# Reserve Deliverability with Application to Short-Term Reserve Product

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# Summary

## Purpose

- Overview MISO reserve and deliverability needs
- Introduce 30 minutes short-term reserve
- Exchange ideas on reserve deliverability

## Key Takeaways

- Increasing needs to manage reserve deliverability in MISO system
- Reserve Post-Deployment Constraints have been included in market clearing to address the deliverability issue
- MISO is also exploring enhancements to better align the reliability needs with market requirements

# MISO currently co-optimizes energy, reserve and ramp product in its DA and RT markets

| *Market Clearing Through Co-Optimization* | *Reserve/Ramp Procurement and Deliverability* |
|---|---|
| Energy | |
| **Regulating Reserve**<br>Capacity held in reserve by a frequency responsive resource for the purpose of providing Regulating Reserve Deployment in both the up/down direction | **Reserve Requirements**<br>System-wide and zonal reserve requirements. |
| **Spinning Reserve**<br>A specified percentage of Contingency Reserve that must be synchronized to the System and converted to Energy within Deployment Period per instruction | **Reserve Deliverability**<br>Dynamic zonal reserve requirement and post zonal reserve deployment transmission constraints. |
| **Supplemental reserve**<br>Contingency Reserve that is not considered Spinning | **Economic and Reliability Impact**<br>Cost of Disqualifying deliverability reserve. Risk of violating thermal limits of transmission. |
| Ramp Capability Product | |
| 30-minute Short-term Reserve | |

# 30 Minutes Short-term Reserve

- Background
  - Load pocket with limited importing capability and quick start units
  - Regional dispatch transfer limits between the North/Central and South regions.
  - System-wide 30-minute flexibility needs / Interconnection Reliability Operating Limits (IROL)
- Motivation
  - Improve commitment process related to load pocket, regional dispatch transfer (RDT), and market-wide reliability needs
  - Improve transparency of costs associating with short-term reserve needs
  - Enhance reliability by aligning operational needs and market models
  - Fostering system-wide requirements to ensure flexibility to meet load and supply volatility and variability with future changes to mix of generation resources

# Short-term Reserve Design

- STR qualified resources
  - Online generators
  - Offline quick-start generators
  - Demand response
- Reserve offer
  - Online resources-no offer (opportunity cost)
  - Offline resources-offer cost
- Ramp rate and capacity
  - STR resource ramp rate is shared – full ramp rate available to each product
  - STR capacity can overlap with ramp product and Contingency Reserve

# Short-term Reserve Constraints

- Resource Level Constraints
  - Resource capacity
  - Maximum cleared STR from single resource
  - 30 minutes ramp rate

- System-wide Constraints
  - System-wide requirement
  - Post-event power balance constraint
  - Post-event reserve deliverability constraints

# Reserve Deliverability

- Post-event power balance constraint
  - Zonal short-term reserve deployment
  - Guarantee post-event power balance
- Post-event reserve deliverability constraints
  - Capture post-event power flow with the consideration of loss of generation and co-optimized zonal short-term reserve deployment
  - Improve reserve deliverability with consideration

# Reserve Procurement Enhancement Constraints

- Post Short Term Reserve Deployment Constraints ($\sigma_{k,e}$)

$$\text{Baseflow}_{\text{k,t}} + \sum_{\text{z}} \text{STRResponse}_{\text{z,e,t}} * \text{ZSTRSens}_{\text{z,t}} - \text{ZNeedSTR}_{\text{e,t}} * \text{ZEventSens}_{\text{e,t}} \leq \text{STRLimit}_{\text{k,t}}$$

Constraint flow impact of reserve deployment on constraint k

Constraint flow impact of event e on constraint k

- $\text{Baseflow}_{\text{k,t}}$ is the base flow before reserve deployment for constraint *k*
- $\text{STRResponse}_{\text{z,e,t}}$ is the reserve deployment in response to event e from zone z
- $\text{ZNeedSTR}_{\text{e,t}}$ is the size of event e in MW

# Optimal Deployment Constraints

- Post-STR deployment power balance constraint ($\varepsilon_e$)

$$\sum_{\mathrm{z}} \mathrm{STRResponse}_{\mathrm{z,e,t}} = \mathrm{ZNeedSTR}_{\mathrm{e,t}}$$

- Maximum zonal STR deployment constraint ($\tau_{k,e}$)

$$\mathrm{STRResponse}_{\mathrm{z,e,t}} \leq \mathrm{ZonalSTR}_{\mathrm{z,t}}$$

- System Wide STR Requirement ($\omega$)

$$\sum_{\mathrm{z}} \mathrm{ZonalSTR}_{\mathrm{z,t}} \geq \mathrm{Systemwide}\ STR\ Requirment$$

- Dynamic Zonal Requirement ($\varphi_z$)

$$\sum_{\mathrm{r \in z}} (\mathrm{OnlineSTR}_{\mathrm{r,t}} + \mathrm{OfflineSTR}_{\mathrm{r,t}}) \geq \mathrm{ZonalSTR}_{\mathrm{z,t}}$$

