2021 Arctic Storm / MISO's Reliability Imperative

MRO Board Meeting

June 24, 2021

Executive Summary

- Extreme weather events are increasing in frequency and intensity, leading to increased risk of weather-induced events for our industry.
- The effects of the Arctic event were felt across MISO and neighboring systems. MISO's procedures worked as drilled and designed, limiting the impact of this extreme event.
- MISO is continuing to focus on the Reliability Imperative as a means of preparing for similar future events.
- Market Redefinition, Long Range Transmission Planning and Operations of the Future have already planned to address many of the issues at play during the Arctic event.

MISO was well positioned for the Arctic Weather due to on-going actions and leveraging operating procedures before and during the event

MISO regularly coordinates with our neighbors during these events and during normal operations

SYSTEM TOPOLOGY

- Highly inter-connected grid across 15 states and Manitoba
- Diverse generation mix
- Relationships with seams partners

ON-GOING

- Coordinated Seasonal Assessments (Winter)
- Winter Readiness Workshops
- Emergency Procedure Drills

PRE-EVENT

- Issued Informational Advisories & Cold Weather Alert
- Daily coordination with neighbors
- Committed additional gas generation early to secure fuel supply
- Declared Conservative Operations

ARCTIC EVENT

February 15, 2021

- Local Transmission Emergency – Western Load Pocket (SE Texas)

February 16, 2021

- Local Transmission Emergencies
  - Western Load Pocket (SE Texas)
  - North-Central Louisiana
- Transmission System Emergency – South-Central Illinois
- Maximum Generation Event Step 5 – South Region

Unprecedented flows across our system that aided the interconnection also contributed to the need for emergency declarations

Net Scheduled Interchange (GW)

