



MISO Short Term Reserve and Ramp Capability Products

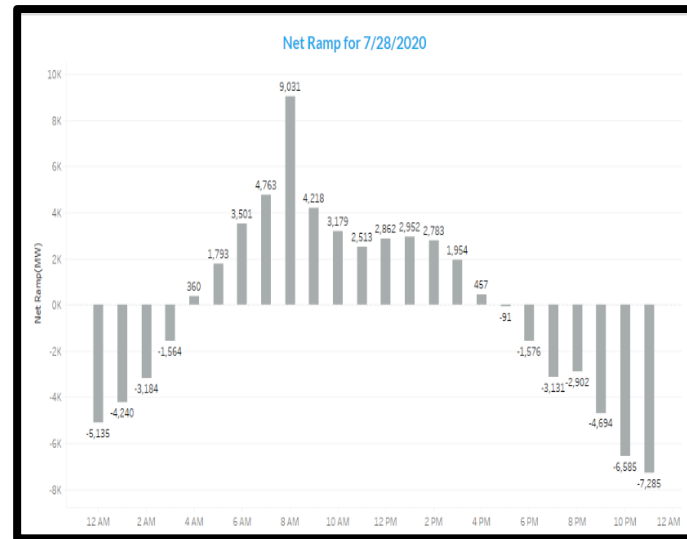
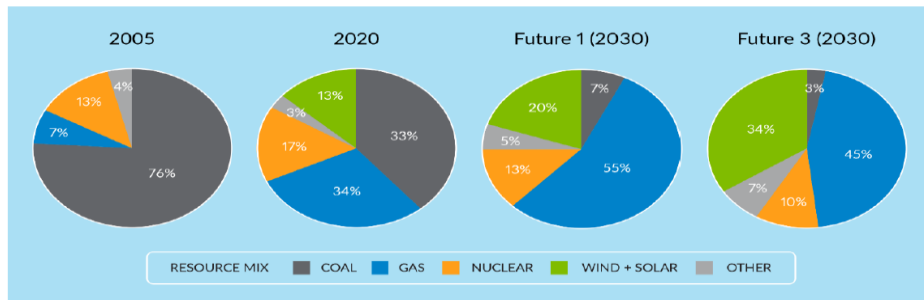
ESIG Meteorology and Market Design
for Grid Services Workshop

June 13, 2023

With a transitioning fleet, MISO is facing increasing variability and uncertainty

- Retirement and decarbonization drives new generation mix and risk profile
- Ramping needs and uncertainty continue to increase and potentially shift to sunset hours

MISO Generation Mix (% of total annual energy by fuel type)

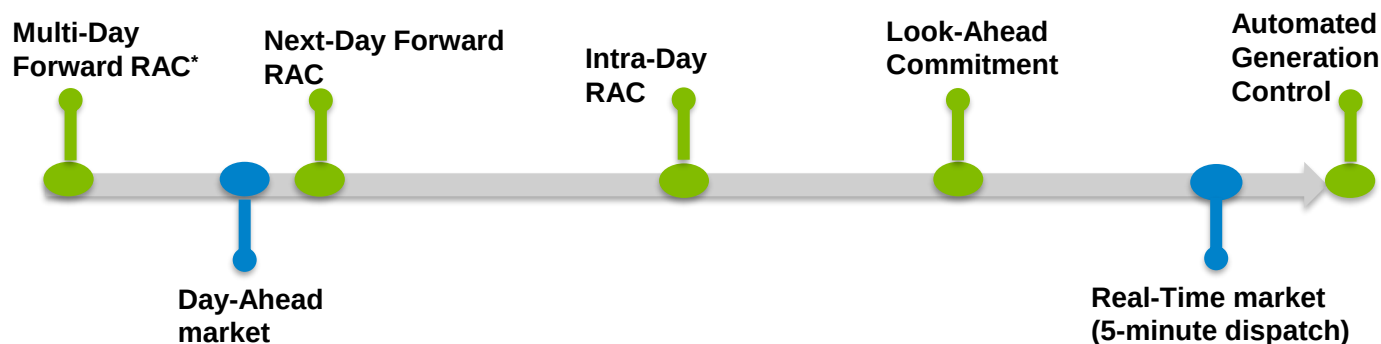


Up to > 9 GW/hr net ramp when wind drop coupled with morning load ramp



Expect the net ramp to increase when coupling with sunset and decreasing imports

Market products are used through multi-stage market clearing to manage ramp and uncertainty

