9 independent system operators/regional transmission operators (ISOs/RTOs) in North America.

Two-thirds of the United States is served by these independent grid operators.



Western Electricity Coordinating Council (WECC)

WECC oversees reliability planning and assessments, and monitors and enforces compliance for the Western Interconnection, which extends from Canada to Mexico, and part of 14 western states.

- The ISO is the largest of the 38 balancing authorities within WECC's footprint
- The ISO manages 61 percent of WECC's total electric load



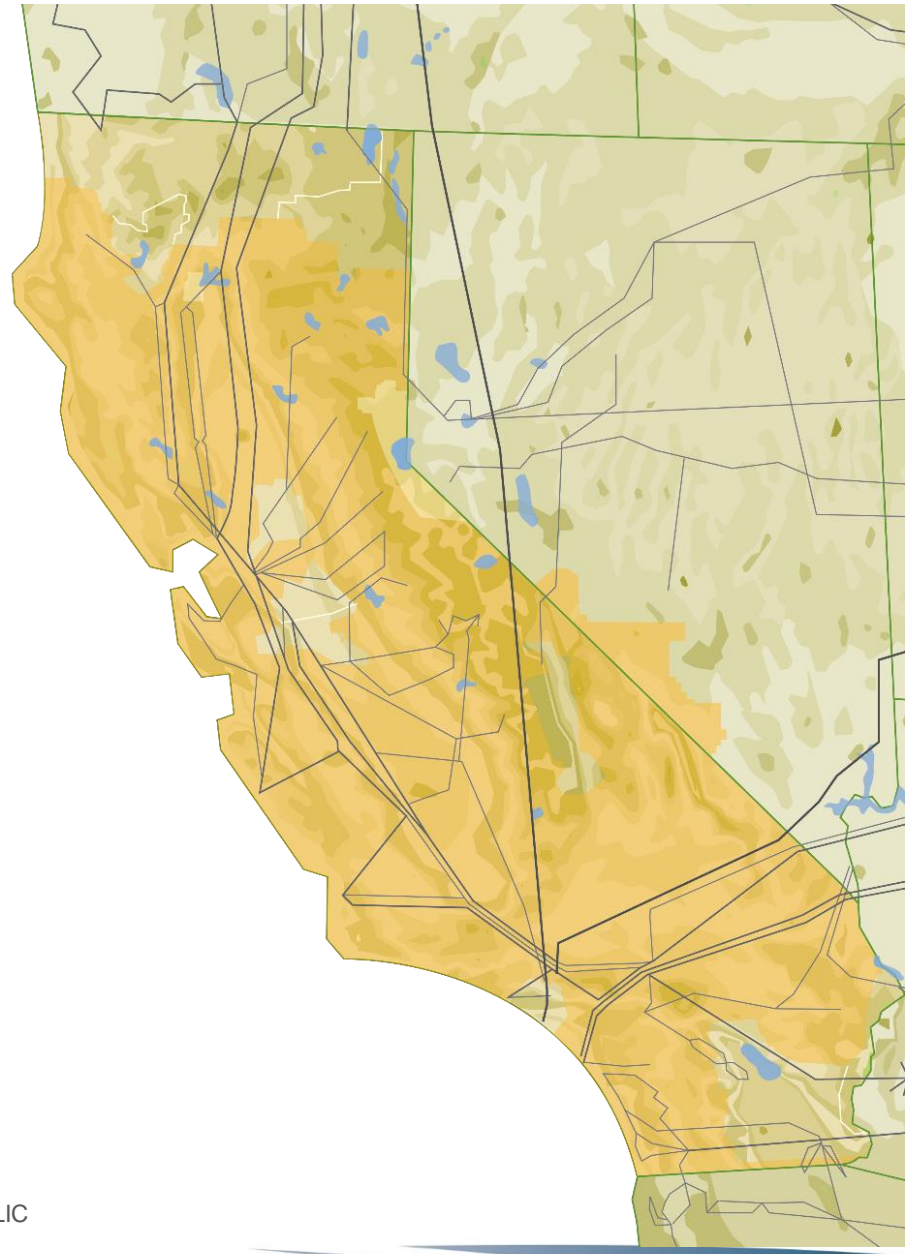
California ISO facts

26,000 circuit-miles of
transmission lines

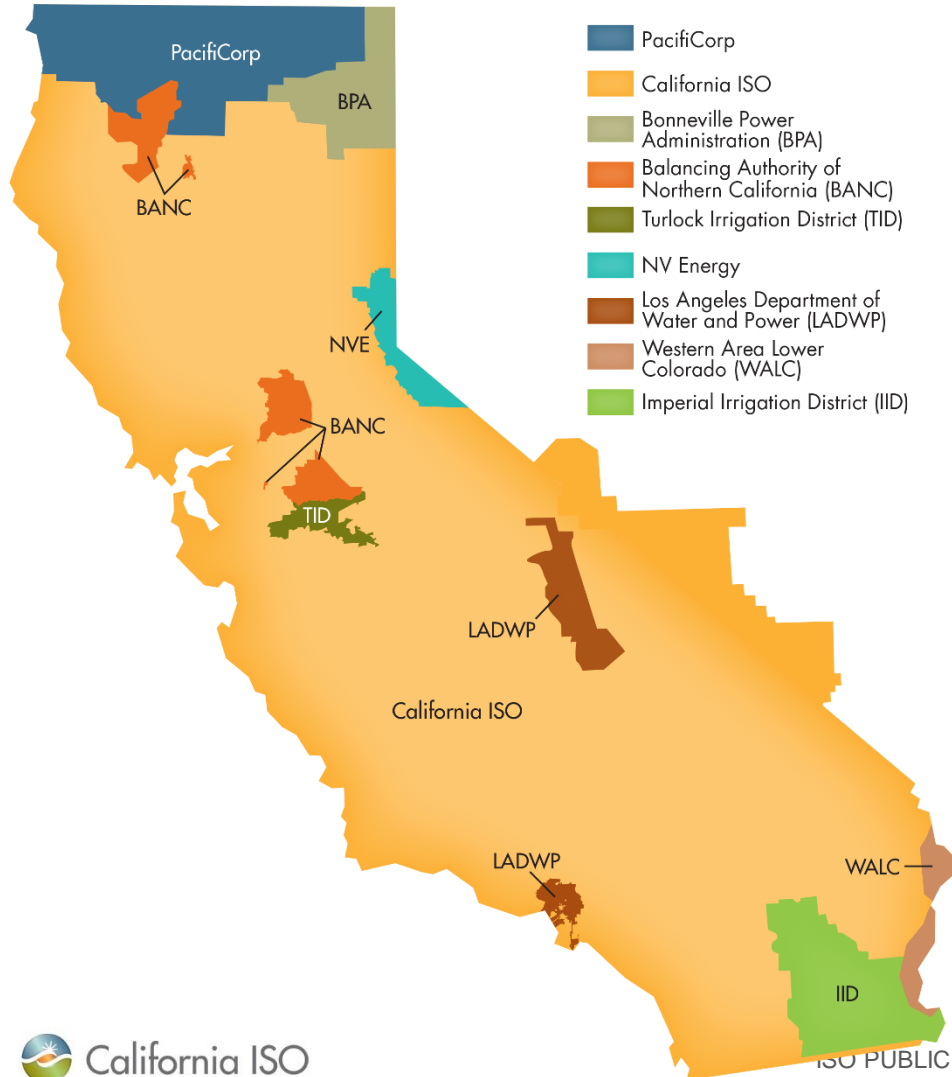
\$10.8 billion annual market
(2018)

78¢ per MWh grid management
charge (June 1, 2020)

33,617 average market
transactions per day (2020)



California balancing authorities



The California ISO manages the flow of electricity for about 80 percent of California and a small portion of Nevada, which encompasses all of the investor-owned utility territories and some municipal utility service areas.

