Price Formation and Multi-Period Dispatch

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Customers preferences, de-carbonization goals and economics are accelerating a fleet transition



² * Goals vary in methodology, base years and specific targets.



MISO has several initiatives underway to prepare



🚯 👘 * 2030 Energy projections (MWh) compiled from Integrated Resource Plans, investor reports and other sources 🛛 🦉



The challenge of managing unit constraints and ramping needs will likely grow in importance

02/21/2020. Long-lead units cannot start, emergency alert set for the South Region

- Operations expected stressed conditions in the South Region and called on 3 long-lead units.
- Long-lead units (not committed in Day Ahead and called through FRAC) could not start a few hours ahead and little additional operations were available.



Increasing uncertainty makes the pricing, commitment and dispatch problems harder

Monthly Average Aggregate Day Ahead to Real Time Forecast Error





Credit: Roz Chast, New Yorker, December 2004 R.C.

Long Zhao, Anupam Thatte, Steve Rose and Chen-Hao Tsai, MISO

* Reflects worst case scenario of additive errors.



Uncertainty and variability will become increasingly impactful to maintaining margins

- The margin between supply resources and obligations is an indicator of how close the system is to emergency or loss of load.*
- It is influenced by a number of factors, some of which are highly variable and uncertain
 - Outages
 - Intermittent generation
 - Net scheduled interchange

Margin = Available non-intermittent generation + intermittent generation + RDT limit + Net Scheduled Interchange + Load Resources (BTMG + LMR + EDR) - Load - Operating Reserve

* Emergencies include alerts through to load shed

⁶ RDT = Regional Dispatch Transfer Limit | BTMG = Behind the Meter Generation LMR = Load Modifying Resources | EDR = Emergency Demand Response



We are Making Progress

The industry has made significant progress recently in enhancing pricing efficiency and computational capability. Additional work is underway to address uncertainty.



Industry Times Vol. X New Approaches to Solve Convex Hull! Subscription Industry researchers have found enhanced ways to formulate the unit commitment and dispatch problems to better solve convex hull pricing. Industry Times Vol X Subscription **New Stochastic Trials Underway!** With the support of the Department of Energy, several industry researchers have begun stochastic trials that are expected to provide insight into approaches for managing uncertainty.

Recent Papers

- Y. Yu, Y. Guan, Y. Chen, An Extended Integral Unit Commitment Formulation and an Iterative Algorithm for Convex Hull <u>Pricing, IEEE Transactions on Power Systems, May 4, 2020</u>.
- Y. Chen, F. Pan, J. Holzer, E. Rothberg, Y. Ma, A. Veeramany, High Performance Computing Based Market Economics Driven Neighborhood Search & Polishing Algorithm for Security Constrained Unit Commitment, IEEE Tran. on Power Systems, Accepted.

Next Steps and Ongoing Efforts

- Merging convex hull advancements with rolling window
- Stochastic trials and merging methods
- Application to multi-configuration unit models e.g., combined cycle, storage, etc.
- Exploration of uncertainty reserve product
- Continued computational enhancements
- Other enhancements: outage coordination, resource adequacy enhancement, etc.



Additional Considerations

- Reliability before efficiency
 - Some inefficiency versus an infeasible or late solution
 - How best to reflect operator actions to avoid reliability risks?
- Flexibility how to incent / acquire needed flexibility?
 - Better incorporate cost of supply and operator actions
 - Better reflect load still very administrative limited data!
 - What about transmission, long to medium-term behavior and capacity and resource type decisions?
- Uncertainty how good is the forecast and who bears the costs?
- Supporting states with traditional utility models and those with competitive retail access
- Can simpler be better? Will market participants understand dispatch and prices?





Thank you