Commission on Energy Choice

Regional and National Marketplace Presentation

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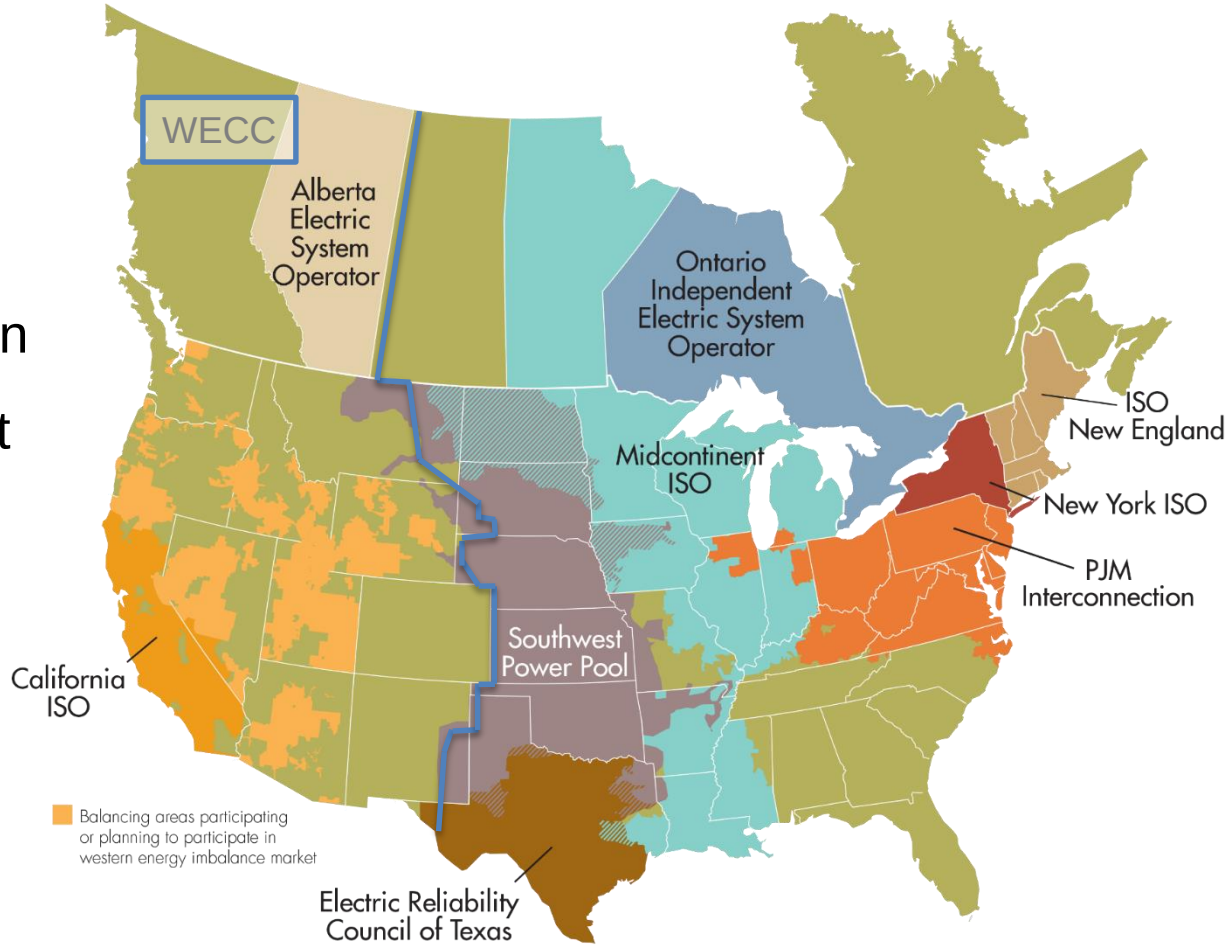
Overview of Independent System Operators (also called Regional Transmission Organizations)

- Coordinates, controls and monitors the operation of the electrical power system
- Independent from business interests in sales or purchases of electric power
- Exclusive responsibility for grid operations, short-term reliability, and transmission service within a region
- Marketplace for wholesale power

There are nine independent/regional transmission operators (ISOs/RTOs) in North America

California ISO

- One of 38 balancing authorities in the western interconnection
- Nonprofit public benefit corporation, serving over 30 million consumers
- Serves 80% of California and small portion of Nevada