There are certain pockets of California where local public power companies manage their own transmission systems.

RC West

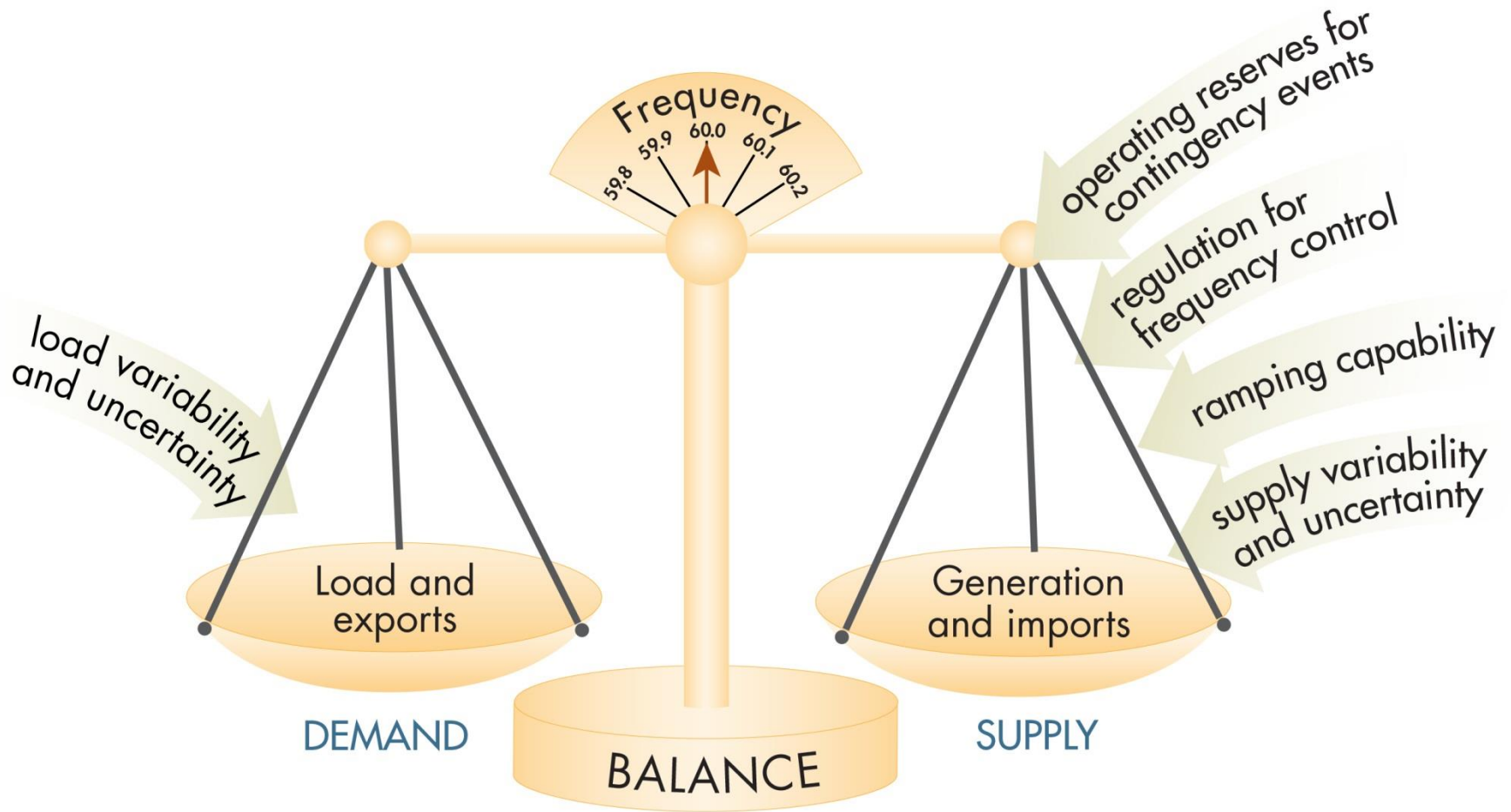
The ISO became the reliability coordinator for the majority of the Western Electricity Coordinating Council (WECC) in 2019.

Reliability coordinators:

- Have authority and responsibility for grid stability
- Monitor the interconnected grids in the West for compliance with federal and regional standards
- Authorize measures to prevent or avoid system emergencies in day-ahead or real-time operations
- Lead system restoration following major incidents

