2018 Arctic Cold Snap

January 11, 2018
Updated January 29, 2018

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

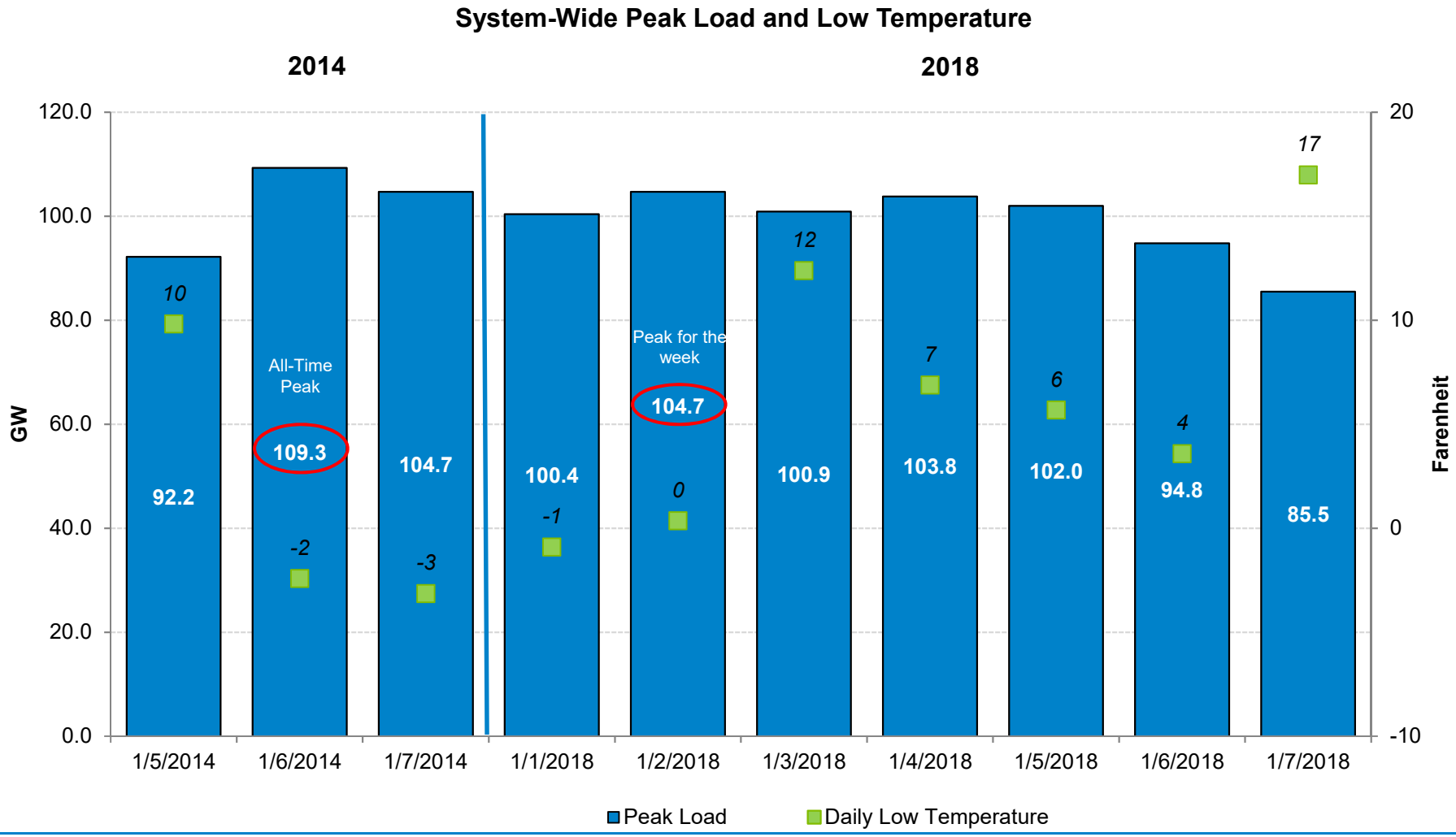
- MISO and Members reliably managed operations during a period of extreme cold the first week of January
- High load, driven by cold temperatures, and unavailable generation, created challenges throughout the event
- Enhancements made following the 2014 polar vortex, especially in electric-gas coordination, 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