Organized Markets of North America

Member	HQs	Installed Capacity	Miles Lines	Population
Alberta ESO, AESO	Calgary, AB	14,568 MW	16,155	3.7 M
California ISO, CAISO	Folsom, CA	71,740 MW	26,000	30 M
Electric Reliability Council of Texas, ERCOT	Austin, TX	84,000 MW	40,530	23 M
Independent ESO, IESO	Toronto, ON	35,858 MW	18,641	13.7 M
ISO New England, ISONE	Holyoke, MA	30,500 MW	9,000	14.7 M
Midcontinent ISO, MISO	Carmel, IN	190,539 MW	65,800	48 M
New York ISO, NYISO	Rensselaer, NY	37,978 MW	11,056	19.5 M
PJM Interconnection, PJM	Valley Forge, PA	176,569 MW	82,546	65 M
Southwest Power Pool, SPP	Little Rock, AR	83,465 MW	60,944	18 M
Total		**725,217 MW**	**330,672**	**236 M**

Who oversees us?

We are governed by a Governor appointed/ Senate confirmed **Five Member Board**

We are regulated by
FERC Federal Energy Regulatory Commission

We are compliant with
NERC North American Electric Reliability Corporation

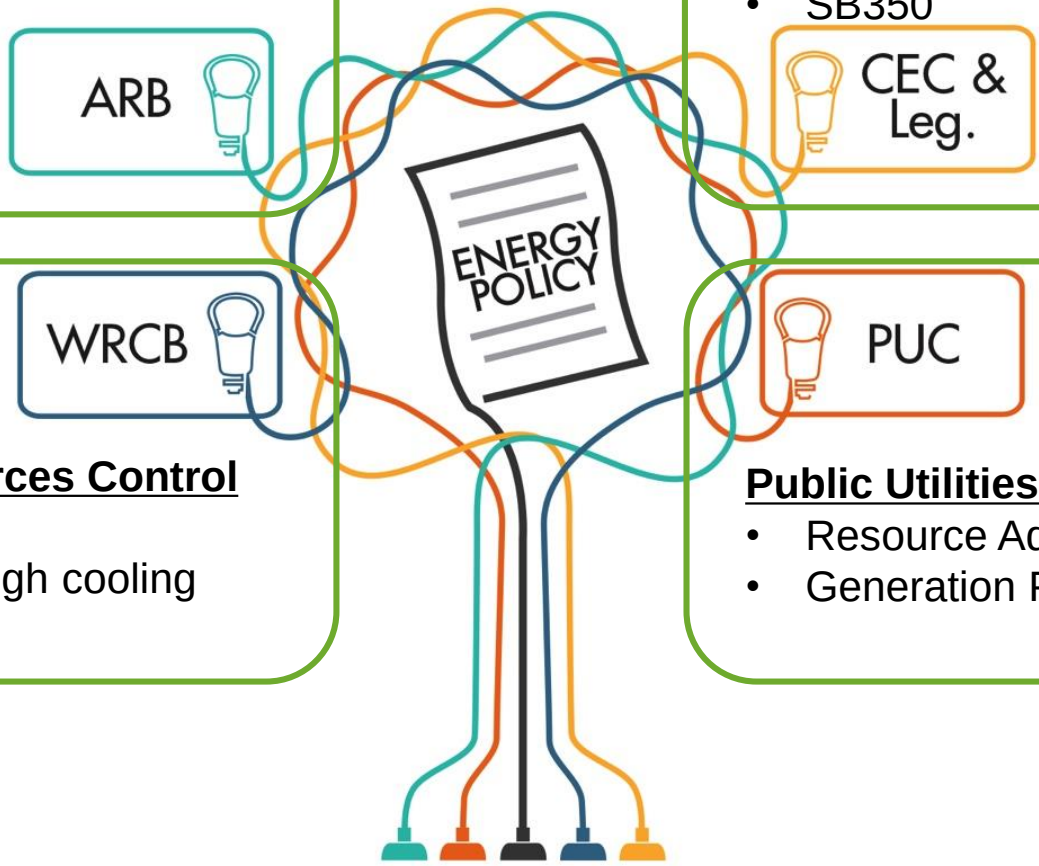
We are part of
WECC Western Electricity Coordinating Council

Department of Market Monitoring – analyzes market performance to identify potential anti-competitive market behavior or market inefficiencies

