Presentation Updates since January 11 MSC

- Slide 4: Added data for Jan 4 – 7, updated remaining data where needed
- Slide 5: Added data for Jan 4 – 7. Since we have a new peak for the month, changed the heading and the text box on Jan 2
- Slide 6: Updated latest outage data according to CROW
- Slide 7: Added “Other” cause code, and updated note to provide additional detail around fuel related outages. Also, included hyperlinks in the footnote for Outage Operations BPM and CROW
- Added an Appendix
  - Slide 11: Added DA/RT Price Deviation for Jan 6-7, 2014 and Jan 1-7, 2018
  - Slide 12: Added waterfall chart showing all potential available resources that could have been available on Jan 2
• MISO and Members reliably managed operations during a period of extreme cold the first week of January
• High load, driven by cold temperatures, and unavailable generation, created challenges throughout the event
• Enhancements made following the 2014 polar vortex, especially in electric-gas coordination, improved MISO’s performance
2018 Arctic Cold Snap saw sustained cold temperatures for a longer duration than those of the 2014 Polar Vortex, with improved market outcomes

<table>
<thead>
<tr>
<th>Operating Day</th>
<th>1/6/14 -2°F</th>
<th>1/7/14 -3°F</th>
<th>1/1/18 -1°F</th>
<th>1/2/18 0°F</th>
<th>1/3/18 12°F</th>
<th>1/4/18 7°F</th>
<th>1/5/18 6°F</th>
<th>1/6/18 4°F</th>
<th>1/7/18 17°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Load (GW)</td>
<td>109.3</td>
<td>104.7</td>
<td>100.4</td>
<td>104.7</td>
<td>100.9</td>
<td>103.8</td>
<td>102.0</td>
<td>94.8</td>
<td>85.5</td>
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<td>Wind at Peak (GW)</td>
<td>6.6</td>
<td>2.3</td>
<td>4.4</td>
<td>13.4</td>
<td>9.6</td>
<td>2.6</td>
<td>3.1</td>
<td>12.0</td>
<td>3.9</td>
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<tr>
<td>NAI at Peak (GW)</td>
<td>+2.4</td>
<td>-0.04</td>
<td>-0.39</td>
<td>-0.15</td>
<td>-0.79</td>
<td>+2.06</td>
<td>-0.24</td>
<td>+1.05</td>
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<tr>
<td>Gas Price ($/MMBtu)</td>
<td>6.66</td>
<td>7.00</td>
<td>4.63</td>
<td>4.63</td>
<td>8.79</td>
<td>6.43</td>
<td>6.47</td>
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<td>Avg RT LMP ($/MWh)</td>
<td>122.50</td>
<td>189.95</td>
<td>56.63</td>
<td>69.75</td>
<td>58.53</td>
<td>79.23</td>
<td>55.84</td>
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<td>Max RT LMP ($/MWh)</td>
<td>1,780.70</td>
<td>281.23</td>
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<td>281.23</td>
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<td>RSG ($/Million)</td>
<td>1.0</td>
<td>1.9</td>
<td>1.55</td>
<td>0.97</td>
<td>3.26</td>
<td>2.16</td>
<td>1.83</td>
<td>0.22</td>
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<td>ELMP Impact ($/MWh)</td>
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<td>1.1</td>
<td>10.6</td>
<td>6.7</td>
<td>5.2</td>
<td>3.0</td>
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LMP values are MISO system-wide hourly averages
Temperatures are system-wide daily low values
Gas price – Chicago City Gate
Peak load on January 2, 2018 was 4.2% lower than MISO’s all-time Winter peak on January 6, 2014
Cold Weather Alert and Conservative Operations helped prepare members and minimize cold weather impacts.
Facilitated by increased planning and coordination, outage levels on January 2 were typical for the month of January.

**January 2, 2018 Forced Outages**

- “Other” Code
- Equipment Failure
- Fuel Transportation/Supply Issues
- Weather / Catastrophe

- Nearly all of the affected units cleared in the Planning Resource Auction (PRA). Most of the Fuel Transportation/Supply Issues occurred in the Central Region. A majority of the units indicating fuel-related outages mentioned in MISO’s winter generator survey that they rely upon interruptible or some combination of firm and interruptible pipeline capacity, not dedicated firm capacity or backup fuel capability.

The chart reflects the data as it resided in the CROW Outage system on Jan 18, 2018.
Wind generation at the January 2 peak hour accounted for 13% of total generation.
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
Appendix
Real-Time price spikes are usually due to congestion or reserve scarcity associated with load uncertainty or forced outages.

In comparison to 2014, the DA/RT price difference for the first week of 2018 was much lower.

Note: MISO System-Wide price is based on the hourly average of the active trading hubs.

* Deviation, expressed as a percent of average DA LMP, is calculated as the average of hourly absolute (DA-RT) price differences divided by the average of hourly DA LMPs.
On January 2, 13 GW of additional offline capacity was available while another 10 GW could have been made available under emergency conditions.

*Online Capacity Margin = resources available prior to implementing Emergency Operating Procedures*