California ISO

Procuring flexible capacity to manage net load uncertainty — overview and issues

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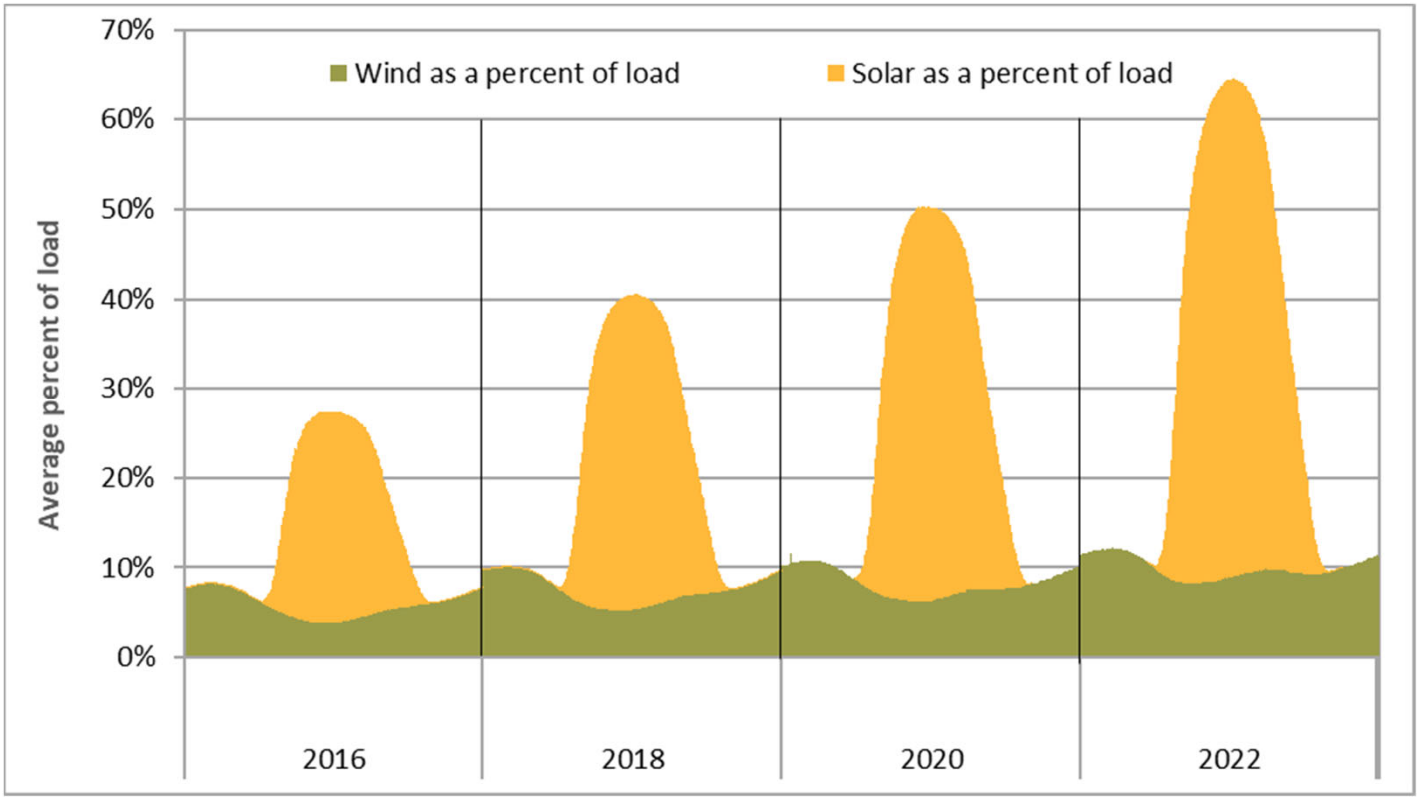
Presentation outline

- Renewable integration in the California ISO (CAISO)
- Overview of the flexible ramping product
- Issues with the flexible ramping product

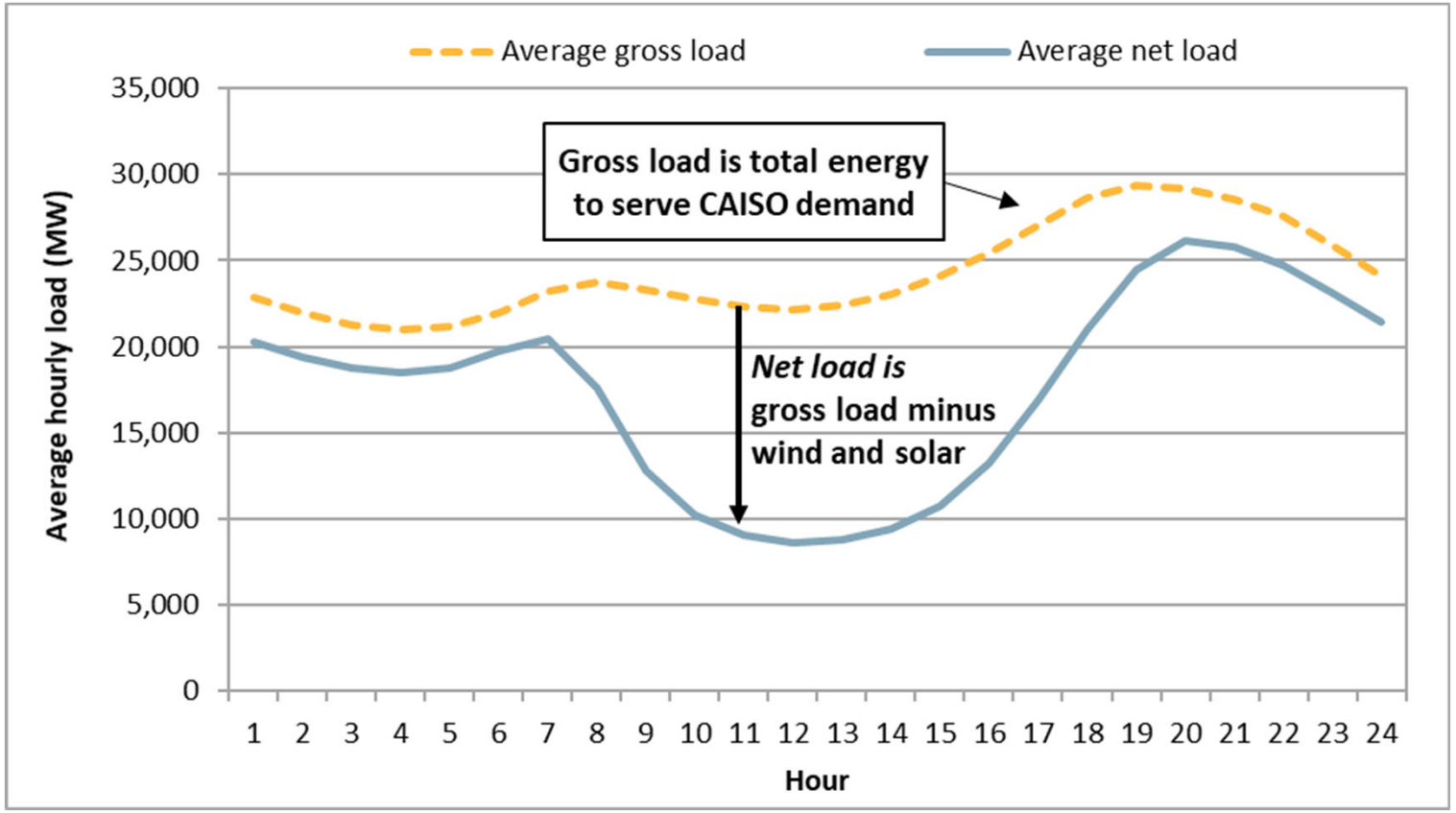
Solar and wind forecasts continue to cover a larger percent of load

Average CAISO wind and solar forecasts as a percent of load (2016-2022)



CAISO operation and market focused on *net load*, total load minus wind and solar

Average hourly CAISO load (2022)

