



UIUC Capstone

Fundamentals of Energy Markets

The energy sector landscape

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Energy Market Management

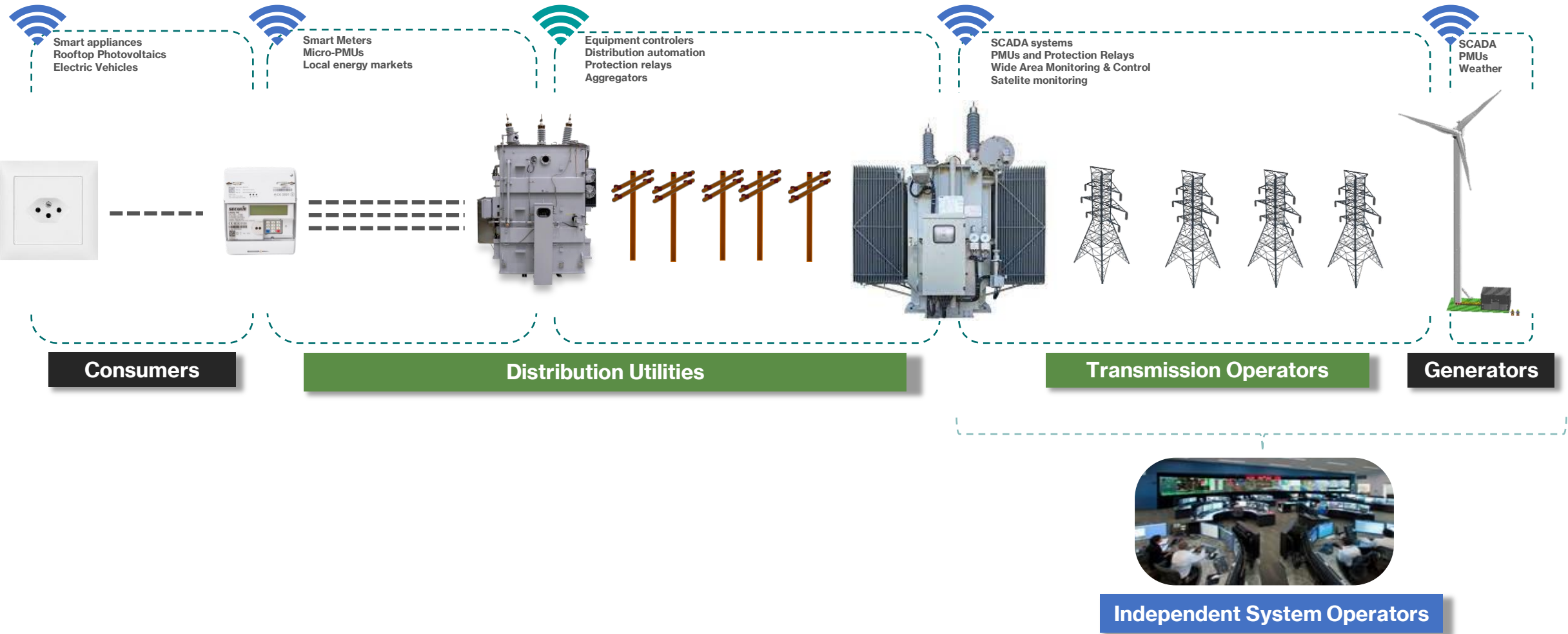
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The fundamental objectives of power system operations are the efficient and reliable supply of electricity.

