



# Overview of Winter Storm Elliott December 23, Maximum Generation Event

Reliability Subcommittee

January 17, 2023

*All data included in this presentation is preliminary as of January 12, 2023, and is subject to change*

# Executive Summary

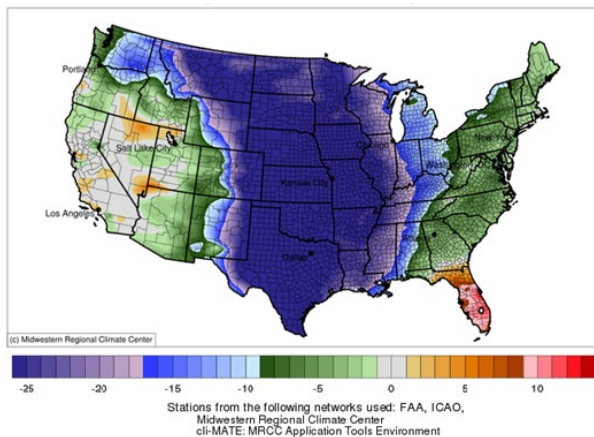


- Winter Storm Elliott delivered rapid, extreme cold to the Eastern Interconnect in December as well as gas supply challenges and historic load forecast volatility
- MISO had enough capacity to manage uncertainty while serving exports to our neighbors
- There were no customer interruptions
- Lessons learned from Winter Storm Uri contributed to successful operations during Elliott; subsequent analysis will lead to additional lessons learned
- Load forecast uncertainty and fuel supply availability are examples of the increasing uncertainty being addressed under MISO's Reliability Imperative

# On December 23, Winter Storm Elliott brought significantly below normal temperatures to MISO, driving high demand for heating; drawing similarities to Winter Storm Uri in 2021

## WINTER STORM URI FEBRUARY 12-18, 2021

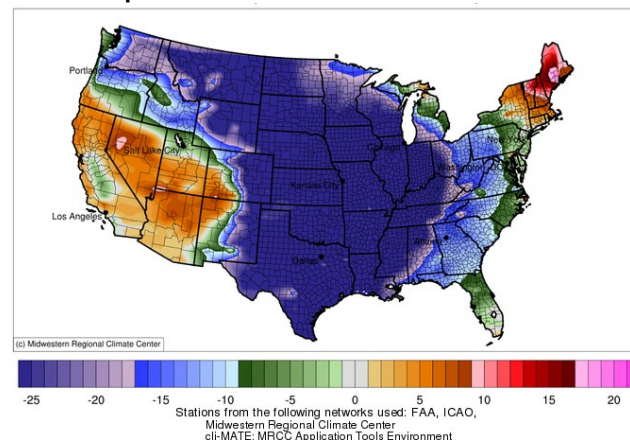
**Average Temperature:  
Departure from 30-Year Normal**



<b>System Peak Load</b>	<b>103 GW</b>
Unplanned Outages ( <i>South</i> )	18 GW
Scheduled Load Modifying Resources*	531 MW
RDT Max Flow & Direction	3.2 GW N-S
Precipitation: <i>Abundant snowfall across MISO's South and Central regions</i>	

## WINTER STORM ELLIOTT DECEMBER 23, 2022

**Average Temperature:  
Departure from 30-Year Normal**



<b>System Peak Load</b>	<b>107 GW</b>
Unplanned Outages ( <i>additional from previous day system-wide</i> )	19 GW
Scheduled Load Modifying Resources*	1.2 GW
RDT Max Flow & Direction	2.7 GW N-S
Precipitation: <i>Modest snowfall across MISO's North and Central regions</i>	

# Emergency operations were required to access additional capacity to mitigate uncertainty and support our neighbors

## ALERTS

### Cold Weather Alert (South)

DEC 22, noon EST – DEC 26, noon EST

Unseasonably cold weather expected across MISO

## WARNINGS

### Maximum Generation Warning (South)

DEC 23, 9:15 a.m. – 12:45 p.m. EST

### Conservative Operations (South)

DEC 23, 9:15 a.m. EST – DEC 26, midnight EST

Tightened conditions due to unit trips and failures to start (~2 GW), higher-than-forecast South load (~2.5 GW), and reduced RDT flow limit N-S (to 1.5 GW)

### Maximum Generation Warning (Footprint)

DEC 23, 4:30 p.m.

