• Winter Operations Highlights
• South Region Max Gen Event
• Regional Dispatch Transfer Data
Challenging weather events were managed well

- New Wind peak of 15.0 GW
- New South winter peak load
- Emergency Energy Purchases used
- Snow and ice in the South shut down businesses, schools and government offices
- In Louisiana, Governor Edwards declared a State of Emergency

### MISO Total Load

<table>
<thead>
<tr>
<th>Average:</th>
<th>80.3 GW (Dec ‘17 – Jan ‘18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>74.9 GW (Dec ‘16 – Feb ‘17)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak:</th>
<th>106.1 GW (Jan 17, 2018)</th>
<th>109.3 GW (January 2014)</th>
</tr>
</thead>
</table>

### Weather:

Arctic air swept through the footprint the end of December and most of January

### MISO South Load

<table>
<thead>
<tr>
<th>Average:</th>
<th>20.6 GW (Dec ‘17 – Jan ‘18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17.9 GW (Dec ‘16 – Feb ‘17)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak:</th>
<th>32.1 GW (Jan 17, 2018)</th>
<th>32.1 GW (January 2018)</th>
</tr>
</thead>
</table>

### Weather:

Record cold temperatures the week of January 15th
MISO and Members reliably managed operations during periods of extreme cold during the month of January:

- High load, driven by cold temperatures, and unavailable generation, created challenges.
- Enhancements made following the 2014 polar vortex, especially in electric-gas coordination, improved MISO’s performance.

On January 17th, MISO advanced to a Maximum Generation Event Step 2c/d in MISO South, making emergency energy purchases to meet load obligations, manage the Regional Dispatch Transfer, and maintain reliability.
Record low South temperatures, high load, and unavailable generation contributed to operating challenges throughout the week of January 15th

- **Extreme Cold Temperatures and Atypical Load**
  - Below average temperatures for the South Region challenged load forecasting and drove higher than normal load

- **Outages**
  - Forced generation outages and delayed outage returns intensified already tight conditions

- **Neighboring systems in the South experienced similar conditions**
  - MISO communicated with neighbors during the event on real-time conditions
MISO South January 17th peak load was 1.8% lower than the region’s all-time peak, realized in August 2015.

**South Region Peak Load and Low Temperature**

- **All-Time Peak**
  - 80°
  - GW: 32.7

- **Winter Peak**
  - 27°
  - GW: 27.0

- **1/15/2018**
  - GW: 20°

- **1/16/2018**
  - GW: 13°

- **1/17/2018**
  - GW: 17°

- **1/18/2018**
  - GW: 31.0
Load, as well as cold temperatures, peaked on January 17th in MISO South, leading to particularly challenging circumstances.

The chart reflects data through 01/28/2018.
Operators used emergency procedures to reliably manage extreme cold temperatures in the South Region on January 17\textsuperscript{th} and 18\textsuperscript{th}.

<table>
<thead>
<tr>
<th>South Region Only</th>
<th>01/15/2018 27°F</th>
<th>01/16/2018 20°F</th>
<th>01/17/2018 13°F</th>
<th>01/18/2018 17°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Load</td>
<td>27.0 GW</td>
<td>31.1 GW</td>
<td><strong>32.1 GW</strong></td>
<td>31.1 GW</td>
</tr>
<tr>
<td>Conservative Operations</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Cold Weather Alert</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Max Gen Alert</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Max Gen Event Step 1</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Max Gen Event Step 2</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Record temperatures, high load, force generation outages and de-rates, as well as delayed outage returns, contributed to the challenging conditions.

● Indicates declaration was active during that day
Tight forecasted conditions led to commitment of all available resources in the South and the use of emergency operating procedures.

*MTLF based on generated load forecast, LBA entered data, and control room discussions

The chart reflects the data as it resided in the CROW Outage system on Jan 29, 2018.
Forced generation outages and derates, in addition to delayed outage returns, further stressed system conditions.
Load management was implemented on January 17th and 18th to address shortage conditions.

MISO is reviewing Load Modifying Resource performance. Data will be available after settlements.