ISO continually coordinates with state agencies

Air Resources Board
- Greenhouse gas regulations

Legislature and Energy Commission
Renewable Portfolio Standard
- SB350



Water Resources Control Board
- Once-through cooling

Public Utilities Commission
- Resource Adequacy
- Generation Procurement

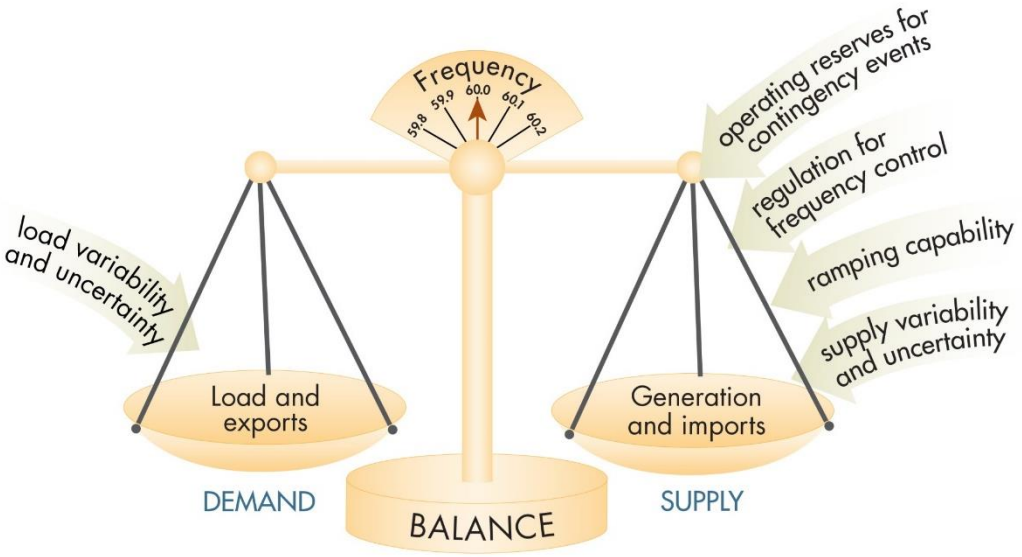
The primary function of an ISO is to ensure that the grid is operating reliably and efficiently

- **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

To keep the system reliable, an ISO must match supply and demand instantaneously all day every day.

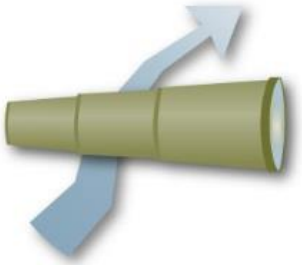
Independent grid operators take a pulse of the grid every few seconds before automatic dispatch systems adjust flows to follow fluctuating conditions such as weather changes and sudden supply shortfalls or surpluses.

- Account for outages
- Coordinating supplies and transmission capability
- Secure the power system from harm
- Modeling that improves visibility into full system



Advanced technology allows an ISO to optimize all available resources to meet system needs.