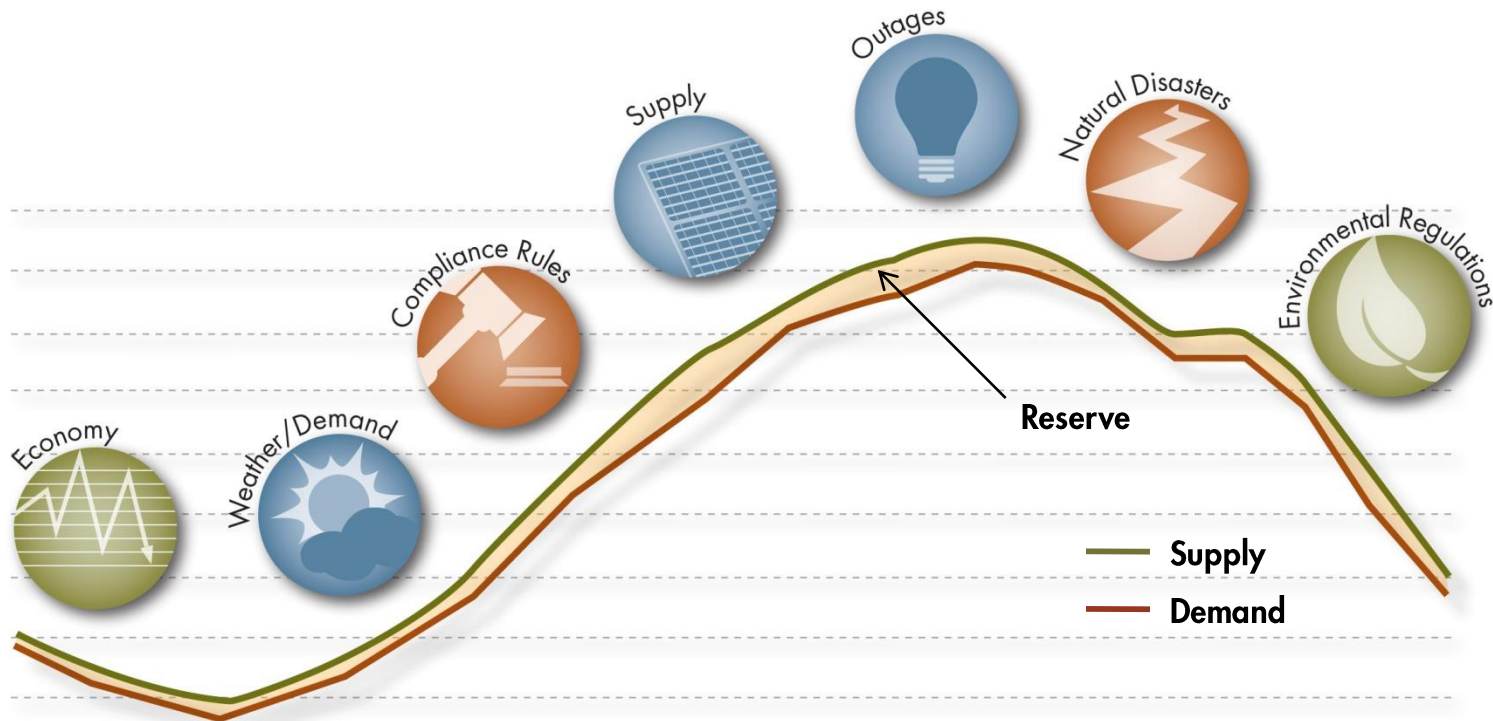


Electricity is produced, delivered, and consumed at the speed of light while balance must be maintained.



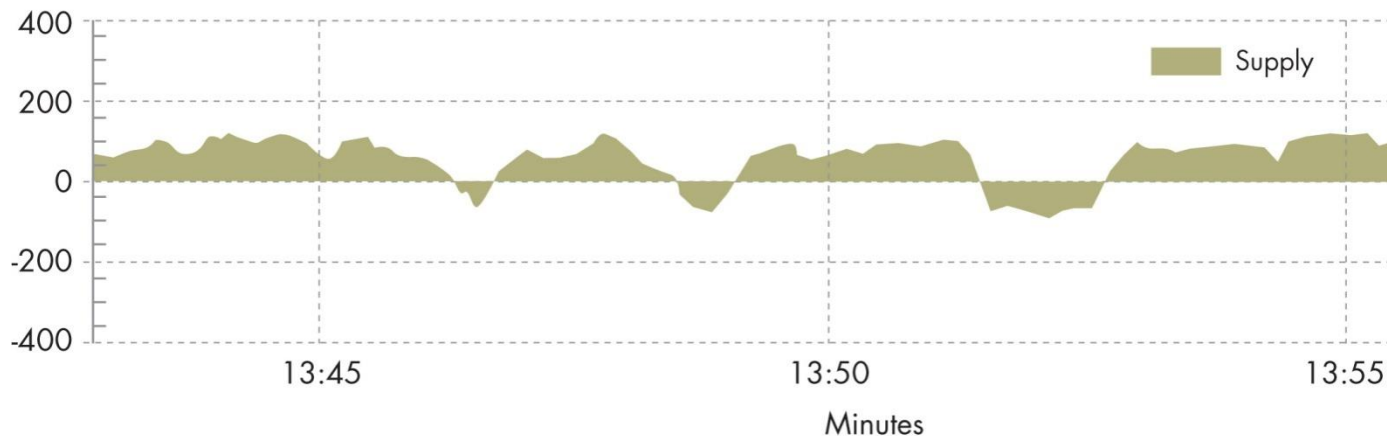
Balancing Inputs

Many factors influence balancing supply and demand.



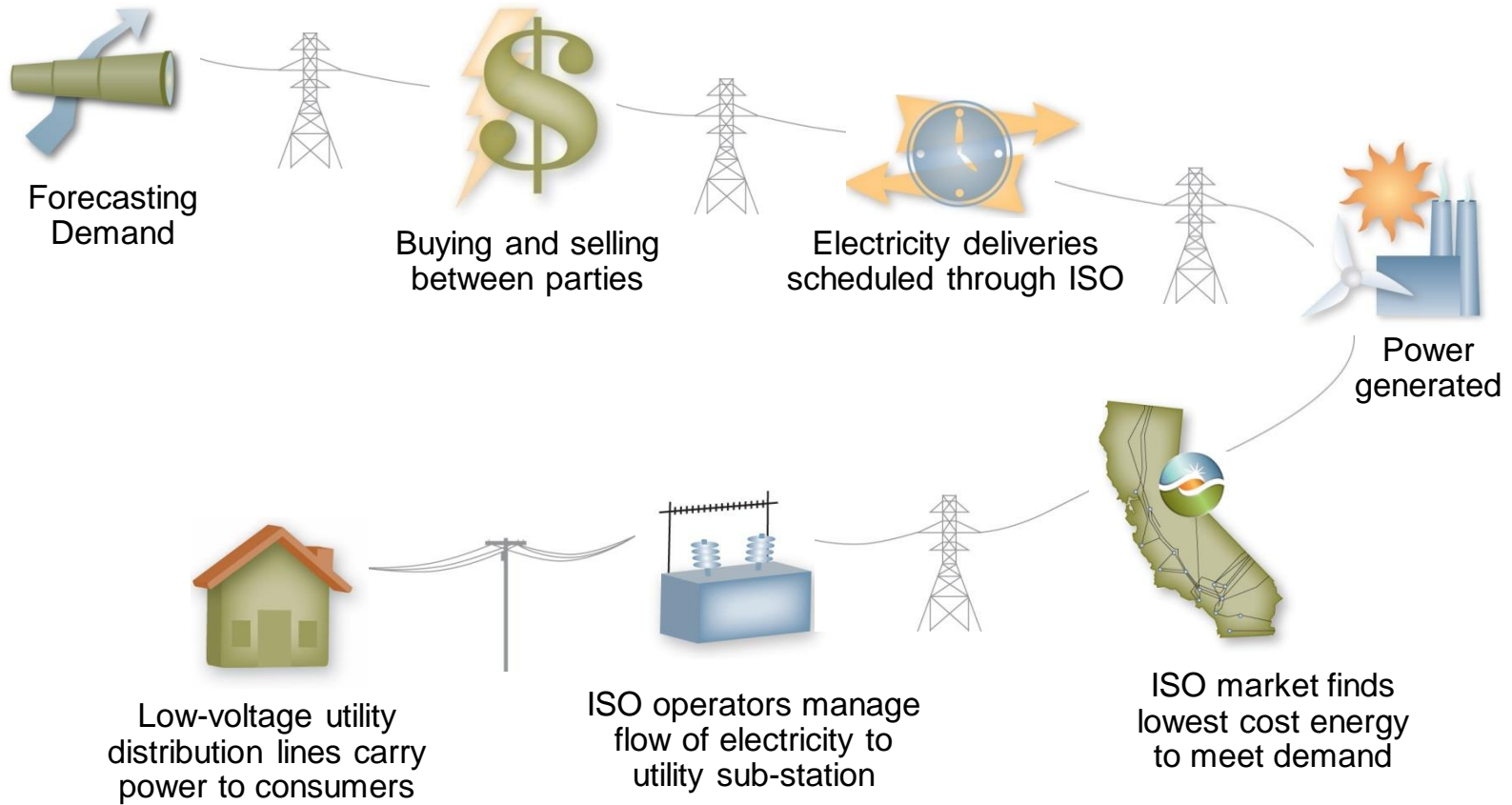
Tight margin for error

For a power grid that can draw 50,000 megawatts of electricity



Electricity supply must be matched within a narrow bandwidth 120 megawatts above or below power demand.

