The Energy Market Landscape in CA and Neighboring Areas: How its Affecting the Cement Industry

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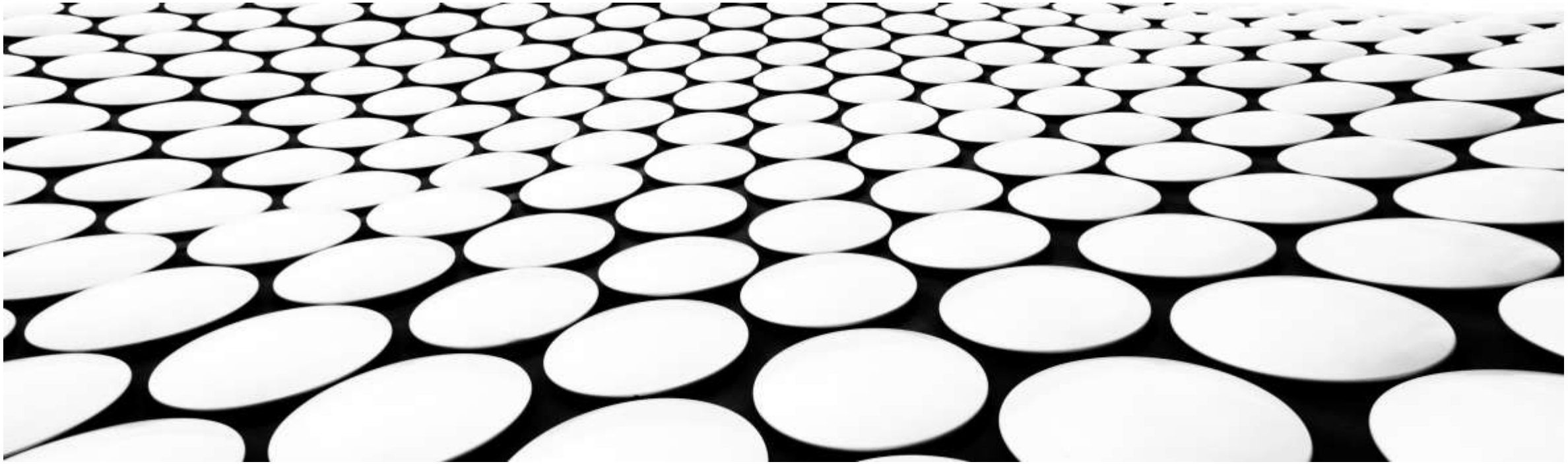


DIRECTOR OF ENERGY AND SUSTAINABILITY

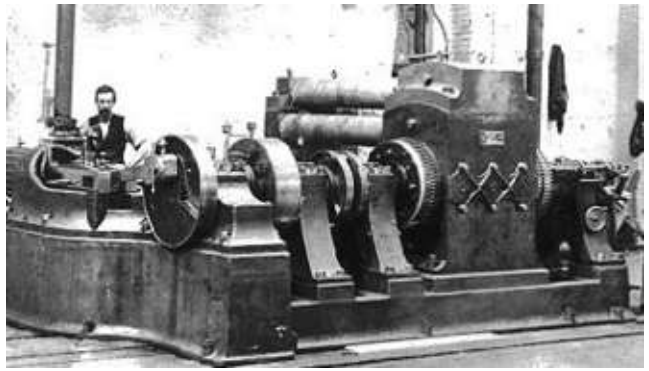
History

- 32 Years with CalPortland
- BS Nuclear Engineering University of Arizona
- US Navy nuclear power veteran

William Jerald

PAYING FOR ELECTRICAL CONSUMPTION 1880'S

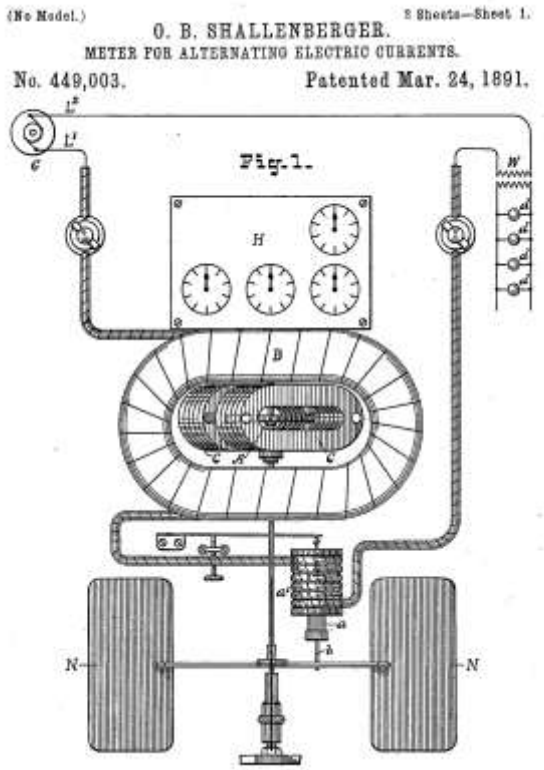
- Thomas Edison, Pearl Street Power Station
- Central Power station
- Billed on a per connected unit
- September 4th, 1882, 6 100KW dynamos powered by coal
- 82 customers with 400 lamps
- By 1884, 508 customers with 10,164 lamps



METERING THE ELECTRICAL CONSUMPTION

- Otto Blathy- (1889) , patent on the first AC kilowatt-hour meter
- Oliver Shallenberger- (1891) Created the Westinghouse “induction disk” watt hour meter

Otto Blathy



Oliver Shallenberger

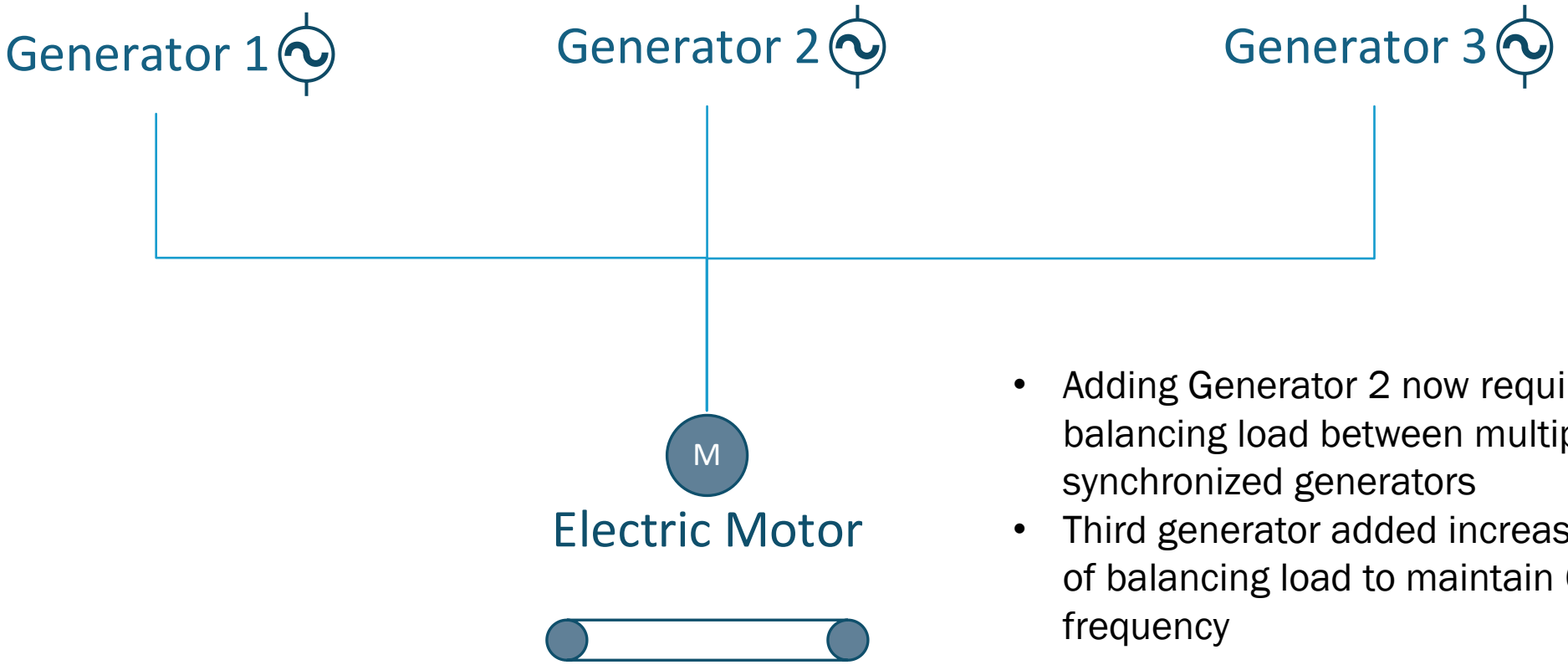
SUBMARINE POWER PLANT PANELS

- Steam Panel
- Reactor Plant Panel
- Electric Plant Panel
- Steam Generator, Diesel Generator, Battery supplies Motor Generators
- Generators follow electrical load with speed regulation to maintain 60hz frequency with operator monitor and action

LOAD CHANGING AND GENERATOR FOLLOWING

- System frequency is 60hz
- Empty conveyor at beginning with generator supplying
- Loader fills hopper, electric motor has higher load, more amps to generator
- Generator frequency drops from extra amperage, generator regulator throttles up to recover frequency (i.e. diesel throttle adds fuel)
- Hopper empties, conveyor load drops,