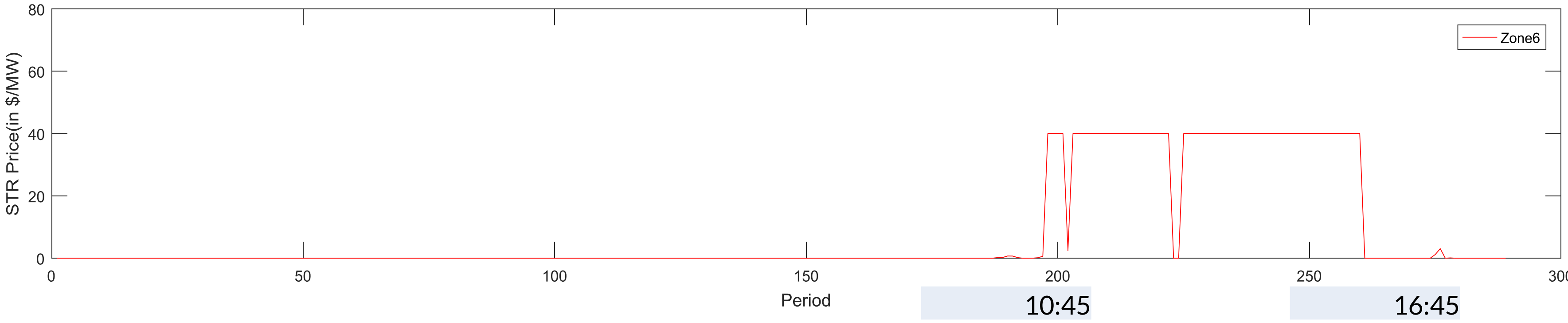
# Zonal Short-Term Reserve Prices

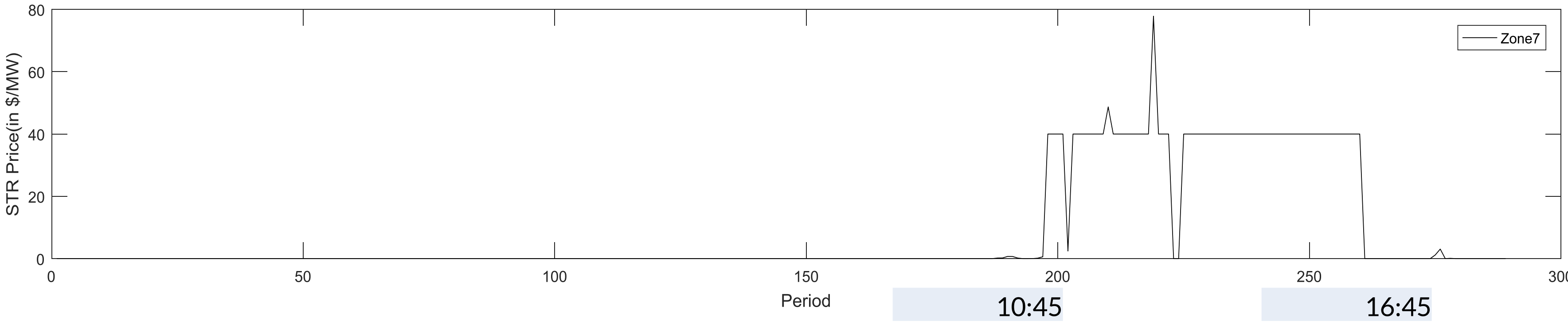
- Zonal STR Price

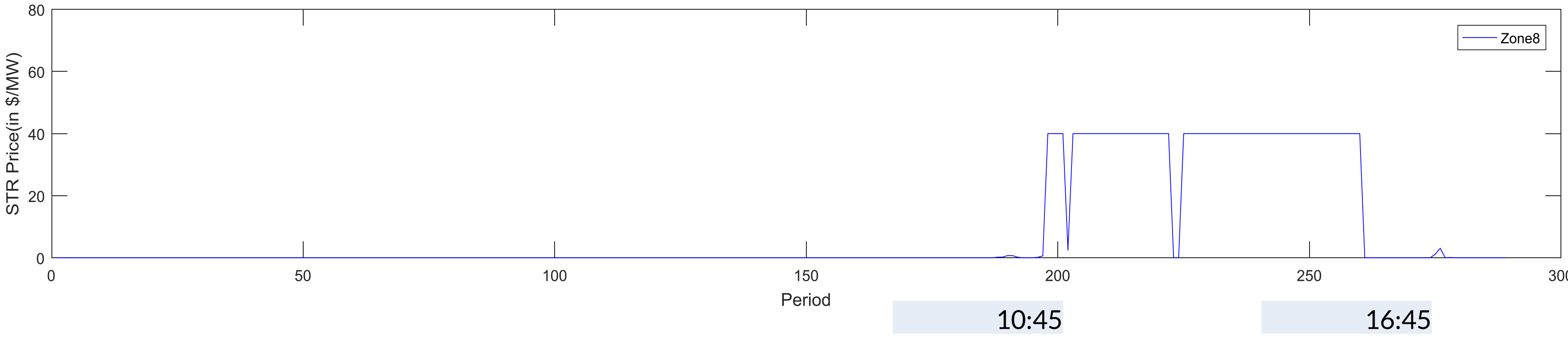
$$\varphi_z = \omega + \sum_e \varepsilon_e + \sum_k \sum_e \{\sigma_{k,e} B_{k,z}^{STR}\}$$

