



Managing Integration of Renewables and Distributed Energy Resources (DERs) into the Transmission System in Deregulated Markets

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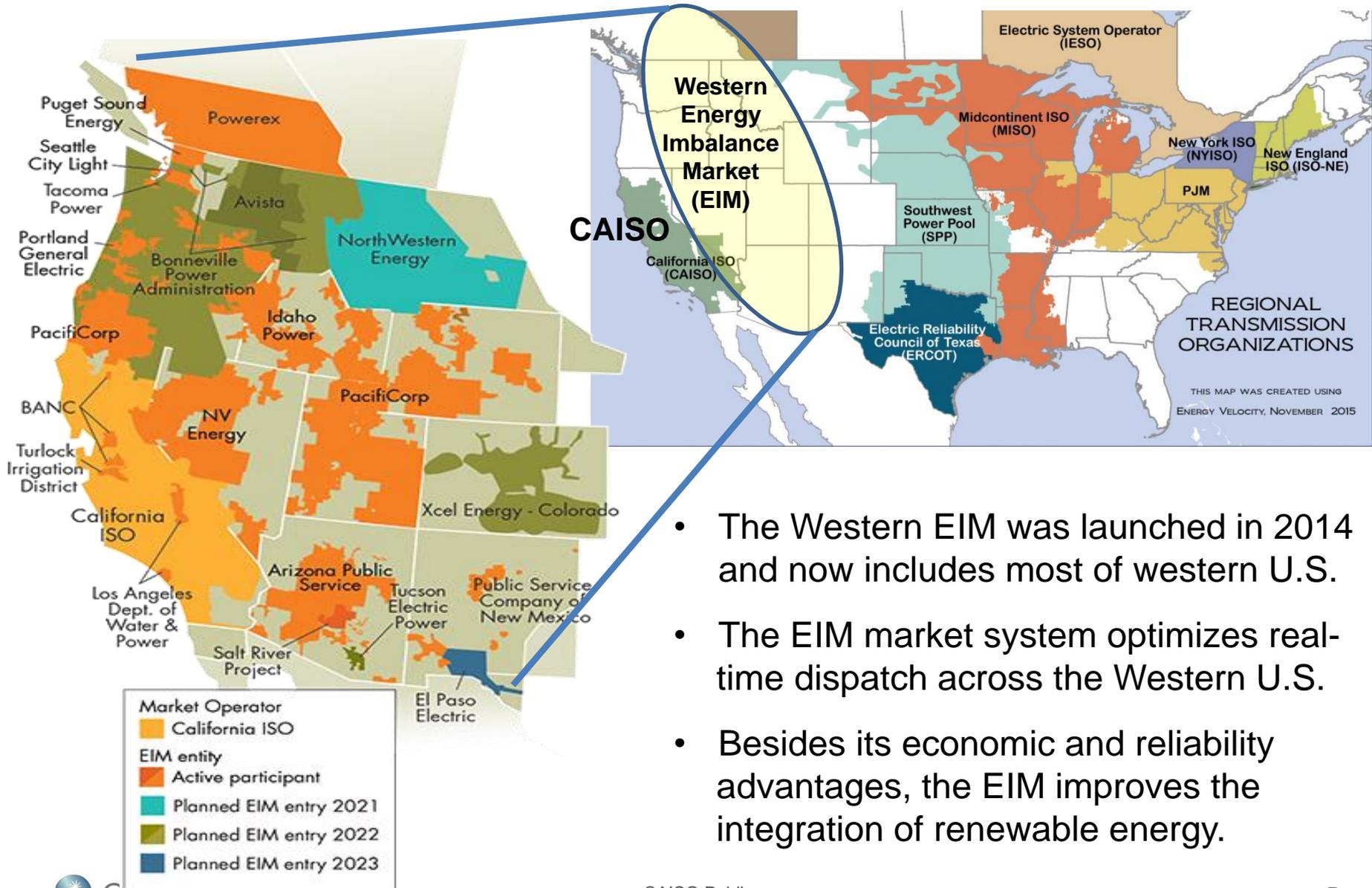
California Independent System Operator

USTDA Brazil Electricity Transmission and Substation Automation

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Background

- California's renewable portfolio standard (RPS) requires that 33% of electricity retail sales in California come from eligible renewable resources by 2020, 60% by 2030 and 100% by 2045.
- In 2019, an estimated 36% of the state's electricity retail sales were generated from qualifying renewables.
- Most of new renewable energy has come from wind and solar (behind-the-grid + large grid-connected).
- Other states in Western U.S. are beginning similar growth of renewables due to state mandated RPS.
- The CAISO formed the Western Energy Imbalance Market (EIM) in 2015 to help integrate renewables throughout the western U.S.
- Large scale battery storage resources being developed and beginning to come on-line as a result of California state policies.

