Purpose:
Summarize operations during the September 15 South Region Maximum Generation Event

Key Takeaways:

• MISO and Members reliably managed operations through rapidly increasing load, underestimated temperature forecasts, and loss of generation

• MISO declared a Maximum Generation Event Step 2c/d to meet South Region load obligations and maintain reliability

• Lessons learned from January 17 allowed for a smoother execution of emergency purchases, public appeals, and increased awareness around the contractual Regional Dispatch Transfer constraint
Forecasted temperatures and cloud cover for the weekend did not materialize. Rapidly increasing temperatures not anticipated by MISO’s weather vendors challenged load forecasting.
The top load forecasting error for the MISO footprint was observed on September 15, 2018.

The system-wide 24 Hour Ahead Load Forecast was 7.6 GW lower than actual. This is the highest under-forecast amount to date!

The temperature forecast error for the afternoon periods ranged 3-5 degrees across the entire MISO footprint.

Since 2011, MISO has had 8 other Emergency Operation Events. Of those, forecasting error was a significant contributing factor once, September 22, 2017.
MISO committed available resources and took actions to mitigate capacity concerns by delaying planned outages and bringing additional generation online.

MISO South Region

- Sep 15 Morning
  - Rapidly increasing temperatures and associated load
  - Outages Rescheduled 1.5 GW

- Sep 15 Afternoon
  - Continued load increases
  - Emergency Ranges 0.3 – 0.6 GW
  - Emergency Energy Purchases 0.6 GW
  - Load Management ~0.018 GW
  - Additional Real-Time Commitments 1.1 GW
  - Load Forecast Error 1.8 GW

- Sep 15 Afternoon
  - Public Conservation Appeals

Normal Operating Processes

- Generation Loss 1.4 GW

Max Gen Alert

Max Gen Event/Cons Ops

* Includes 1000 MW short lead generation and 3000 N-S transfer
Tight operating conditions existed throughout the MISO footprint. MISO worked with members to monitor and respond to changing system conditions throughout the day.

South Region
Load and Capacity (GW) – September 15

South Region Generation Outages and Derates (GW) – September 15

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

The outage chart reflects the data as it resided in the CROW Outage system on 09/21/2018
Load management was implemented to address shortage conditions. Seasonal requirements and long notification times can limit the availability of Load Modifying Resources.

- MISO implemented Load Modifying Resources and Load Management Measures Stage 1 (LMR/LMM) at 15:00 EST.
- Not all entities acknowledged and used Advanced Reporting page in MISO Communication System (MCS) per process.
- LMR performance to be evaluated after receipt of meter data at the end of October.
- New Emergency Demand Response (EDR) in the South has a 12 hour notification time and was not called on.

<table>
<thead>
<tr>
<th>Hour Ending</th>
<th>LMR</th>
<th>LMM</th>
<th>Self Sched LMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>3.2</td>
<td>12</td>
<td>2.6</td>
</tr>
<tr>
<td>17</td>
<td>3.2</td>
<td>12</td>
<td>2.6</td>
</tr>
<tr>
<td>18</td>
<td>5.3</td>
<td>12</td>
<td>2.6</td>
</tr>
</tbody>
</table>

MISO is reviewing Load Modifying Resource performance. Data will be available after settlements.
MISO ensured that the Joint Parties were frequently informed about the status of flows and system conditions.

600 MW of Emergency Energy Purchases were implemented from 1500 to 1830 EST.
Initiated as part of the Maximum Generation Event, emergency pricing performed as designed.

Higher ExPost SMP between 1505EST and 1800EST potentially indicate both fast-start resource and emergency pricing impact.

Higher ExAnte SMP indicates offline fast-start resource pricing impact due to operating reserve scarcity.

Note: pricing data is unapproved as of 09/25/2018
Lessons learned from the January 17 South Region event allowed for more efficient management of obligations for this event.

- Capacity Advisory communication increased situational awareness and encouraged stakeholders to update market data
- Improved collaboration, communication, and coordination within MISO, with members and with neighbors
- Greater awareness and communication surrounding the Regional Dispatch Transfer constraint
- Internal training and drills on Emergency Purchases
- Proactive engagement with Generator and Transmission Owners to identify outages flexible to address any tight operating conditions
MISO continues to drive value by looking for improvements to increase preparedness and respond to challenging situations.