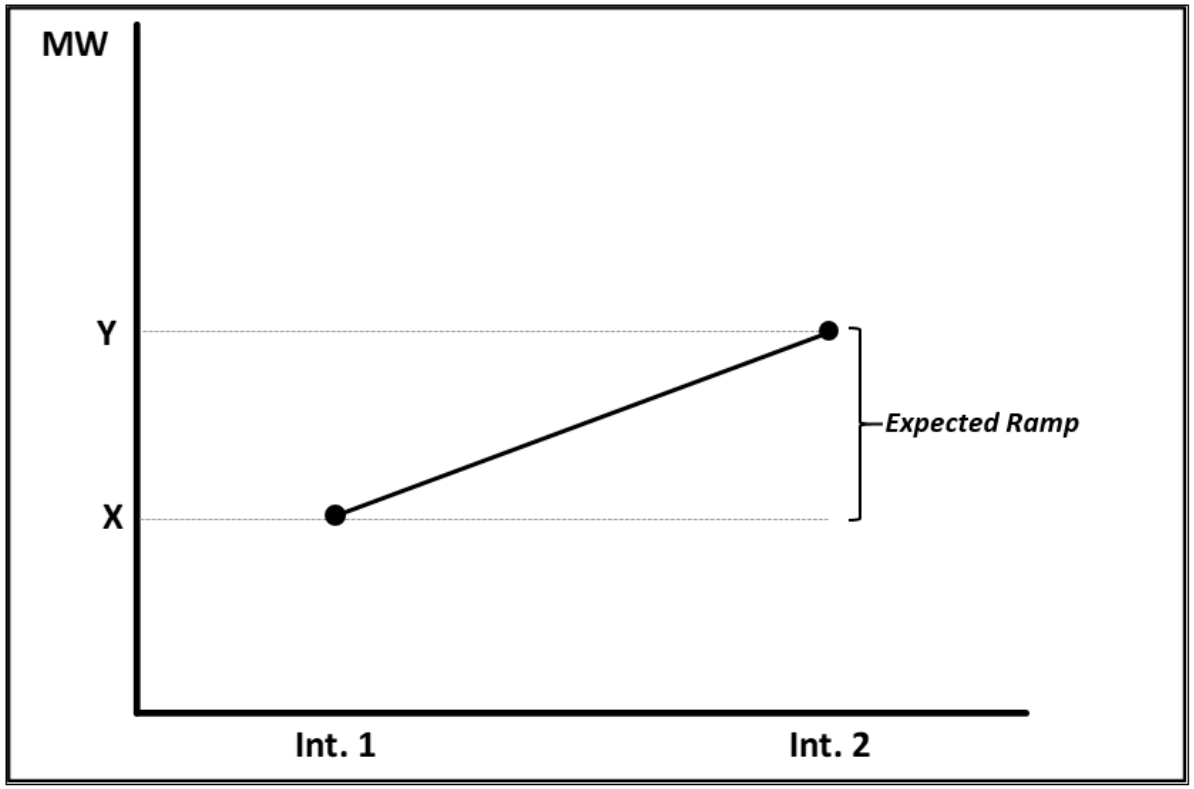


Overview of flexible ramping product

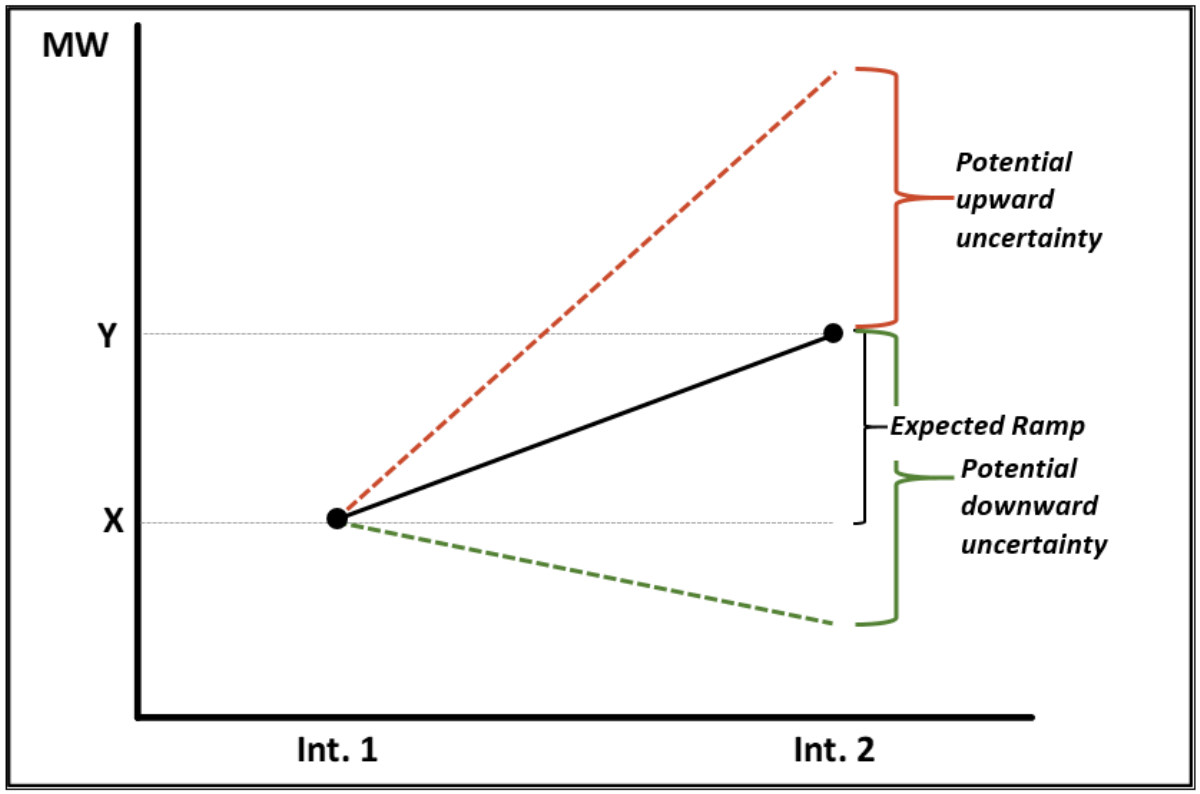
Overview of flexible ramping product

- Enhance reliability and market performance by procuring flexible capacity to manage *net load uncertainty*
  - **Net load:** Load minus wind and solar
  - **Uncertainty:** Forecast error between expected and actual forecasts in the following interval
- Use demand curves to allow the market optimization to consider the trade-off between the cost and benefit of procure more or less flexible ramping capacity.
- The flexible ramping product was first implemented on November 2016, but significant enhancements were implemented on February 1, 2023.

Example, expected increase in the net load forecast in the next interval



The flexible ramping product procures upward and downward flexibility to meet uncertainty surrounding a net load forecast in the next interval



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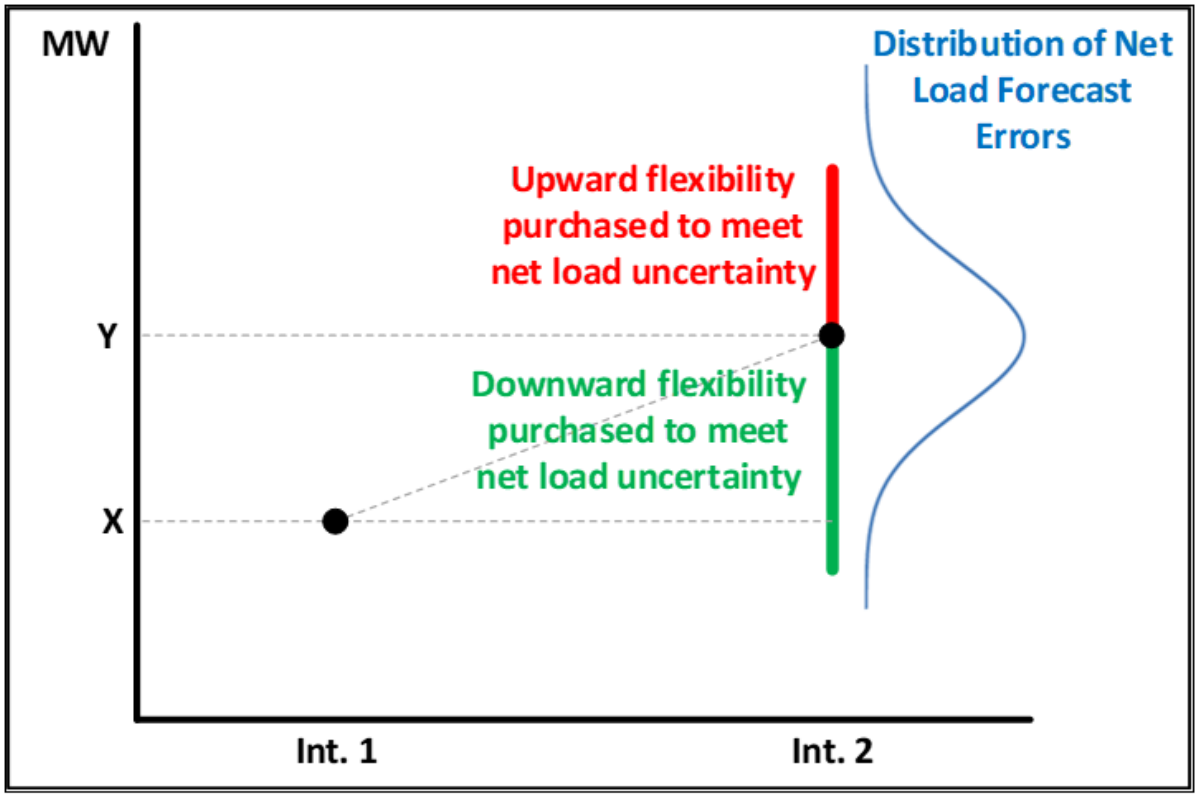
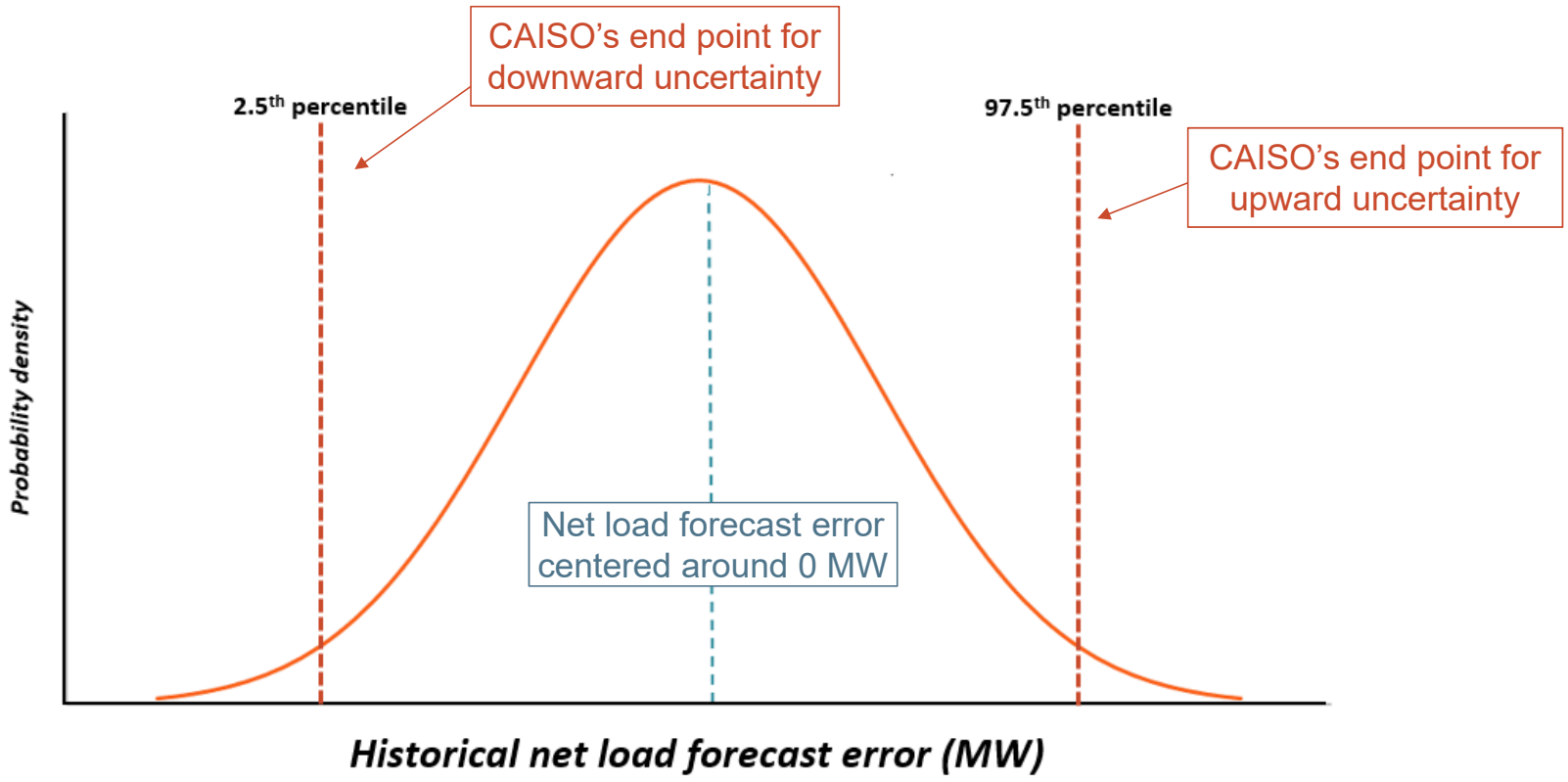