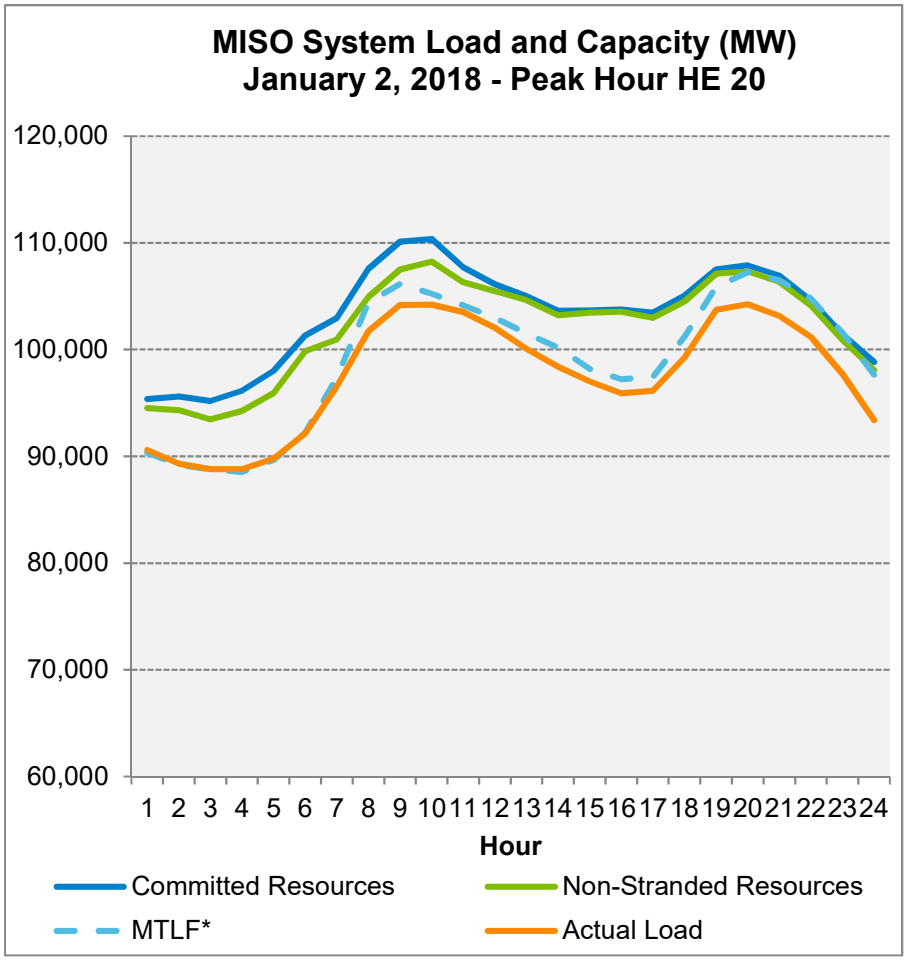
Operating Day	1/6/14 -2°F	1/7/14 -3°F	1/1/18 -1°F	1/2/18 0°F	1/3/18 12°F	1/4/18 7°F	1/5/18 6°F	1/6/18 4°F	1/7/18 17°F
Peak Load (GW)	109.3	104.7	100.4	104.7	100.9	103.8	102.0	94.8	85.5
Wind at Peak (GW)	6.6	2.3	4.4	13.4	9.6	2.6	3.1	12.0	3.9
NAI at Peak (GW)	+2.4	-0.04	-0.39	-0.15	-0.79	+2.06	-0.24	+1.05	-0.16
Gas Price ($/MMBtu)	6.66	7.00	4.63	4.63	8.79	6.43	6.47	-----	-----
Avg RT LMP ($/MWh)	122.50	189.95	56.63	69.75	58.53	79.23	55.84	40.83	26.79
Max RT LMP ($/MWh)		1,780.70		281.23					
RSG ($/Million)	1.0	1.9	1.55	0.97	3.26	2.16	1.83	0.22	0.19
ELMP Impact ($/MWh)	-----	-----	1.1	10.6	6.7	5.2	3.0	1.8	0.2
Cold Weather Alert	•	•	•	•	•	•	•	• South Only	
Cons Ops	•	•	•	•	•	•	•		
Max Gen Alert		•							
Max Gen Warning		•							