The Electricity Sector

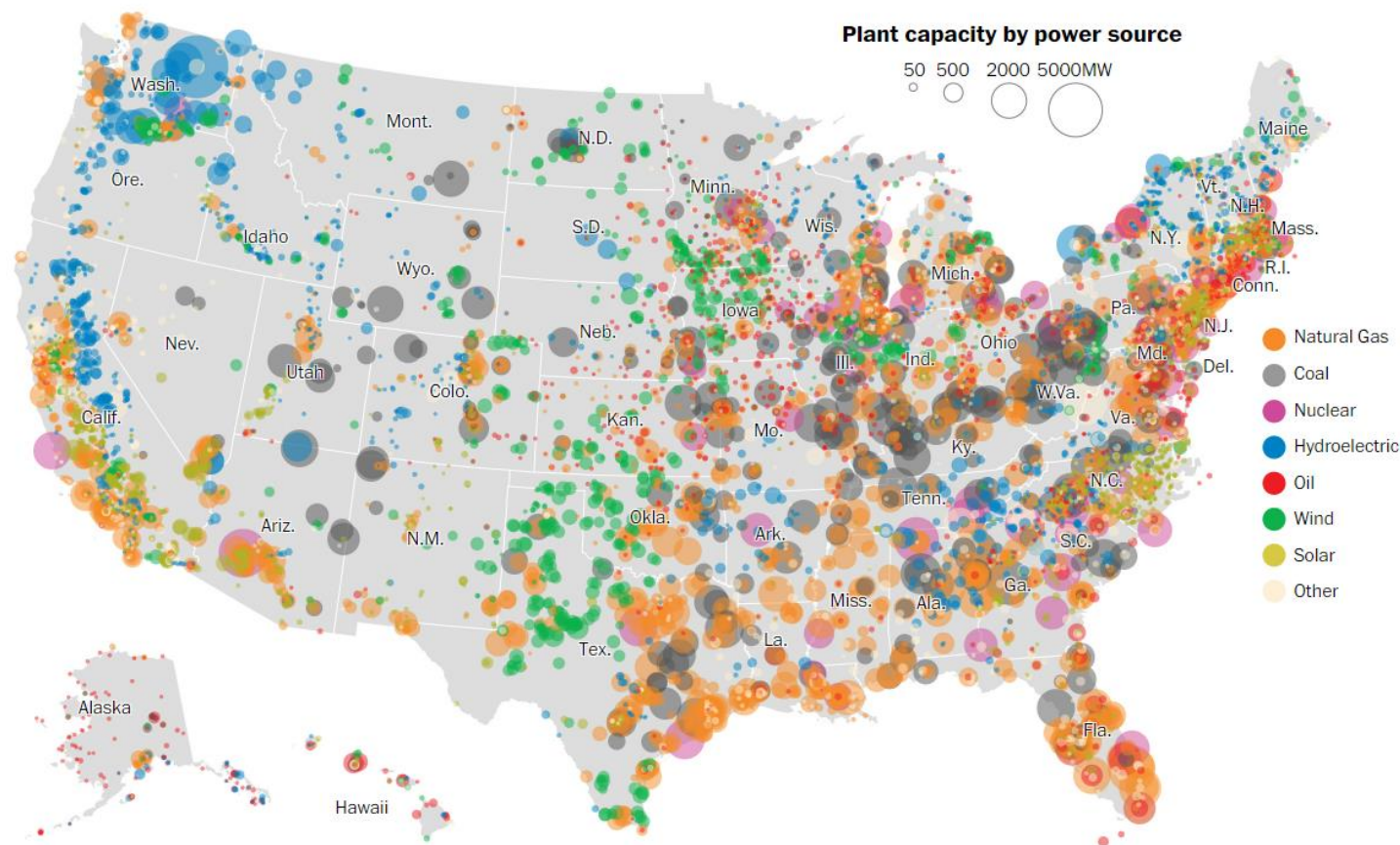
Transmission, Distribution and Generation