$\omega$: system-wide short-term reserve requirement component
$\sum_e \varepsilon_e$: zonal 30-min issue event component
$\sum_k \sum_e \{\sigma_{k,e} B_{k,z}^{STR}\}$: short-term reserve RPE congestion component

# Sample Simulated Zonal STR Prices



# Things to keep in mind when designing solutions

- Computational complexity is a significant factor
  - One post-deployment constraint modeled in each zone for the largest outage event
  - Only model for critical constraints like RDT and IROL
- What events to model
  - Worst scenarios
  - Capture congestion in different areas
- Demand curve design
  - Interaction between post-event power balance constraints and post-event reserve deliverability constraints
  - Interactions with other ancillary service products especially during capacity scarcity scenarios

# Intra-zonal deliverability

- Zonal approach can usually meet operation needs
  - The same set of constraints are used for defining reserve zones and for post-deployment constrain
  - Generators within the same zone usually have close sensitivities therefore short-term reserve is deployed based on aggregated zonal sensitivities.
  - Reserve zone determination
    - Offline studies performed together with quarterly network model
    - Should reserve zones be dynamically determined?

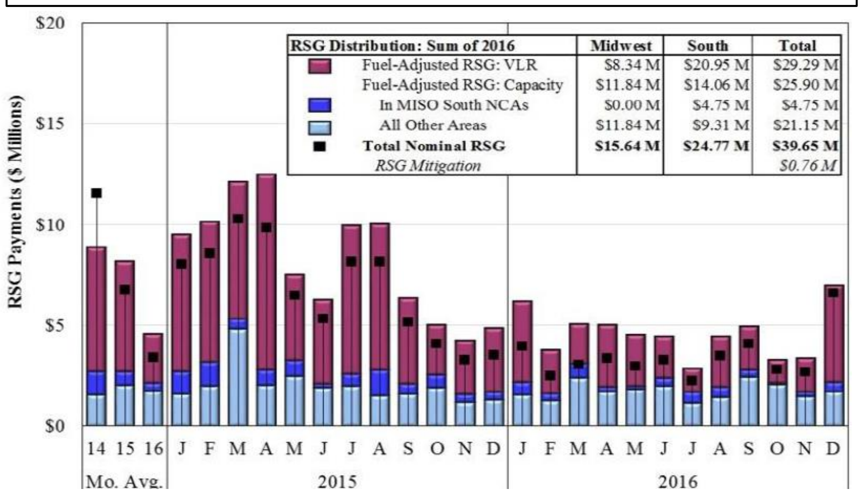
# Questions?

# Appendix

# More reserve and deliverability needs arise from south load pockets and North-South Limit*

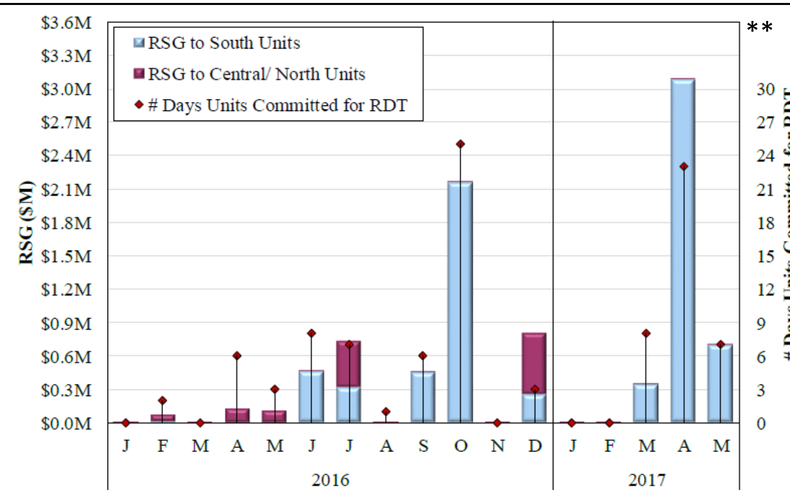
## Exploring new product to manage VLR requirements

- The VLR needs exist because some areas do not have resources that can start within 30 minutes to restore the lost supply after a contingency (*N-1-1*)
- Substantial RSG incurred as resources are committed to hold reserves from online




## Ensuring reserve deliverable between north and south

- MISO commits resources to satisfy capacity requirements in the North and South sub-regions to ensure the largest contingency is managed within N-S Limit






*Note: MISO has an artificial transfer limit after south integration, with 3000MW from North to South and 2500MW from South to North; ** Note: IMM State of Market report 2016*