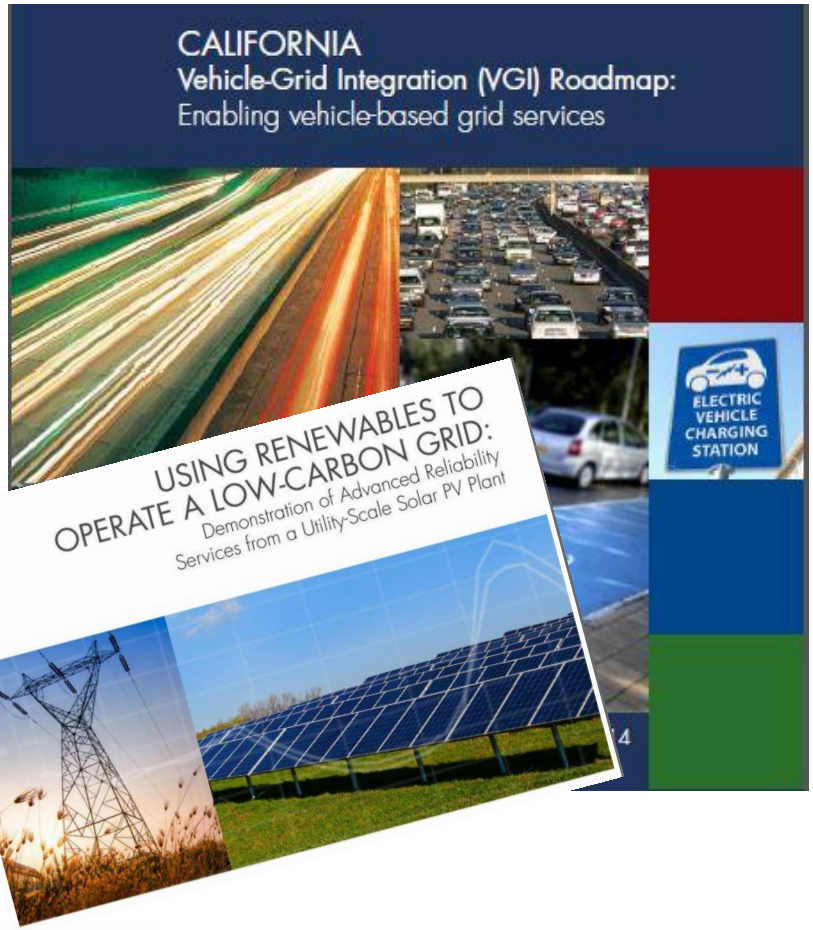
- Regional coordination and finely tuned dispatches are important as energy supply becomes more diverse
- The grid is optimized through advanced software that considers a multitude of factors including bids, transmission and resource constraints, and system conditions.



- Forecasting tools are essential to the market optimization and reliability, drives basic reliability and dispatch operation functions

ISOs use innovative solutions to support state and regional goals while capturing the benefits of technology and geographic diversity

- Increasing energy storage, energy efficiency and demand response allows consumers to reduce use when the grid is low on supply
- Offering time-of-use rates that better match energy production
- Integrating electric vehicles and encouraging owners to charge when supply is high
- Improving flexibility of power plants.



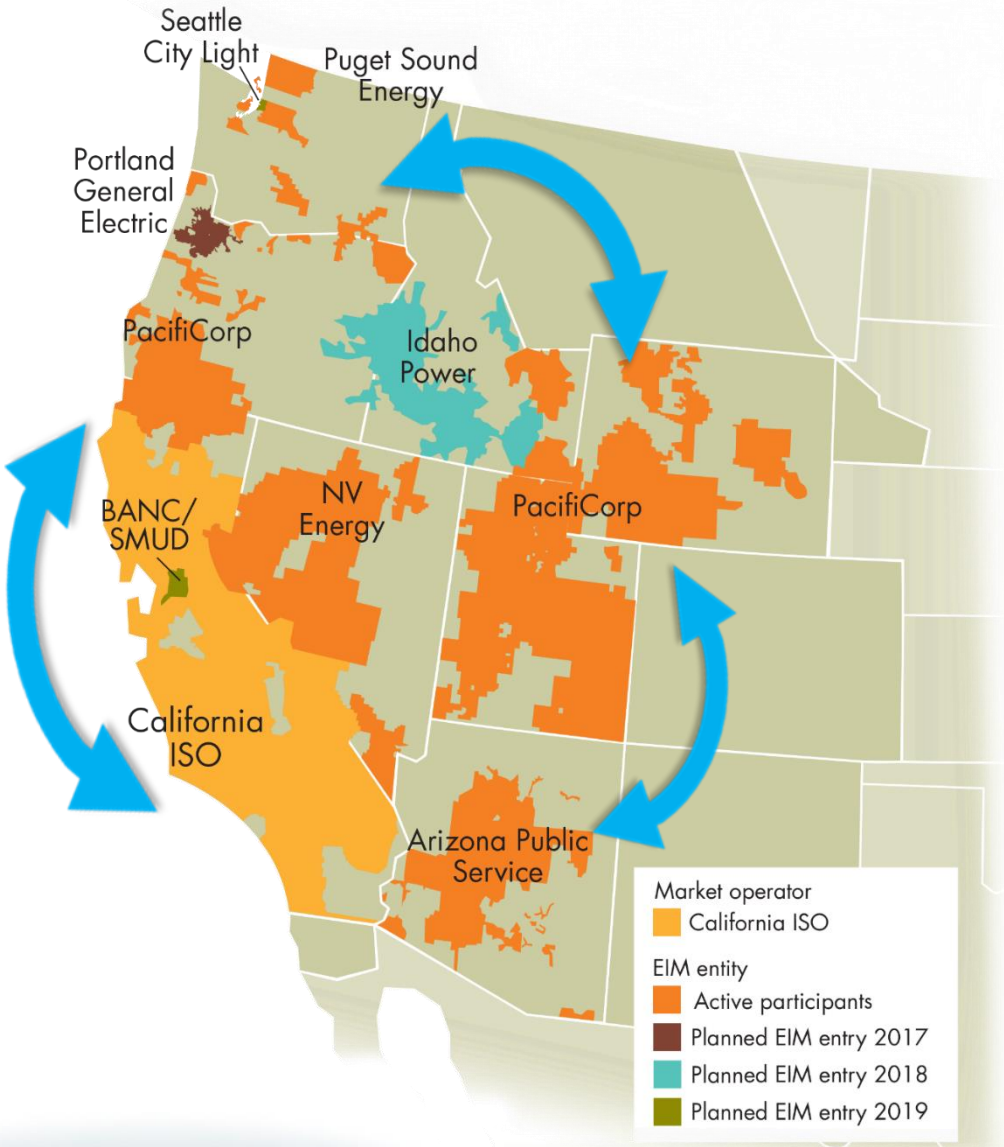
Responsibilities of a vertical integrated utility shift when joining an ISO