LMP values are MISO system-wide hourly averages
Temperatures are system-wide daily low values
Gas price – Chicago City Gate

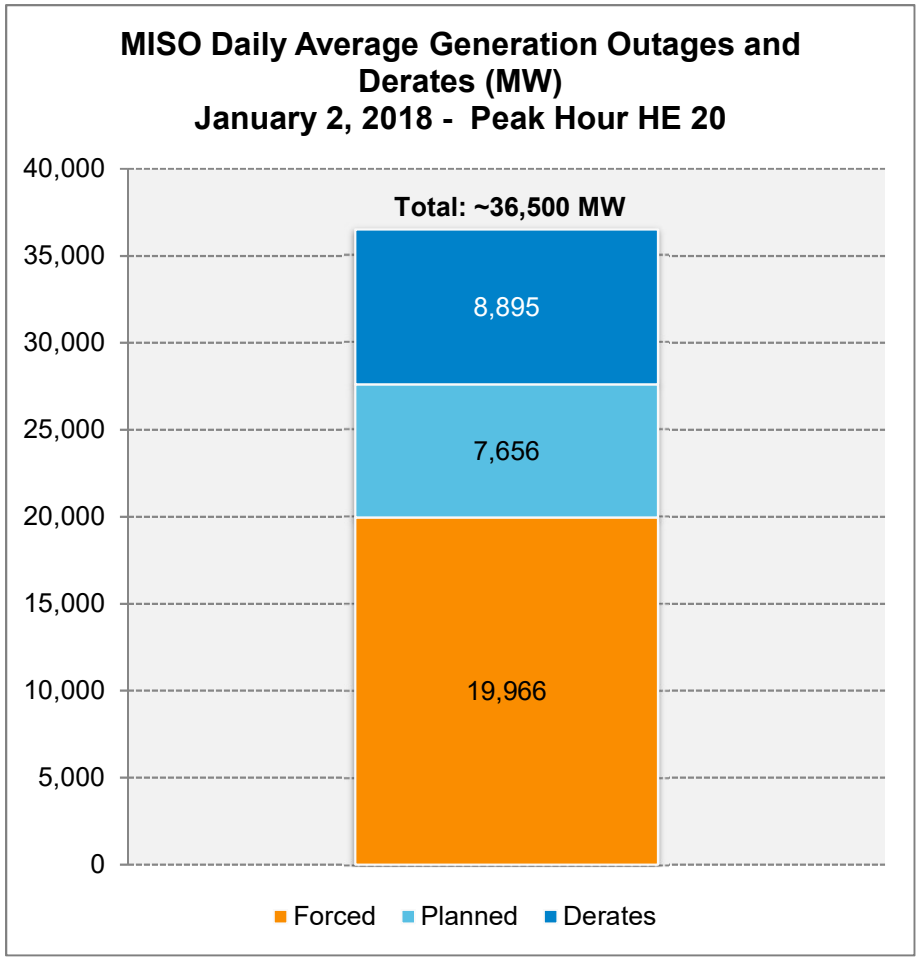
Peak load on January 2, 2018 was 4.2% lower than MISO's all-time Winter peak on January 6, 2014



Cold Weather Alert and Conservative Operations helped prepare members and minimize cold weather impacts