The flow of electricity



ISO Market

Analyzes the grid a day in advance to better manage or avoid real-time bottlenecks.

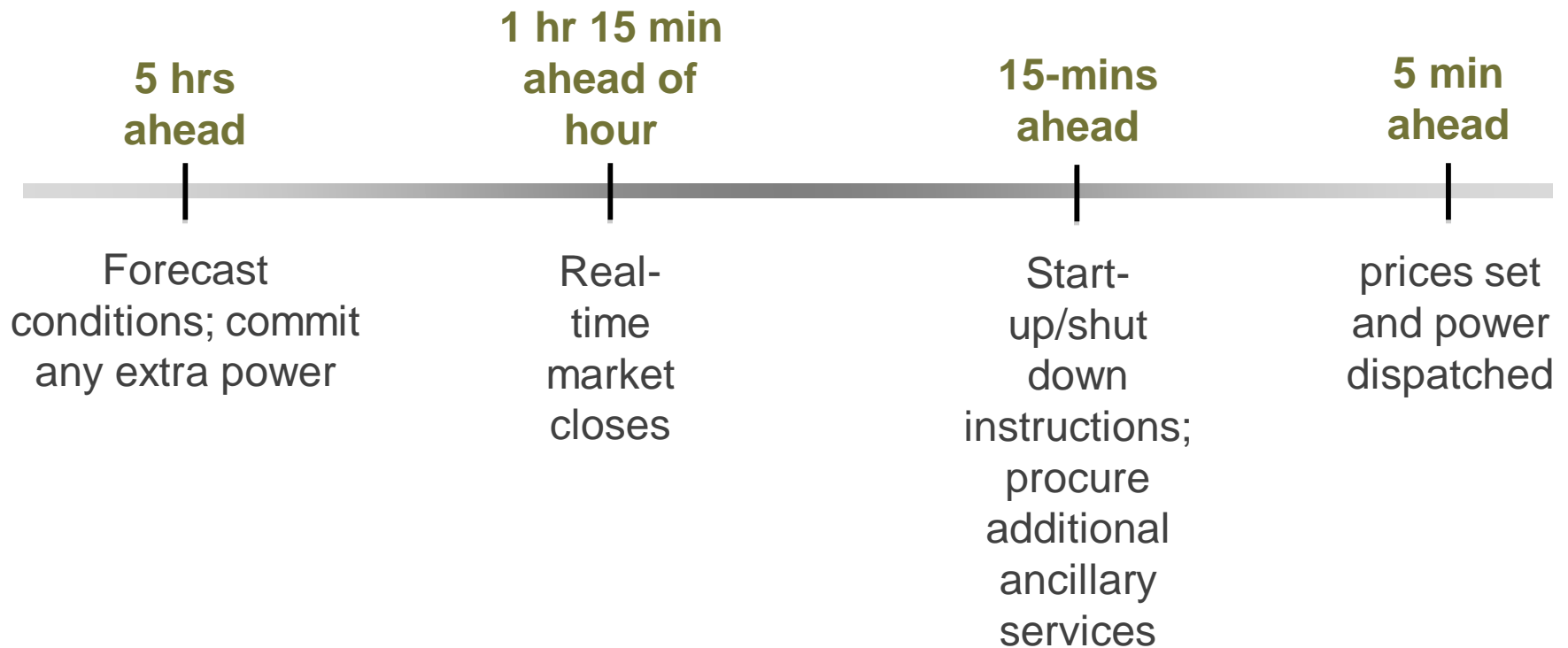
Provides a “one-stop shop” for trading bids, transmission capacity and operating reserves.

Creates cost transparency through locational marginal pricing that prices electricity based on the cost of generating and delivering it.



Real-Time Market

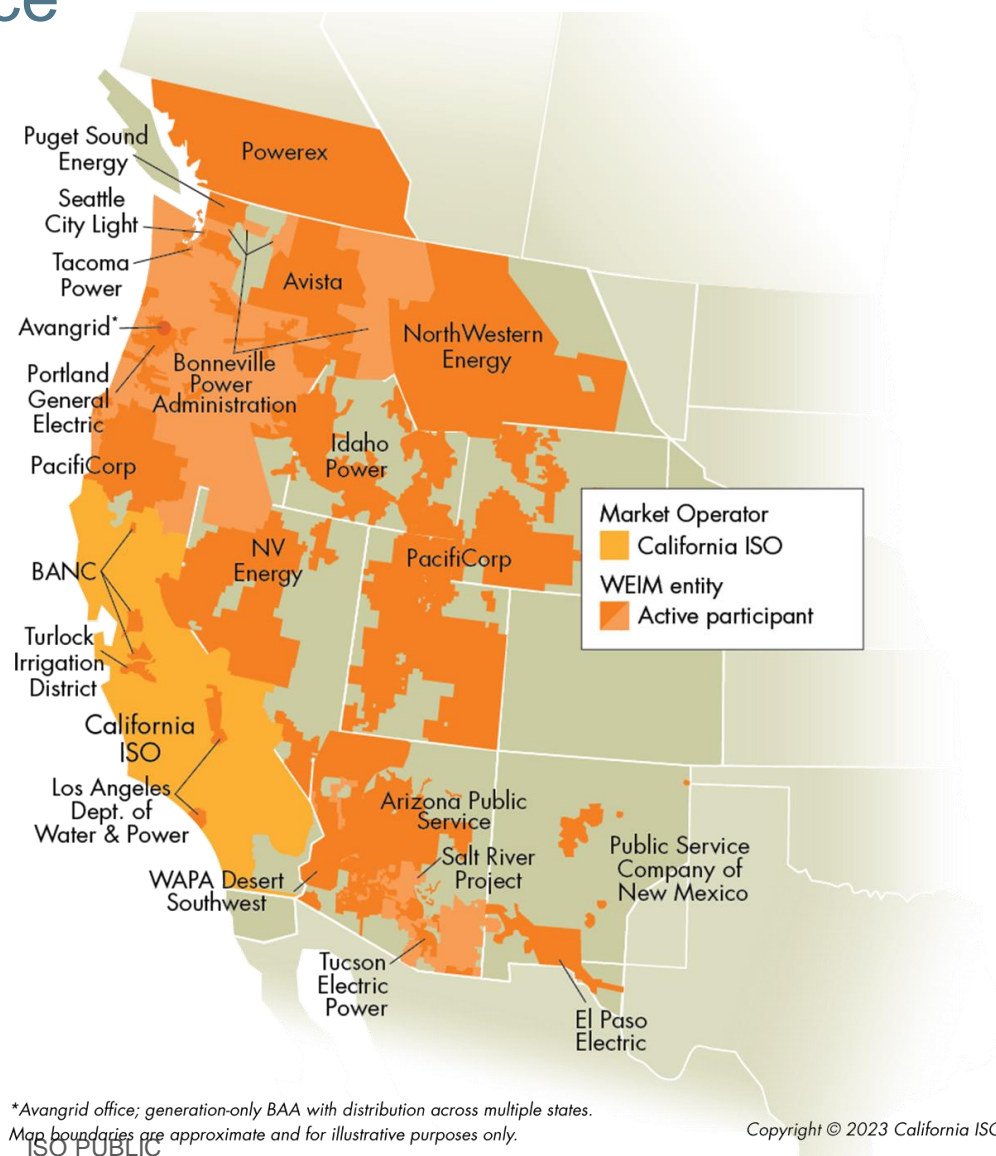
Fine-tunes flow of electricity to follow fluctuations in supply and demand.