The role of Resources Optimization

Spatial Diversity of the Energy Mix

Geographically spread primary energy sources

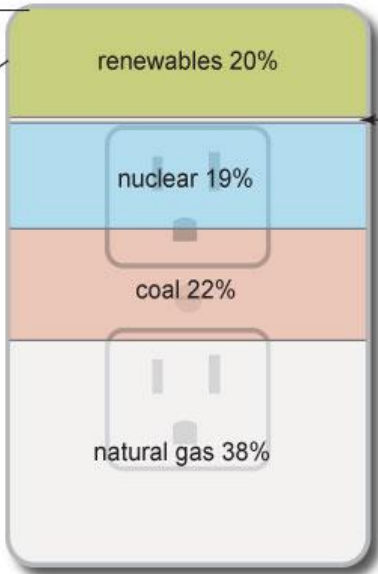


Source: Washington Post - 2017

Sources of U.S. electricity generation, 2021

Total = 4.12 trillion kilowatthours

wind	9.2%
hydro*	6.3%
solar	2.8%
biomass	1.3%
geothermal	0.4%



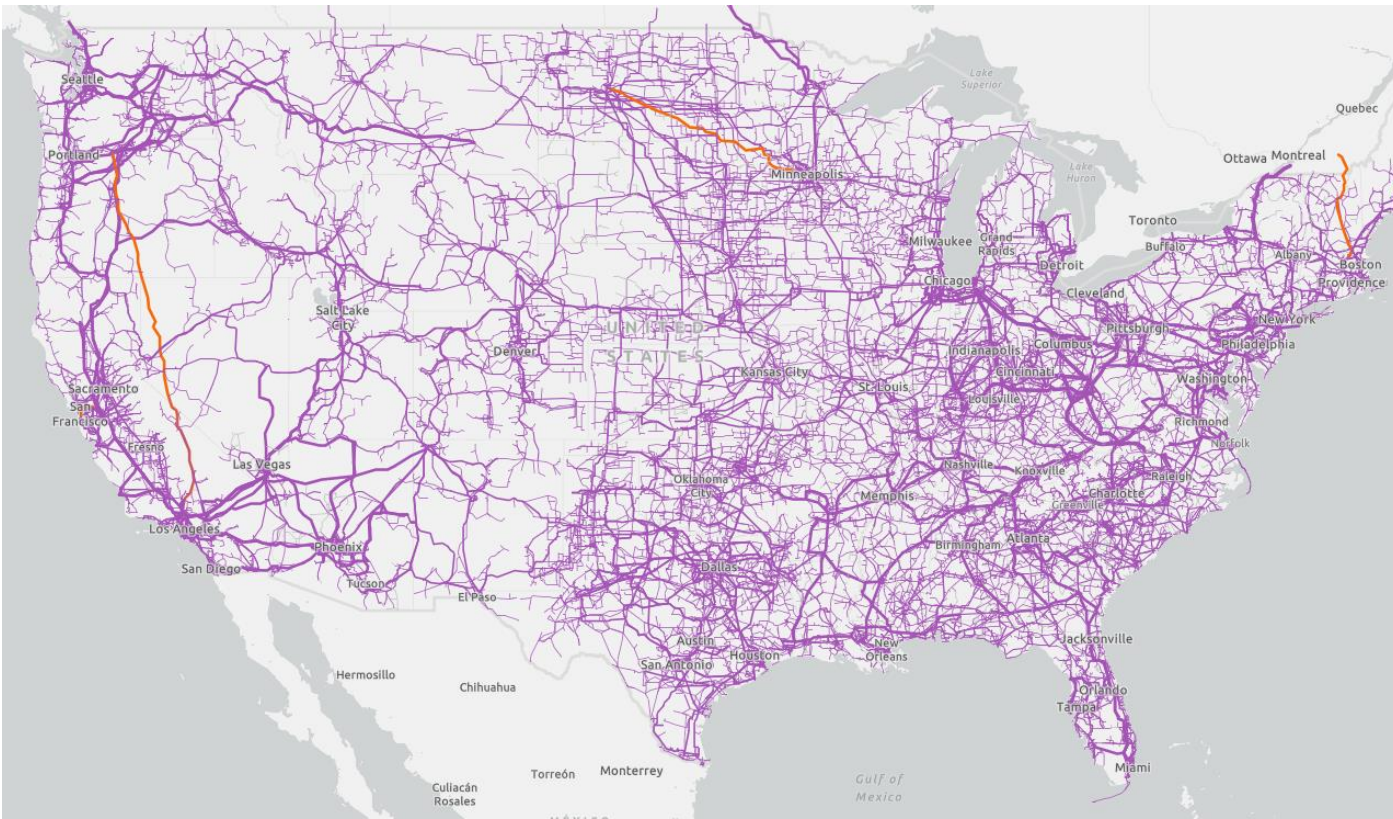
Data source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2022, preliminary data
Note: Includes generation from power plants with at least 1,000 kilowatts of electric generation capacity (utility-scale).
*Hydro is conventional hydroelectric. *Petroleum includes petroleum liquids, petroleum coke, other gases, hydroelectric pumped storage, and other sources.