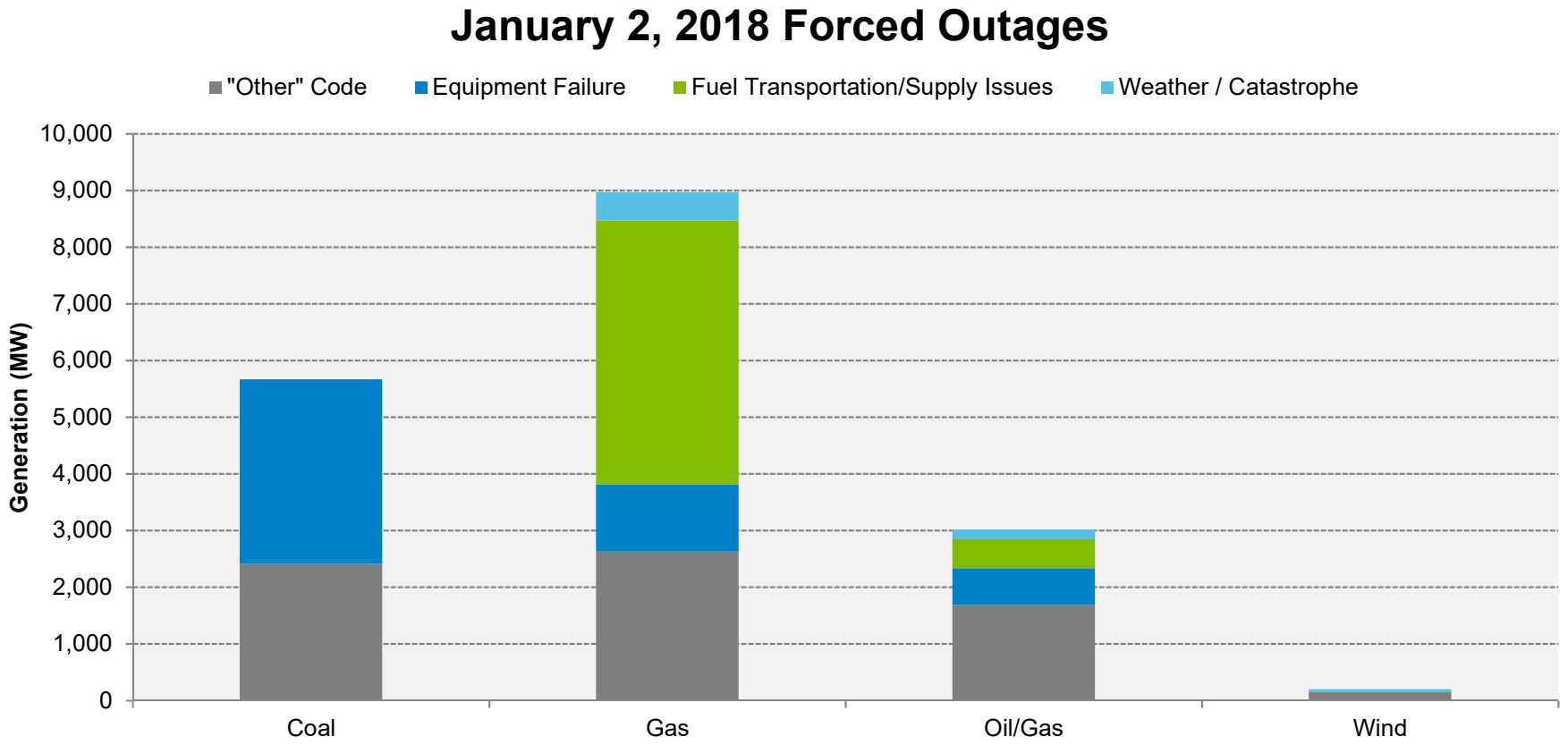


*The chart reflects Unit Dispatch System case. *MTLF based on generated load forecast, LBA entered data, and control room discussions*



The chart reflects the data as it resided in the CROW Outage system on Jan 18, 2018