ISO	Utility
• Balancing Authority Area responsibilities	• Resource planning & procurement
• Transmission level generation interconnections	• Generation Operation
• Generation Dispatch	• Distribution level generation interconnections
• Transmission Planning	• Distribution planning & service to customers
• Transmission access service	• Load interconnection
	• Load metering

Shared: Transmission Operation

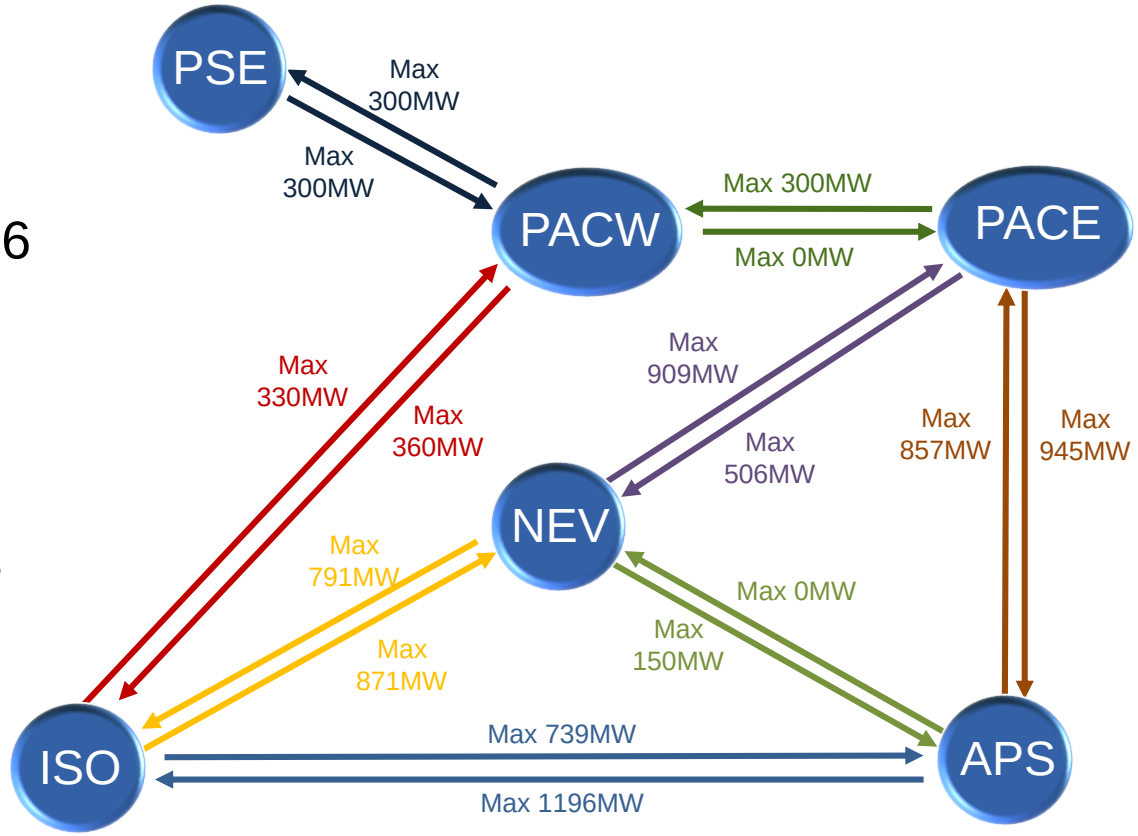
The evolution of the grid includes the western energy imbalance market (EIM)