MULTIPLE GENERATORS SUPPLYING LOAD

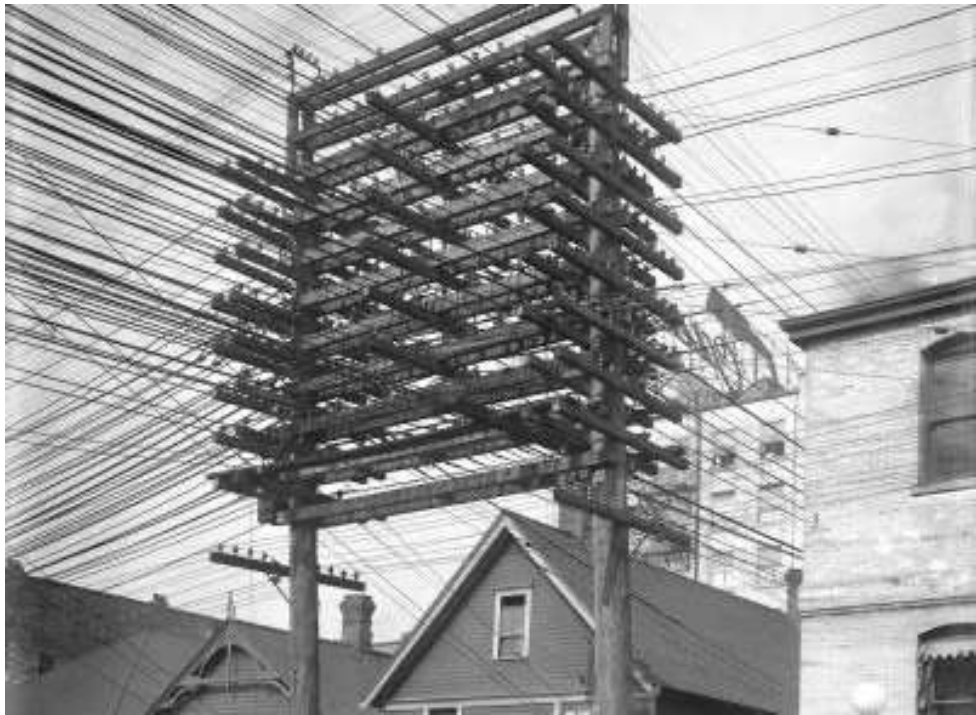


- Adding Generator 2 now requires balancing load between multiple synchronized generators
- Third generator added increase complexity of balancing load to maintain 60hz frequency

EXPANSION, REGULATION & PUBLIC UTILITIES 1920'S-1940'S

- The Public Utility Holding company Act (1935)
- Rural Electrification Act (1936) – Regulating private monopolies and funding coops
- Tennessee Valley Authority (1933)- public funding, hydroelectric dams, (now includes nuclear)
- By 1940's electricity billing was standardized as monthly metered statements

3.2
owing high-voltage transmission lines and related networks in 1933.



POST WAR MODERNIZATION AND EVENTUALLY DEREGULATION

- Two Part tariffs- fixed service fee plus kWh usage charge
- US is a mix of investor owned utility, public utility, and cooperatives
- Government subsidies for nuclear and hydroelectric plants in some regions
- Energy Policy act 1992- allows deregulation, competition (Texas and California are examples of deregulated regions)

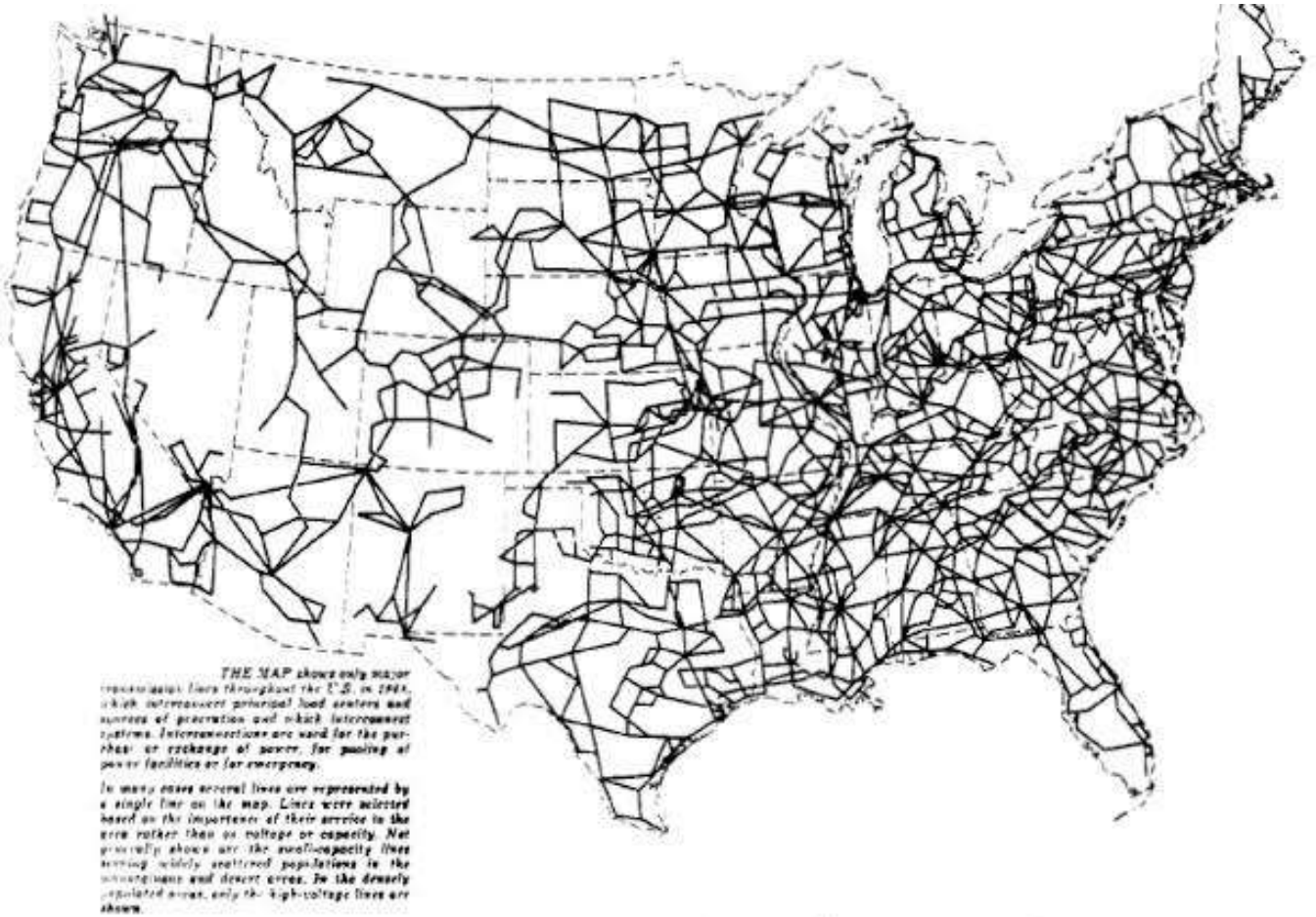
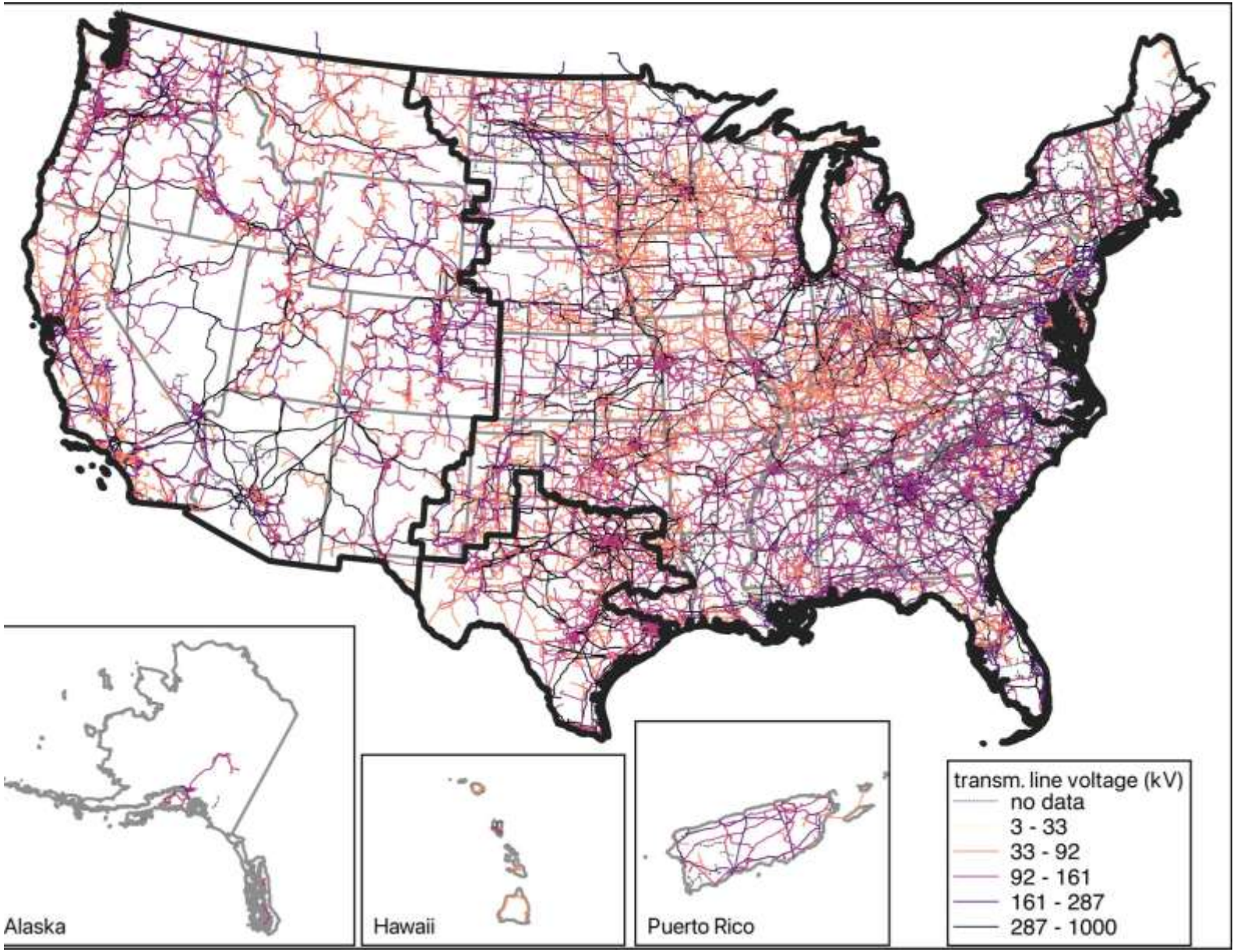