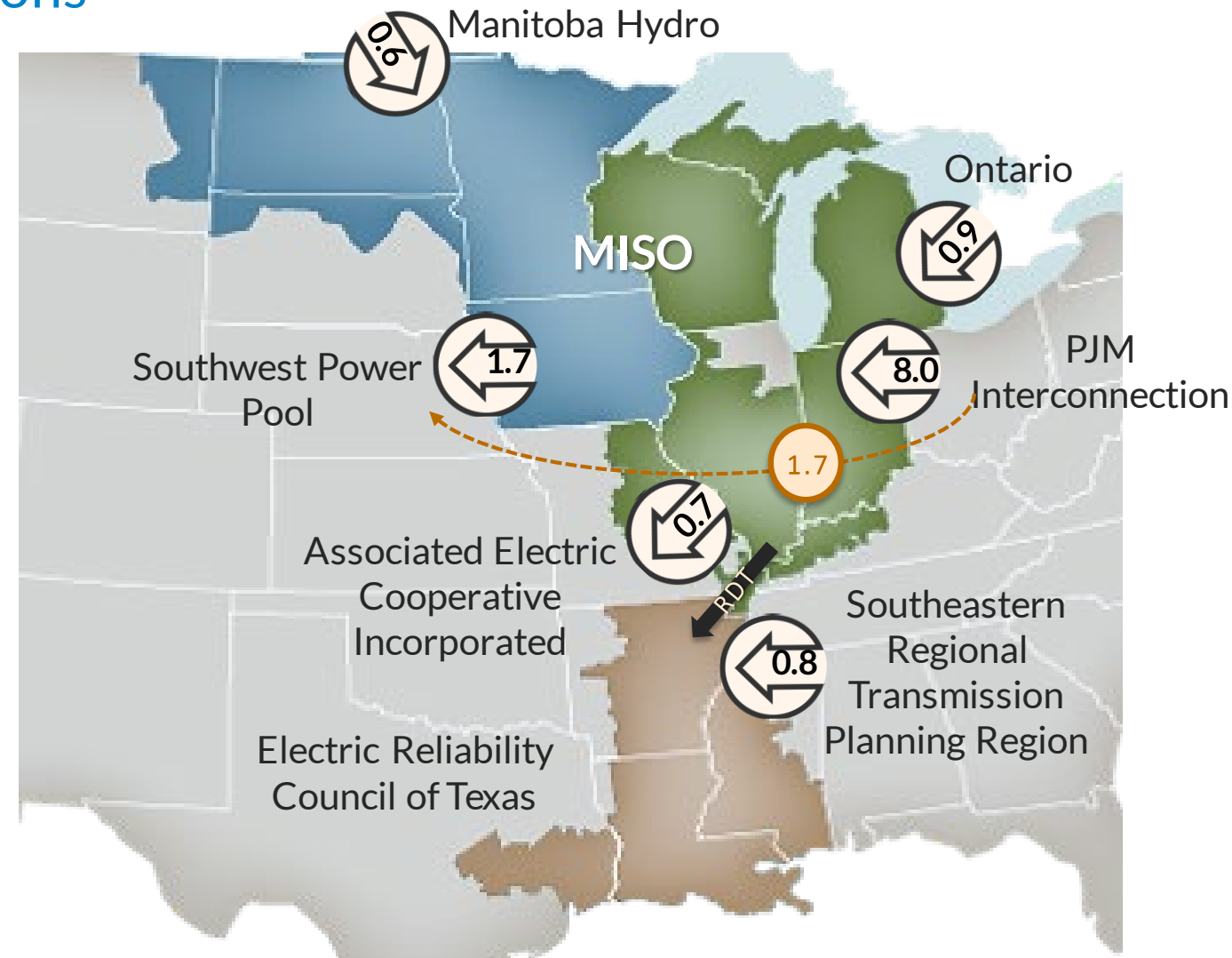


Image represents average flows into, out of and through MISO over 3 days (February 15-17, 2021)

RDT = Regional Dispatch Transfer, which has a North-South limit of 3 GW

This event serves to illustrate the urgency to complete the work of responding to the Reliability Imperative

RELIABILITY IMPERATIVE

Market Redefinition
Long-Range Transmission Planning
Operations of the Future
Market System Enhancement

- Availability is less than expected when conditions are tight, and the significant drivers (e.g., winterization, fuel assurance) are unique to seasons (Addressed through Market Redefinition: Resource Adequacy Construct and Accreditation)
- Sufficient transfer capability within and between markets is critical to enabling the advantages of regional diversity (Addressed through Long Range Transmission Planning)
- Assessment of uncertainties is critical for adequate and efficient commitment and real-time operational response (Addressed through Operations of the Future)
- Resource adequacy evaluation in constrained areas is necessary (Addressed through Market Redefinition: Resource Adequacy)

Planned improvements in Market Redefinition will address many aspects of severe weather events, including the recent Arctic event

- Planned reforms create seasonal Resource Adequacy requirements
- Improvements to accreditation provide stronger alignment between accredited value and resource availability in tightest operating hours
- Enhancements to emergency and scarcity pricing help ensure prices reflect underlying system conditions, especially during severe events
- Arctic event reinforces needs for reforms and acceleration where possible, including review of winterization and fuel assurance information sharing / analytics