Source: EIA - 2021

The role of Resources Optimization

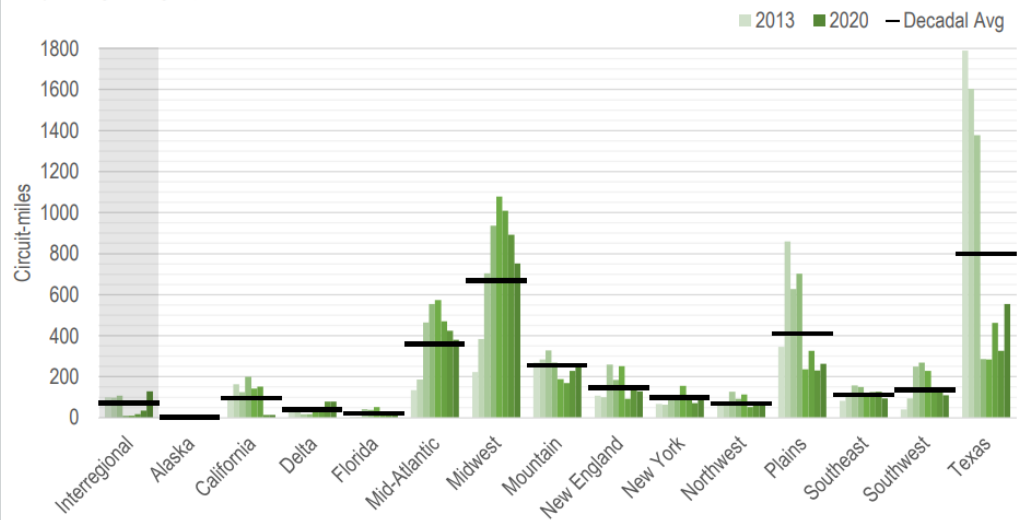
Availability of Transmission System to Interconnect Demand and Supply

Interconnections ensure supply and demand needs across wide areas



Source: EIA - 2021

Circuit-miles of transmission by in-service year, 2011-2020
3-yr rolling averages plotted

