



California ISO

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

Petar Ristanovic, California ISO

Khaled Abdul-Rahman, California ISO

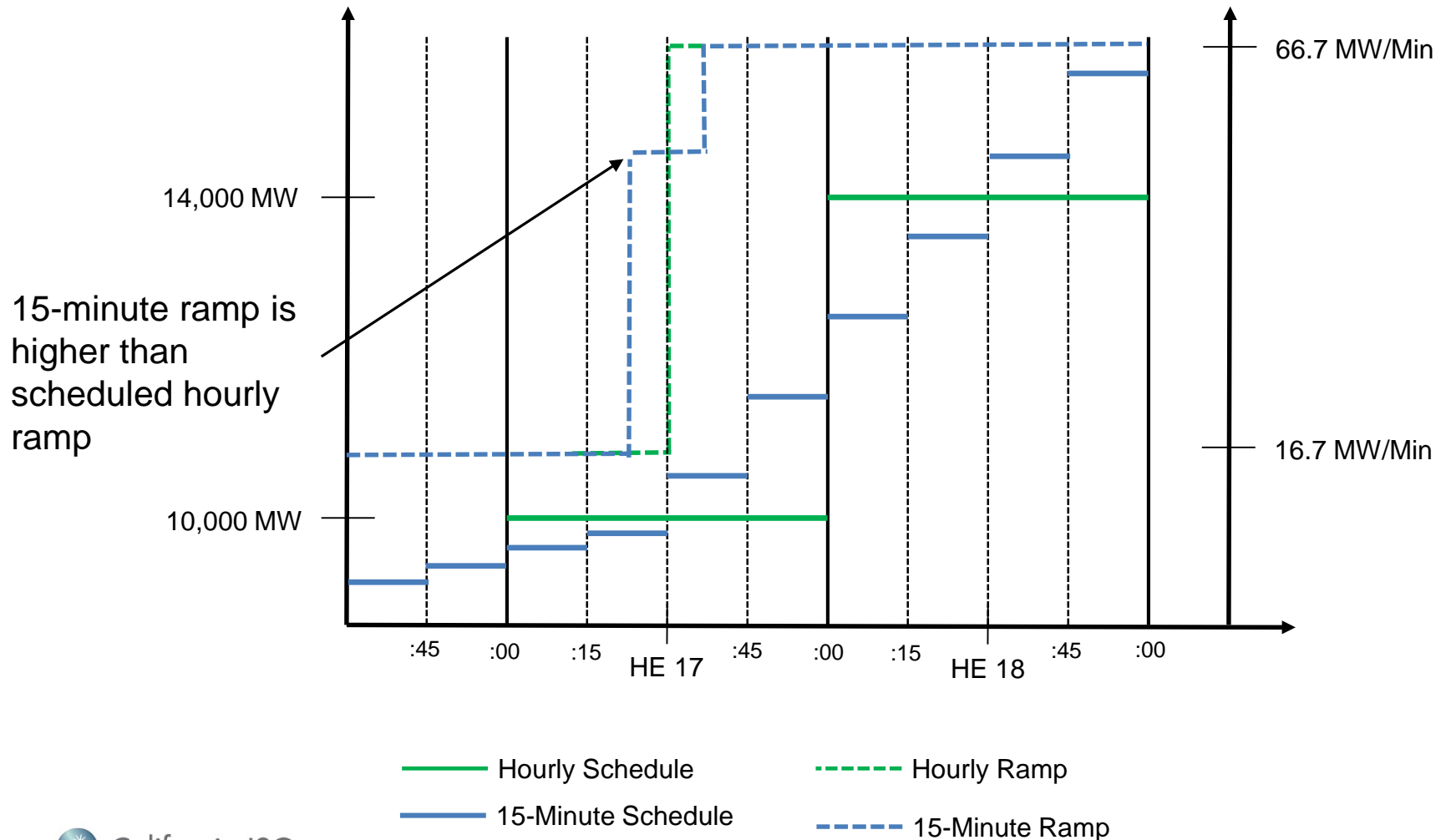
George Angelidis, California ISO

Don Tretheway, California ISO

FERC Technical Conference

June 26, 2018

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