Fig. 2. Schematic backbone transmission map illustrating the major interconnecting tie lines in the United States as of the end of 1969 (courtesy of Edison Electric Institute).

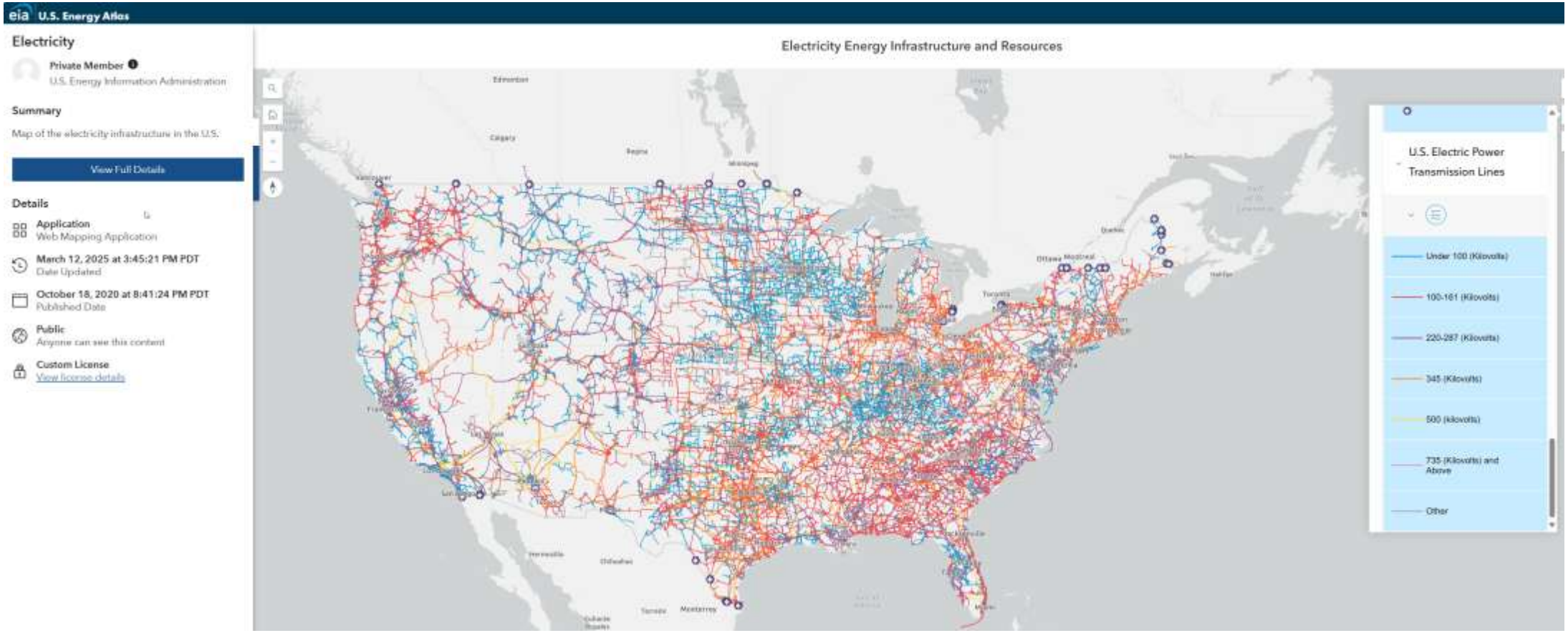
US ELECTRICAL TRANSMISSION SYSTEM

- Pacific Northwest National Laboratory



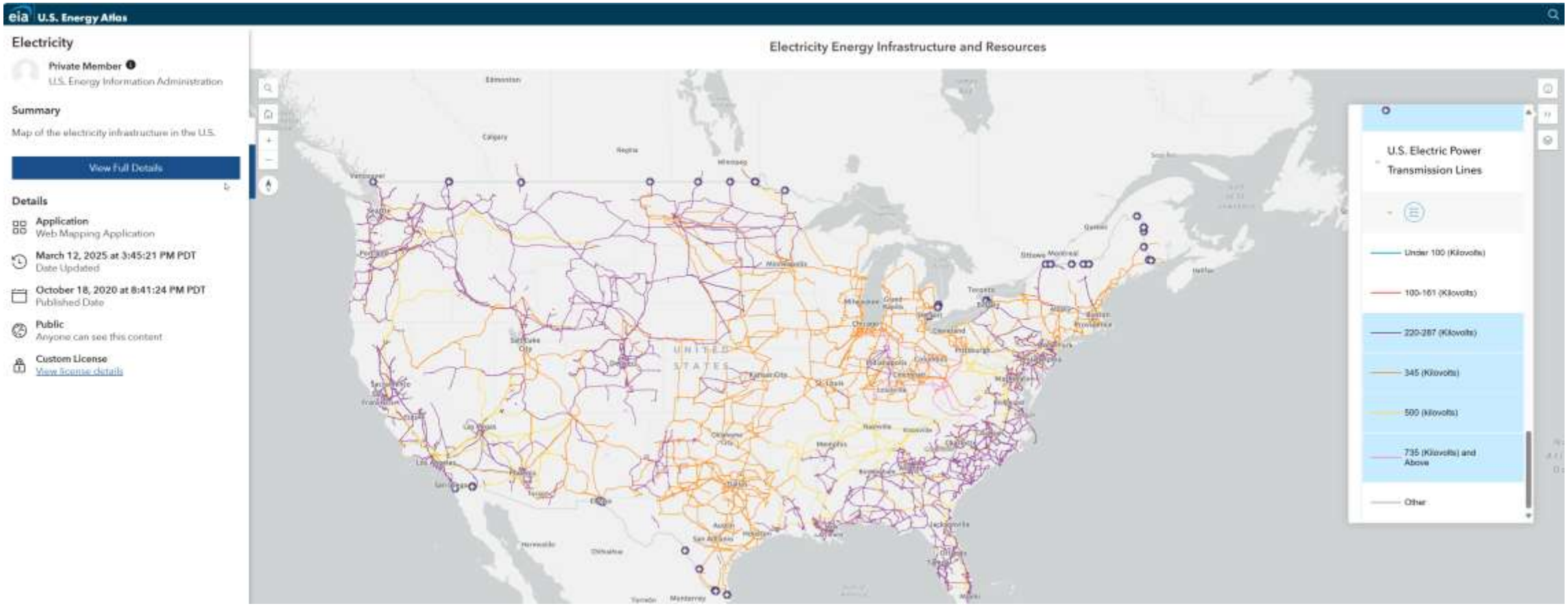
EIA – TRANSMISSION DATA

735KV TO SUB 100KV



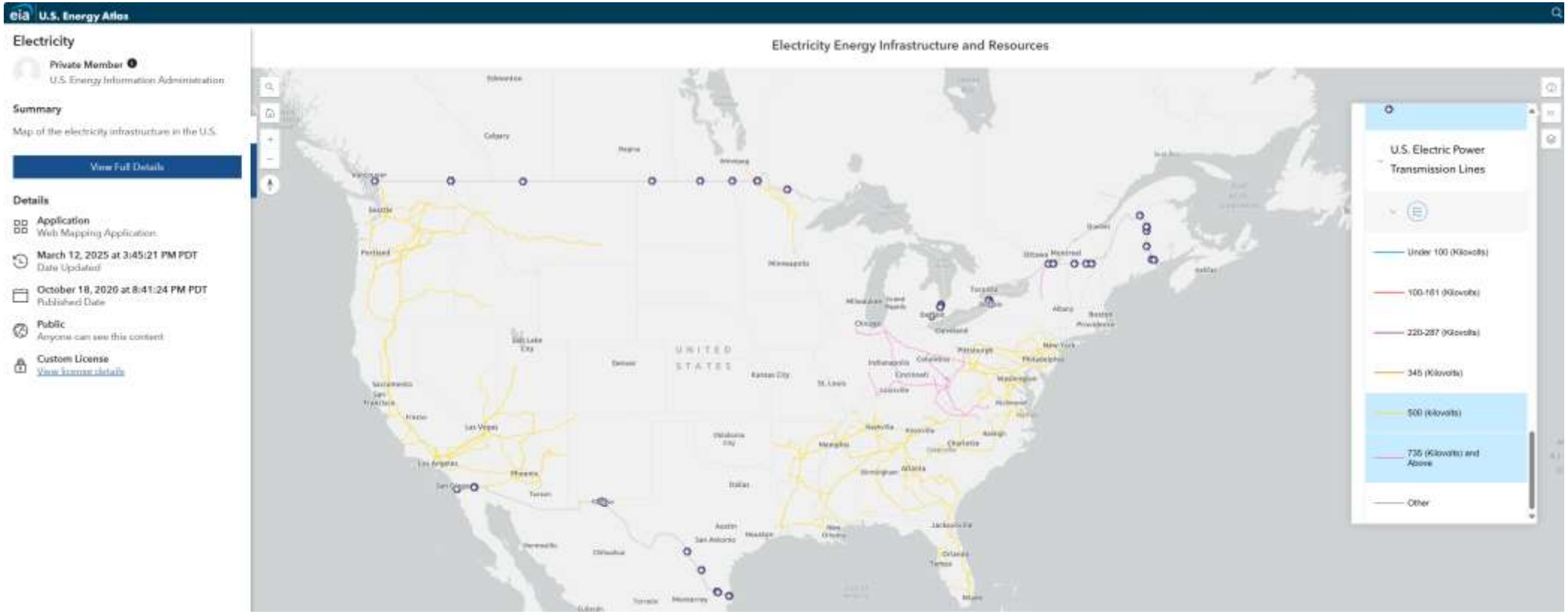
EIA – TRANSMISSION DATA