Western Energy Imbalance Market (WEIM)

Since its launch in 2014, the WEIM has enhanced grid reliability, generated billions of dollars in benefits for participants, and improved the integration of renewable energy resources.

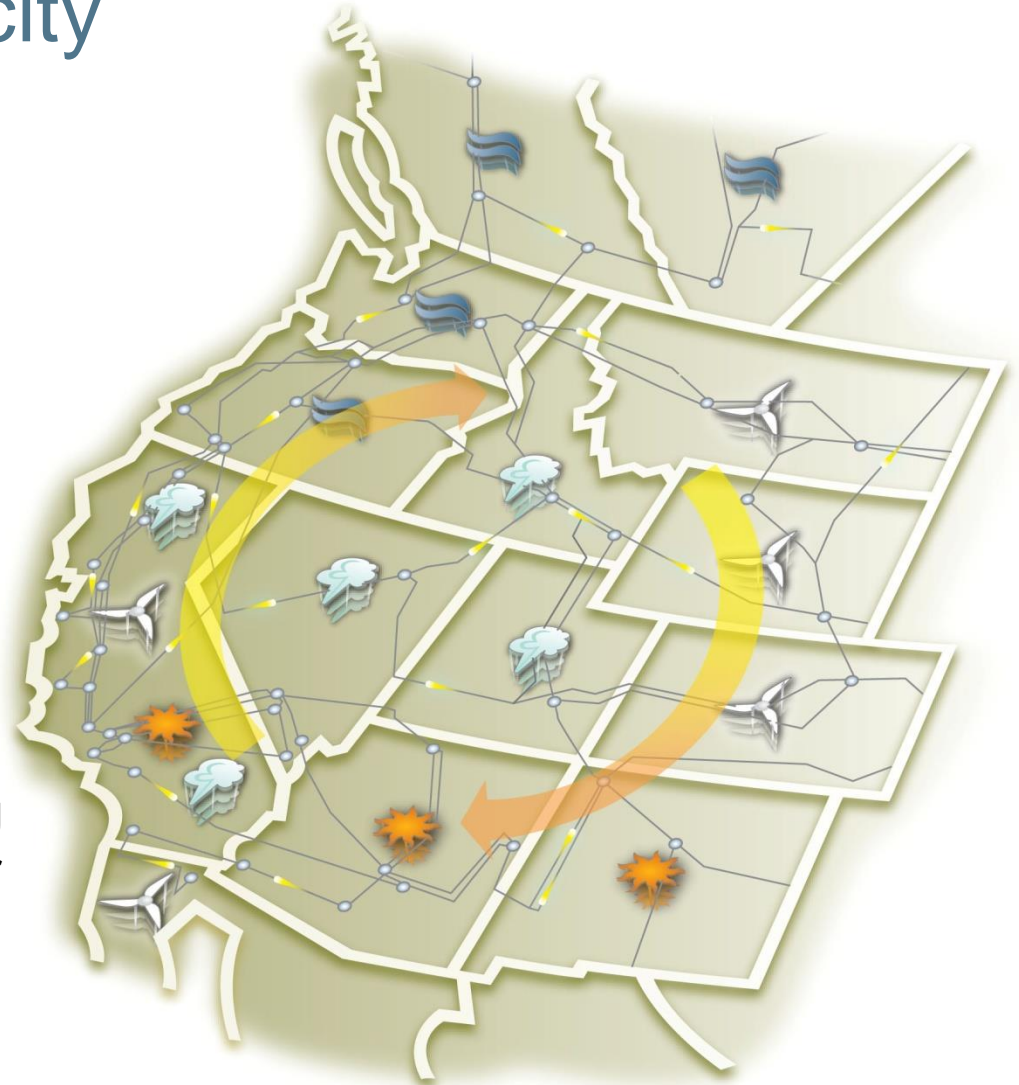
- 22 participating entities
- Gross benefits exceeds \$3 billion
- Reduced about 800,000 metric tons of CO₂



Resource reciprocity

Welcome to the Western Grid

- CA is one of 14 states within **Western Electricity Coordinating Council**
- Resource sharing enhances reliability, helps achieve renewable targets and manages cost
- A quarter of all the electricity that keeps the lights on during the summer comes from other areas of the West including parts of Canada and Mexico



Natural gas



Modern natural gas generators are quick starting and can fluctuate output levels rapidly in response to changes in demand.

These plants are especially helpful in meeting the steep upward ramp in demand that occurs when the sun sets and solar production declines.



Solar



By 2030, utility-scale solar power plants will supply an estimated 21,000 MW each day to the ISO electric grid.

Rooftop solar is not connected to the high-voltage transmission system, but they affect the ISO's markets and grid operation. Rooftop solar is expected to produce up to 16,000 MW by 2030.

Grid operators must find other resources in the late afternoon to meet demand when solar production drops and energy demand begins to rise.



Large hydro



Although hydroelectric energy generation is weather dependent, it is a valued, clean resource that can be ramped up or down to offset fluctuations in other renewable power sources, like wind and solar.

Nuclear



California's one nuclear power plant, Diablo Canyon provides 10 percent of the energy needed to serve customers. Owned by PG&E, the plant is slated for closure by 2025.

Wind



Wind is fast becoming one of the West's most dynamic renewable resources, with brisk industry growth, and future development of offshore wind farms. While wind conditions can be highly variable, generators typically take advantage of night winds.

Recent ground-breaking tests conducted by the ISO show that wind resources can supply ancillary and reliability services to the grid, which can lead to increased wind resources in the future.



Storage

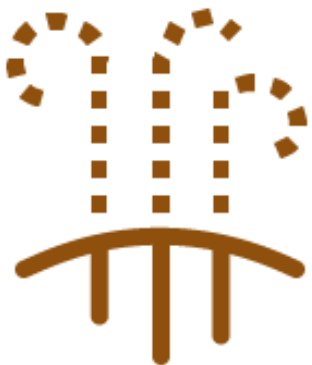


The energy storage industry is developing short- and long-duration storage options to serve both distribution and transmission systems.

Short duration battery resources in the ISO are helpful when renewable energy production declines, while longer-duration storage can help with seasonal and longer term weather changes.



Geothermal



Geothermal energy amounts to about 5 percent of the total power resources in California. The Geysers in Northern California is the largest producing geothermal field in the world, generating 628,000 MW in 2018.

Because geothermal power plants use hot water from deep underground to create steam that runs turbines, their emissions are very low, producing less than 1 percent of the CO₂ emissions when compared to fossil-fuel plants.



Small hydro



Small hydro plants that provide 30 MW or less of energy are considered renewable resources in California. This is in part because these plants have less impact on the environment and natural habitats.

Biofuel



Bio fuel is energy generated using agricultural residue, manure-generated methane, gas captured from landfills, and the organic fraction of trash that is burned or broken down by decay.

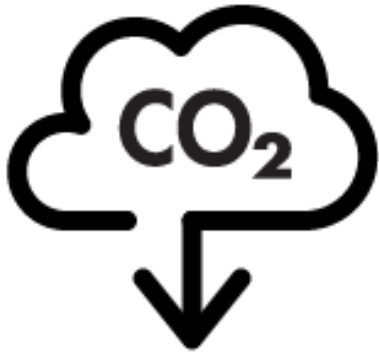
Renewable Portfolio Standard (RPS) goals

California requires all utilities to purchase energy that meets the state's aggressive renewable energy goal mandate.