Early 2010's

2011

Texas

Cold Weather

- 4 GW load shed
- 3.2M people effected

Southeast

Tornado Outbreak

- 300+ transmission towers destroyed

Southwest

Heat wave

- 12-hour power failure
- 2.7M people effected

2012

Eastern US

Derecho Blackout

- 4.2M people effected

East Coast

Superstorm Sandy

- 8.6M people effected

Mid 2010's

2014

Midwest, East Coast

Polar Vortex

- Forced Outages: PJM 38 GW, MISO 29 GW

2017

Texas

Hurricane Harvey

- Forced Outages: 10 GW

Late 2010's

2018

Gulf Coast

Hurricane Michael

- 1.7M people effected

East Coast

Bomb Cyclone

- Record gas deployment

2019

Midwest

Polar Vortex

- Forced Outages: PJM 21 GW, MISO 30 GW

2020

California

Heat & Wildfires

- Rotating blackouts

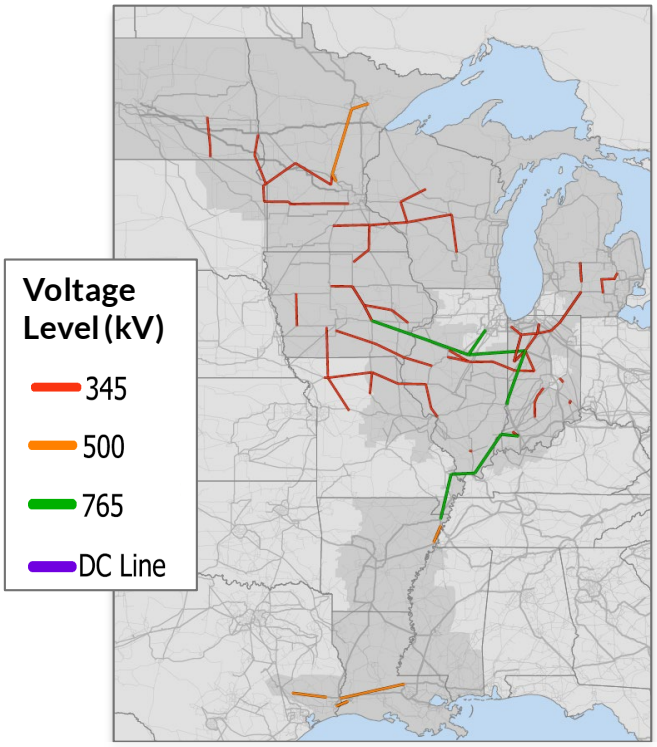
2021

Texas

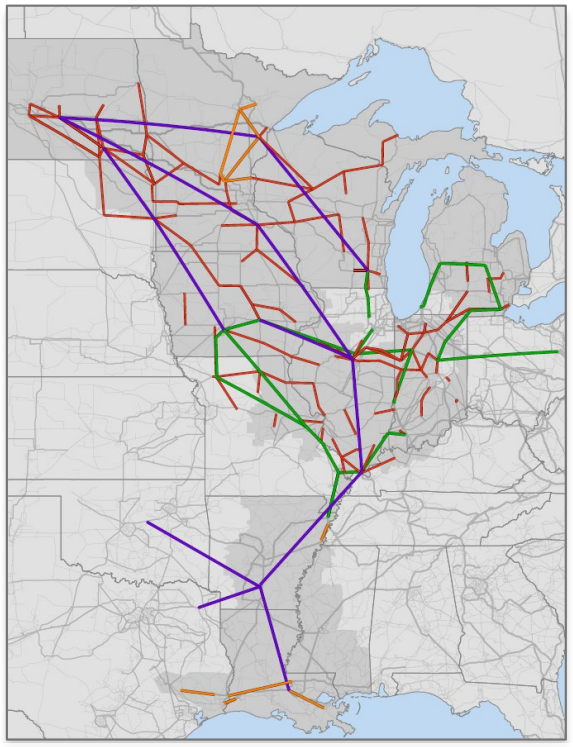
Arctic Event

- 4 million affected
- 30 GW forced outage
- 20 GW load shed

The Long Range Transmission Planning roadmap addresses both the near- and long-term needs of the MISO system