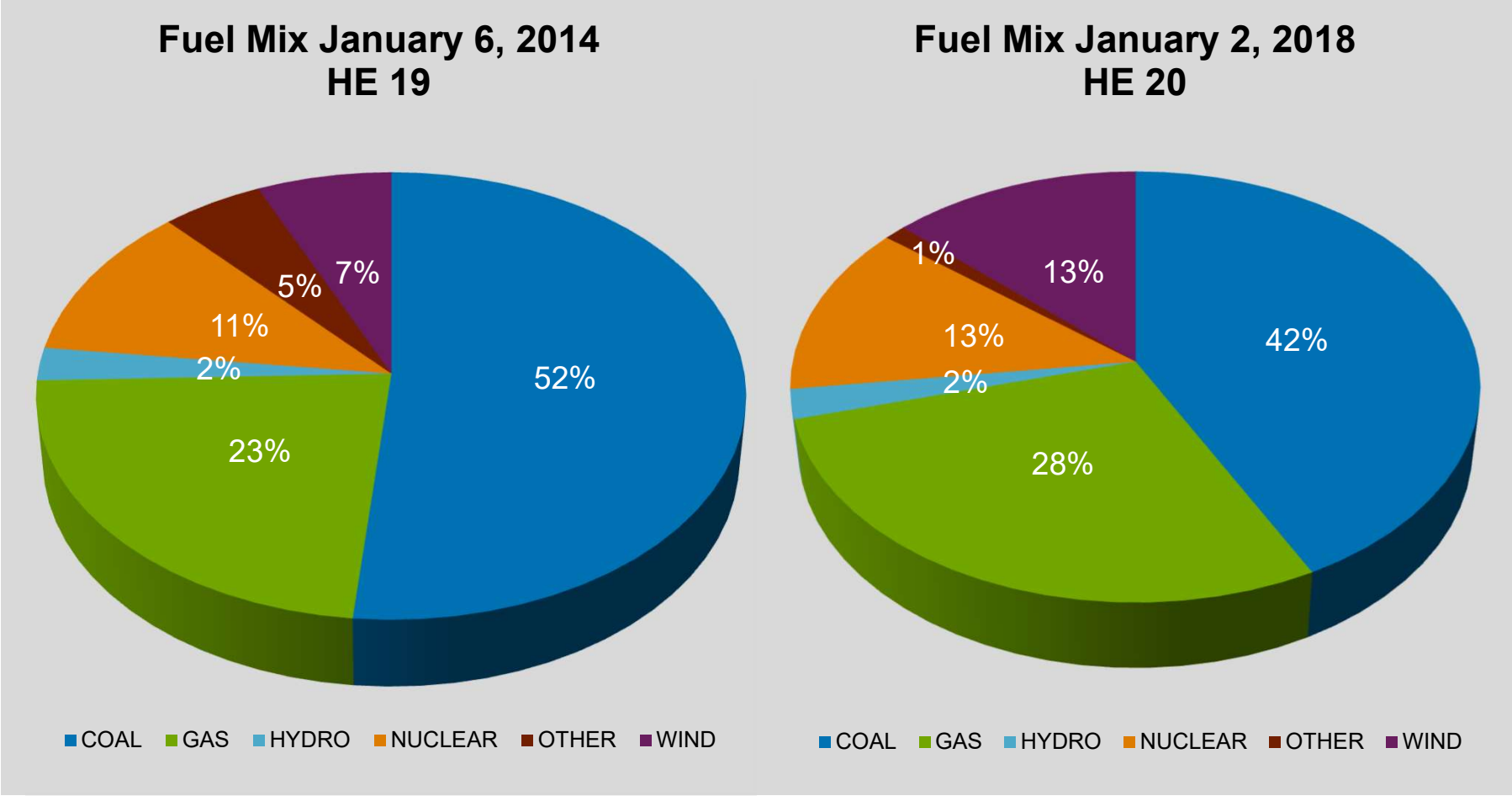
Facilitated by increased planning and coordination, outage levels on January 2 were typical for the month of January