- In 2030, the state's RPS requires 60 percent of the energy provided by utilities to be from a qualified renewable source
- By 2045, 100 percent of all energy provided to consumers must be from zero carbon resources

Emissions



The ISO supports the integration of low and zero carbon energy resources, like wind, geothermal, hydro, storage and solar to meet California greenhouse gas emission policies.

40%

Below 1990
levels by 2030

80%

Below 1990
levels by 2050

Lowering emissions is now a regional effort, because many neighboring states also have similar mandates.

Managing power



As more renewable energy is integrated on the electric system, often during the middle of the day, these resources produce more power than needed.

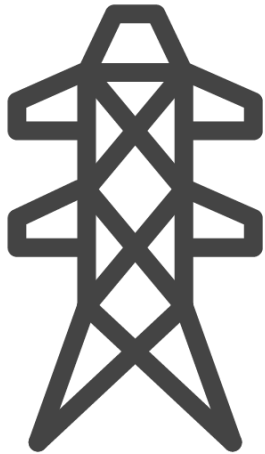
To avoid curtailing these resources, excess renewable energy can be stored for use later.

The ISO has adopted new policies to accommodate distributed energy projects, such as battery storage.



Transmission planning

The ISO collaborates with stakeholders in an annual process to create a long-term transmission plan. Engineers design and analyze complex models and simulations to identify grid expansion needs to:

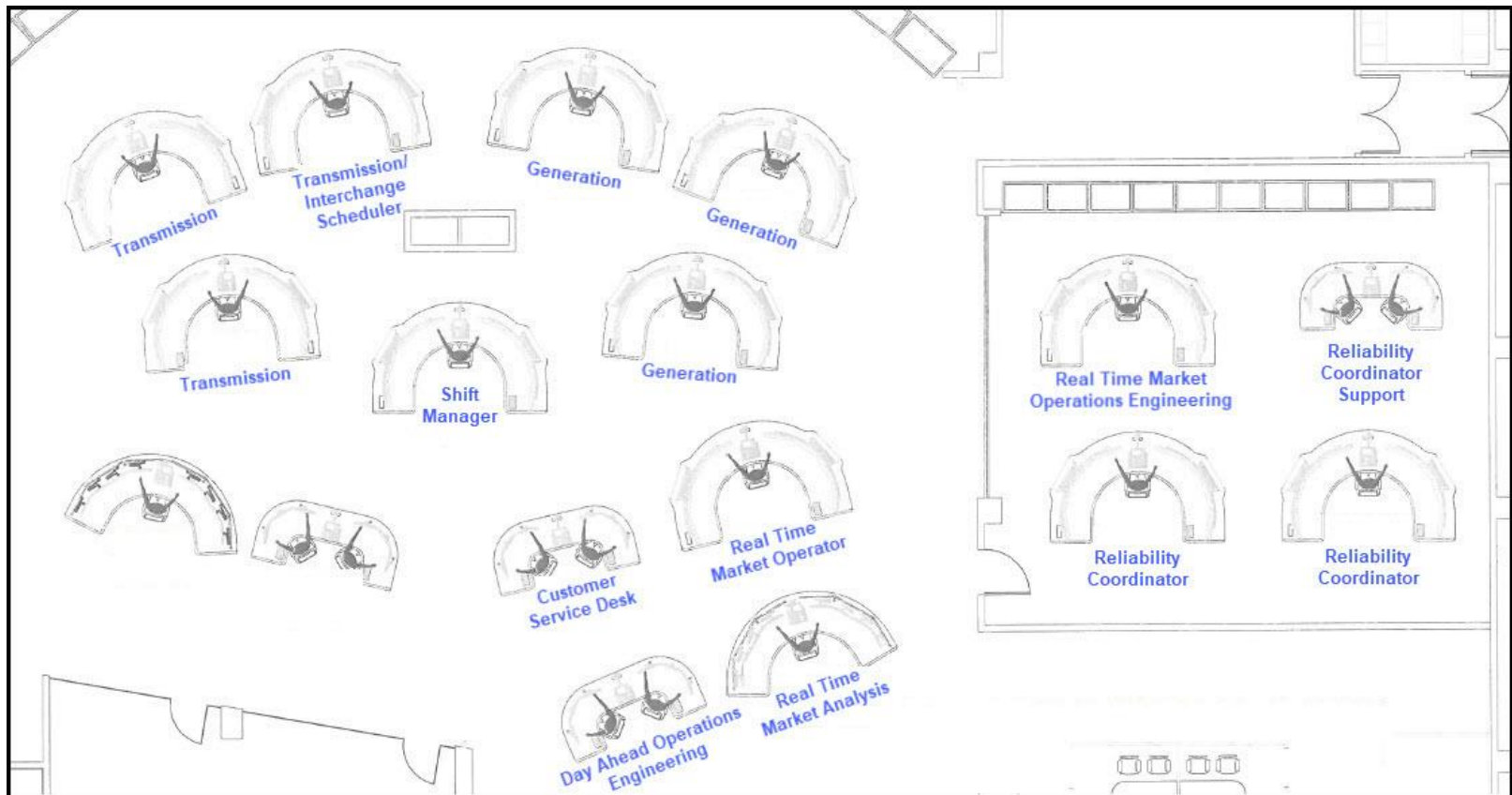


- Address reliability such as load growth
- Support public policy such as state energy and environmental goals
- Reduce costs through economic upgrades