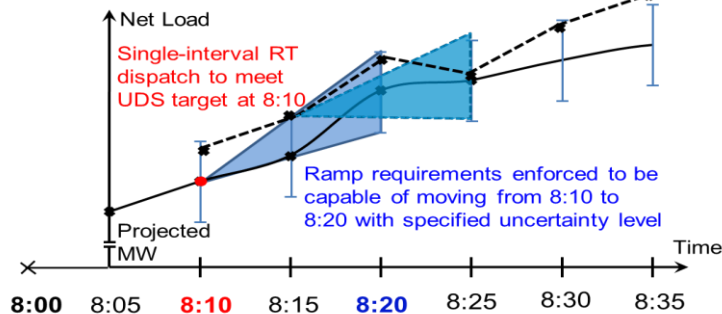


Market Product	Response Time	Uncertainty Coverage
Short-Term Reserve	30min	30min-3hour
Ramp Capability Product	10min	10min-30min
Supplemental Reserve	10min	Largest contingency
Spinning Reserve	10min	Largest contingency
Regulation	5min	4sec-5min

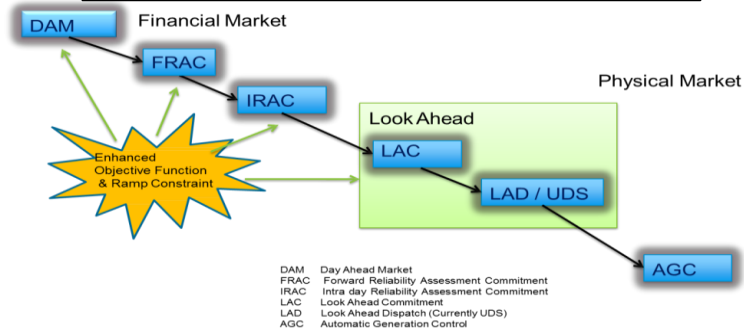
Ramp Capability Product

- With increasing renewable penetration and interchange variability, ramp capability product was developed in 2016 to manage increasing ramping needs
- The market-based ramp management approach provides transparent price signals to incentivize resource flexibility

Requirements set to manage net load variations & uncertainty 10min ahead

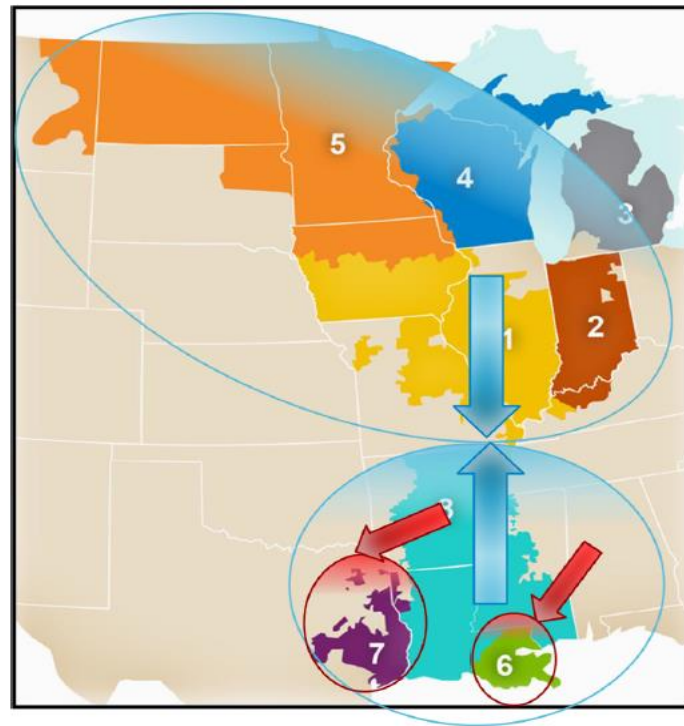


Co-optimization with energy and AS from Day-Ahead to Real-Time



Short-Term Reserves (STR)

- STR is an ancillary service product included in the Day-Ahead and Real-Time Markets that is co-optimized with the other Energy and Operating Reserves products
- Implemented in December 2021
- With Reserve Procurement Enhancement implemented in Q3 2022, STR helps to manage uncertainty at:
 - System wide level
 - Regional level
 - Sub-regional level