- *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

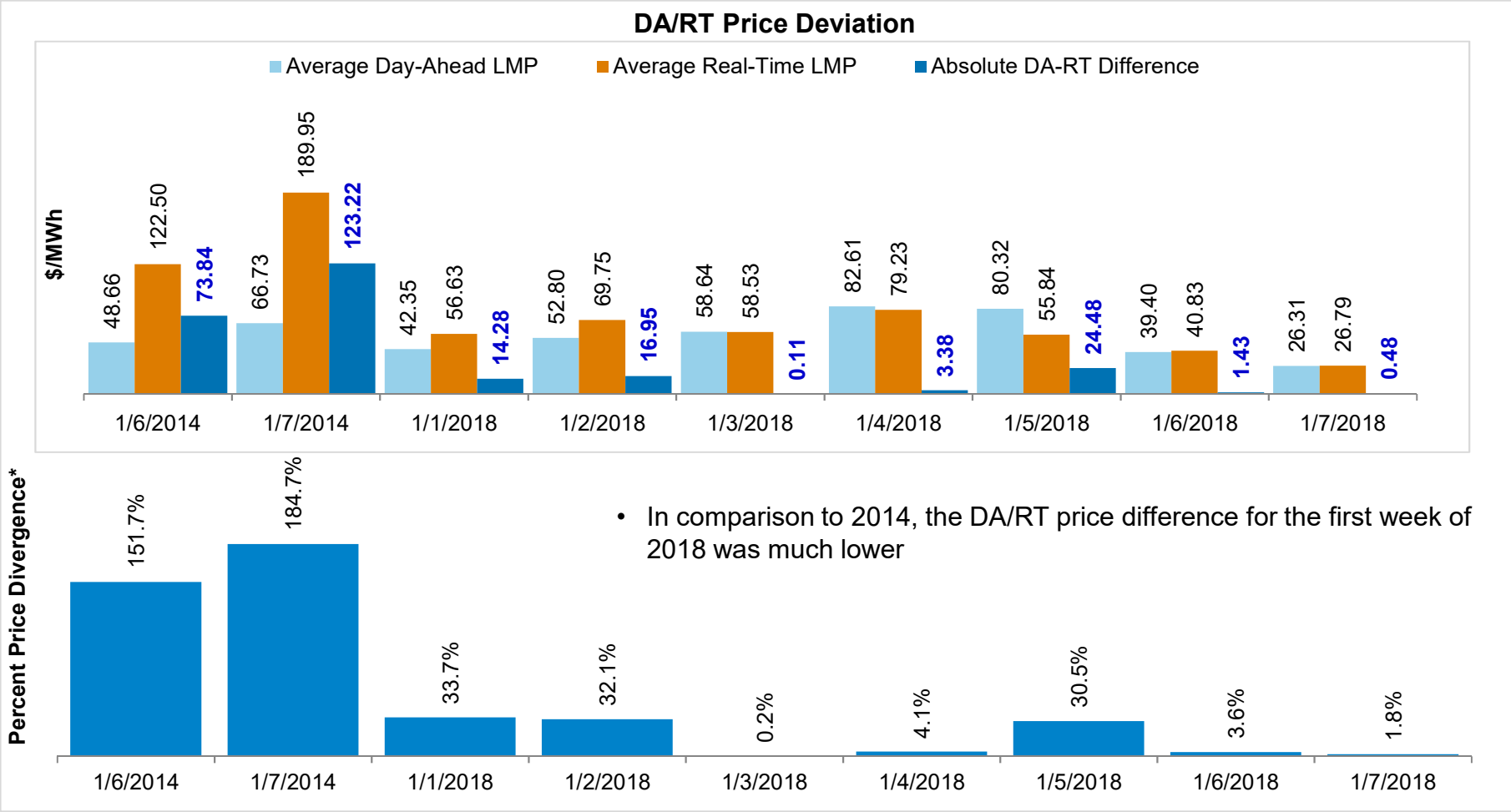
- FERC Winter Readiness Technical Conference
- MISO EOP & Winter Readiness Workshops
- Emergency Response & Power System Restoration Drill

