MISO South Region Maximum Generation Event Overview for April 4th

MISO Market Subcommittee
Thursday, May 11th
Purpose & Key Takeaways

Purpose:
Evaluate Market Capacity Emergency Processes used during the April 4th Maximum Generation Event

Key Takeaways:
- Operators used emergency procedures, coordination across control centers, and coordination with members and neighbors to reliably manage conditions
- Load Modifying Resources were deployed
- Emergency pricing was initiated and worked as designed
Contributing factors for Max Gen Event April 4th

• **High Load**
  • Load resembled May levels more than early April levels, temperatures were ~8°F above normal

• **High Generation Outages**
  • Forced outages and seasonal maintenance drove increased generation outages

• **High Transmission Outages**
  • Recent severe weather and planned seasonal maintenance caused generation stranded behind constraints
MISO monitored and responded to changing system conditions throughout the day.

- **Maximum Generation Event Step - 1b/c and NERC EEA* 1 Declaration**
- **Projected Energy Surplus = 0**
- **All resources committed**
- **Emergency Pricing activated**

**08:00**
- **Maximum Generation Alert Declaration**
- **Projected Energy Surplus = 155 MW**

**08:21**
- Load Modifying Resources and Load Management Measures Stage 1 Implemented

**13:18**
- Conservative Operations Declaration Canceled and returned transmission outages

**14:51**
- Maximum Generation Event Step – 2a/b and NERC EEA* 2 Declaration

**15:00**
- Demand response in use
- **Projected Energy Shortfall = 447**

**21:00**
- Maximum Generation Event Terminated

**22:00**
- Conservative Operations Terminated

*EEA = Energy Emergency Alert
Above average temperatures drove higher than average load, contributing to challenging circumstances.
Transmission and generation outages limited available capacity

The chart reflects Unit Dispatch System case. *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 May 4th, 2017
Emergency Pricing worked as designed

- Emergency Pricing provided accurate price signals
- The Security Constrained Economic Dispatch (SCED)-pricing engine dispatched into emergency capacity in one Real-Time interval
  - Ex-Post prices were set using an Emergency Offer Floor proxy in that interval (15:55 EST)
  - Net Scheduled Interchange increase and constraint relief addressed forecasted capacity shortfall
- The SCED-pricing engine appropriately placed emergency capacity in the supply stack to reflect its availability after economic capacity
  - Price suppression evident in Ex-Ante prices was prevented in Ex-Post Emergency Pricing
Emergency Pricing Example for one Unit

- **Ex-Ante LMP** was $45 including 22 MWs of emergency capacity
- **Ex-Post LMP** was $162 with no use of emergency capacity
  - The $162 price signal more accurately reflects the emergency conditions
  - If emergency resources are used than price rises to the Emergency Offer Floor

<table>
<thead>
<tr>
<th>Engine</th>
<th>Economic Max (MW)</th>
<th>Emergency Max (MW)</th>
<th>Set Point (MW)</th>
<th>LMP ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex-Ante</td>
<td>400</td>
<td>422</td>
<td>422</td>
<td>45.10</td>
</tr>
<tr>
<td>Ex-Post</td>
<td>400</td>
<td>422</td>
<td>400</td>
<td>161.95</td>
</tr>
<tr>
<td>delta</td>
<td>0</td>
<td>0</td>
<td>-22</td>
<td>116.85</td>
</tr>
</tbody>
</table>

- **Ex Ante**: Emergency range in Ex-Ante offered at $30/MWh. Unit dispatched to Emergency Max
- **Ex Post**: Emergency range in Ex-Post offered at Emergency Offer Floor. Unit dispatched down to Economic Max
Load management implemented to address shortage conditions

- MISO implements Load Modifying Resources and Load Management Measures Stage 1 (LMR/LMM) at 15:00 EST
- All entities acknowledged and used Advanced Reporting page in MISO Communication System (MCS)
- First ever LMR implementation in South and first LMR implementation in MISO since 2007
- LMR performance to be evaluated after receipt of meter data at the end of May

\[
\begin{array}{ccccccc}
\text{Hour Ending} & \text{16} & \text{17} & \text{18} & \text{19} & \text{20} & \text{21} \\
\text{LMR} & 0 & 0 & 101.2 & 146.4 & 152.7 & 712.4 \\
\text{LMM} & 15 & 15 & 15 & 15 & 15 & 15 \\
\text{Self Sched LMR} & 2.5 & 2.5 & 2.5 & 2.5 & 2.5 & 2.5 \\
\end{array}
\]