220KV – 735KV

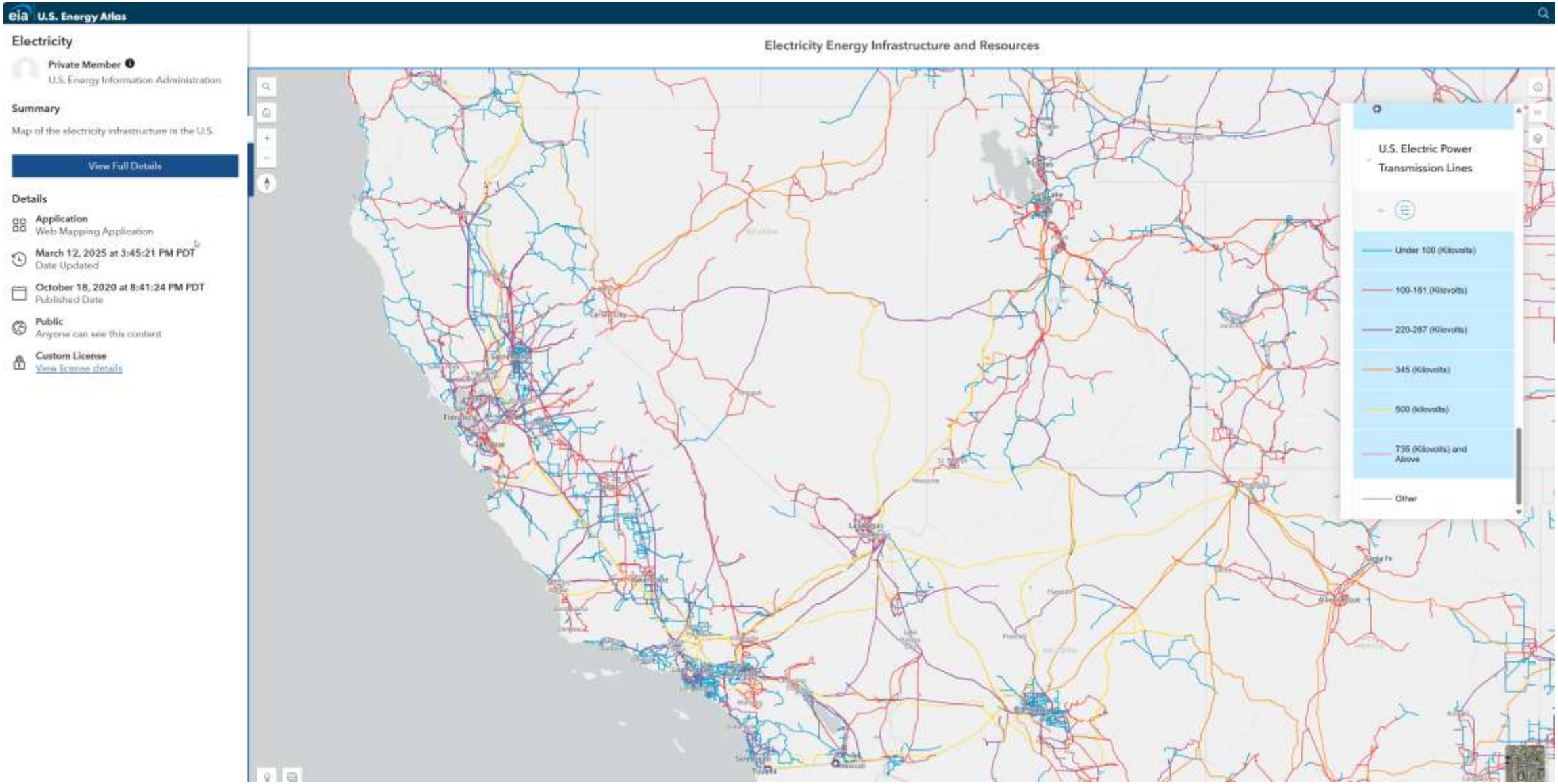


EIA – TRANSMISSION DATA

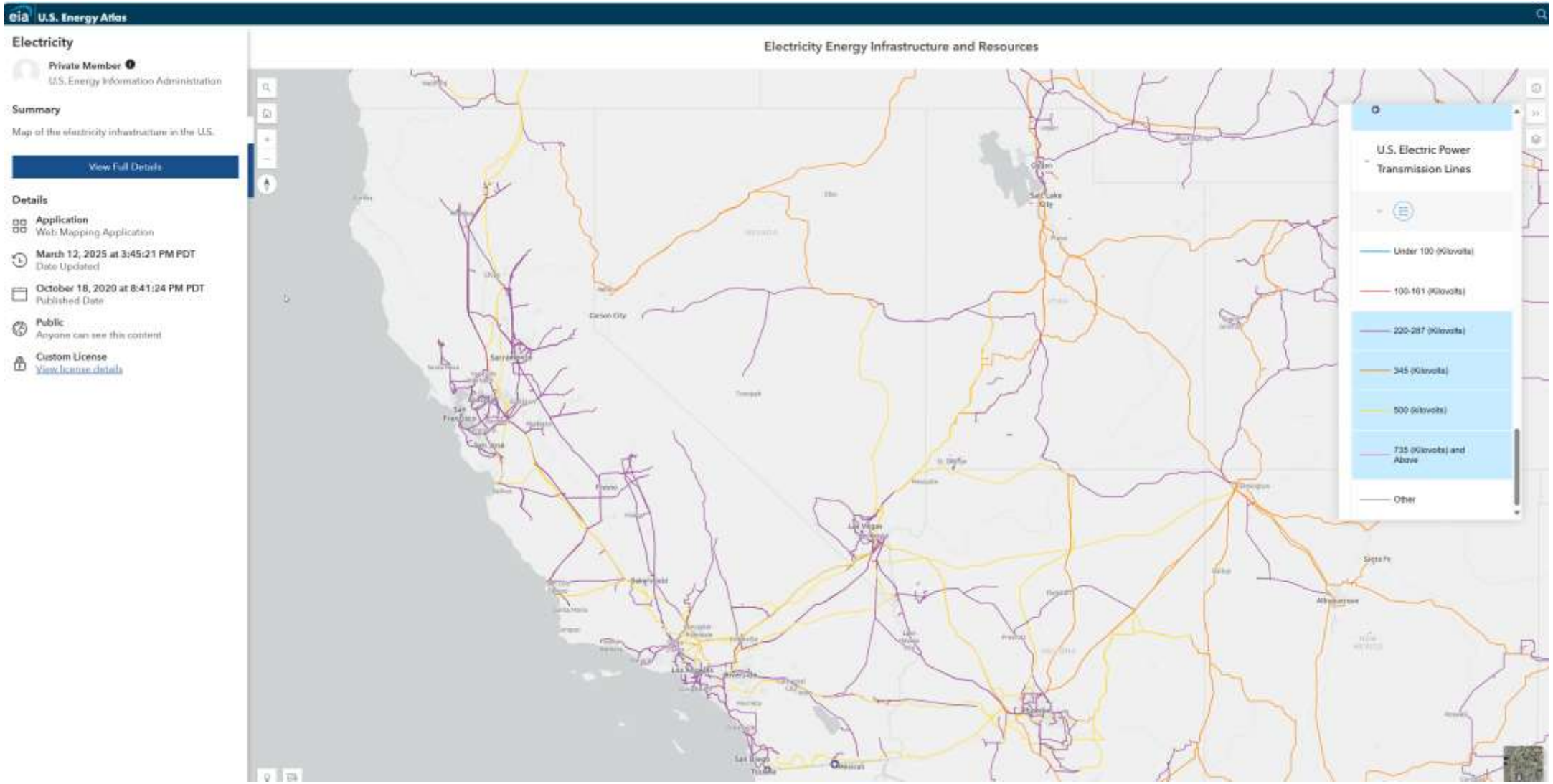
500KV – 735KV



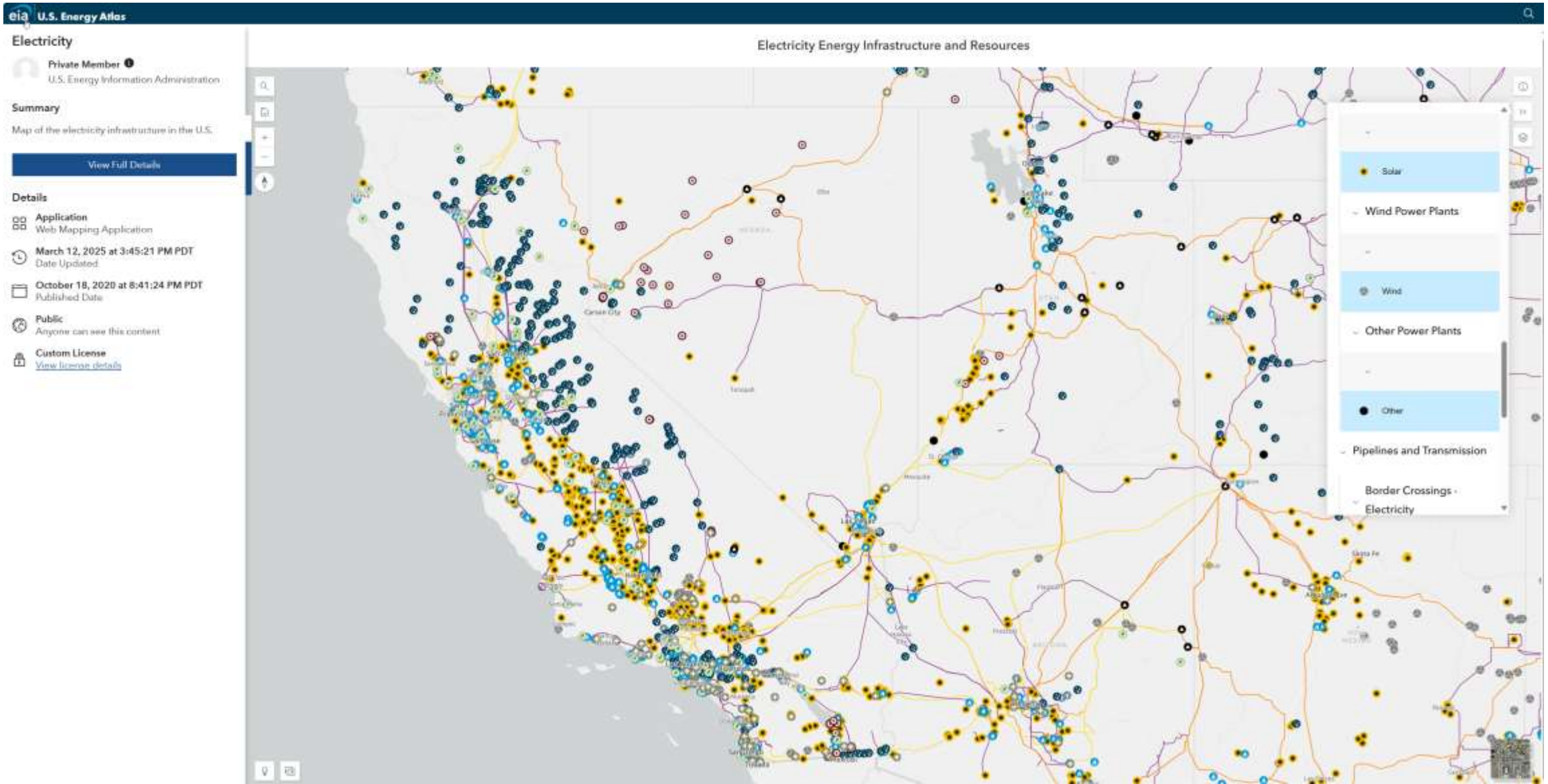
EIA – CALIFORNIA TRANSMISSION DATA



EIA – CALIFORNIA TRANSMISSION DATA



GENERATION-


eia U.S. Energy Atlas
Electricity
Private Member
U.S. Energy Information Administration
Summary
Map of the electricity infrastructure in the U.S.
View Full Details