Example distribution of historical net load forecast error



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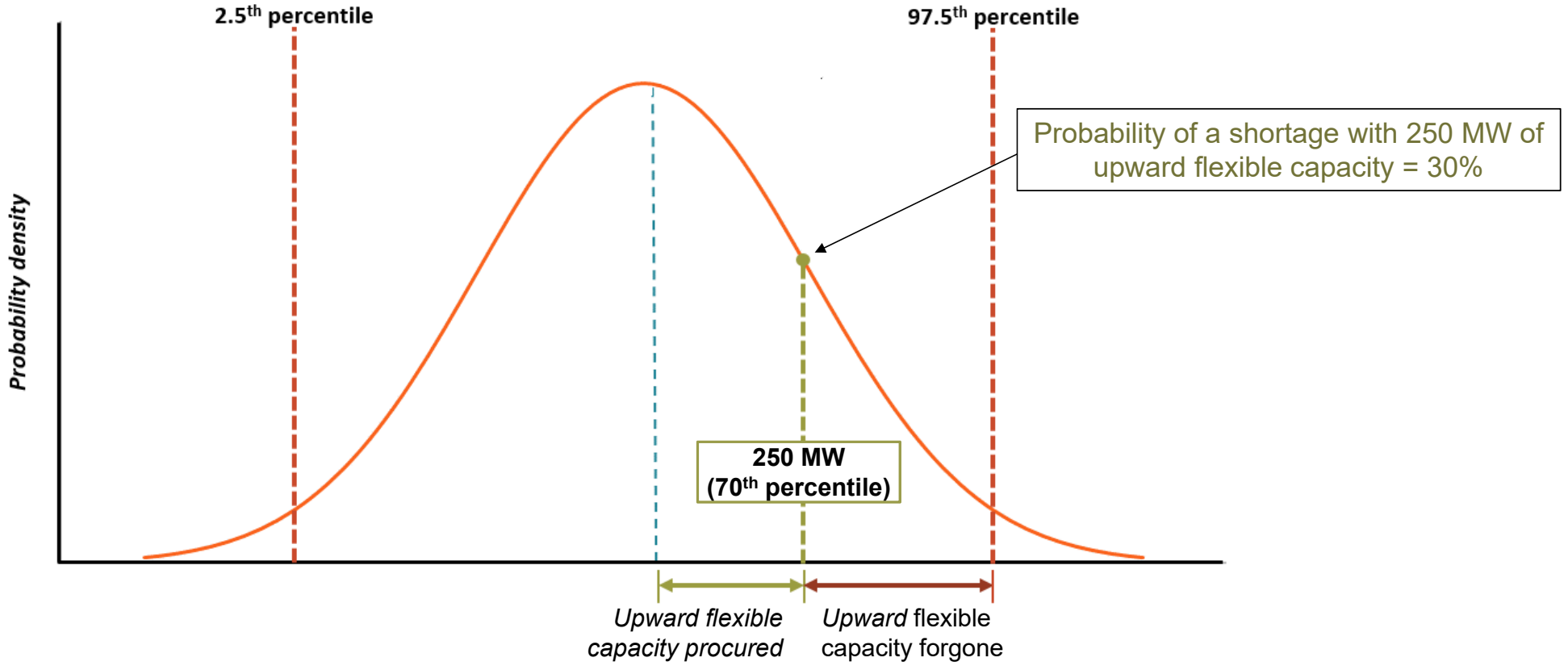

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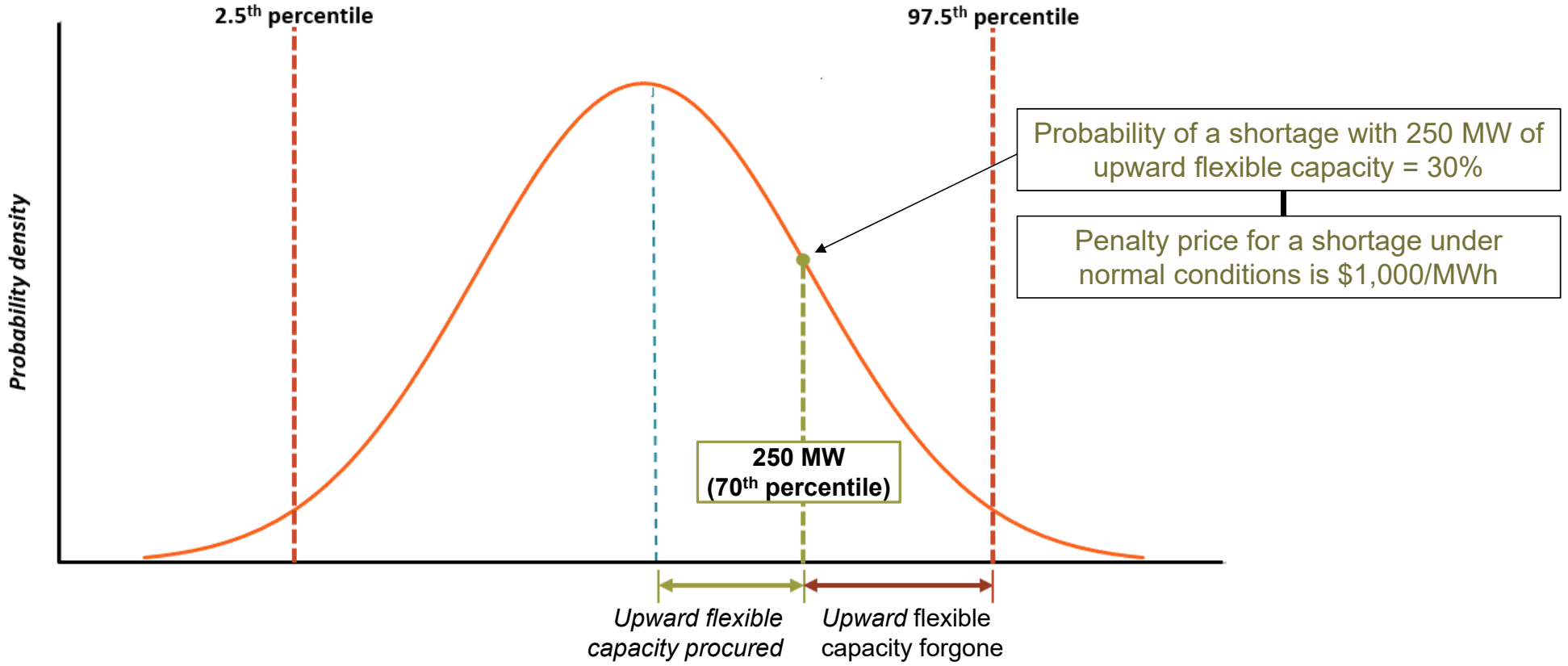
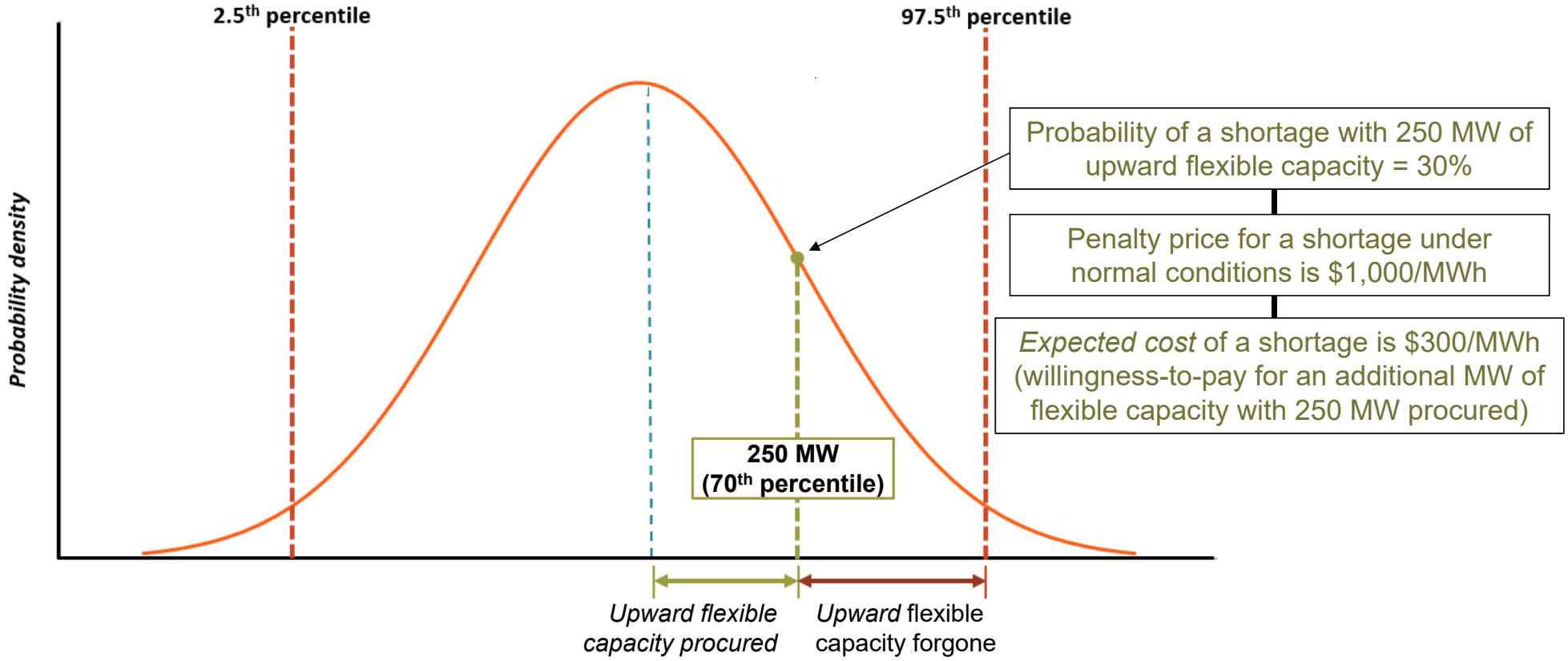