- 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
- Integration of renewables across a larger geographical area through economic dispatch
- Enhances reliability with more visibility into larger system



Western EIM energy transfer capability is strong between western entities

- Gross benefits to participants measure over $142 through 2016
- Reduced renewable energy curtailment
- Displaced greenhouse gas emitting resources
- Reduced flexible ramping requirements across footprint

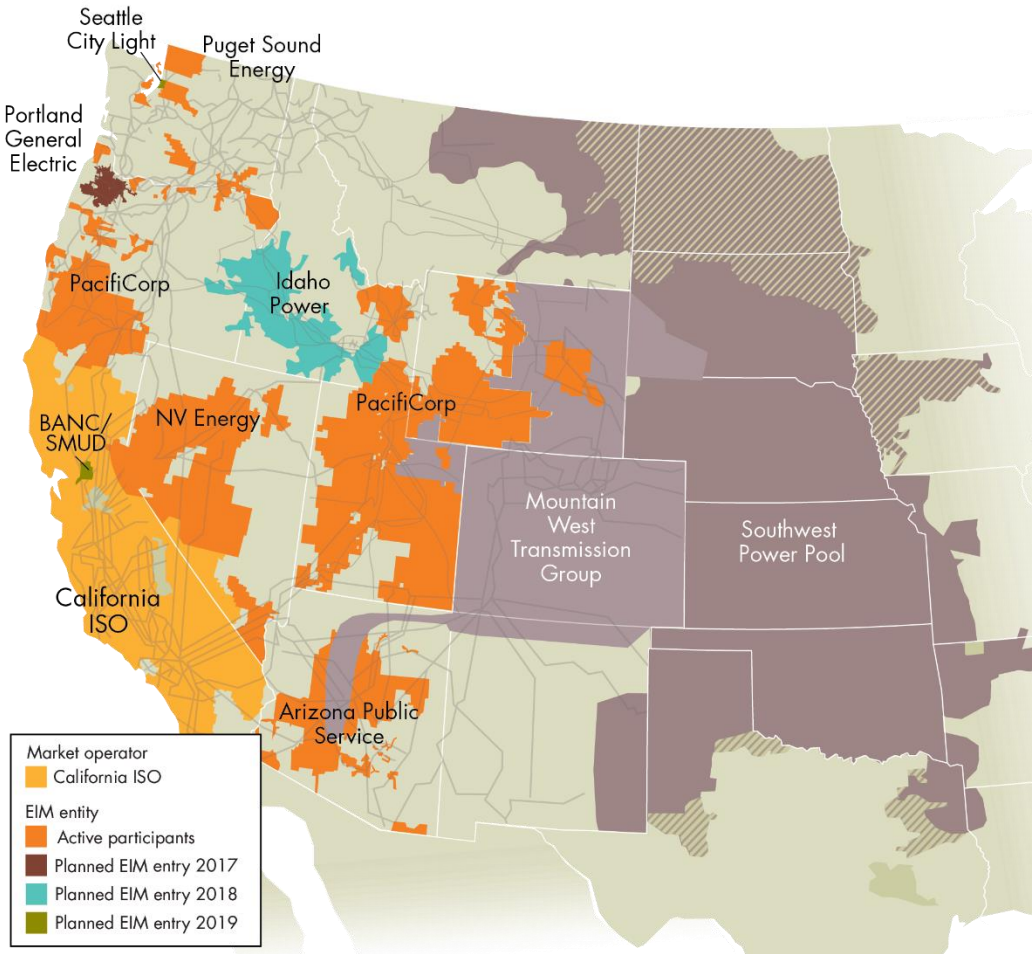


Regional markets require collaboration and engagement from a broad set of stakeholders