### Conservative Operations (Footprint)

DEC 23, 9 p.m. EST – DEC 24, noon EST

Tighter conditions due to higher-than-forecast system-wide loads, forced outages driven primarily by fuel supply issues and units that failed to start

## EVENTS

### Maximum Generation Event, Step 1b (Footprint)

DEC 23, 5:30 p.m.

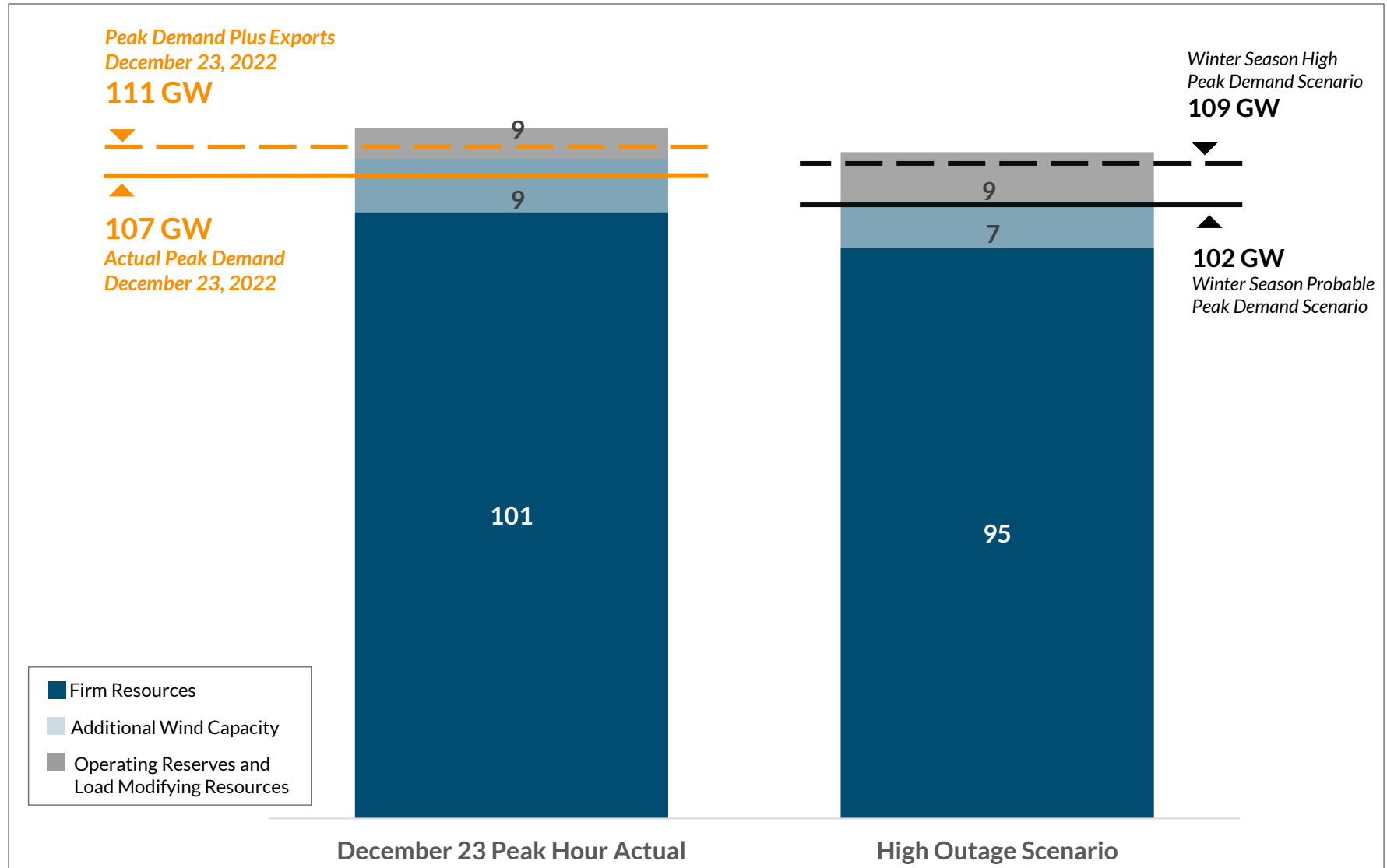
Tight conditions worsened with real-time transmission congestion and diminishing generation deliverability