MISO South has no registered Emergency Demand Response.
Emergency energy purchases also helped manage the Regional Dispatch Transfer

Approximately 1100 MW of Emergency Energy Purchases were implemented starting around 0730 EST.
Conclusions and Lessons Learned

• Coordination within MISO, with members, and with neighboring RCs ensured reliable outcomes
  – Increased staffing during the extreme cold weather event
  – Drills on emergency processes enables successful plan execution

• Demand Side Management was implemented
  – Further review after receiving meter data from Market Participants
  – Continue to drill on process

• Emergency Energy Purchases were successfully implemented
  – Additional clarification needed in the procedure
  – Additional training to be conducted
Regional Dispatch Transfer Flow
Regional Dispatch Transfer Performance

Jan 1, 2017 - Dec 31, 2017

North-South 74% (3,000MW Limit)

South-North 26% (2,500MW Limit)
Regional Dispatch Transfer Performance
Regional Dispatch Transfer Performance

Seasonal View

Sep 1, 2017 - Nov 30, 2017
North-South 74%
(3,000MW Limit)
South-North 26%
(2,500MW Limit)

Dec 1, 2017 - Jan 31, 2018
North-South 91%
(3,000MW Limit)
South-North 9%
(2,500MW Limit)

Regional Transfer UDS Flow

Regional Transfer UDS Flow
MISO planned for, monitored, and responded to changing system conditions throughout the day.

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Region</th>
<th>Start Time (EST)</th>
<th>End Time (EST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservative Operations</td>
<td>South</td>
<td>1/15/2017 6:00</td>
<td>1/18/2017 1400</td>
</tr>
<tr>
<td>Cold Weather Alert</td>
<td>South</td>
<td>1/16/2017 6:00</td>
<td>1/18/2017 1400</td>
</tr>
<tr>
<td>Maximum Generation Alert</td>
<td>South</td>
<td>1/17/2017 5:00</td>
<td>1/17/2017 12:00</td>
</tr>
<tr>
<td>EEA Level 2 and Maximum Generation Event Step 2a/b</td>
<td>South</td>
<td>1/17/2018 7:00</td>
<td>1/17/2018 12:00</td>
</tr>
<tr>
<td>LMR Scheduling Instructions Sent (900 MW)</td>
<td>South</td>
<td>1/17/2018 7:00</td>
<td>1/17/2018 11:00</td>
</tr>
<tr>
<td>Modified Conservative Operations</td>
<td>RC Footprint</td>
<td>1/17/2018 6:00</td>
<td>1/17/2018 14:00</td>
</tr>
<tr>
<td>Modified Maximum Generation Alert</td>
<td>North &amp; Central</td>
<td>1/17/2018 6:00</td>
<td>1/17/2018 14:00</td>
</tr>
<tr>
<td>Maximum Generation Event Step 2c/d</td>
<td>South</td>
<td>1/17/2018 6:10</td>
<td>1/17/2018 12:00</td>
</tr>
<tr>
<td>Emergency Energy Purchase (700 MW)</td>
<td>South</td>
<td>1/17/2018 7:30</td>
<td>1/17/2018 12:45</td>
</tr>
<tr>
<td>Emergency Energy Purchase (300 MW)</td>
<td>South</td>
<td>1/17/2018 7:34</td>
<td>1/17/2018 10:00</td>
</tr>
<tr>
<td>Emergency Energy Purchase (150 MW)</td>
<td>South</td>
<td>1/17/2018 8:15</td>
<td>1/17/2018 12:00</td>
</tr>
<tr>
<td>Maximum Generation Alert Termination</td>
<td>North &amp; Central</td>
<td>1/17/2018 9:00</td>
<td></td>
</tr>
<tr>
<td>Conservative Operations Termination</td>
<td>North &amp; Central</td>
<td>1/17/2018 9:30</td>
<td></td>
</tr>
<tr>
<td>Maximum Generation Event Step 2c/d</td>
<td>South</td>
<td>1/17/2018 6:10</td>
<td>1/17/2018 14:00</td>
</tr>
<tr>
<td>Reduced the 7:30 Emergency Energy Purchase to 350 MW</td>
<td>South</td>
<td>1/17/2018 12:45</td>
<td>1/17/2018 13:15</td>
</tr>
<tr>
<td>EEA Level 1 and Maximum Generation Event - Step 1a</td>
<td>South</td>
<td>1/17/2018 14:00</td>
<td>1/17/2018 23:59</td>
</tr>
<tr>
<td>EEA Level 2 and Maximum Generation Event - Step 2a/b</td>
<td>South</td>
<td>1/17/2018 19:00</td>
<td>1/17/2018 23:59</td>
</tr>
<tr>
<td>LMR Scheduling Instructions Sent (1000 MW)</td>
<td>South</td>
<td>1/17/2018 19:00</td>
<td>1/17/2018 23:00</td>
</tr>
<tr>
<td>Maximum Generation Event - Step 2c/d</td>
<td>South</td>
<td>1/18/2018 6:00</td>
<td>1/18/2018 12:00</td>
</tr>
<tr>
<td>LMR Scheduling Instructions Sent (1000 MW)</td>
<td>South</td>
<td>1/18/2018 6:00</td>
<td>1/18/2018 12:00</td>
</tr>
<tr>
<td>LMM Implementation (15 MW)</td>
<td>EES</td>
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</tr>
<tr>
<td>EEA Level 1 and Maximum Generation Event - Step 1b/c</td>
<td>South</td>
<td>1/17/2018 20:55</td>
<td>1/17/2018 23:59</td>
</tr>
<tr>
<td>EEA Level 0 and Maximum Generation Alert</td>
<td>South</td>
<td>1/17/2018 23:15</td>
<td>1/18/2018 23:59</td>
</tr>
<tr>
<td>EEA Level 2 and Maximum Generation Event - Step 2c/d</td>
<td>South</td>
<td>1/18/2018 6:00</td>
<td>1/18/2018 12:00</td>
</tr>
<tr>
<td>LMR Scheduling Instructions Sent</td>
<td>South</td>
<td>1/18/2018 6:00</td>
<td>1/18/2018 12:00</td>
</tr>
<tr>
<td>EEA Level 0 and all Events/Alerts Terminated</td>
<td>South</td>
<td>1/18/2018 10:45</td>
<td></td>
</tr>
</tbody>
</table>
Lessons learned from the 2014 Polar Vortex have become a standard part of successful operations.