Defining the price for flexibility

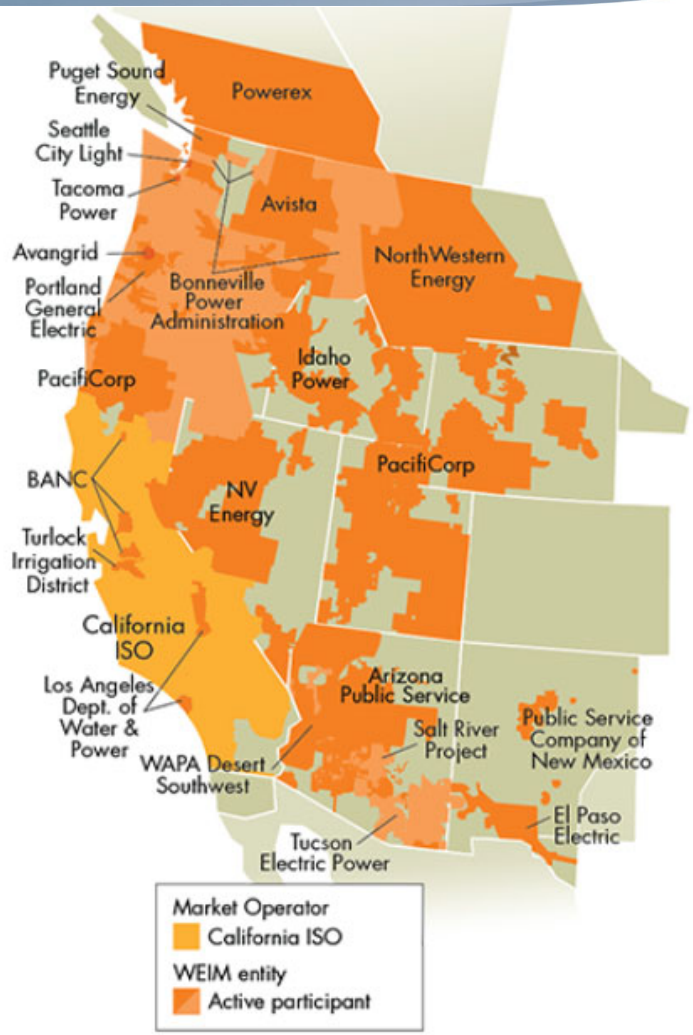


Issue 1

Stranded flexible ramping capacity

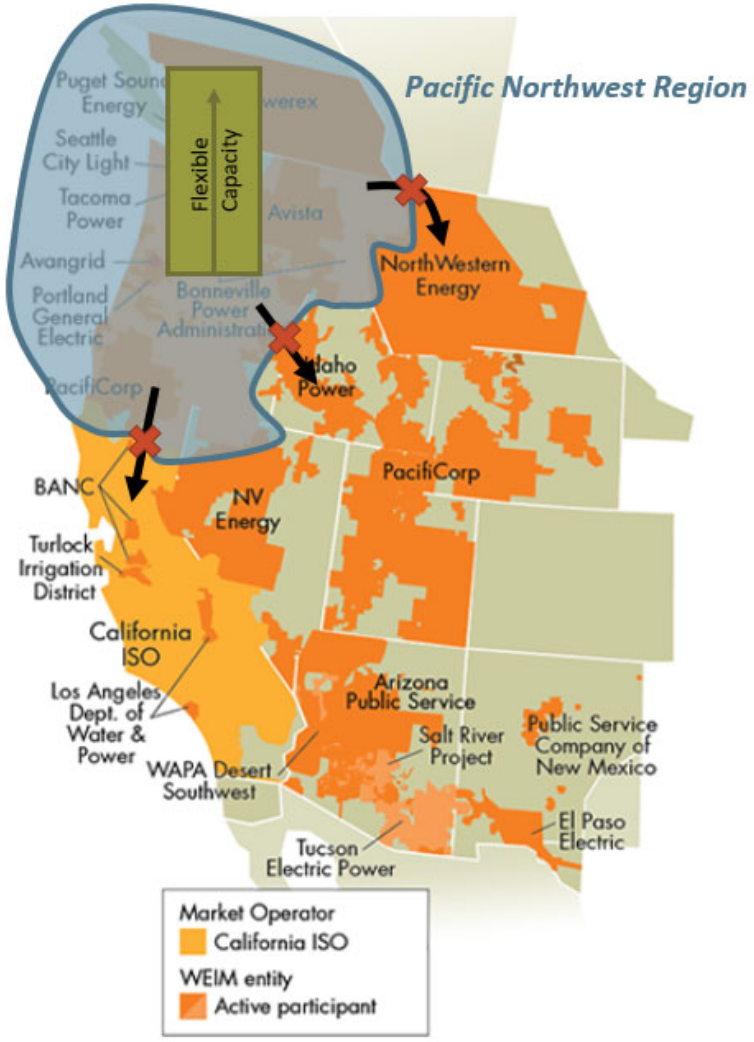
Regional integration through the real-time Western Energy Imbalance Market (WEIM)

- The WEIM allows balancing areas outside of the California ISO to participate in the real-time market
- Twenty-one entities outside of the California ISO participate in the WEIM
- Transmission capacity between areas allow market optimization to balance supply and demand across the footprint
- Flexible ramping capacity was mostly procured to meet system-wide uncertainty needs



Flexible ramping capacity was often stranded behind transmission constraints

- Original flexible ramping product implementation did not consider transmission constraints
- Flexible capacity procured to meet system-wide uncertainty needs was often stranded behind transmission constraints
- Transmission constraints prevents flexible capacity from being deployable if uncertainty materializes
- Low or zero prices for flexible capacity



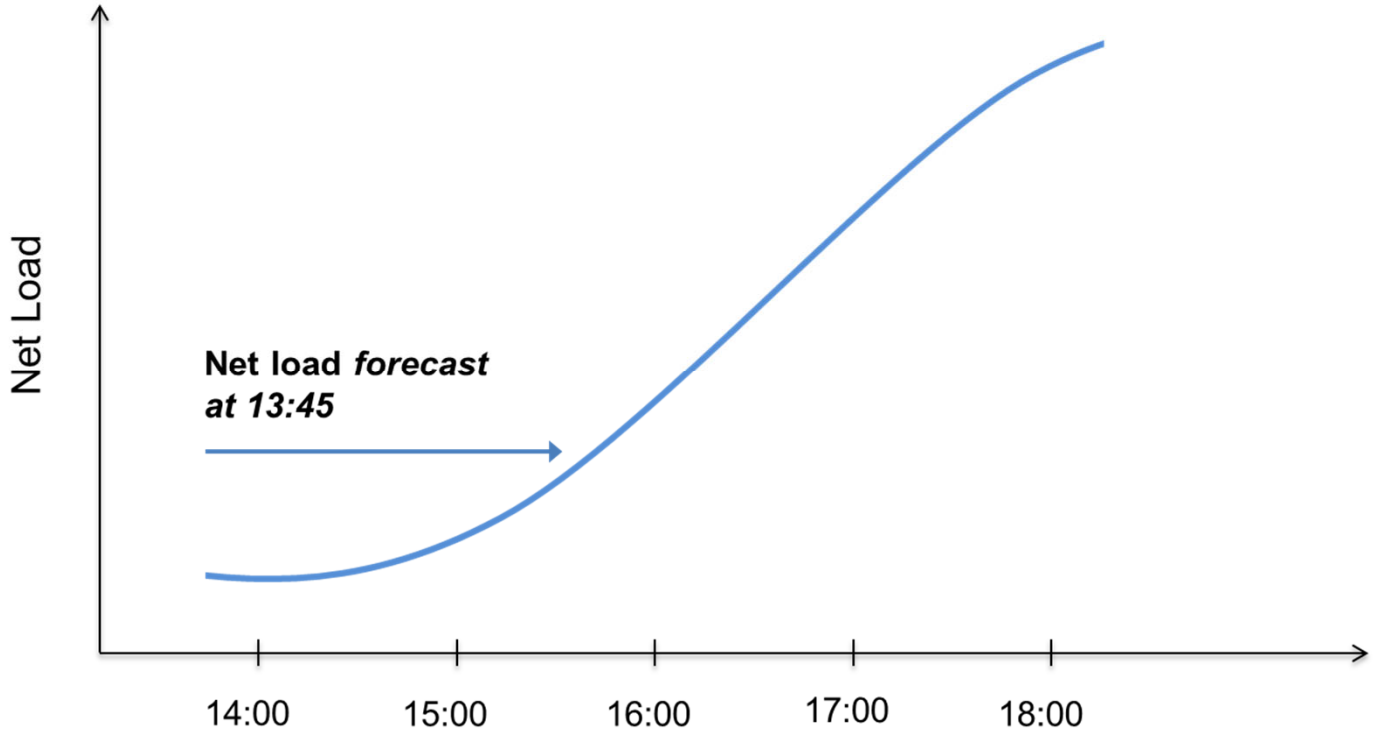
Flexible ramping product was significantly enhanced on February 1, 2023