### Maximum Generation Event, Step 2a (Footprint)

DEC 23, 6 p.m. – 9 p.m. EST

Emergency procedures allowed access to demand response, which reduced the peak demand

# Reserve capacity was closely monitored, and exports would have been curtailed if conditions had worsened



# MISO consistently exported power to southern neighbors with a maximum value of nearly 5 GW

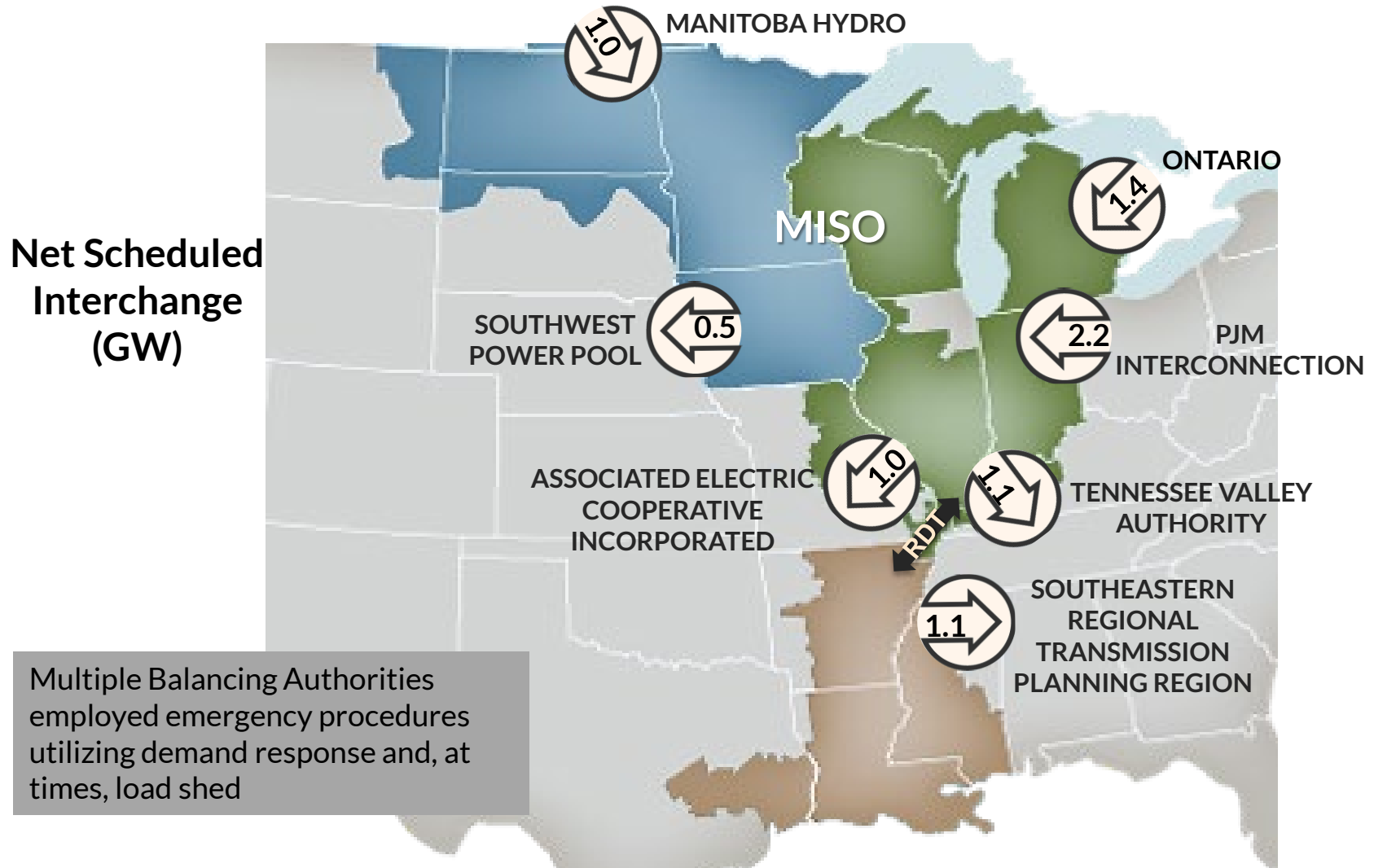
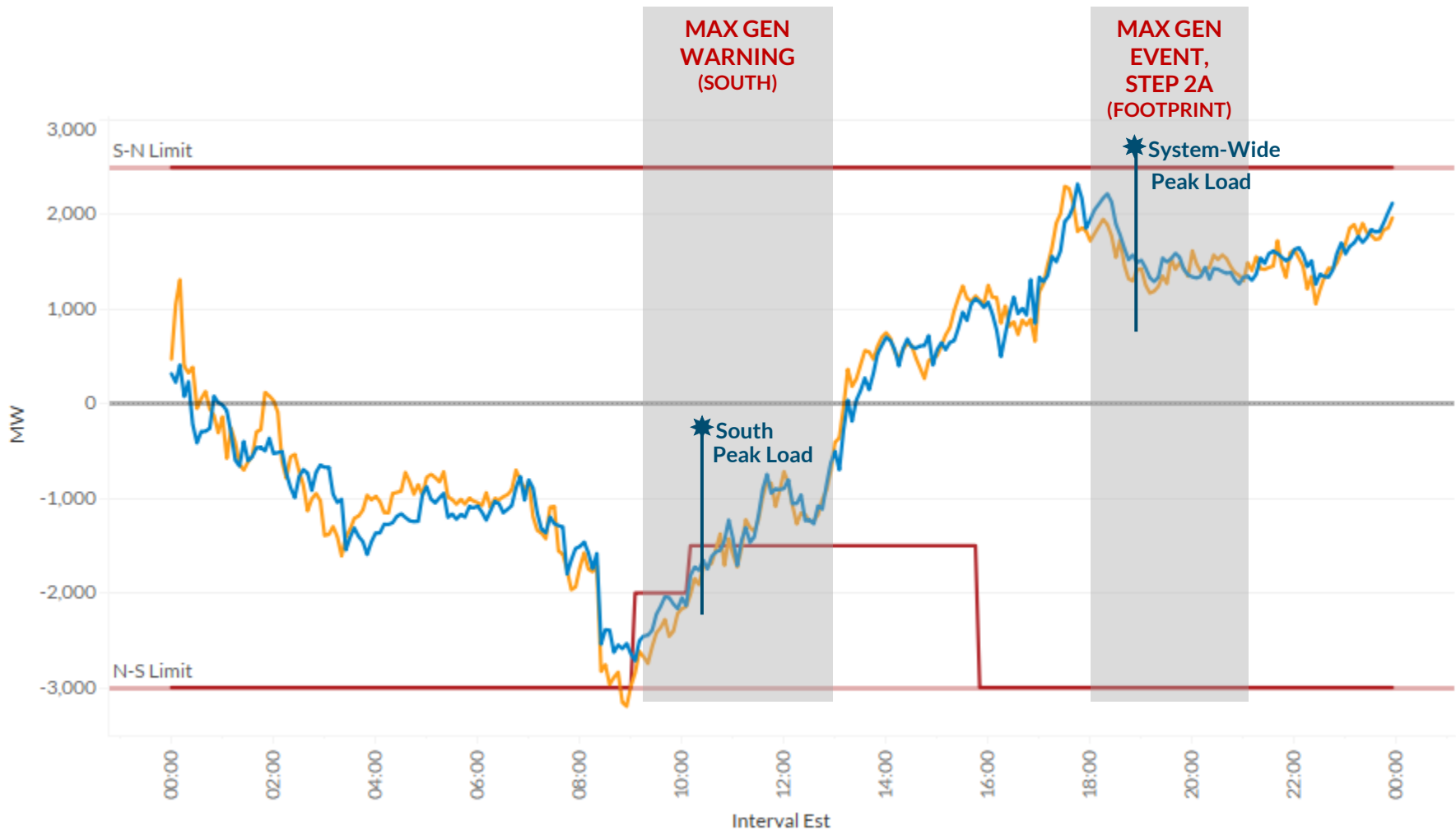