Details
Application
Web Mapping Application
March 12, 2025 at 3:45:21 PM PDT
Date Updated
October 18, 2020 at 8:41:24 PM PDT
Published Date
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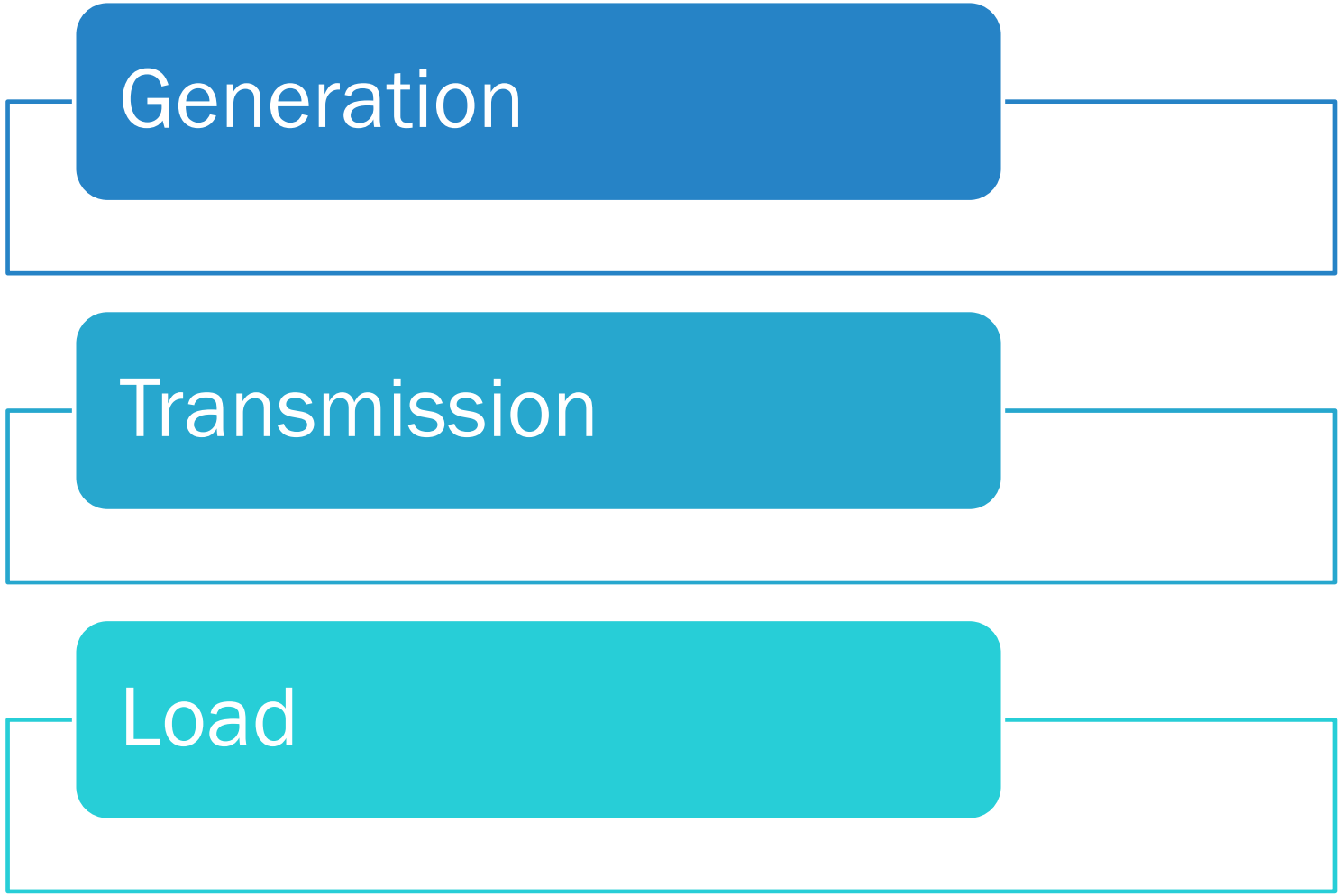
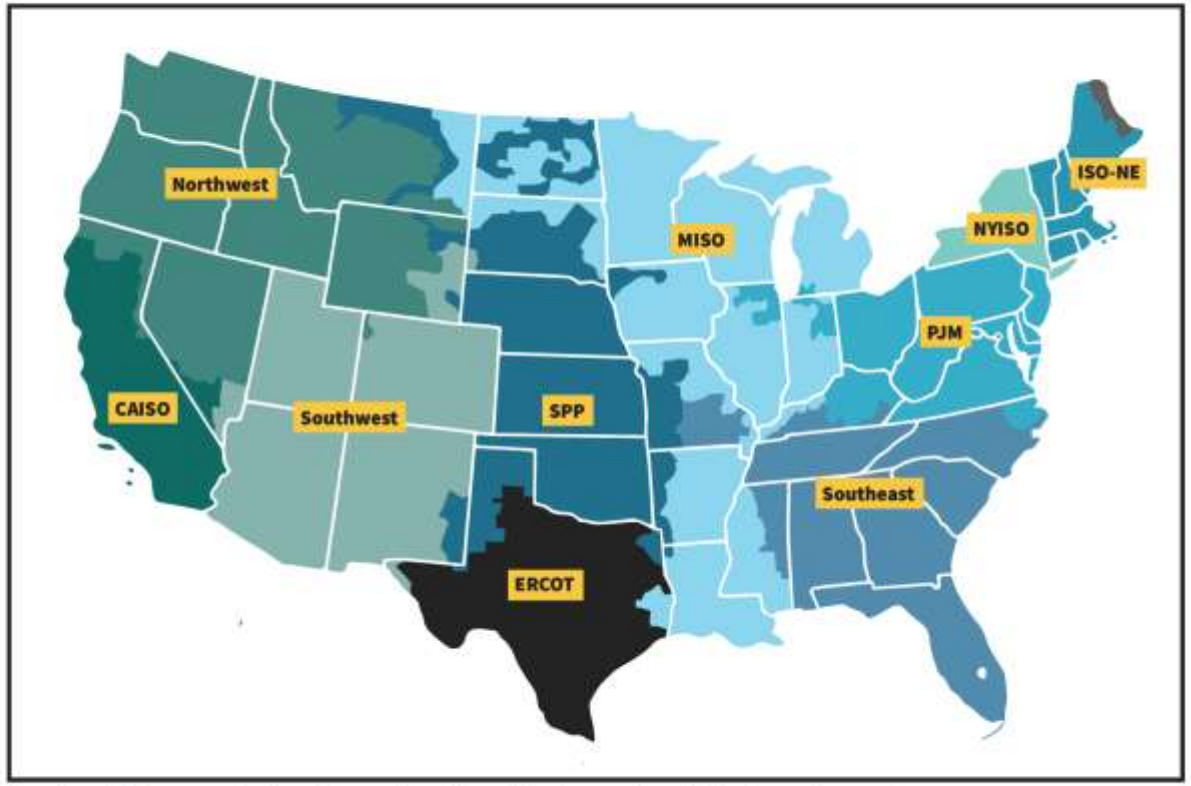
Electricity Energy Infrastructure and Resources
Solar
Wind Power Plants
Wind
Other Power Plants
Other
Pipelines and Transmission
Border Crossings - Electricity