- Flexible ramping product is now modeled at each node to ensure that flexible capacity awards are feasible and appropriately priced.
  - Flexible capacity awards now produced through two deployment scenarios that adjusted the expected net load forecast in the following interval by the lower and upper ends of uncertainty that might materialize
  - Use these scenarios to produce deliverable flexible capacity awards that do not violate transmission or transfer constraints

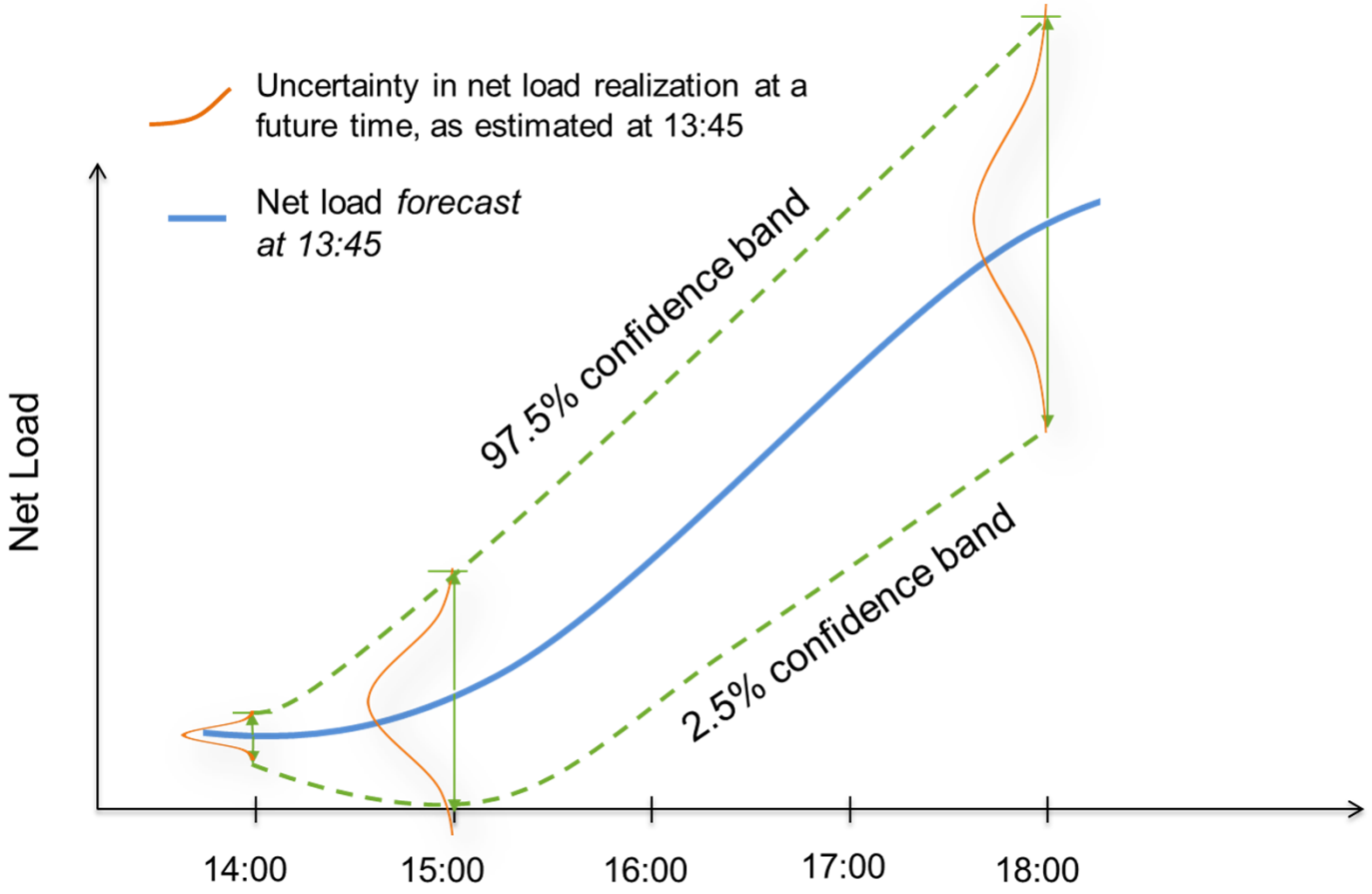
Issue 2

Short-horizon for considering uncertainty

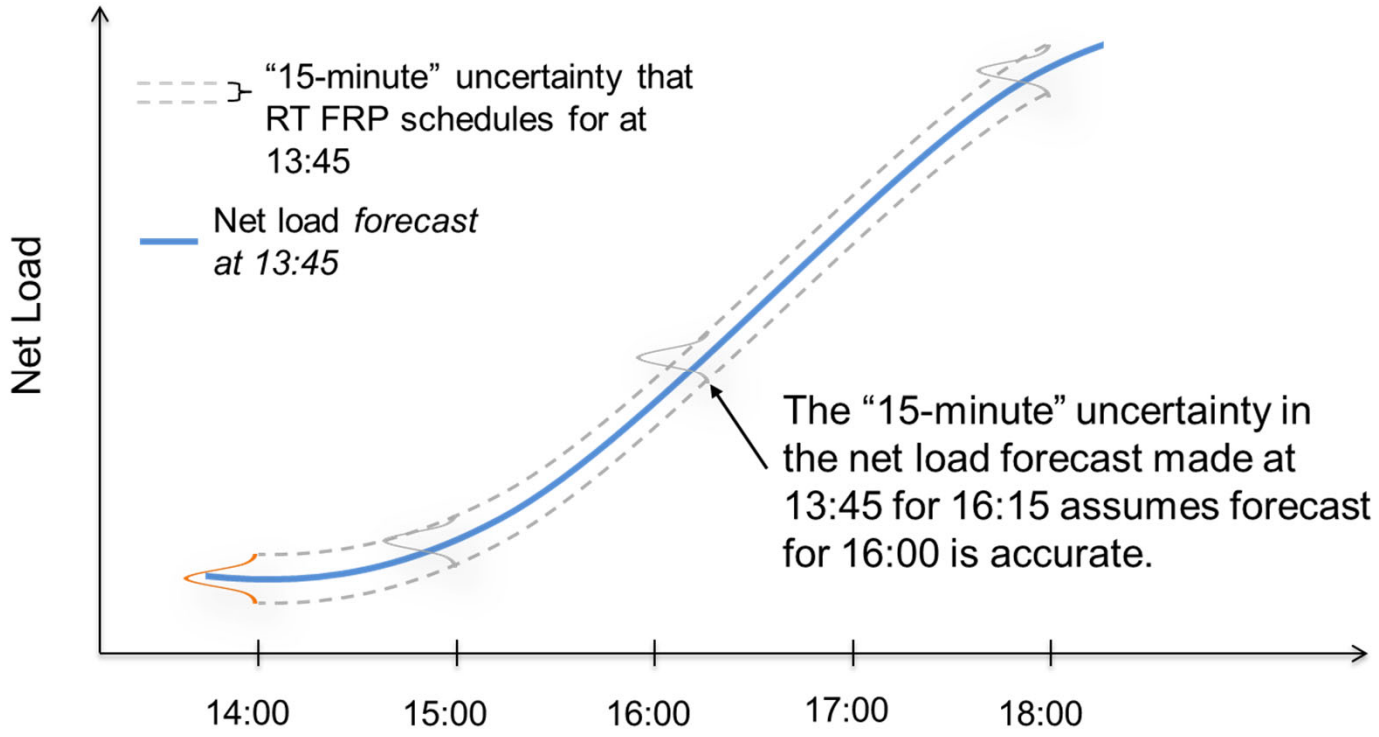
In real-time, the market software uses net load forecast for every interval up to 4.5 hours in future to determine optimal schedules at the current interval (e.g. 13:45 in this example).