Image represents average flows into and out of MISO December 23, 2022

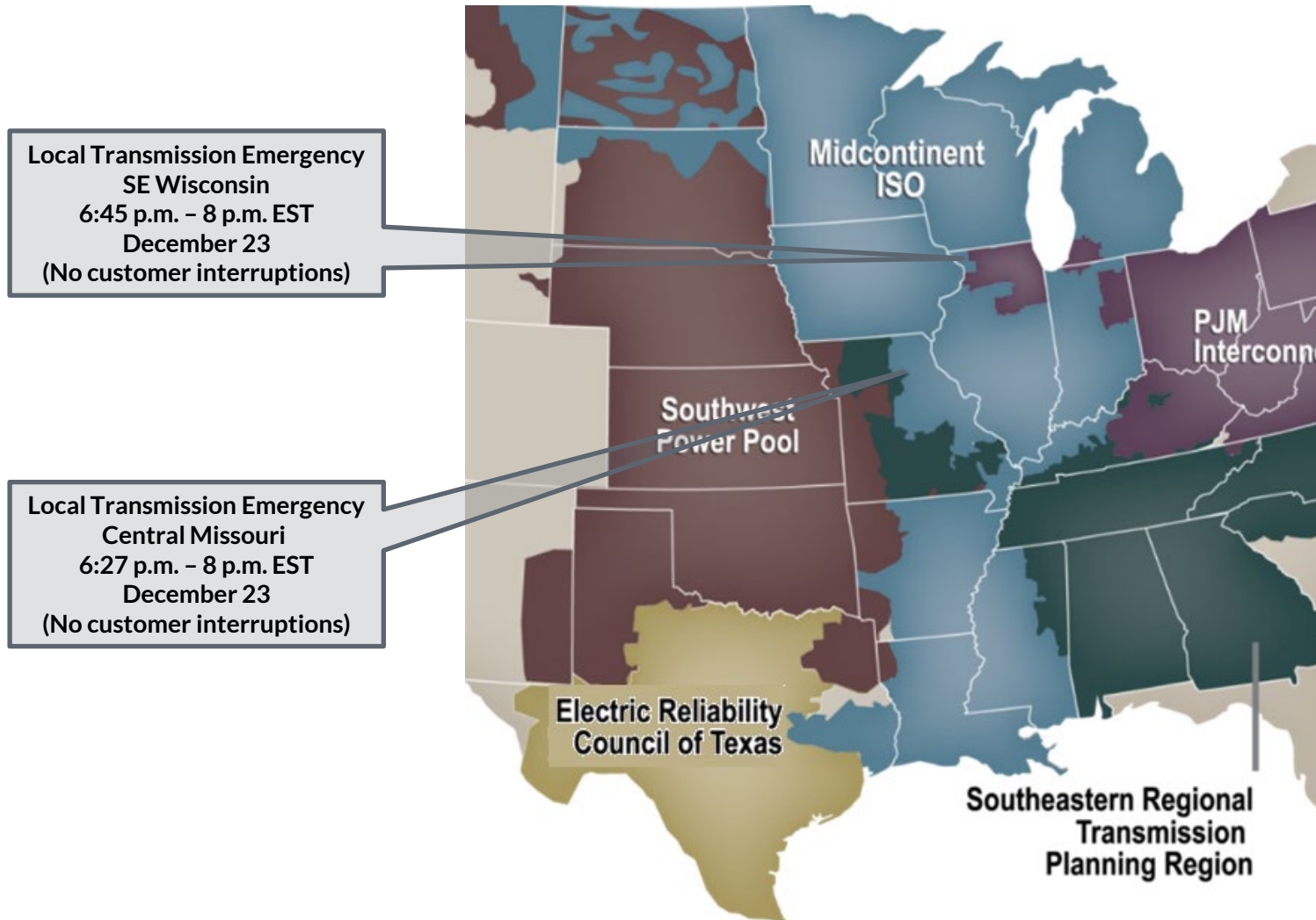
RDT = Regional Directional Transfer, which has a North-South limit of 3.0 GW and South-North limit of 2.5 GW