**Gas-Electric Coordination Initiatives**
- Enhanced Operational Tools
- Gas-Electric Market Alignment
- Generation Fuel Survey
- MISO Winterization Guidelines
- Operational Situational Awareness

**Generation Portfolio**
- Diverse generation pool to ensure reliability
- Planning and collaboration with members and gas industry for wind and natural gas utilization

**Emergency Preparedness**
- FERC Winter Readiness Technical Conference
- MISO EOP & Winter Readiness Workshops
- Emergency Response & Power System Restoration Drill

**Operational Readiness**
- Communication, Coordination, and Planning
- Reliability & Pipeline Calls
- Pipeline & Price Monitoring
- Emergency Procedures
- Operational & Market Enhancements
MISO’s operating procedures ensure reliability and gain access to certain resources during emergency situations.

Emergency Operating Procedures guide operator actions when an event has the potential to, or actually does, negatively impact system reliability.

- Conservative System Operations
- Severe Weather Alert
- Geo-Magnetic Disturbance Warning
- Cold Weather Alert
- Hot Weather Alert

Maximum Generation Emergency Procedures:

**Alert**
- Define boundaries/suspend maintenance

**Warning**
- Step 1 - Schedule in External Module E Capacity Resources
- Step 2 - Curtail Non-firm energy sales
- Step 3 - Implement reconfiguration options

**Event**
- Step 1 - Emergency Generation and Emergency Dispatch Ranges
- Step 2 - Load Management
- Step 3 - Utilize Operating Reserves
- Step 4 - Reserve Call and Emergency Reserve Purchases
- Step 5 - Firm Load Shedding

Tier I Emergency Price Offer Floor

Tier II Emergency Price Offer Floor
Capacity Sufficiency Issues

Status Update – February, 2018
Executive Summary

During events in October 2016 and April 2017, MISO did not adequately predict insufficient capacity conditions in sub-areas which led to MISO commencing steps of the Maximum Generation Event procedure and declaring Conservative System Operations.

Update Summary

MISO has completed a majority of the short-term/medium-term recommendations and has better visibility, coordination and procedures in place. MISO is currently working on technology solutions to provide better tools to Operations Personnel.
MISO’s goal is to improve visibility into capacity sufficiency issues through completion of process improvement recommendations. Currently 64% of recommendations are complete while working on long-term solutions.

### Overall Status
- **Completed**: 18/28
- **In Progress**: 7/28
- **Not Started**: 3/28

### Issue Theme

<table>
<thead>
<tr>
<th>Issue Theme</th>
<th>Not Started</th>
<th>In Progress</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of Regional Directional Transfer Limit</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Reserve Zones</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Determination of Stranded MWs</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Conservative System Ops &amp; Capacity Emergencies</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Outage Analysis</td>
<td>-</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Process and Reporting</td>
<td>-</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

### Key Projects:
1. Cross functional team performing a staged analysis to ensure adequate operating reserves including evaluation of Reserve Zones – *Market Design and Evaluation, Transmission Security Planning, & Unit Commitment Teams*

2. MISO Policy Decision on application of RDT across MISO Operations in progress. – *Operations Management*

3. Generator Outage Capacity Impact Analysis Capital Project in progress. – *Outage Coordination Tool Improvement*

4. IT Agile Team added storage for historical data on the South Sufficiency display to aid data analysis. Completed. – *Unit Commitment*
Questions

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