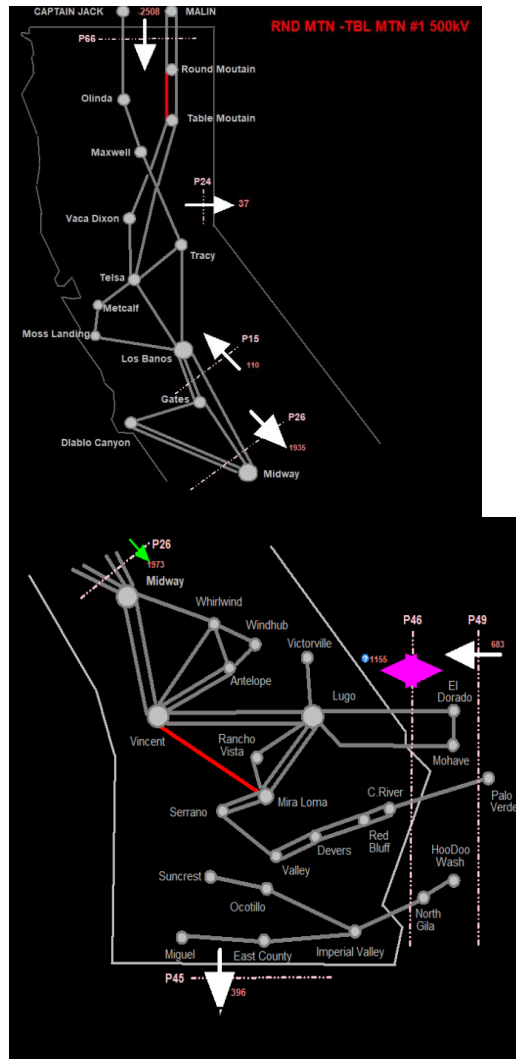
California ISO Control Room



Control Room Staff and Systems



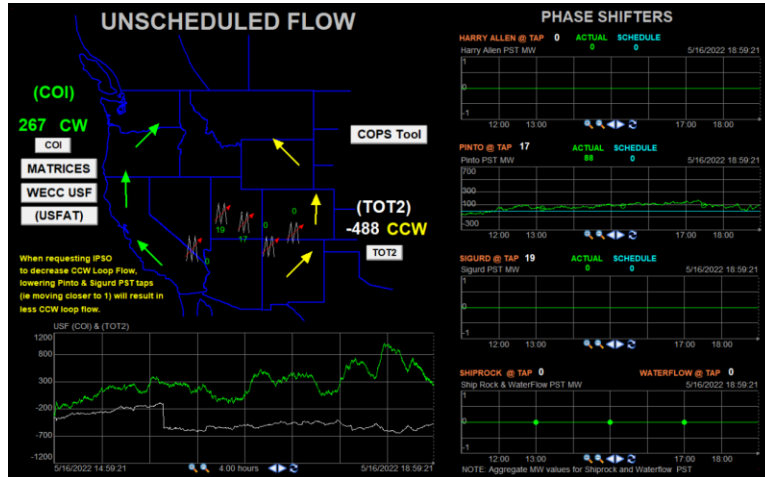
Control Room Staff and Systems



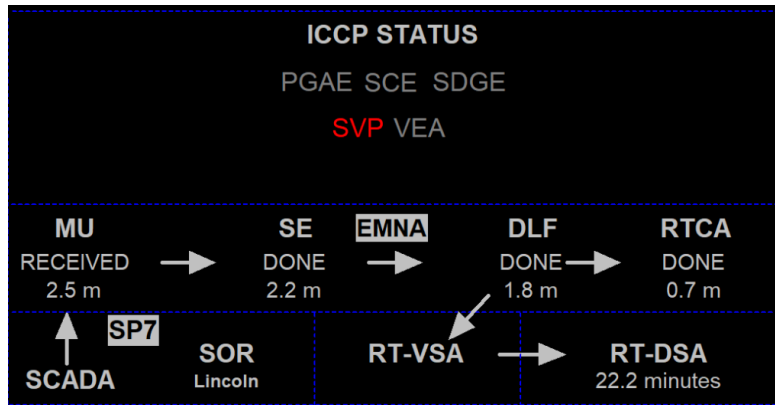
Transmission Reliability Displays

- Displays 500 kV substations and circuits
- COI (CA Oregon Intertie)
- Pacific DC Intertie

Control Room Staff and Systems



- Unscheduled Flow
- Intercontrol Center Communication Protocol (ICCP) Status
- Combined ACE of other BAs



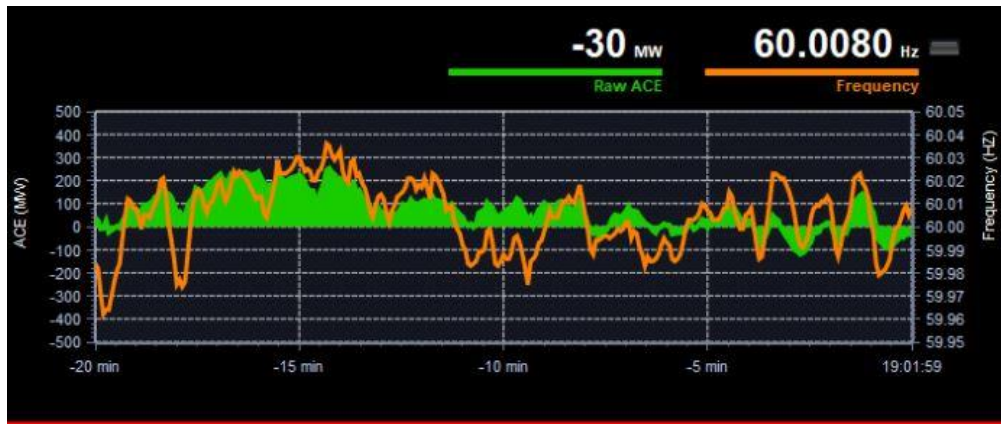
Pacific Northwest	California	Rocky Mountain	Desert Southwest
-55	420	121	124

Control Room Staff and Systems



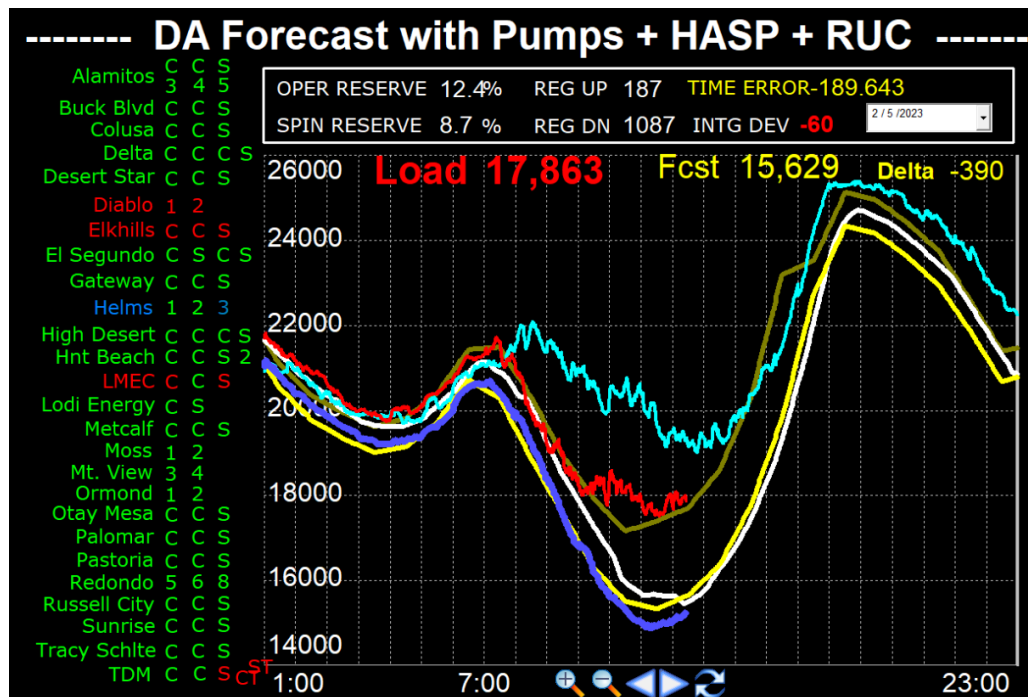
- Real Time Contingency Analysis (RTCA)
- Over 8000 contingencies studied every 5 minutes