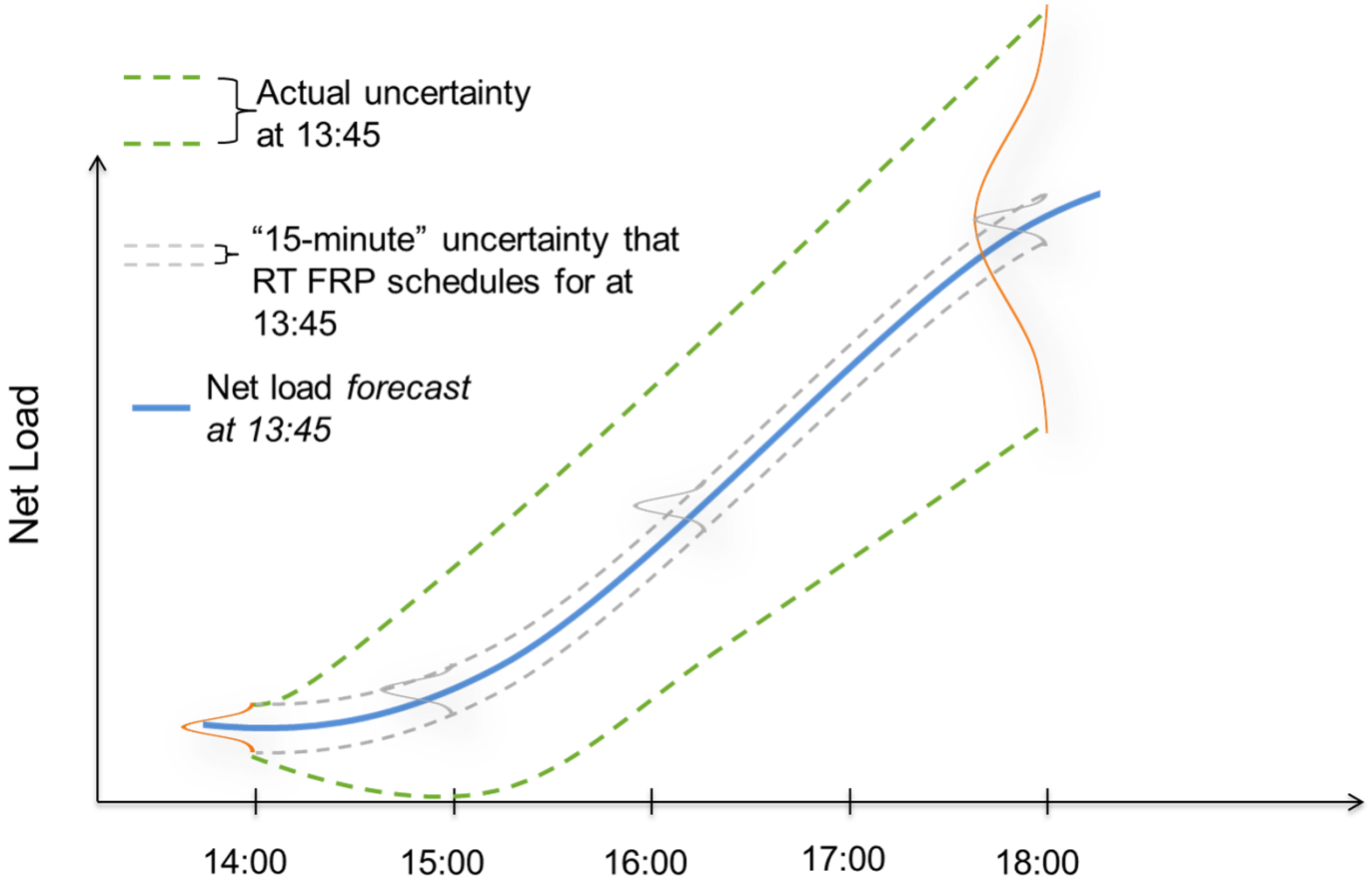
At 13:45 the uncertainty over what net load may actually be at each point in time over the next 4.5 hours grows further out in the future.



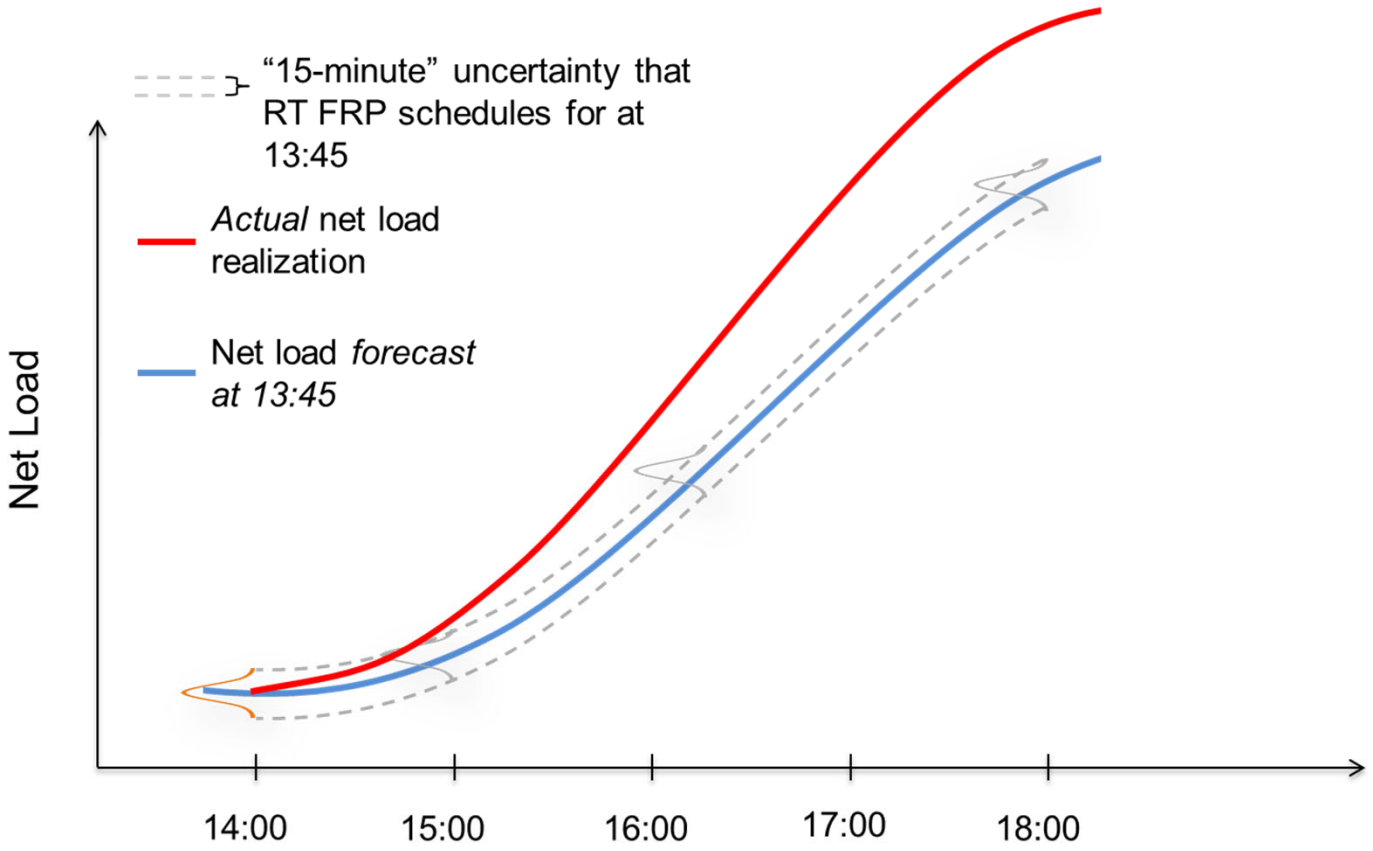
Flexible ramping product has improved real-time software by considering some uncertainty around the net load forecast for every interval 4.5 hours in future used to determine optimal schedules at the current interval.



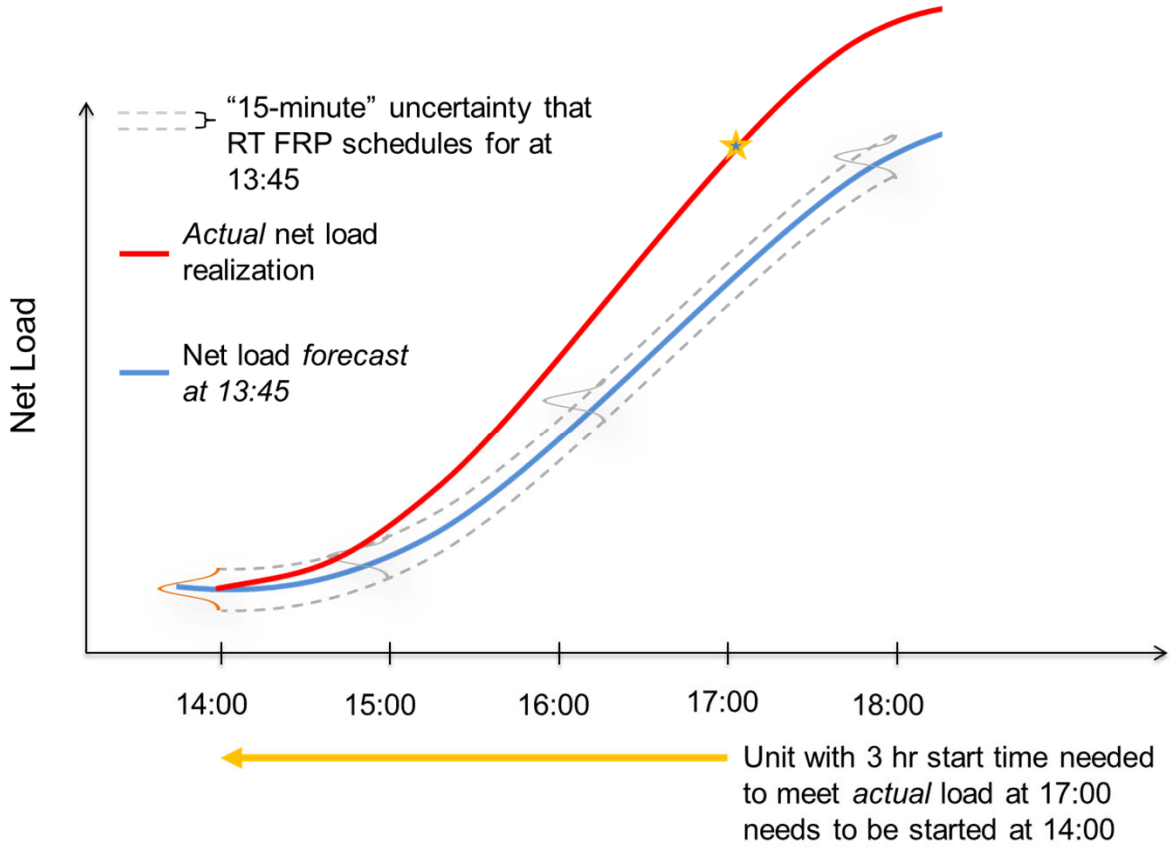
The “15 minute” uncertainty used by FRP is substantially less than actual uncertainty over what net load forecast may be 1 to 4 hours in future



