California ISO's Day-Ahead Market Enhancements under High Renewable Penetration Paradigm

Petar Ristanovic, California ISO
Khaled Abdul-Rahman, California ISO
George Angelidis, California ISO
Don Tretheway, California ISO

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Hourly schedules do not position the fleet to respond to sharp transitions in net load ramp

15-minute ramp is higher than scheduled hourly ramp
Day-ahead market enhancements address net load curve and uncertainty previously left to real-time market

• 15-minute scheduling granularity in day-ahead market to more closely follow actual ramp

• Combine integrated forward market and residual unit commitment into single optimization

• Add flexible ramping product to the day-ahead market to address uncertainty
What is the flexible ramping product?

- Reserved upward and downward ramping capacity procured at $t-1$ to be delivered if needed at $t$ to meet the demand forecast plus upward and downward uncertainty.

Implemented in the real-time market Fall 2016
Day-ahead market has three targets to meet: bid in load, upward and downward uncertainty.
15-minute scheduling granularity in day-ahead market to more closely follow actual ramp

• Operational benefits
  – Commit resources to more closely match steep net-load ramps
  – Reflect sharp changes in ramp that occur within the hour
  – Improve VER scheduling in day-ahead
  – PNW hydro resources can provide 15-minute schedules in day-ahead, but not real-time

• Technical challenges
  – Market optimization solves for 96 intervals vs 24
  – Solving market within current market timelines
  – Settlement updates to nearly all charge codes
Combine integrated forward market and residual unit commitment into single optimization

• Operational benefits
  – Optimal unit commitment vs two stages with different objectives
  – Reliability capacity addresses under-supply and now over-supply
  – Ramping capability to address uncertainty can be procured relative to demand forecast

• Technical challenges
  – Larger problem to solve by combining constraints
  – Deliverability of FRP to meet reliability capacity
Add flexible ramping product to the day-ahead market to address uncertainty

• Operational benefits
  – Positions fleet to ensure ramp capability to meet uncertainty in real-time
  – FRP awards secure a real-time must offer obligation

• Technical challenges
  – Deliverability of FRP awards to address uncertainty
  – Modifying requirement calculation to scale with level of load, wind and solar
  – Demand curve used to procure day-ahead uncertainty
  – FRP cost allocation for reliability capacity, uncertainty awards and energy schedules
Day-ahead market enhancements address net load curve and uncertainty previously left to real-time market

- 15-minute scheduling addresses granularity issues between day-ahead market and FMM

- Day-ahead flexible ramping product ensures sufficient ramp feasible resources to meet imbalances that materialize in real-time

- Combining IFM/RUC allows the flexible ramping product to be procured relative to ISO net load forecast