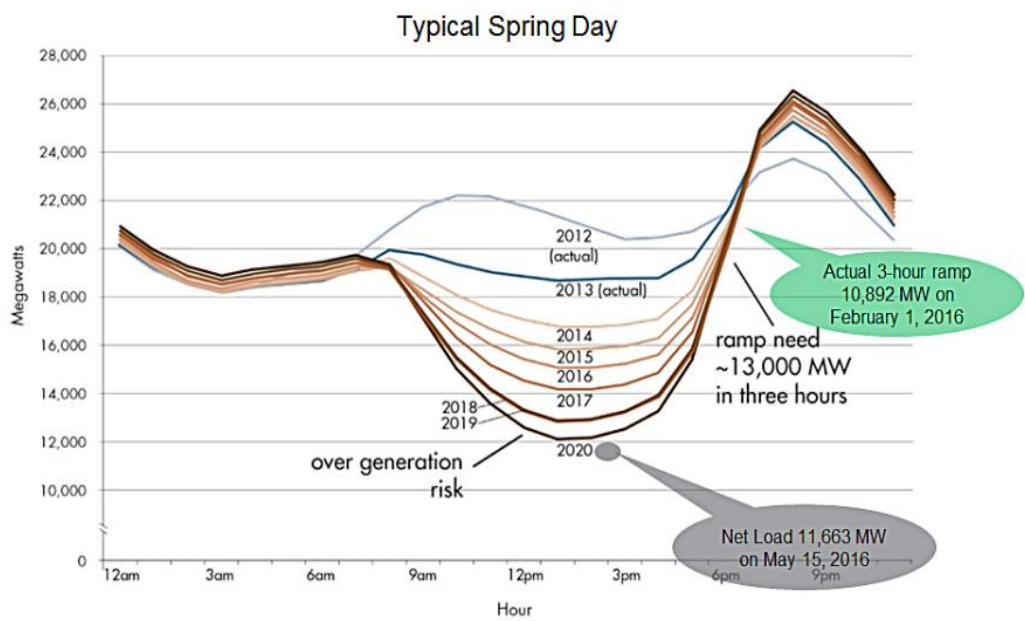


Source: DOE – 2023 “National Transmission Needs Study”