STR key features in the MISO Markets

- STR is used to manage 30 min – 3-hour uncertainty
- Resources must have a 30 min response time
- STR is cleared on both offline and online resource



30 Minute Ramp
Response Time



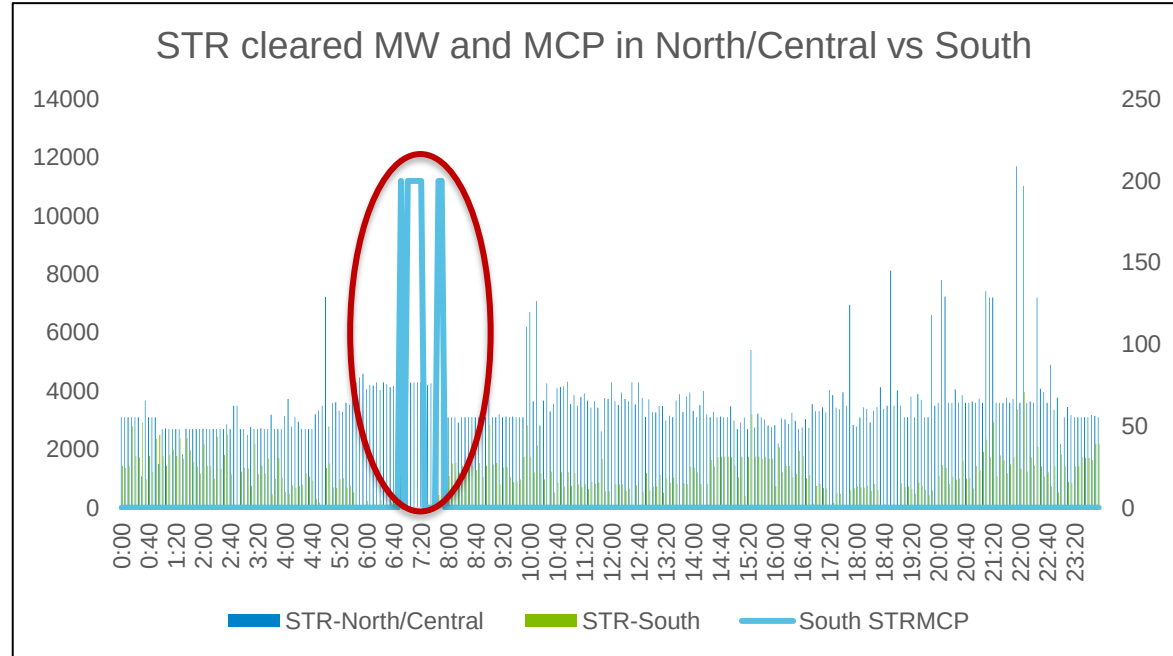
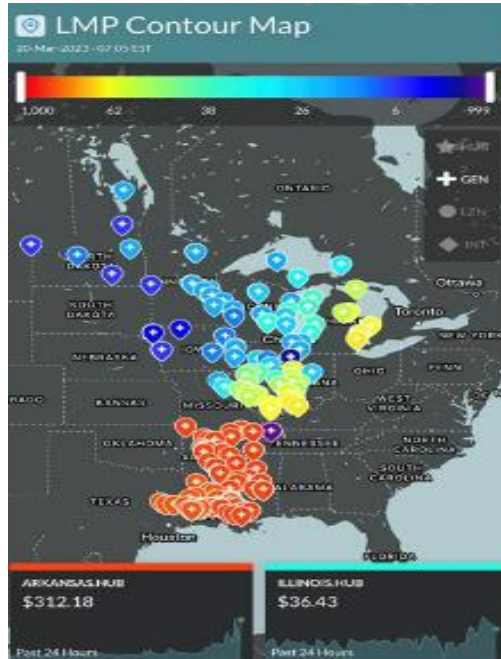
Offline and Online



Capacity Eligibility

Example: STR procures flexibility to manage uncertainty and sends shortage pricing when and where scarcity occurs

- A production day experiencing tight conditions in the MISO South region during morning load ramp



Determination of reserve requirements is key in aligning reliability needs with efficient market outcomes