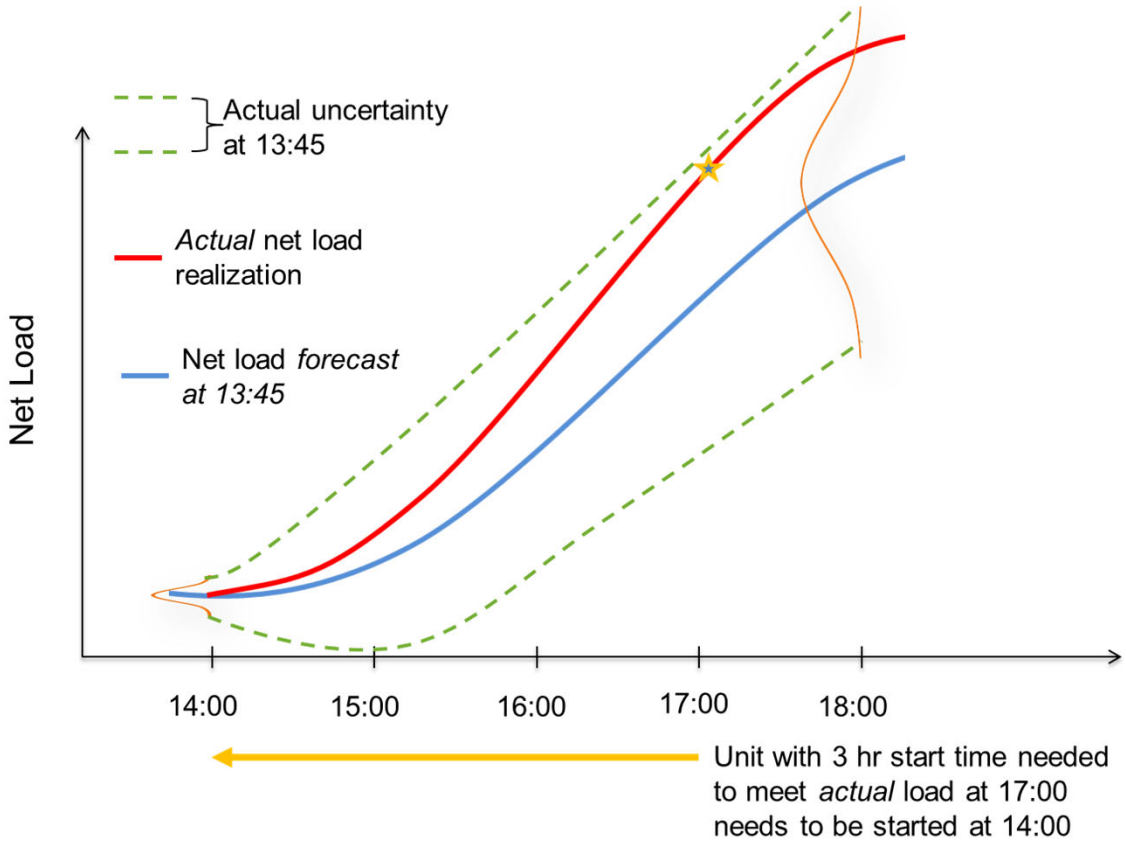
The real-time market software does not optimally position resource fleet to meet potential high net load outcomes 1 to 4 hours in the future.



For example, software will miss opportunity to start units with 3 hour start times that are needed by 17:00 to meet potential high net load outcomes– requires manual operator interventions

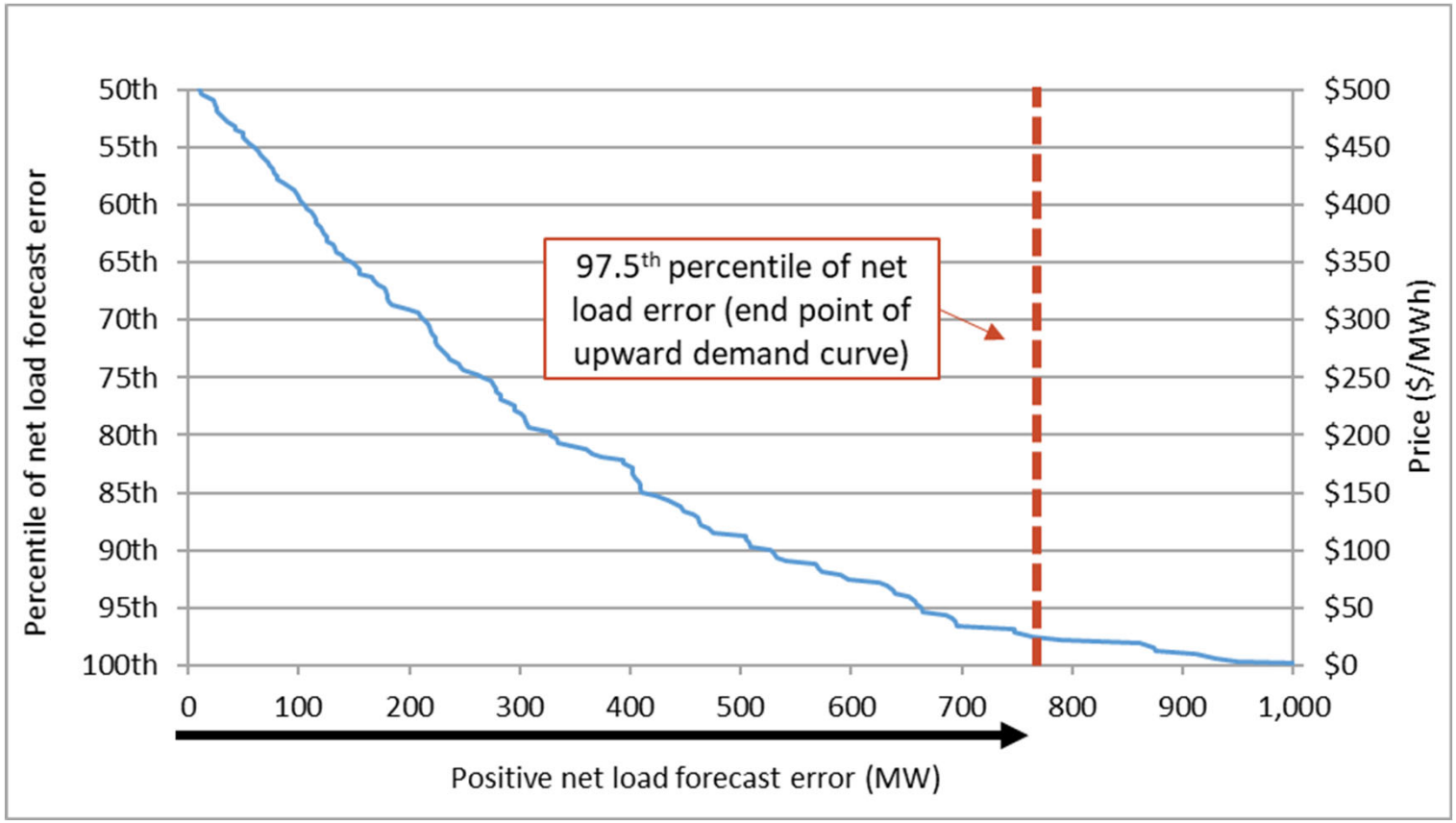


Considering actual net load uncertainty 1 to 4 hours in future would allow the real-time software to position resources to meet higher potential net load outcomes.