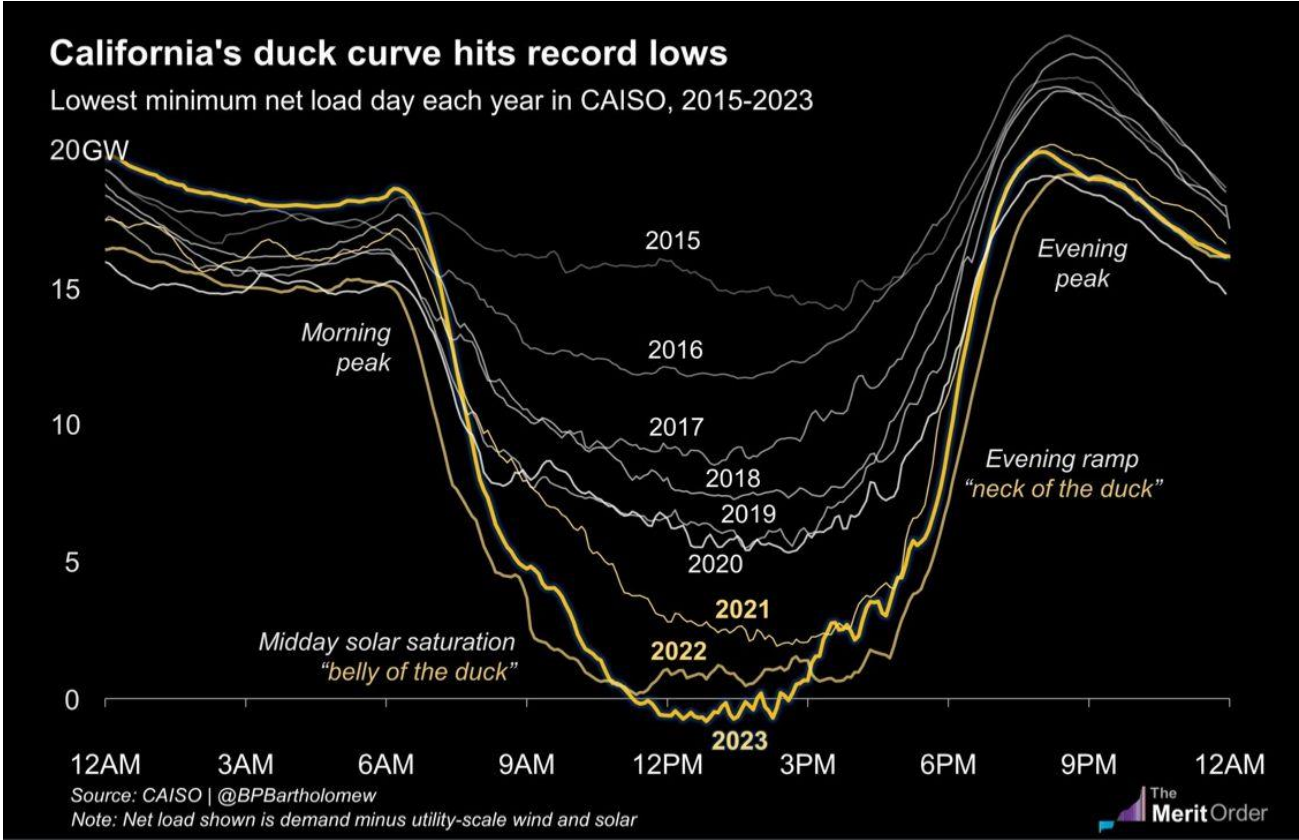
The role of Resources Optimization

Temporal Dependencies and Adaptability

Long-term, medium-term, short-term and very-short-term power balance



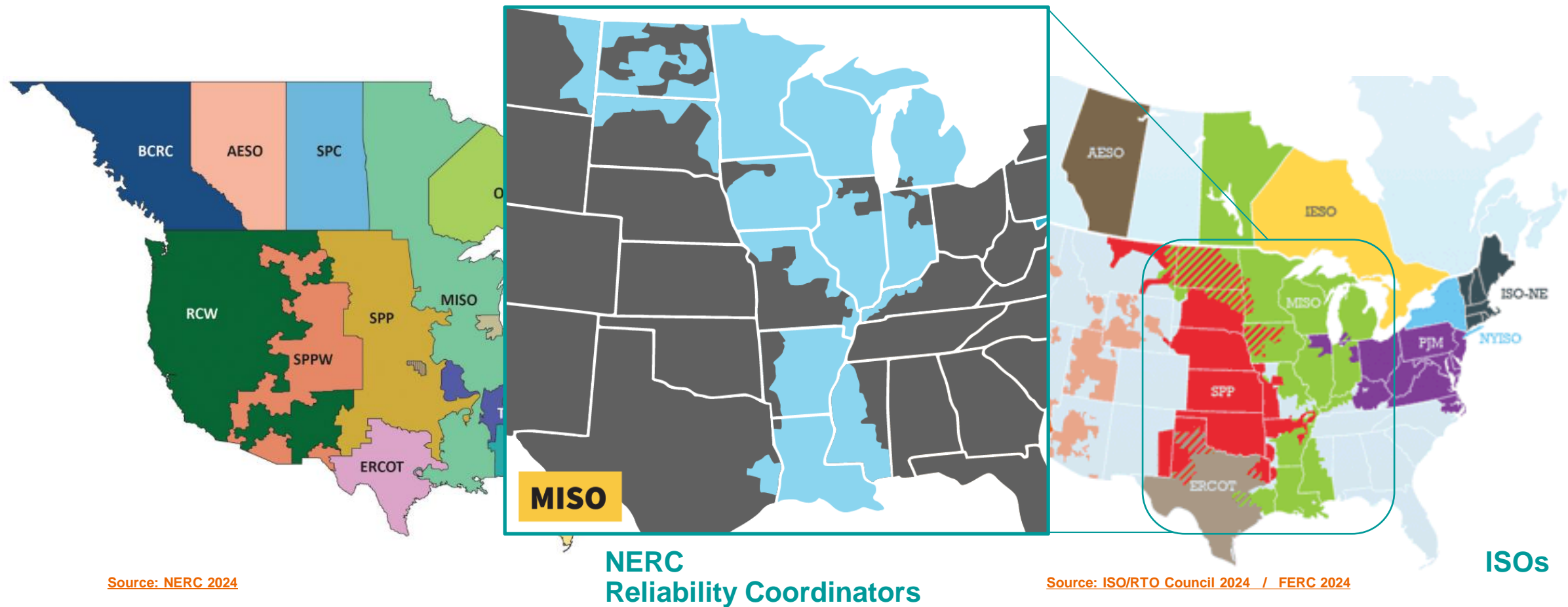
Source: CAISO Original "Duck Curve" - 2013