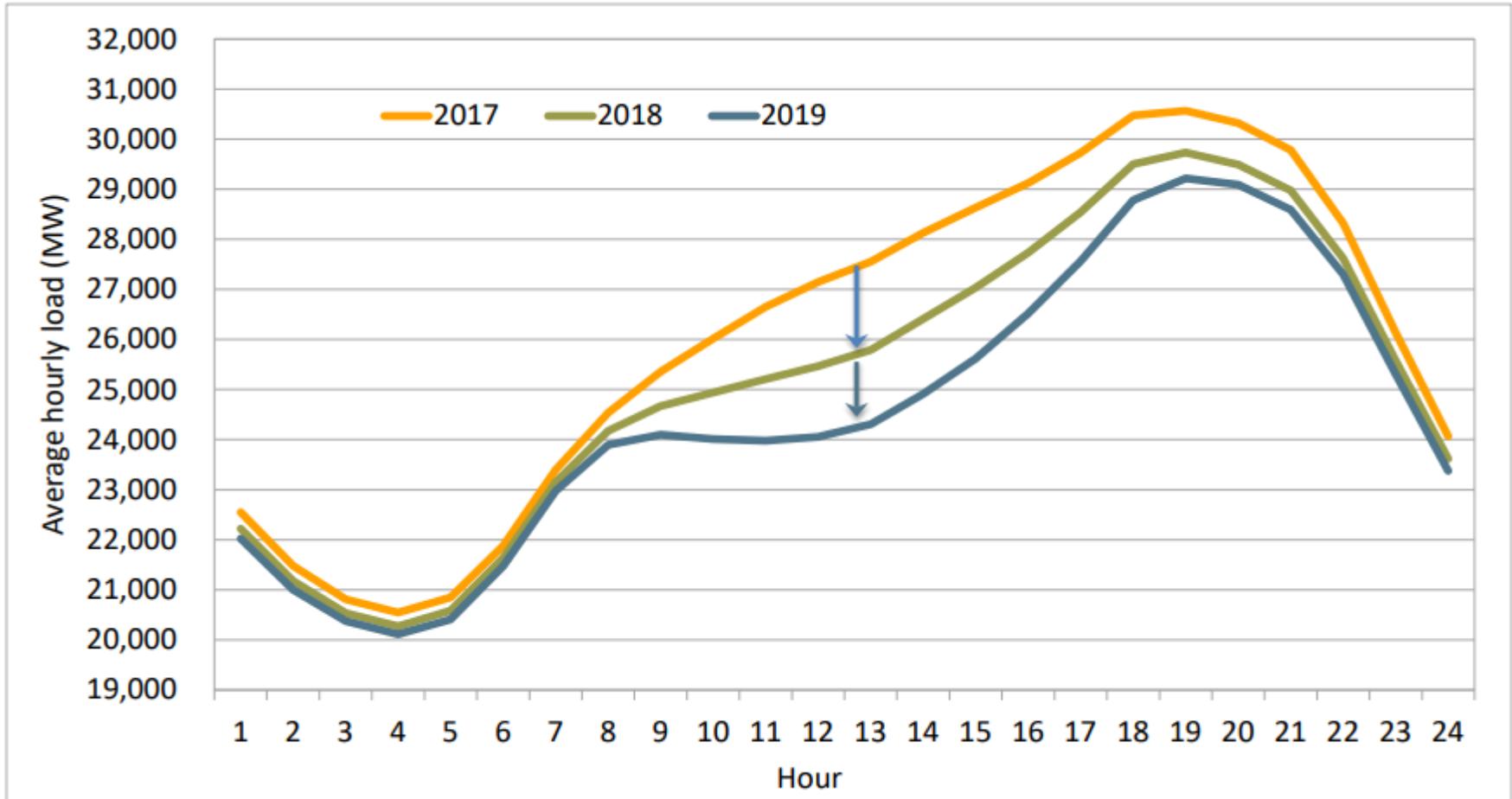


Western Energy Imbalance Market (EIM)