Control Room Staff and Systems



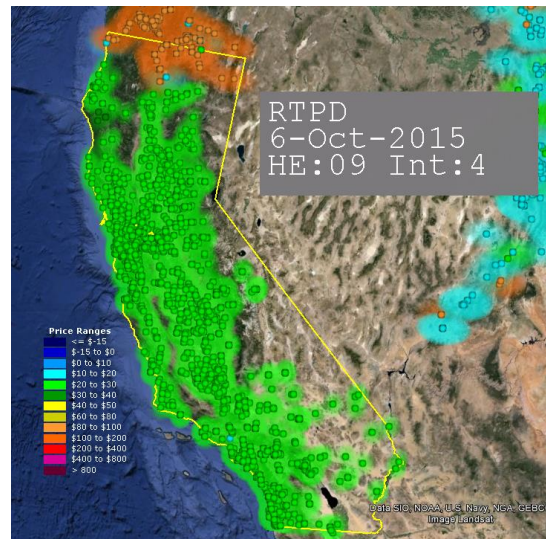
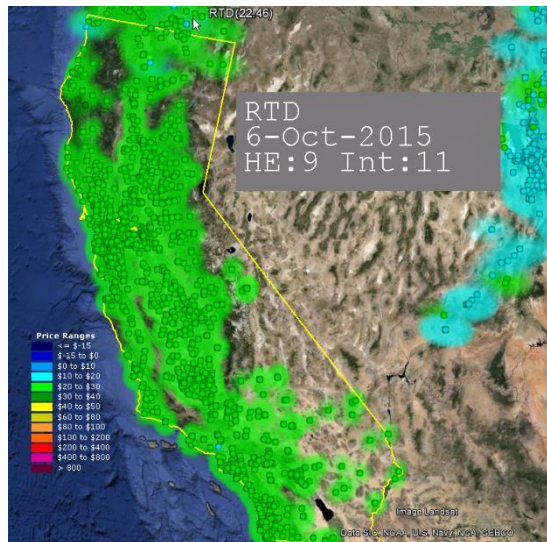
- Area Control Error (ACE)
- Operators keep a close eye on this display
- Frequency (orange) is how we gauge how well we are doing

Control Room Staff and Systems



- Multiple data points displayed
- Actual Demand (Red)
- Demand – battery and pumps (Purple)
- Day-Ahead forecast (Yellow)
- Real Time Forecast (White)
- Similar Day (Blue)

Control Room Staff and Systems



- Uses heat coloring
- Prices at over 10,000 nodes
- Ticker-Tape pricing scrolls non-stop with average LMP

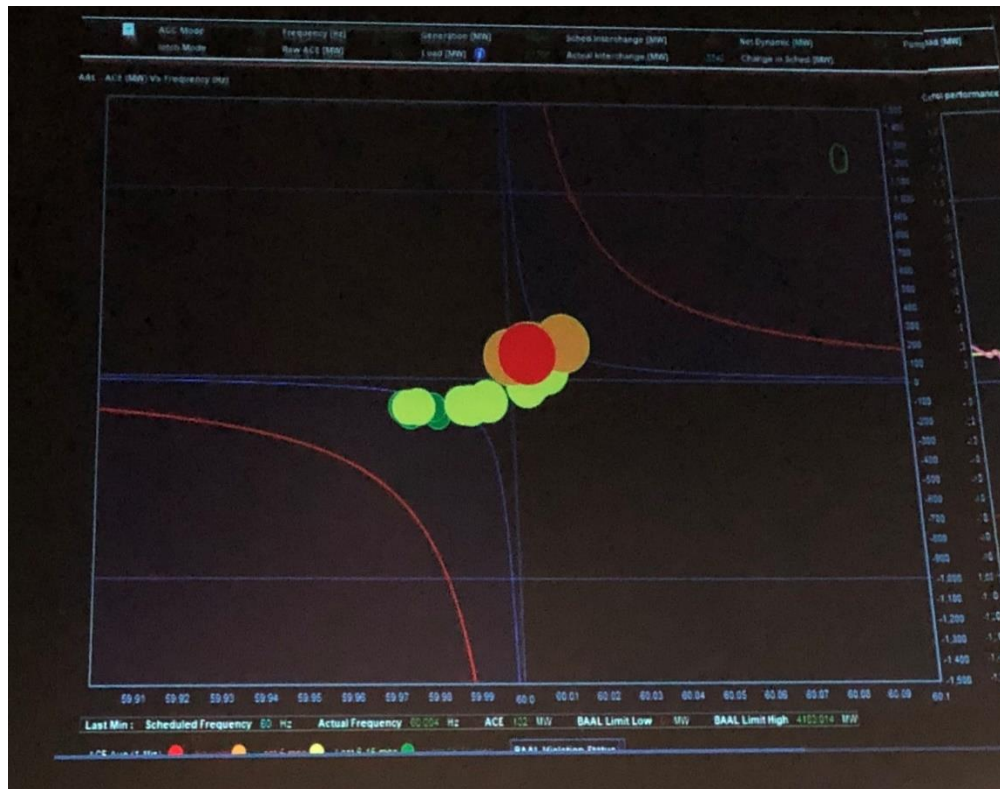
TH_SP15_GEN=\$24 TH_NP15_GEN=\$24 DLAP_SDGE=\$24 DLAP_

Control Room Staff and Systems



- Renewable generation
- NGR Generation and State of Charge (SOC)
- Regulation (Up and Down)
- Reserves (Operating and Spinning)
- Energy Transfer System Resource (ETSR)

Control Room Staff and Systems



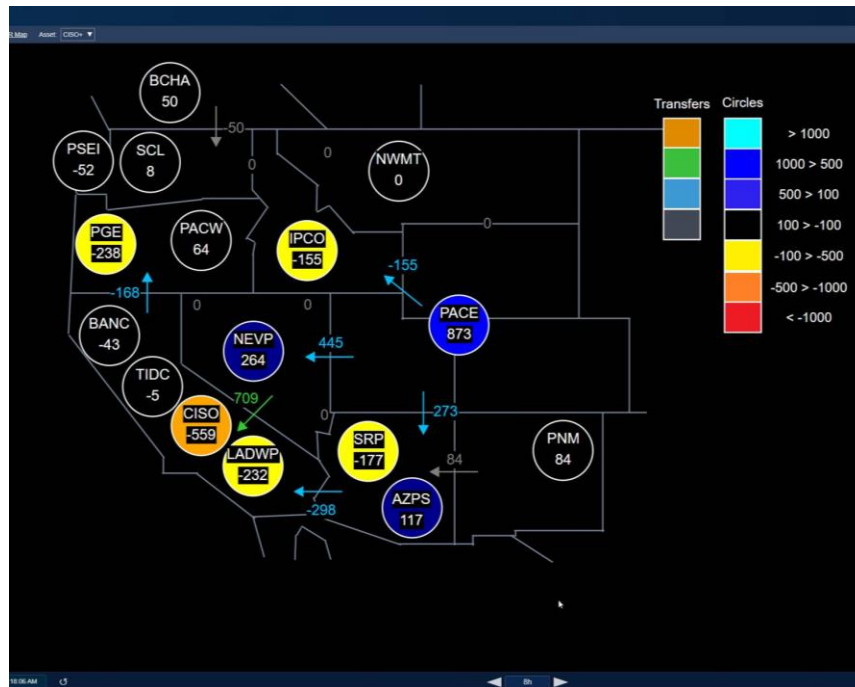
- Balancing Authority Ace Limit (BAAL)
- Reliability Based Control (RBC)
 - Interconnection frequency
- Frequency v ACE ratio

Control Room Staff and Systems



- Weather and Fire Displays
 - Precipitation
 - Cloud Cover
 - Wildfires

Control Room Staff and Systems



- Western Energy Imbalance Market
 - Direction of Energy Flow
 - Color coded for Price