Decision Making at the High Level of Power Systems

Reliability Coordinators and Independent System Operators

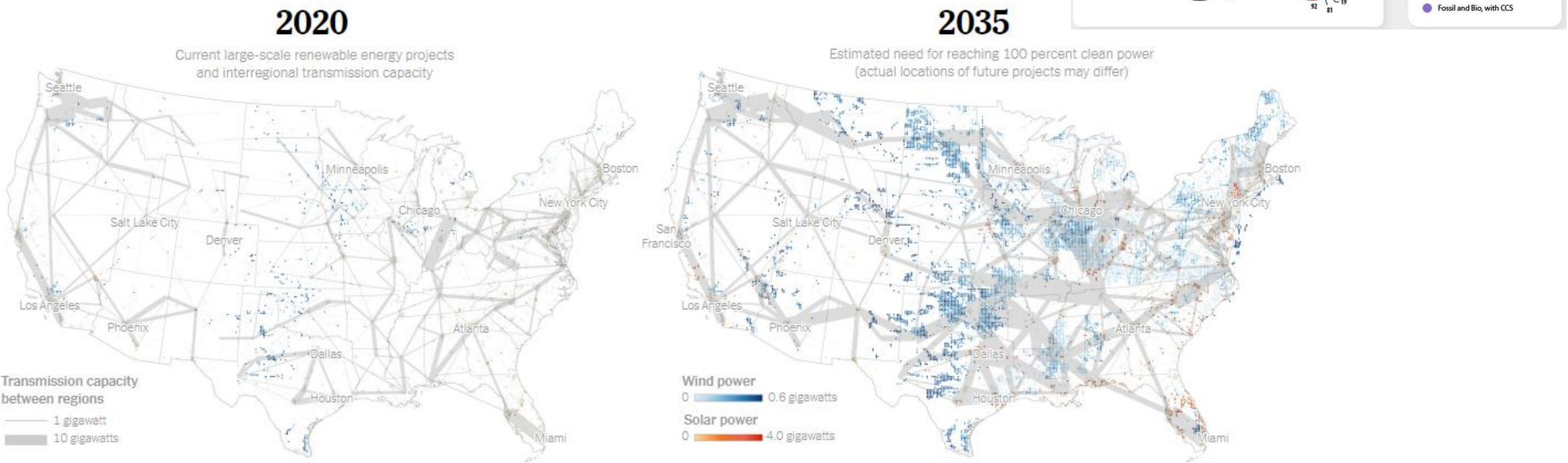
Decision making the efficient and reliable supply of electricity



Evolution of Infrastructure and Energy Mix for the Energy Transition

Increasing interconnections to accommodate more renewables

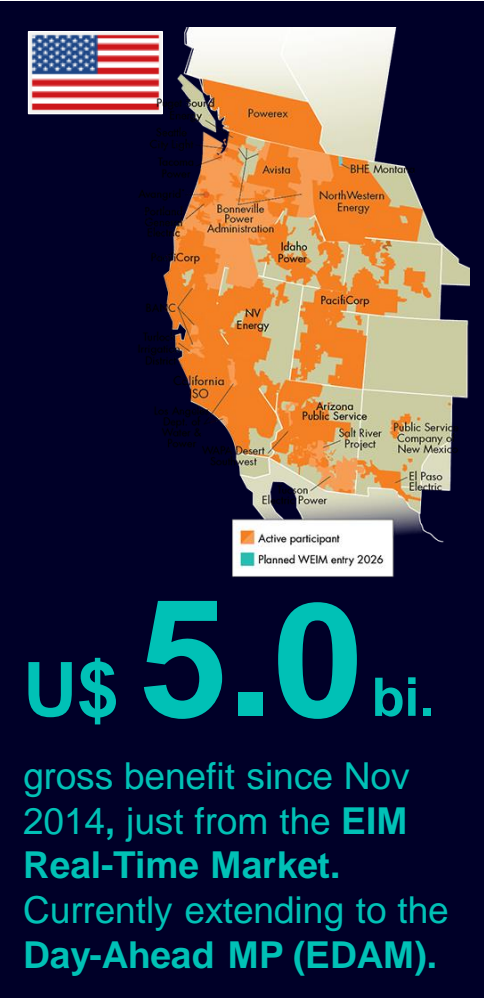
The evolution towards of a 100 % Clean Electricity Sector requires massive changes on the entire infrastructure and the way we manage the grid