- Continued improvements on Emergency Pricing
- Conduct drills and training on Emergency Purchases with external entities
- Improve management of uncertainty between DA and RT load forecasts
- Continue to work with Joint Parties on management of the Regional Dispatch Transfer
- Coordinate with RAN* effort to address demand side management and emergency procedures

*Resource Availability and Need (RAN)
Appendix
MISO’s operating procedures ensure reliability and gain access to additional 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
- Geo-Magnetic Disturbance Warning
- Severe Weather Alert
- Cold Weather Alert
- Hot Weather Alert

Maximum Generation

**Alert**
- Define boundaries/suspend maintenance

**Warning**
- Schedule in External Resources, Curtail Non-firm exports, Reconfiguration

**Event**
- Step 1 (NERC EEA 1)
  - Emergency Resources/Dispatch Ranges
- Step 2 (NERC EEA 2)
  - 2a. Load Management Procedures
  - 2b. Load Management Measures Stage 1/Load Management Resources
  - 2c. Emergency Demand Response
  - 2d. Emergency Energy Purchases/Public Appeals
- Step 3
  - 3a. Utilize Operating Reserves
  - 3b. Load Management Measures Stage 2
- Step 4
  - Reserve Call and Emergency Reserve Purchases
- Step 5 (EEA 3)
  - Firm Load Shed

**Termination**

Data Source: SO-P-NOP-00-449 Rev 0 Conservative System Operations and SO-P-EOP-00-002 Rev 3 MISO Market Capacity Emergency procedures
MISO frequently prepares for emergency situations.
Compounding load forecast errors required implementation of emergency processes to meet South Region obligations.

<table>
<thead>
<tr>
<th>South Region Only</th>
<th>09/13/2018 87°F</th>
<th>09/14/2018 92°F</th>
<th>09/15/2018 93°F</th>
<th>09/16/2018 94°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Load</td>
<td>26.9 GW</td>
<td>28.4 GW</td>
<td>29.3 GW</td>
<td>29.3 GW</td>
</tr>
<tr>
<td>Henry Hub Gas Price ($/MMBtu)</td>
<td>2.93</td>
<td>2.93</td>
<td>2.86</td>
<td>2.86</td>
</tr>
<tr>
<td>Avg RT LMP ($/MWh)</td>
<td>$41.77</td>
<td>$65.07</td>
<td>$174.79</td>
<td>$29.88</td>
</tr>
<tr>
<td>Highest RT LMP ($/MWh)</td>
<td>$178.91</td>
<td>$530.07</td>
<td>$691.55</td>
<td>$81.8175</td>
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<tr>
<td>Capacity Advisory</td>
<td>Called for Operating Days September 17 and September 18. Raised awareness over the weekend.</td>
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<tr>
<td>Maximum Generation Alert</td>
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<tr>
<td>Max Gen Event Step 2</td>
<td></td>
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<td></td>
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<tr>
<td>Conservative Operations</td>
<td></td>
<td></td>
<td></td>
<td>Through 09/19/2018</td>
</tr>
<tr>
<td>Max Gen Event Step 1</td>
<td></td>
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</tbody>
</table>

- Temperatures are daily high values
- LMP is calculated as an average of four Hubs in the South region

Shading indicates declaration was active during that day

Data Source: Real-Time Operations, Market Analysis, and MISO Website
September to-date peak load follows recent historical trends, aligning more closely with summer system conditions.

Fall Actual Peak Load (GW)

The entire bar represents actual peak load.

- 2014: 111.2 GW
- 2015: 113.9 GW
- 2016: 115.1 GW
- 2017: 114.7 GW
- 2018: 114.7 GW
- Fall 2018 Forecast: 120.0 GW

- Fall Actual Peak Load follows recent historical trends, aligning more closely with summer system conditions.

- Fall Forecasted Peak Load (GW)

- 2018: 110.6 GW
- Fall 2018 Forecast: 110.6 GW

- 90/10 forecast

* September 2018 To-Date
Temperature deviations from average and atypical weekend load patterns were greater for MISO System than for MISO South.
Tight operating conditions existed throughout the MISO footprint. MISO used operating procedures to monitor and respond to changing system conditions.

System-Wide Load and Capacity (GW) – September 15

System-Wide Generation Outages and Derates (GW) – September 15

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

The outage chart reflects the data as it resided in the CROW Outage system on 09/21/2018