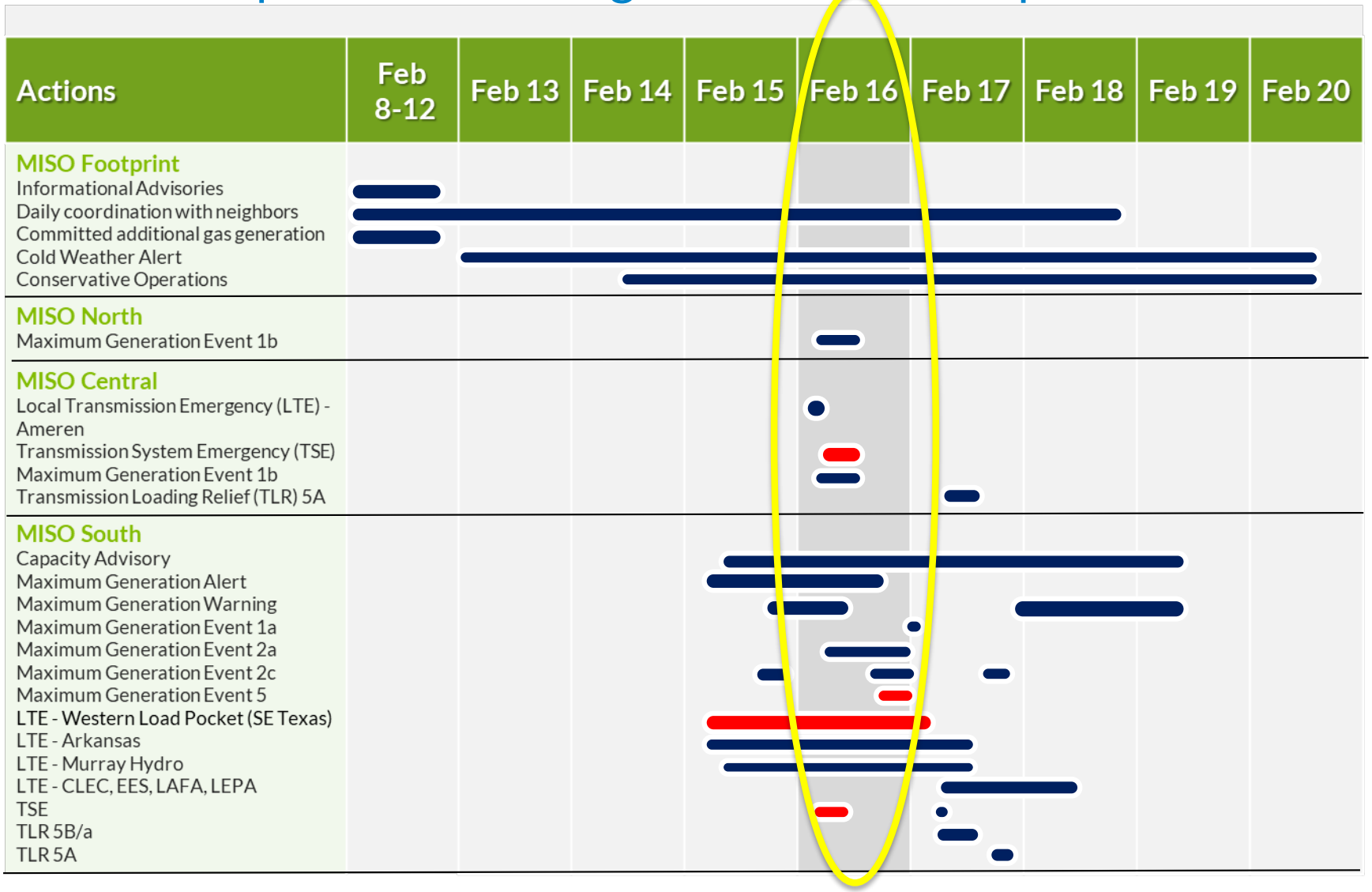
Future 1



Futures 1, 2, 3

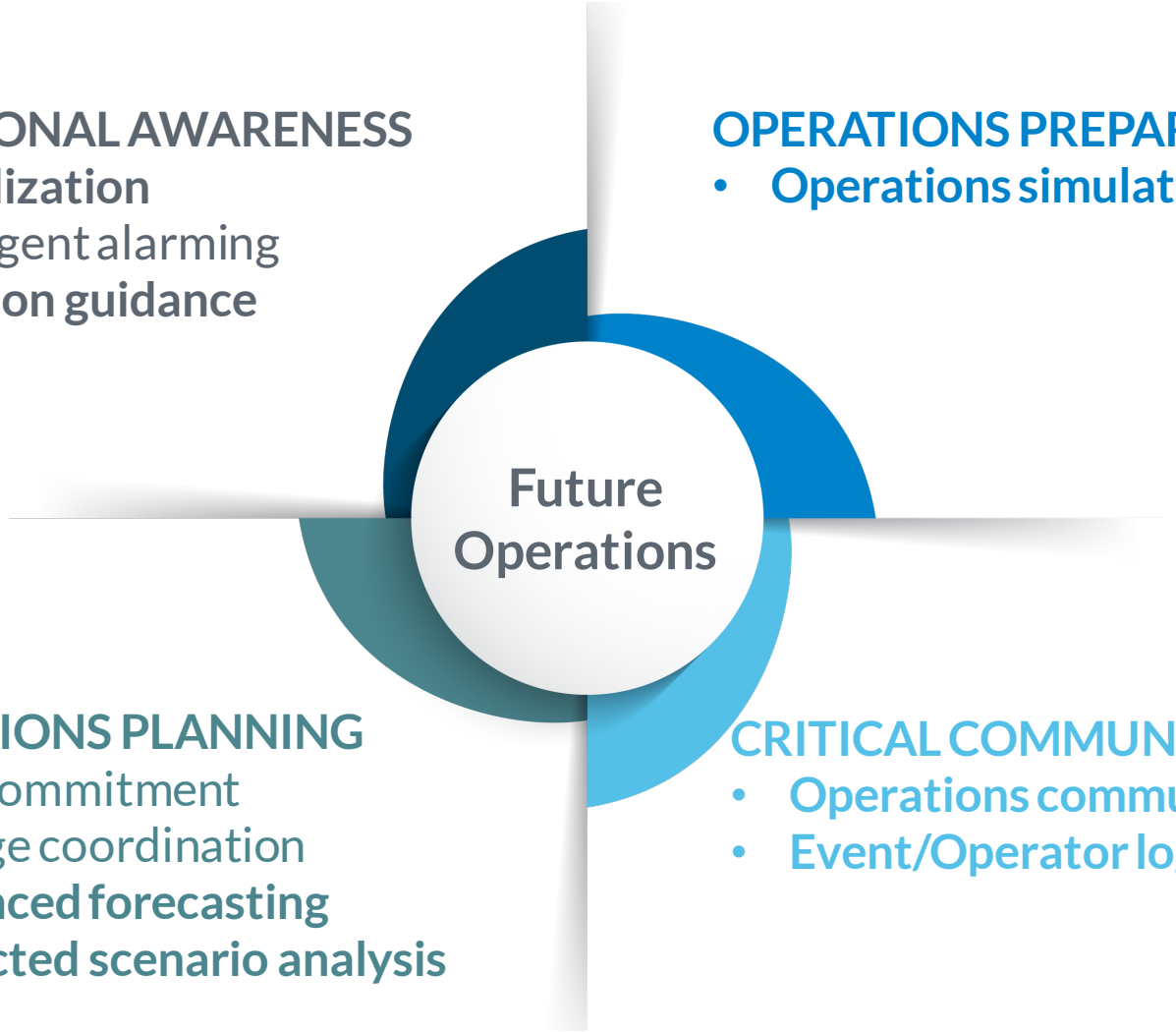
Continued investment in the transmission system – within the MISO footprint and along our seams – will strengthen our ability to maintain reliability

During a three-day period, MISO managed multiple independent and interdependent challenges across the footprint



Duration of load curtailment and recovery associated declarations shown in red
Duration of declarations shown in blue

Operations of the Future focus areas plan to enhance day-to-day operations and managing extreme events



Keys to success in responding to the Reliability Imperative

Velocity

- Risks are changing rapidly and responding to the Reliability Imperative is urgent.

Coordination with our members, states, neighbors, and industry

- Increasingly volatile weather patterns and evolving resource fleets will require MISO to implement comprehensive changes.
- MISO needs to work with neighbors to ensure that we can continue to identify improvements in how we support each other effectively during normal and challenging conditions.
- MISO will support NERC and FERC reviews, and individual state investigations, as we all learn from events in California, Texas, and internationally.

It all has to move together

- The components of the Reliability Imperative are interrelated and will require coordinated action from many players in the MISO region.