Technical appendix

Creating a demand curve from historical forecast error



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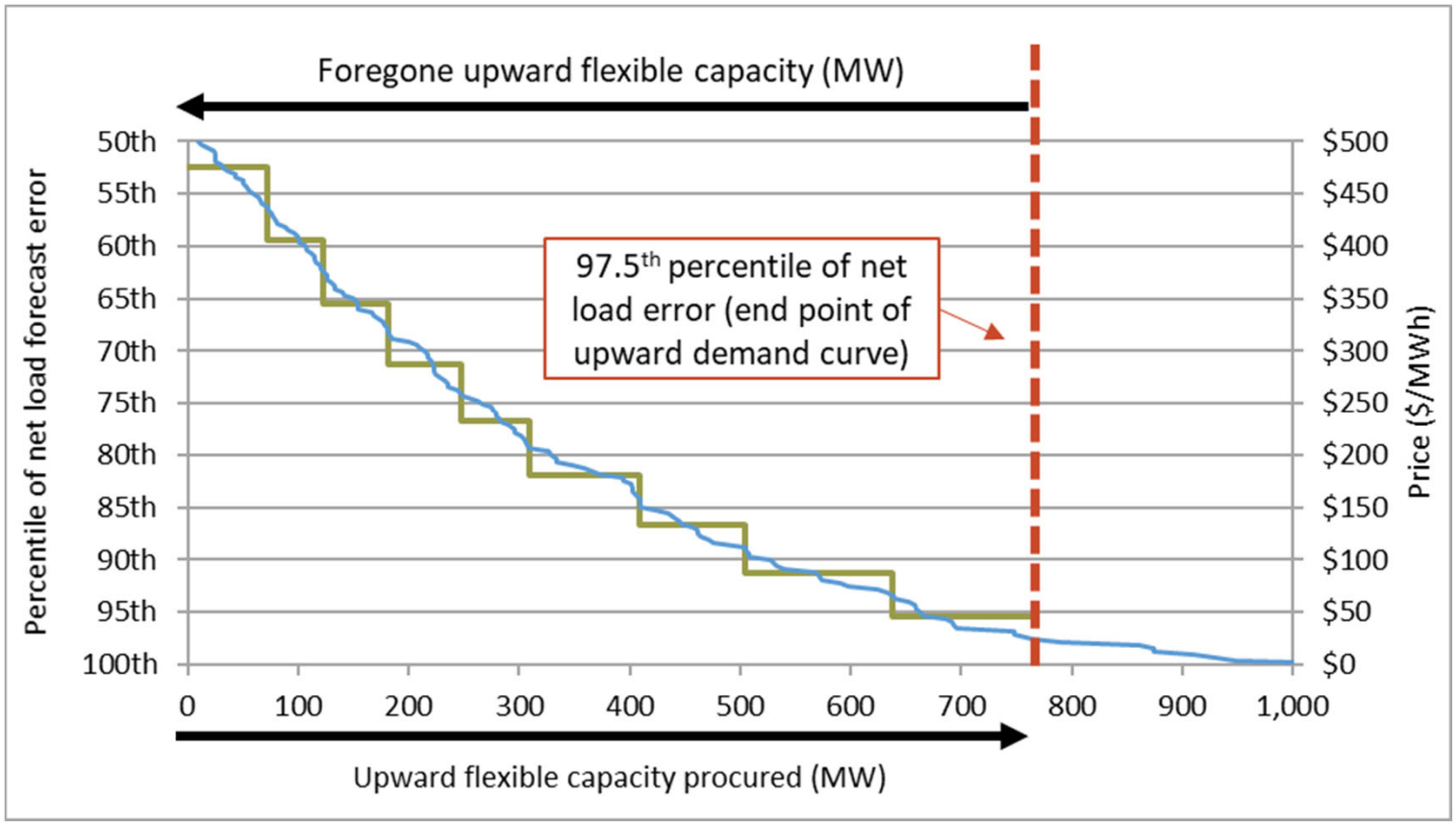

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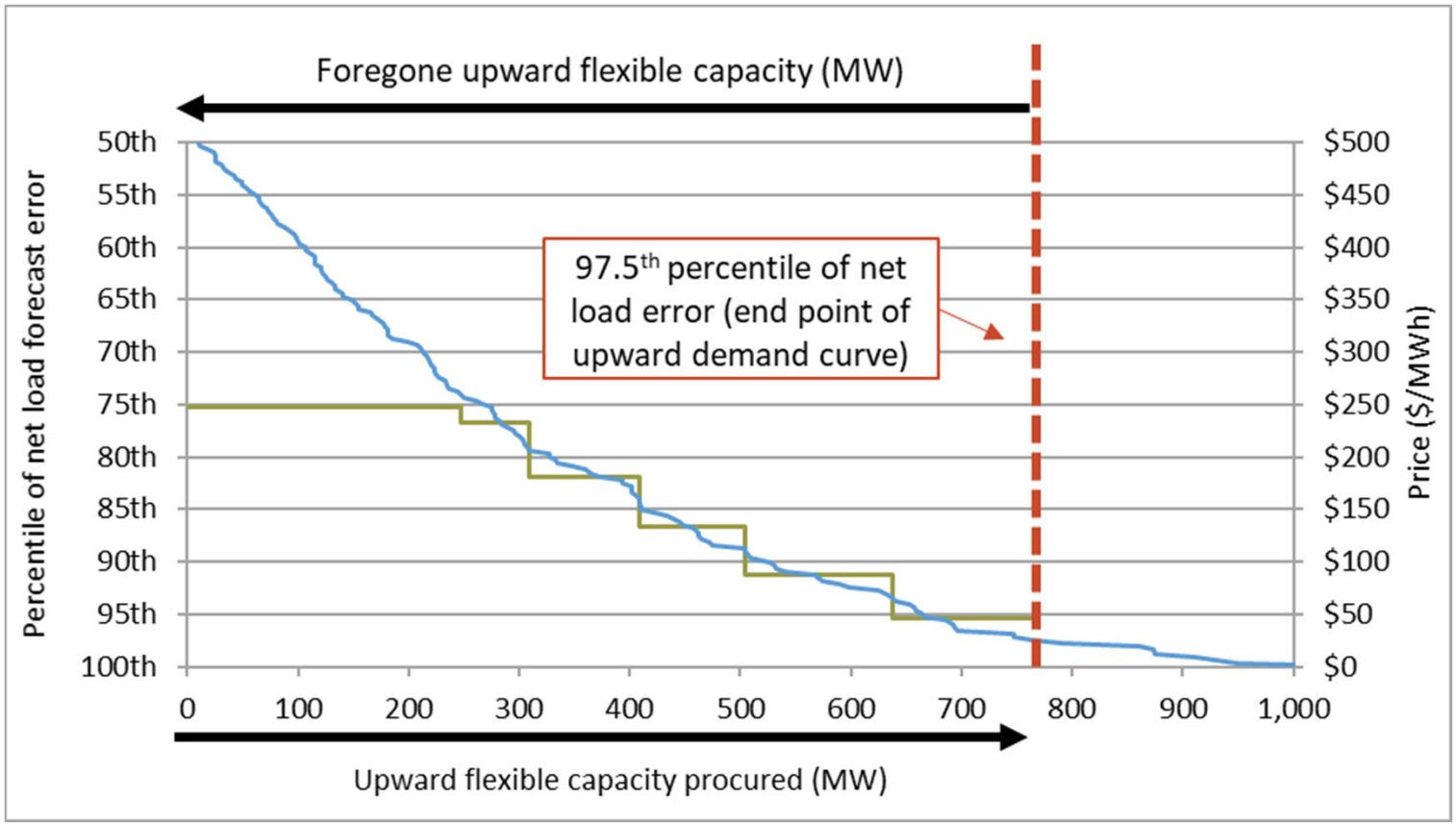
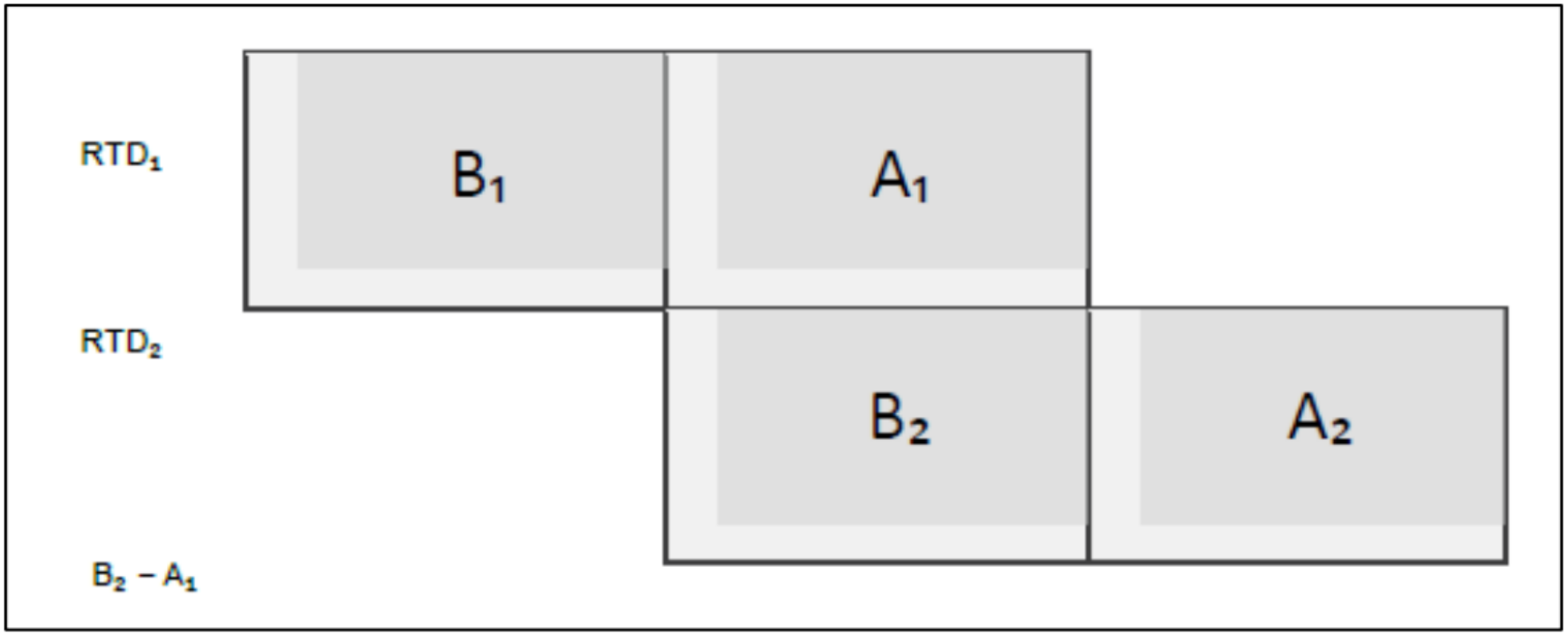


5-minute market uncertainty



15-minute market uncertainty