- Quantify net uncertainty across operating timeframes
 - Net uncertainty includes load, wind, solar, NSI, generation availability
- Predict associated risk level for upcoming operating day to establish daily reserve requirements
- Automation, visualization and validation to gain experiences

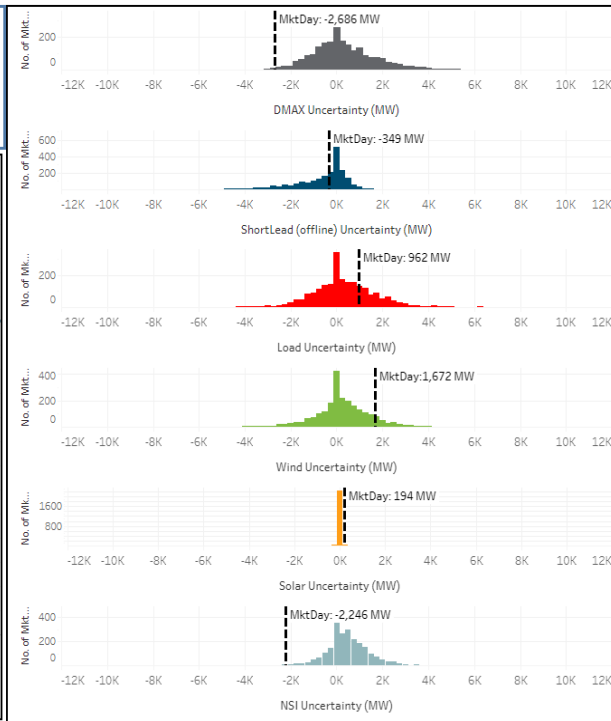
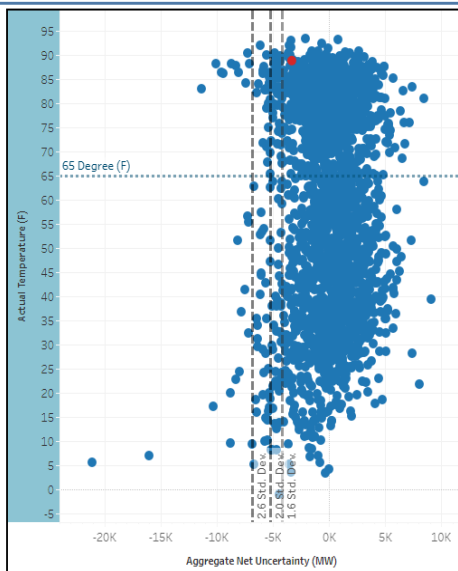
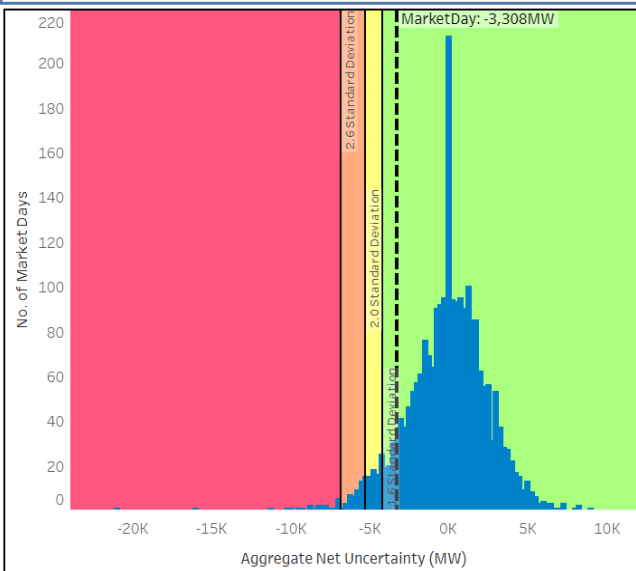
Establish dynamic reserve requirements based on daily risk profile

June 03, 2023 Systemwide

Aggregate Net Uncertainty (MW)

-3,308

DMAX Uncertainty MW	-2,686
ShortLead Uncertainty MW	-349
- Load Uncertainty MW	962
Wind Uncertainty MW	1,672
Solar Uncertainty MW	194
NSI Uncertainty MW	-2,246
- Stranded MW	-856



Roadmap to fully dynamic reserves as system needs and technology mature