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

- Continuous training and drills on capacity shortage processes ensured reliable outcomes
- Demand Side Management was implemented and acknowledged. MISO will evaluate performance after receiving data from Market Participants
- Emergency Pricing worked as designed
- MISO will build on improvements underway following the capacity emergency in October 2016, including review and improvement of generation and transmission outage coordination processes
Contact Information

- Rob Benbow (rbenbow@misoenergy.org)
Completed and ongoing improvements following October 2016 Capacity Emergency
# Areas of Improvement

<table>
<thead>
<tr>
<th>Improvement Area</th>
<th>Issue Summary</th>
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<tbody>
<tr>
<td>Conservative System Operations and Capacity Emergencies</td>
<td>Evaluate thresholds for entering into steps of the Maximum Generation Emergency Procedure on a sub-regional basis</td>
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<tr>
<td>Outage Analysis</td>
<td>Improve accuracy of the forced outage rate, zonal import capability assumptions and outage analysis capabilities</td>
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<tr>
<td>Regional Directional Transfer (RDT) Limit</td>
<td>Ensure consistent application and enforcement of RDT limits</td>
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<tr>
<td>Determination of Stranded MW</td>
<td>Improve calculation and incorporation of stranded MW</td>
</tr>
<tr>
<td>Process and Reporting</td>
<td>Increase visibility into regional capacity and include information as part of “handoff” reports, along with identify any additional training requirements</td>
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<tr>
<td>Reserve and Resource Adequacy Zones</td>
<td>Work with MISO Stakeholders to discuss viability of establishing a MISO South Region Reserve Zone</td>
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Summary of Critical Improvements – Near Term

- **Application of Regional Directional Transfer (RDT) Limit**
  - Improve capability to monitor the capacity needs of South Region in Real-Time, Planning, and Forward Processes

- **South Sufficiency Tool**
  - Create better awareness about how close we operate to South Capacity Margin in Real Time

- **Multi-Day Forward Reliability Assessment Commitment (FRAC) Tool**
  - Incorporate RDT into Multi-Day FRAC studies to assess capacity margin and have visibility into capacity issues earlier

- **Stranded MW**
  - Calculate MWs stranded behind the Regional Directional Transfer Limit and display Real Time results to operators

A total of 28 recommendations were proposed by the review team to be able to better prepare and predict Capacity Insufficiency. The above recommendations were deemed most critical in order to prepare for capacity sufficiency events.
Summary of Critical Improvements – Mid Term

Look Ahead Commitment Tool

• Include the Regional Directional Transfer Limit in the Look Ahead Commitment case.

Tool

Dart Release deployed 4/9/17

Maintenance Margin

• Update the Maintenance Margin calculation in the short term to provide greater accuracy to look at inputs to the Loss of Load Expectation (LOLE) calculation, including adjusting the load forecast and capacity import limits input data to be more conservative.

Tool

Completed 4/14/17

Generator Outage Capacity Analysis

• Develop business case for Generator Outage Capacity Analysis capability development and investment.

Tool

Capacity Margin

• Evaluate and analyze capacity margin thresholds for sub-regional capacity sufficiency, conservative and emergency operations declarations.

Process
### Summary of Critical Improvements – Longer Term

<table>
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<td>• Evaluate prioritization of the “Develop additional short-term capacity reserves requirements” project from the Market Roadmap.</td>
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<th>Reserve Procurement</th>
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<td>• Based on outcome of applying the Regional Directional Transfer limit throughout Forward Operations and Planning, evaluate Reserve Zones and Tariff language including consideration of reserve zone for MISO South.</td>
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<td>• Construct and implement Generator Outage Capacity Analysis capability, retire maintenance margin process.</td>
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<td>• Work with stakeholders to evaluate Tariff changes to remove restrictions on MISO’s ability to move generation outages based on capacity and risk level.</td>
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