Source: National Renewable Energy Laboratory (2022) “Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035”

Siemens Energy Market Management

Optimization Engine that enabled the growth of CAISO EIM and future EDAM



CAISO Provides Open Transparent Market, Greens the Grid and Power lives of 30 million consumers

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- Established methods to inform the Customers and involve their judgment in selecting the features to update the base product.

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- Full suite of applications providing a Bid to Bill Solution over time varying time horizons ranging from a few minutes to a few days.
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- Core of all market application process thus providing consistency of results.
- Detailed resource model that accounts for Variable Energy (e.g., Wind, Solar), Combined Cycle Plant, Energy Storage and Hybrid Energy Resources, and more.
- Full Network Model AC solution, Loss Modeling and Contingency Analysis for network constraints

Accelerating transition for zero carbon grid



904,219 tons of CO2 reduced since 2015



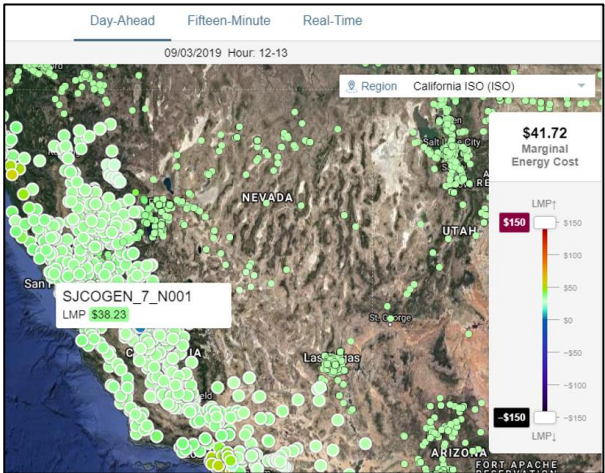
50% Reduction in Flexible Reserve (2023 Q3)



Customer: California Independent System Operator

Period: Since 2009 - Ongoing

Highlights: SCUC/SCED Engine for Day Ahead and Real Time Markets





Cool Places to Look:



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ANALYSIS & PROJECTIONS

ANNUAL ENERGY OUTLOOK 2023

Release Date: March 16, 2023 | Next Release Date: 2025 | [AEO Narrative](#) | [AEO Narrative Figures](#)

OVERVIEW

DATA

NARRATIVE

EIA's National Energy Modeling System (NEMS), which we use to produce our *Annual Energy Outlook* (AEO), requires substantial updates to better model hydrogen, carbon capture, and other emerging technologies. To facilitate these model enhancements, we will not publish an AEO in 2024. You can find more information in [our Statement on the Annual Energy Outlook](#) and EIA's plan to enhance long-term modeling capabilities.

Data Tables

Reference case tables

Available formats:

[XLSX](#) | [INTERACTIVE](#) | [API](#)

Side case tables

Available formats:

[XLSX](#) | [INTERACTIVE](#) | [API](#)

Release Event

Release Event Presentation

The *Annual Energy Outlook* (AEO) presents an assessment by the U.S. Energy Information Administration of the outlook for energy markets through 2050.

[PDF](#) | [PPT](#) | [webcast of release](#)

Note: You can access chart data by right-clicking the chart in the PPT file.

Press release

[View release](#)

Issues in Focus

May 23, 2023

[Effects of Liquefied Natural Gas Exports on the U.S. Natural Gas Market](#)

March 16, 2023

[Inflation Reduction Act Cases in the AEO2023](#)

<https://www.eia.gov/>

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Providing an open, transparent energy market

<https://www.caiso.com/Pages/default.aspx>

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Thank You

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