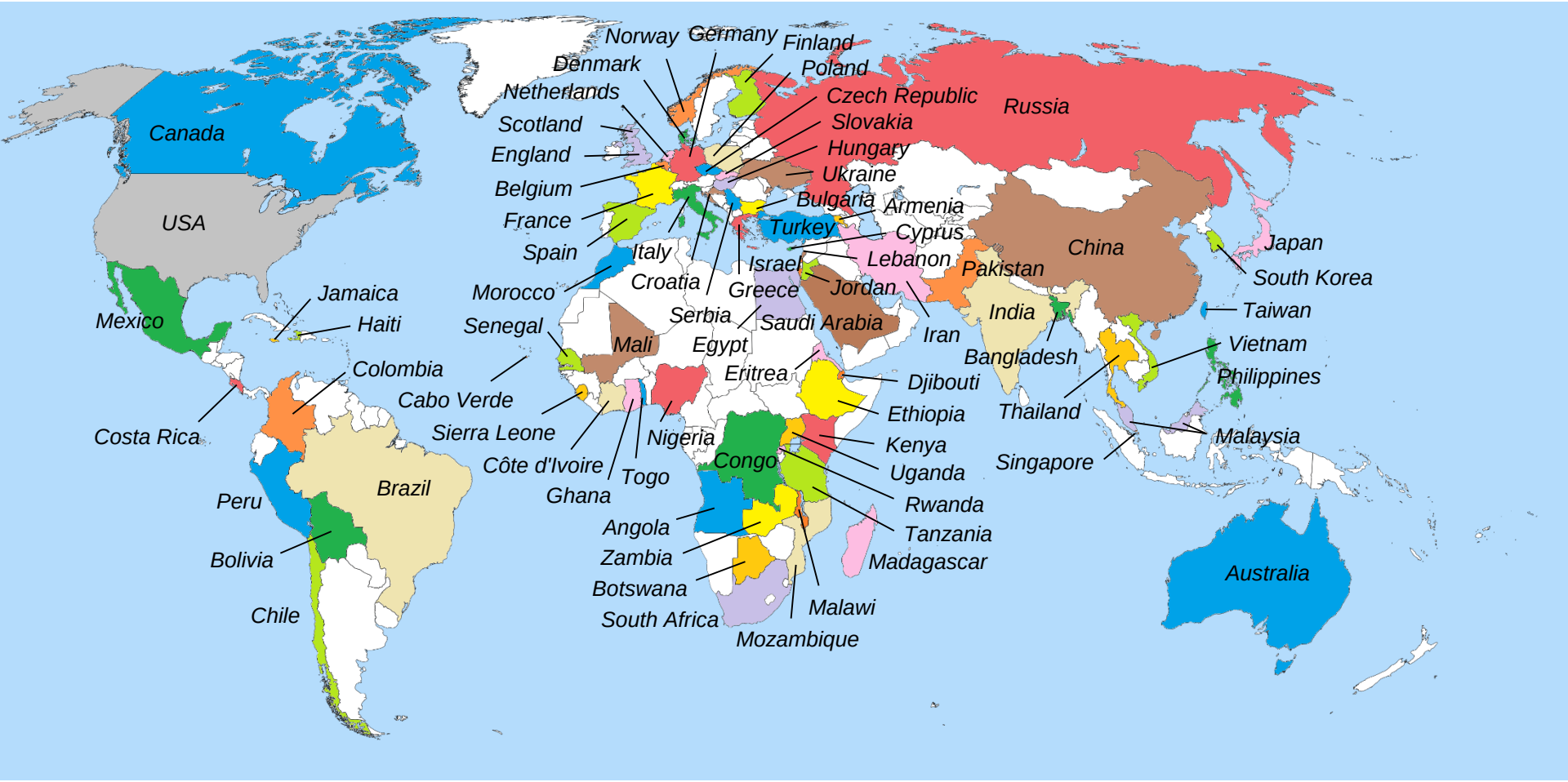
Market integration would also require:

- California statute change to amend governance
- Approval by state regulatory bodies and FERC
- Combine Balancing Authority Areas and NERC certification

Mountain West Transmission Group is exploring opportunities to join ISO (negotiating with SPP)



In 2016, representatives from 77 countries came to the ISO to discuss renewable integration and grid modernization



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Note:

CPUC and CEC Meeting on Customer Choice in Electricity in California

Friday, May 19, 2017 8:45 AM - 5:00 PM

Byron Sher Auditorium, CalEPA Building, 1001 I St., Sacramento

Also available via webcast at https://video.calepa.ca.gov/