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

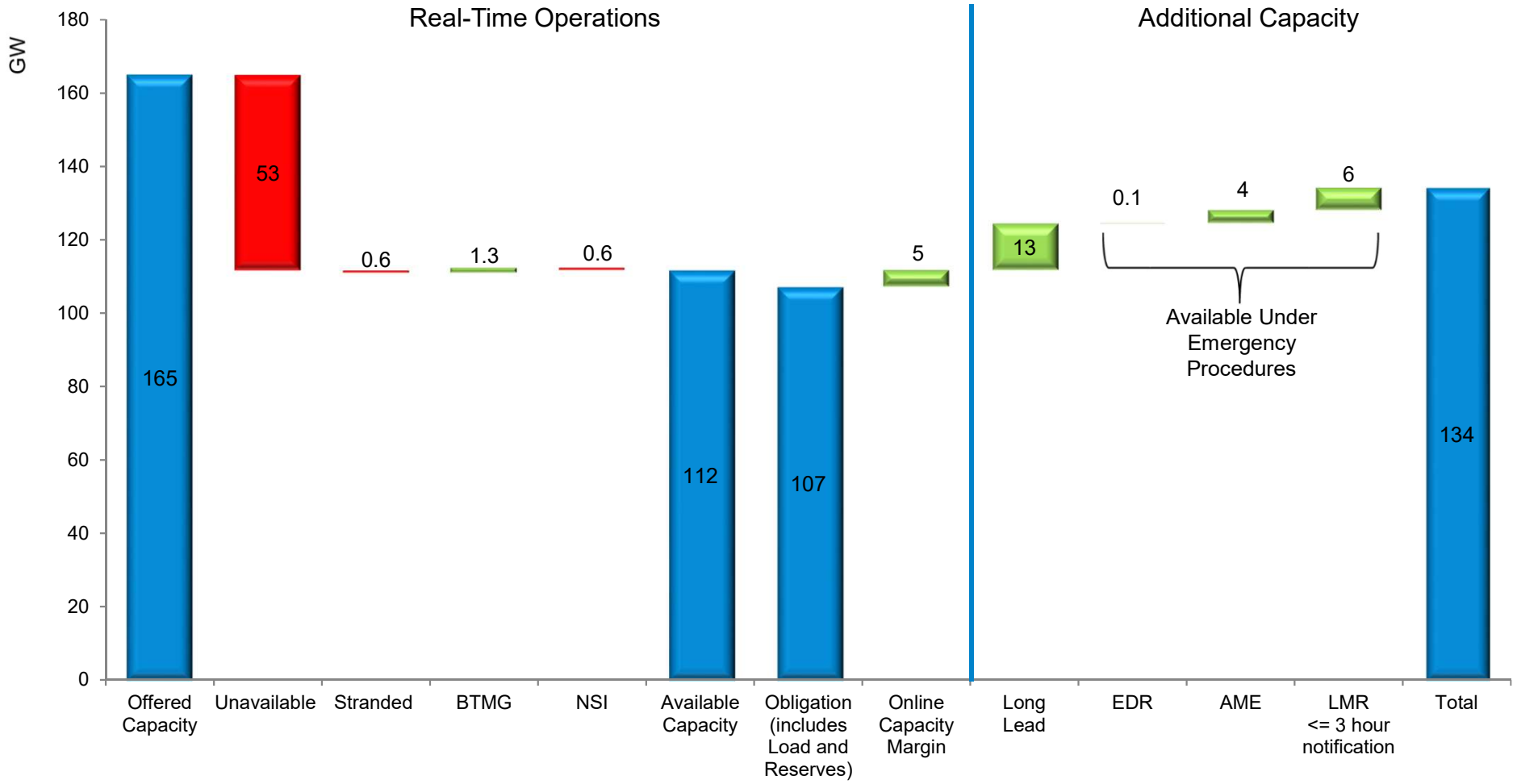


- In comparison to 2014, the DA/RT price difference for the first week of 2018 was much lower

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*