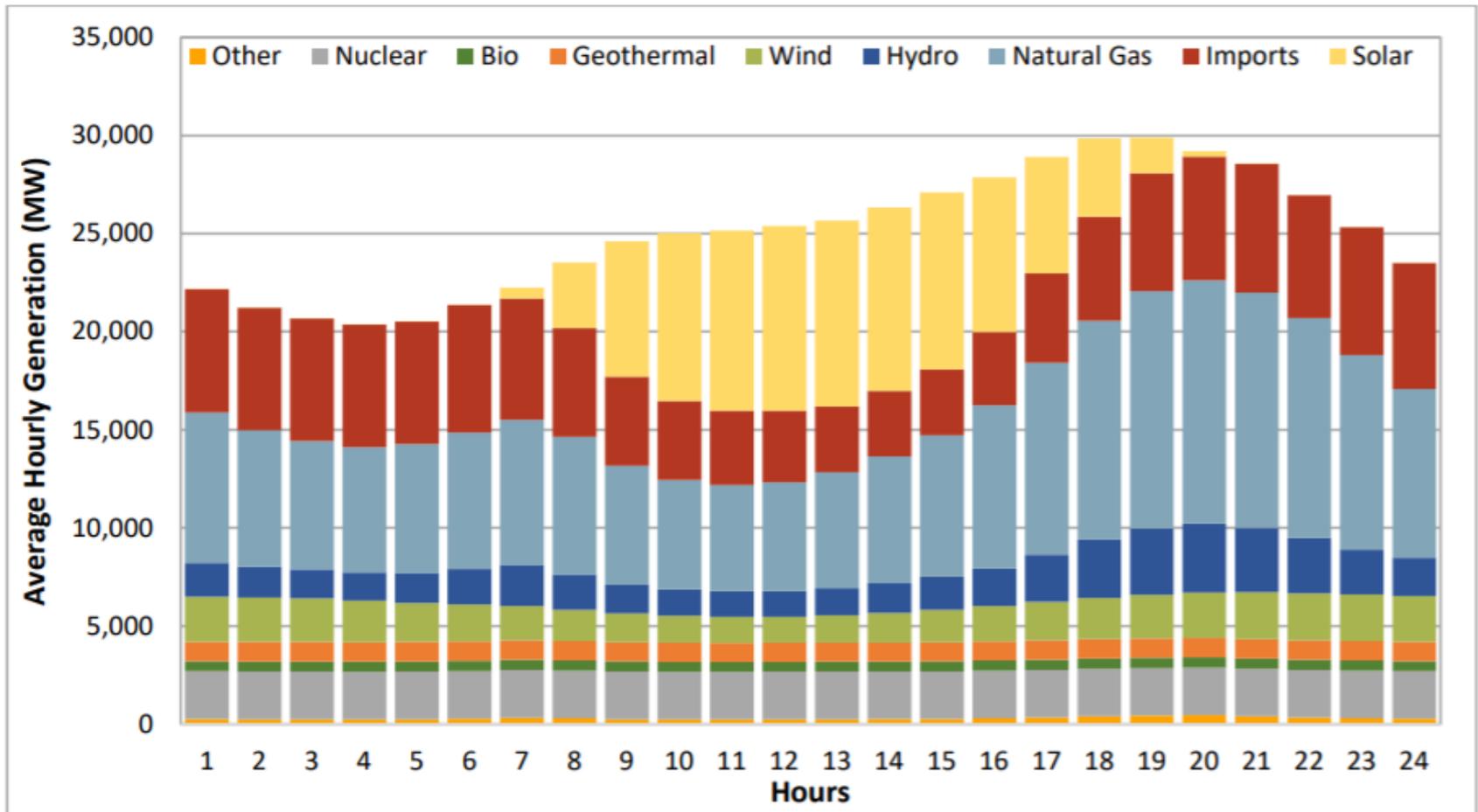
CAISO

- The Western EIM was launched in 2014 and now includes most of western U.S.
- The EIM market system optimizes real-time dispatch across the Western U.S.
- Besides its economic and reliability advantages, the EIM improves the integration of renewable energy.