MANAGING GENERATION AND LOAD



RTOs and ISOs



Regional Transmission Organizations/Independent System Operators

Independent System Operators (ISO) grew out of Orders Nos. 888/889 where the Commission suggested the concept of an Independent System Operator as one way for existing tight power pools to satisfy the requirement of providing non-discriminatory access to transmission. Subsequently, in Order No. 2000, the Commission encouraged the voluntary formation of Regional Transmission Organizations (RTO) to administer the transmission grid on a regional basis throughout North America (including Canada). Order No. 2000 delineated twelve characteristics and functions that an entity must satisfy in order to become a Regional Transmission Organization.

US RTO AND ISO ORGANIZATIONS

PJM Interconnection (RTO): Mid-Atlantic and parts of the Midwest (e.g., PA, NJ, MD, DE, OH, VA).

Midcontinent Independent System Operator (MISO, RTO): Midwest and South (e.g., IL, IN, MI, MN, LA, AR).

Southwest Power Pool (SPP, RTO): Central Plains (e.g., KS, OK, NE, parts of TX).

New York ISO (NYISO): Entire state of New York.

ISO New England (ISO-NE, RTO): New England states (CT, MA, ME, NH, RI, VT).

California ISO (CAISO): Most of California (plus small parts of NV).

Electric Reliability Council of Texas (ERCOT, ISO): Most of Texas.

CAISO MAP

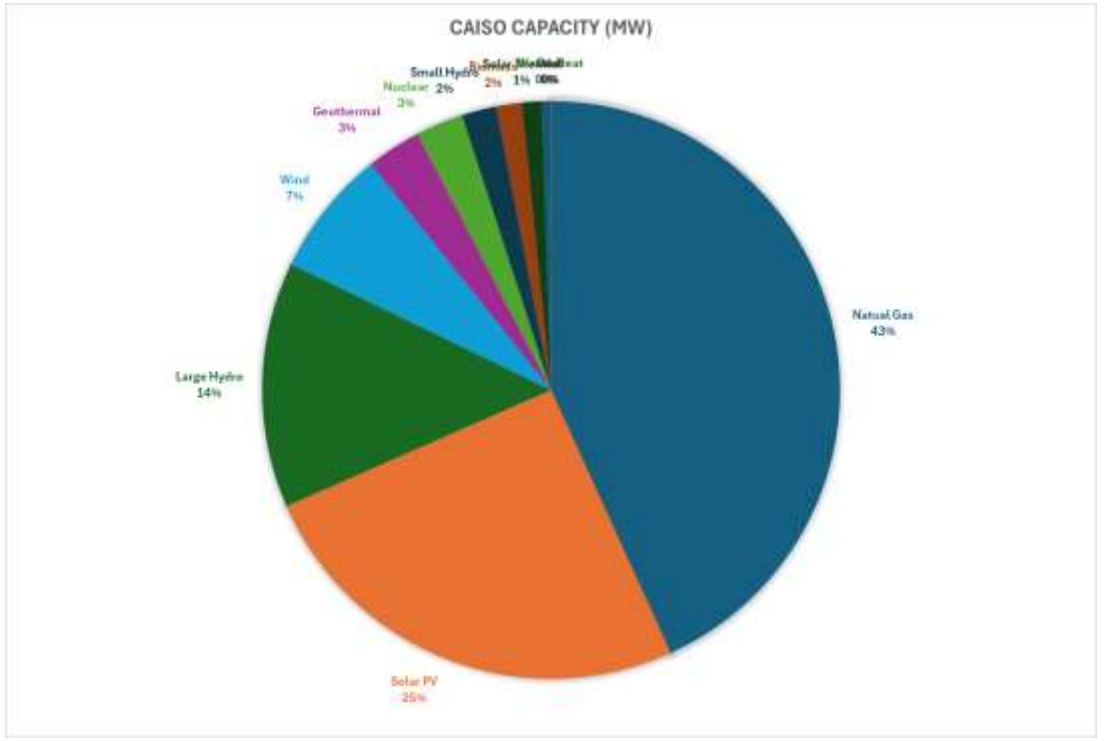
CAISO 2024 TRANSMISSION PLANT MAP

CAISO

- Grid Management: CAISO monitors and controls the transmission system to maintain reliability, balancing electricity supply and demand in real time
- Energy Markets: It operates wholesale electricity markets, including day-ahead and real-time markets, where utilities and other entities buy and sell power.
- Renewable Integration: CAISO plays a major role in integrating renewable energy sources like solar and wind, managing their variability to keep the grid stable.
- Western Energy Imbalance Market (EIM): Since 2014, CAISO has run the EIM, a real-time market allowing utilities across the Western U.S. to trade energy, improving efficiency and reducing costs.
- Planning and Upgrades: CAISO plans for future grid needs, including transmission upgrades to support growing demand and renewable energy goals.

CAISO GENERATION CAPACITY

Fuel Type	Capacity (MW)
Natual Gas	38,576.00
Solar PV	22,510.00
Large Hydro	12,281.00
Wind	6,360.00
Geothermal	2,715.00
Nuclear	2,393.00
Small Hydro	1,726.00
Biomass	1,278.00
Solar Thermal	984.00
Oil	351.00
Coal	63.00
Waste Heat	48.00
	89,285.00