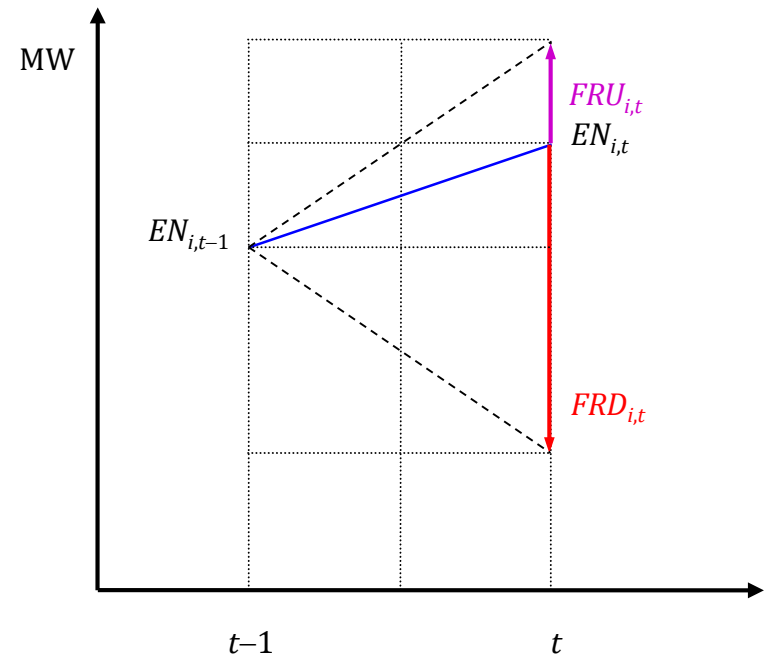


Day-ahead market enhancements address net load curve and uncertainty previously left to real-time market

- 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

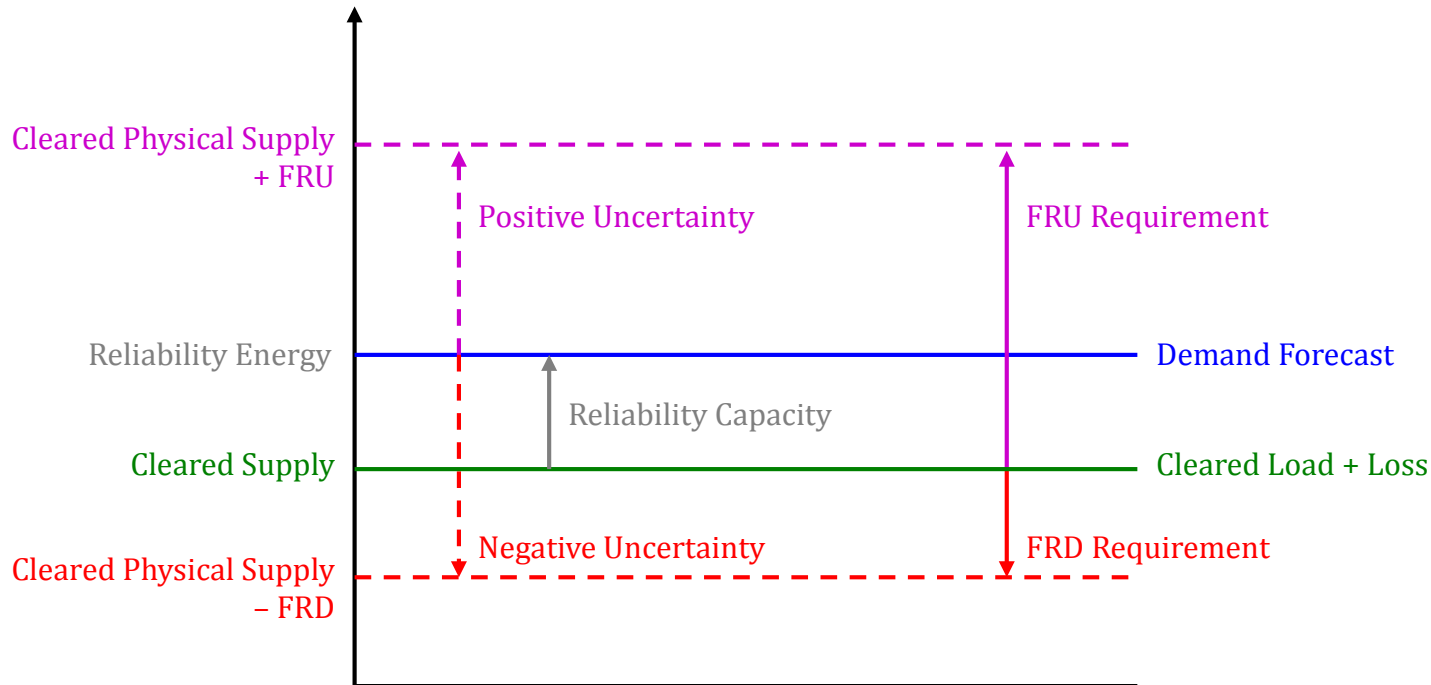
What is the flexible ramping product?

- 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