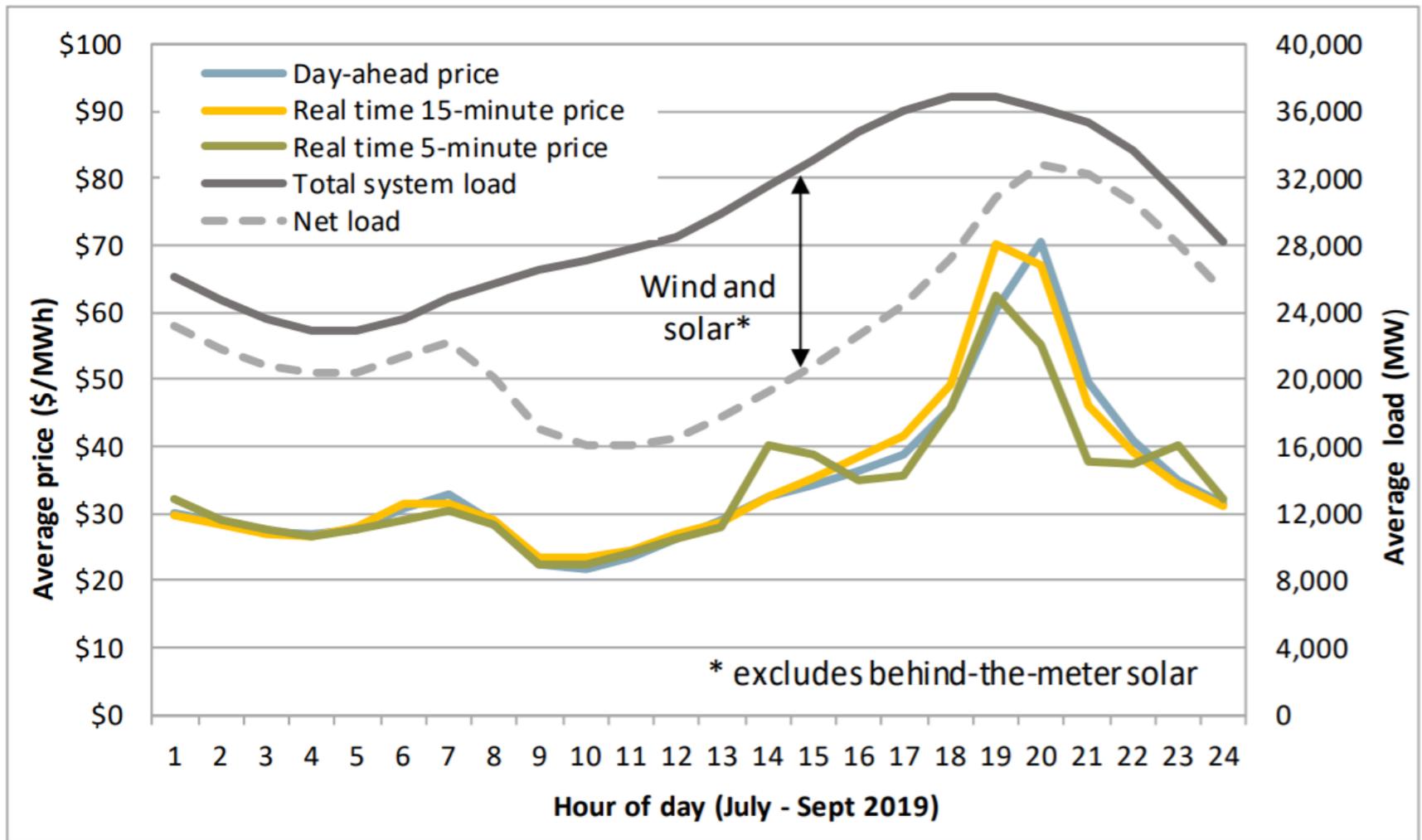
Total system load shape has changed dramatically due to growth of behind-the-meter solar.



In 2019, grid-connected solar accounted for about 11% of total CAISO energy, while wind accounted for about 7%.



Energy market prices throughout the Western U.S. are now driven by “net loads” (i.e. total loads less interconnected wind and solar)



Four key challenges and initiatives

1. Long and short term load forecasting which explicitly accounts for behind-the-meter intermittent renewables and other DERs (and climate change?).
2. Market structures that support system planning needs and policy objectives
 - Resource adequacy requirements, capacity markets or energy only market?
 - Resource adequacy requirements/counting methods that account for actual energy and flexible ramping capacity in key hours of day.
 - Increase reserve margin target incorporated in resource adequacy requirements?

Four key challenges and initiatives (continued)

3. Market products/software that can help incent development and efficient dispatch of flexible ramping capacity and load shifting resources.
 - Enhance real-time flexible ramping product
 - Add day-ahead flexible ramping product
 - Enhanced software for dispatch of battery storage resources
 - Increase flexibility of demand response

4. Increased regionalization to achieve more efficient scheduling/use of transmission and ramping capacity in day-ahead and real-time.
 - Continue to expand EIM footprint
 - Add EIM day-ahead market or scheduling process
 - Regional resource adequacy and flexible ramping requirements