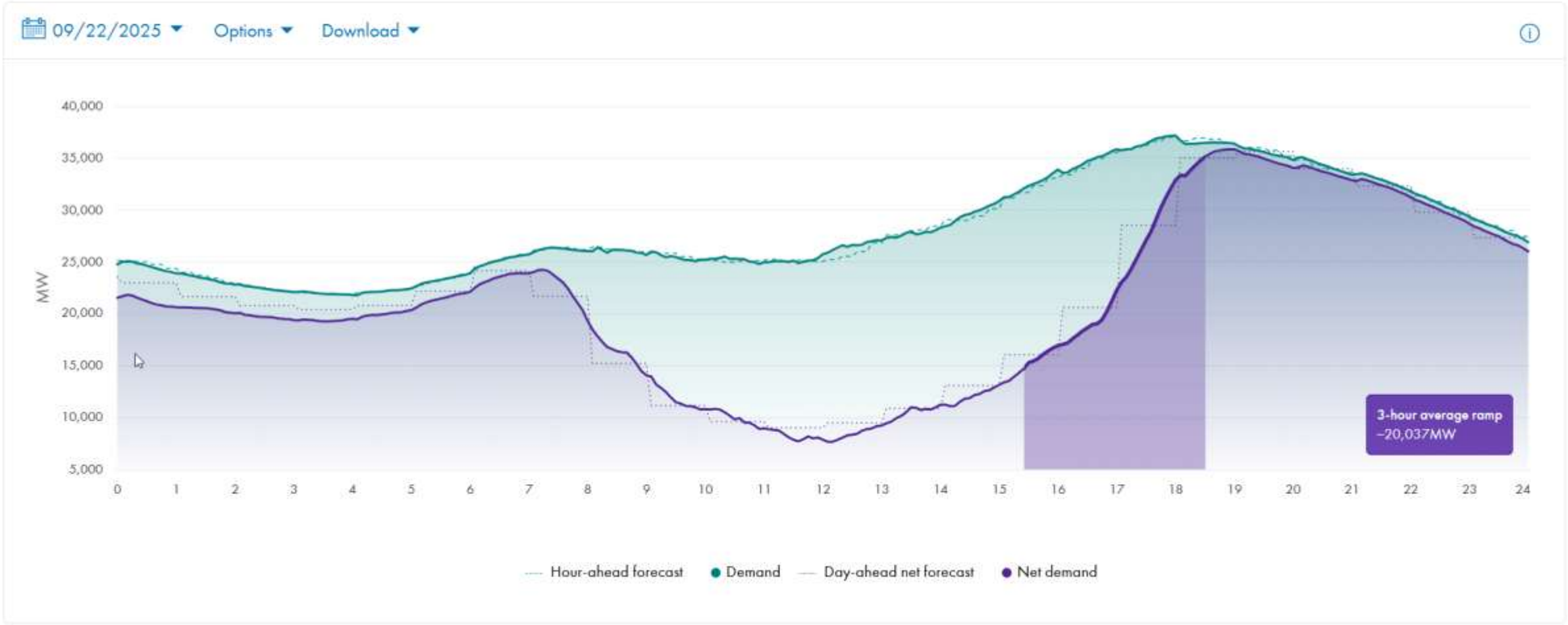
DIABLO CANYON NUCLEAR POWER PLANT

- Westinghouse Design
- Unit 1- 1138 MW
- Unit 2- 1118 MW
- 18,000 GWh annually
- 9% of California generation
- 23% of the Carbon free generation

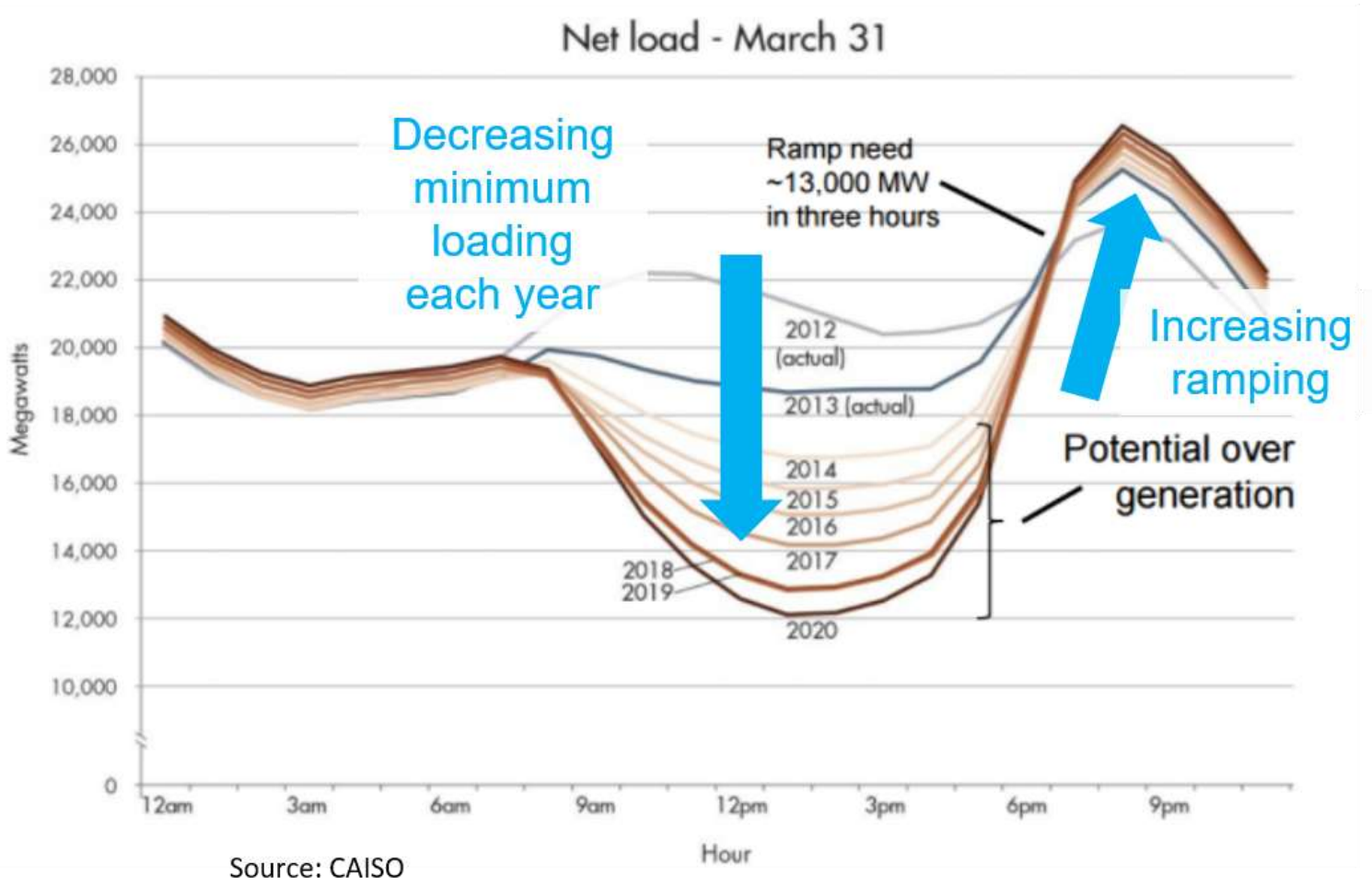
CAISO NET DEMAND

Net demand trend

System demand minus wind and solar, on a 5-minute average, compared to system and forecasted demand.



California “Duck Curve”

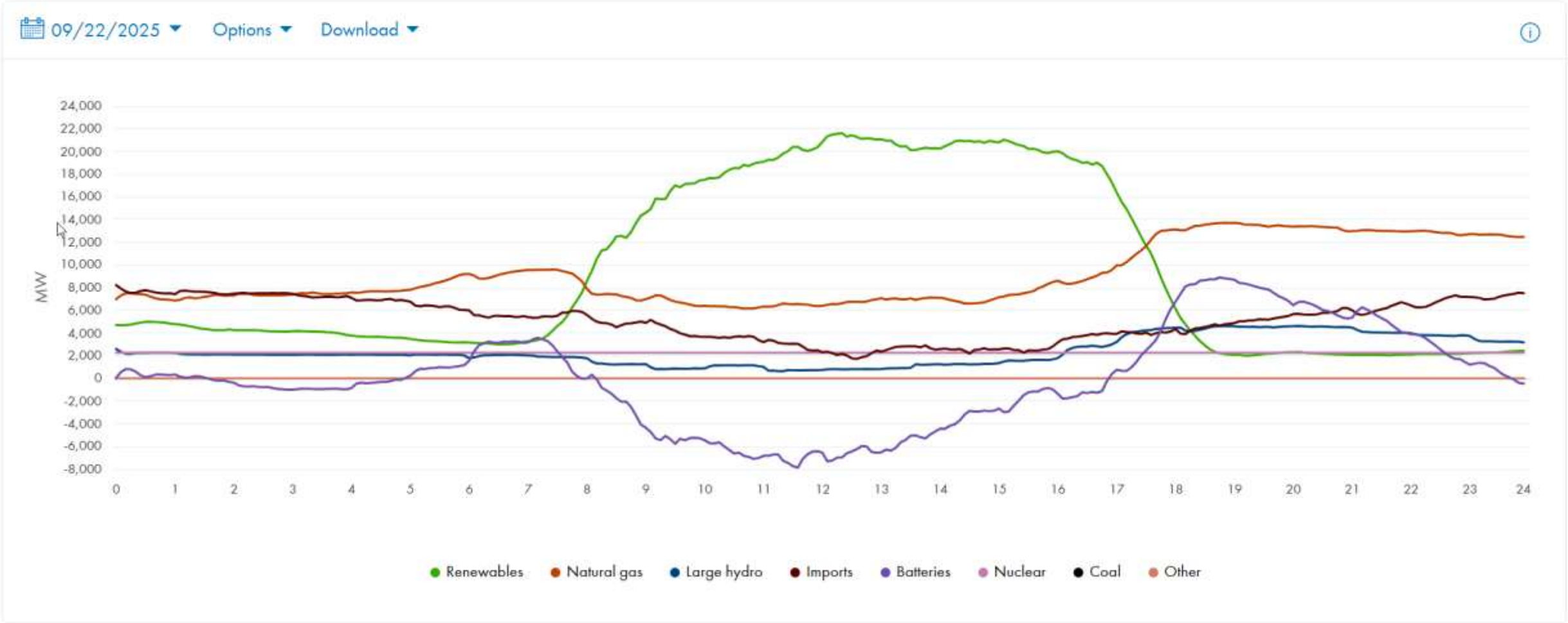


Source: CAISO

CAISO SUPPLY TREND

Supply trend

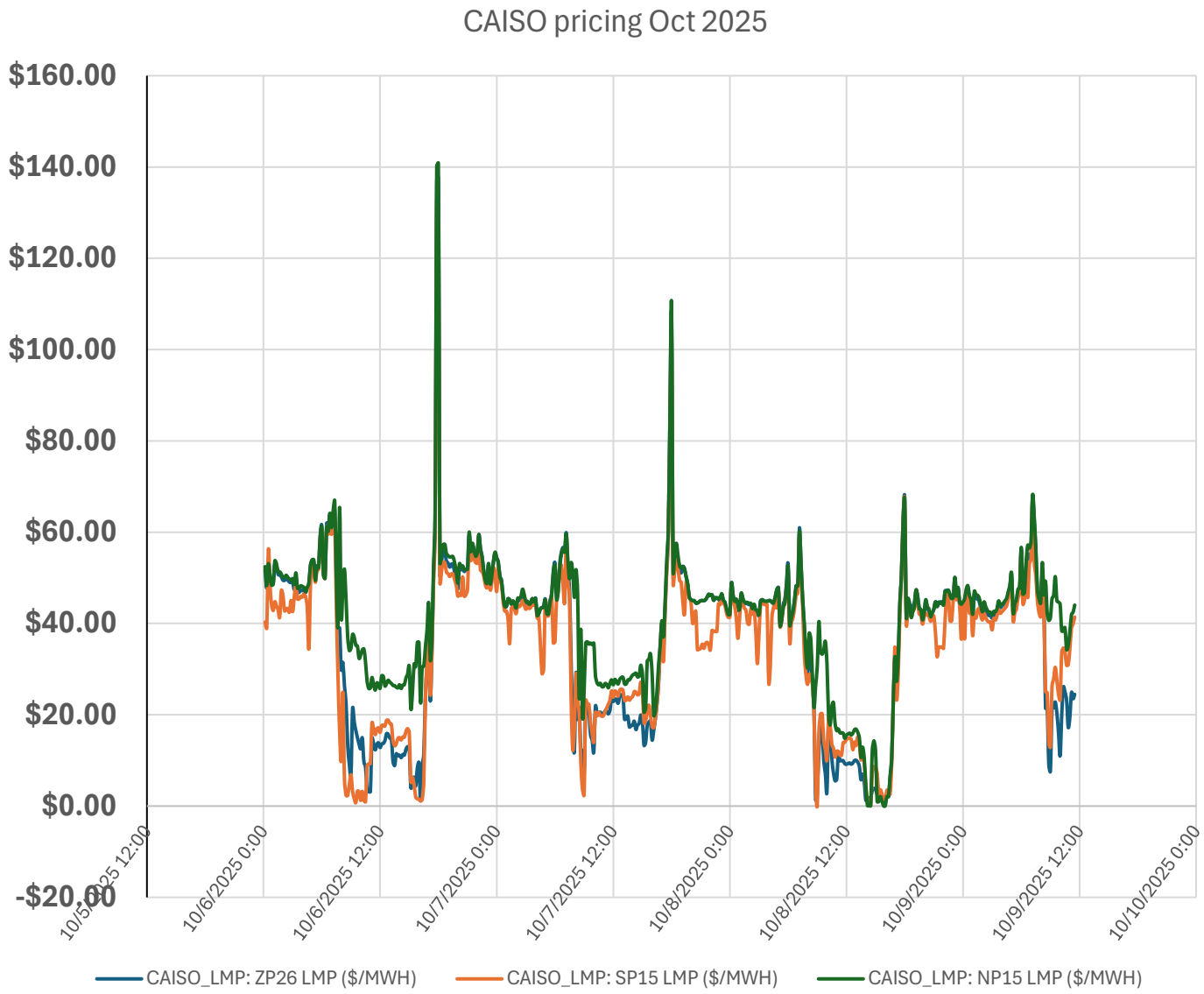
Power separated by resource, on a 5-minute average.



THE DUCK CURVE HAS BECOME THE CANYON CURVE

CAISO ENERGY PRICES

CAISO toggles the price of power to get generators to respond



RESOURCE ADEQUACY

- The success of the increased Solar allows for reduced generation needs during the daytime hours
- Natural gas power plants need to idle all day and perform during the evening on peak
- Natural gas plants start to retire due to economic issues
- CAISO recognizes that the capacity loss is becoming a problem
- Resource Adequacy charges (RA) are substantially increased in order to incentize a power plant to be available
- Picture is at a 1100MW power plant that wasn't running for 24 hours due to prices to low to operate, but it is needed in case renewables falter

WESTERN ENERGY IMBALANCE MARKET (WEIM)

- Real time electricity market (no day ahead), Started in 2014
- Allows energy to be imported or exported from CAISO during the real time between participants
- PacifiCorp
- Bonneville Power
- NV Energy
- Arizona Public Service
- Portland General Electric
- Tucson Electric Power
- An example is that spring time solar generation is in a surplus, the power is more than California can consume, this low and sometimes negative price is exported to these utilities , they enjoy very low energy prices, and the California renewables don’t have to be shut off. (Ask me how a solar system can afford negative prices!)

EXTENDED DAY-AHEAD MARKET (EDAM)

- Expansion of WEIM
- Approved by Federal Energy Commission (FERC) December 2023, launching in 2026
- Reduces cost by optimizing resources and minimizing expensive last minute purchases
- Enhances grid stability by coordinating on a larger footprint
- Supports clean energy goals

EXTENDED DAY-AHEAD MARKET (EDAM)

Participant/Entity	Status	Expected Join Year	Notes/Geographic Scope
PacifiCorp	Committed	2026	Multi-state utility (OR, WA, CA, ID, WY, UT); initial launch partner.
Portland General Electric (PGE)	Committed	2026	Oregon-based utility; initial launch partner.
Los Angeles Department of Water and Power (LADWP)	Intent to Participate	2027	California's largest municipal utility.
Balancing Authority of Northern California (BANC)	Agreement Signed	2027	Includes Western Area Power Administration (WAPA) Sierra Nevada Region; Northern CA focus.
Western Area Power Administration (WAPA) Sierra Nevada Region	Pursuing Participation	2027	Federal power marketer; operates within BANC.

SOUTHWEST POWER POOL (SPP)

- Regional Transmission Organization (RTO) in central US (East of MISO territory)
- Geographic Scope: Covers all or parts of Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming, serving over 18 million customers
- Pushing westward towards territory that CAISO and the new RO would like to manage
- Markets+ Initiative, would compete with the CAISO EDAM, but the SPP is an actual RTO where EDAM/WEIM is a voluntary market

Headquarters Little Rock, AK

PATHWAYS

- There is an attempt to create a new Regional Organization in the West
- Pathways- name of the stakeholder group creating the core of the new RO
- CAISO was legally prevented from joining any external RO
- Governor recently signed AB 825 which now legalizes the ability of CAISO joining an RO
- New RO would contract with CAISO due to the already existing infrastructure, RO would be a separate body

SPP MARKETS+

- **El Paso Electric**: Joined Markets+ as a full participant, effective January 2025, as part of SPP's expansion of the market in the Western Interconnection.
- **Tucson Electric Power**: Announced as a Markets+ participant in early 2025, committing to the market's development for enhanced grid reliability and resource integration.
- **Public Service Company of New Mexico (PNM)**: Also joined Markets+ in early 2025, aligning with other utilities to leverage SPP’s day-ahead market services.
- **Idaho Power**: Confirmed participation in Markets+ in 2025, focusing on cost savings and renewable integration in the Western energy market.
- **NorthWestern Energy**: Joined Markets+ in 2025, as part of the growing coalition of utilities in the Western Interconnection.
- **Deseret Power**: Became a Markets+ participant in 2025, contributing to the market’s goal of optimizing resource sharing.

SPAIN BLACKOUT 4/28/2025

- Phase 0- Week before and morning of event, voltage instability between 9:00am and 12pm
- Phase 1- System oscillations 12:00-12:30
- Phast 2- Generation loss due to overvoltage 12:32- 12:33
- Phase 3- Collapse to zero peninsular voltage 12:33
- Phase 4- Restore power 2:36pm 4/29/2025
- 15 GW of generation went off line

SPAIN PENINSULA OUTAGE FACTORS

- A combination of factors contributed:
- **Initial Triggers**: Small outages in southern Spain, possibly from large solar installations or anomalous oscillations in 400 kV lines due to extreme temperature variations (induced atmospheric vibration). This caused a sudden loss of generation and unexpected spikes in transport network demand.
- **Grid Vulnerabilities**: Insufficient ancillary services like frequency regulation and inertia, exacerbated by the high share of inverter-based renewables (solar and wind), which lack the rotational stability of traditional synchronous generators (e.g., nuclear, gas, hydro). The grid had adequate planned capacity but operated with reduced conventional backups.
- **Human and Operational Errors**: The grid operator (Red Eléctrica de España, REE) miscalculated the energy mix and lacked sufficient voltage regulation capacity. Conventional power plants (coal, gas, nuclear) failed to respond adequately—some were offline or did not activate controls as expected. Poor planning and coordination between REE and private utilities hindered automatic defenses.

POWER PLANT GENERATION MIX

- Spain has been shutting thermal plants down
- Classic spinning generation provide an inertia that can survive intermittent voltage and frequency swings
- Digital renewable generators (solar) struggle with intermittent swings
- A thermal plant can take hours to startup and can’t respond in seconds unless already online and connected to grid

AB 2109

- AB 2109 was signed into law fall of 2024
- When a facility installs generation connected to the CA utility, the account is still responsible for non bypassable charges (i.e. public purpose charges)
- Cement plants could install waste heat generation, but the departing load charges limit economic value
- AB 2109 removes the non bypassable charges for waste generation
- This is now California law, but after one year the CPUC has not taken up the job of modifying the utility tariffs in order to allow for this active law to be implemented

THANK YOU!

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