# MISO complied with Joint Parties requests to reduce flows by 1,500 MW during the morning peak, which contributed to an emergency declaration in the South and a recall of non-firm exports

Regional Directional Transfer Flow for December 23, 2022

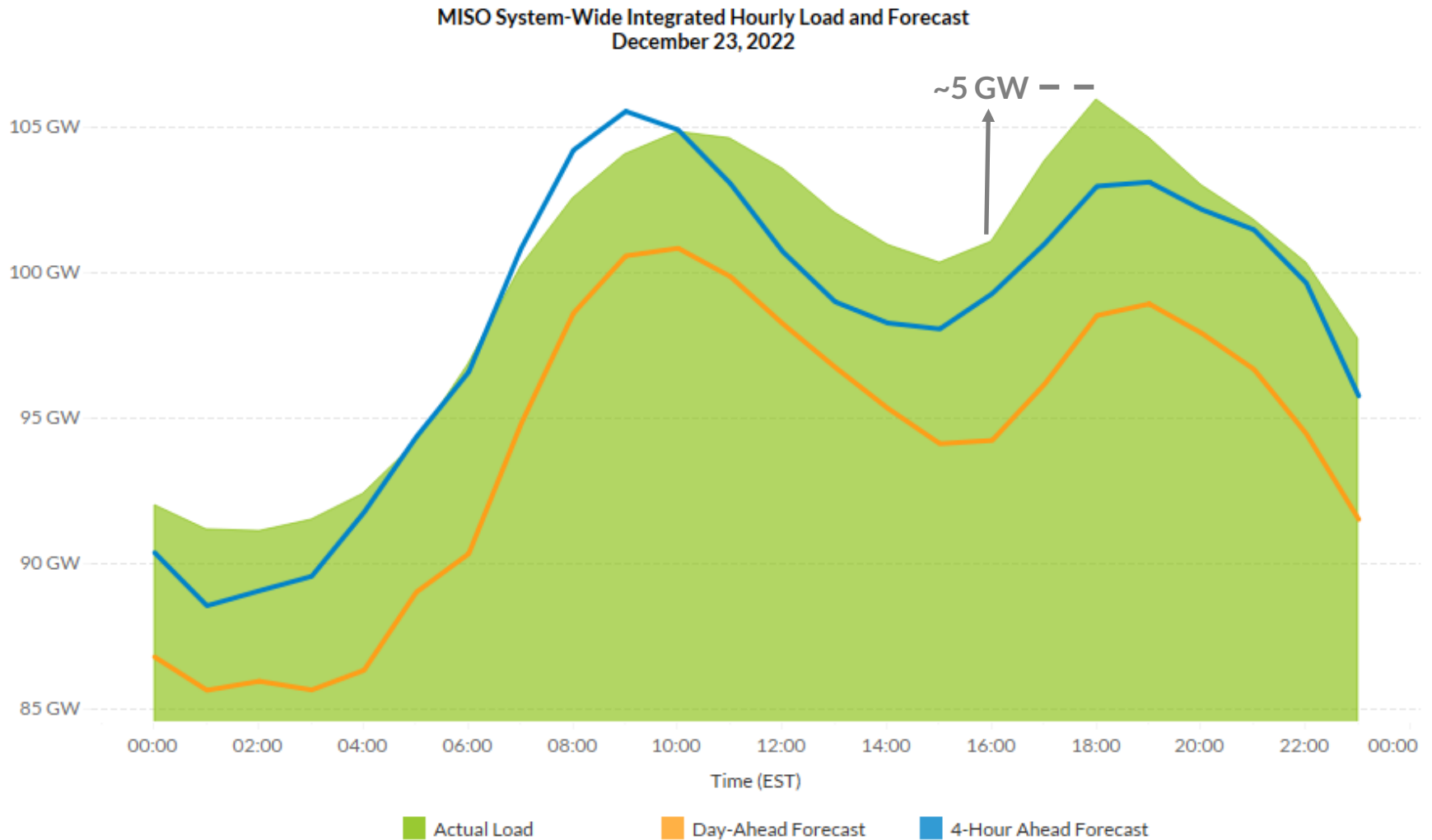


# Two local transmission emergencies were declared to manage severe congestion on transmission lines



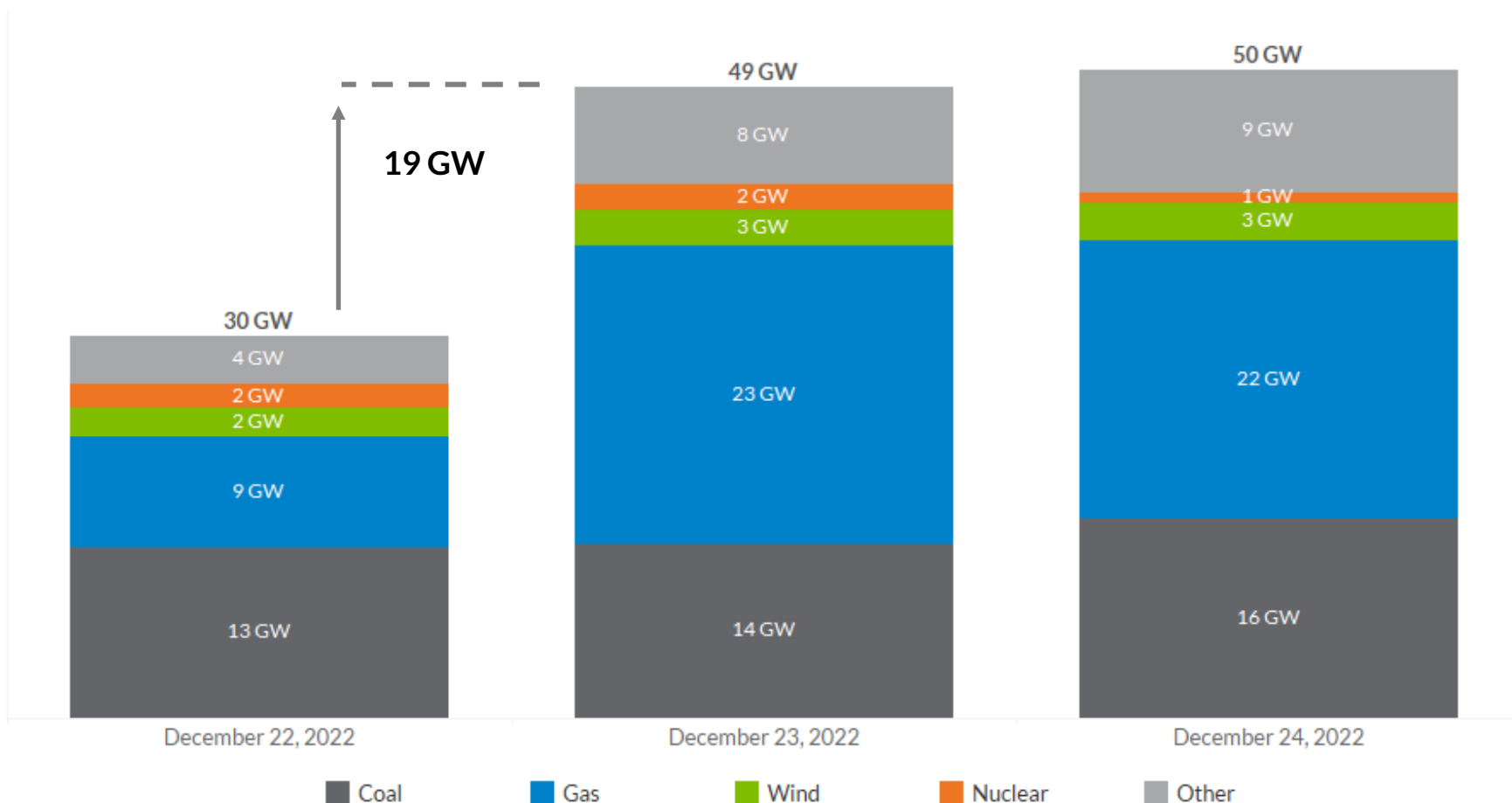


# Abnormally high load forecasting errors occurred due to a lack of historical data for similar extreme conditions in December



# Gas supply availability contributed to increased unplanned outages, particularly in the afternoon, that pushed MISO into emergency procedures

MISO System-Wide Daily Average Unplanned\* Generation Outages by Fuel



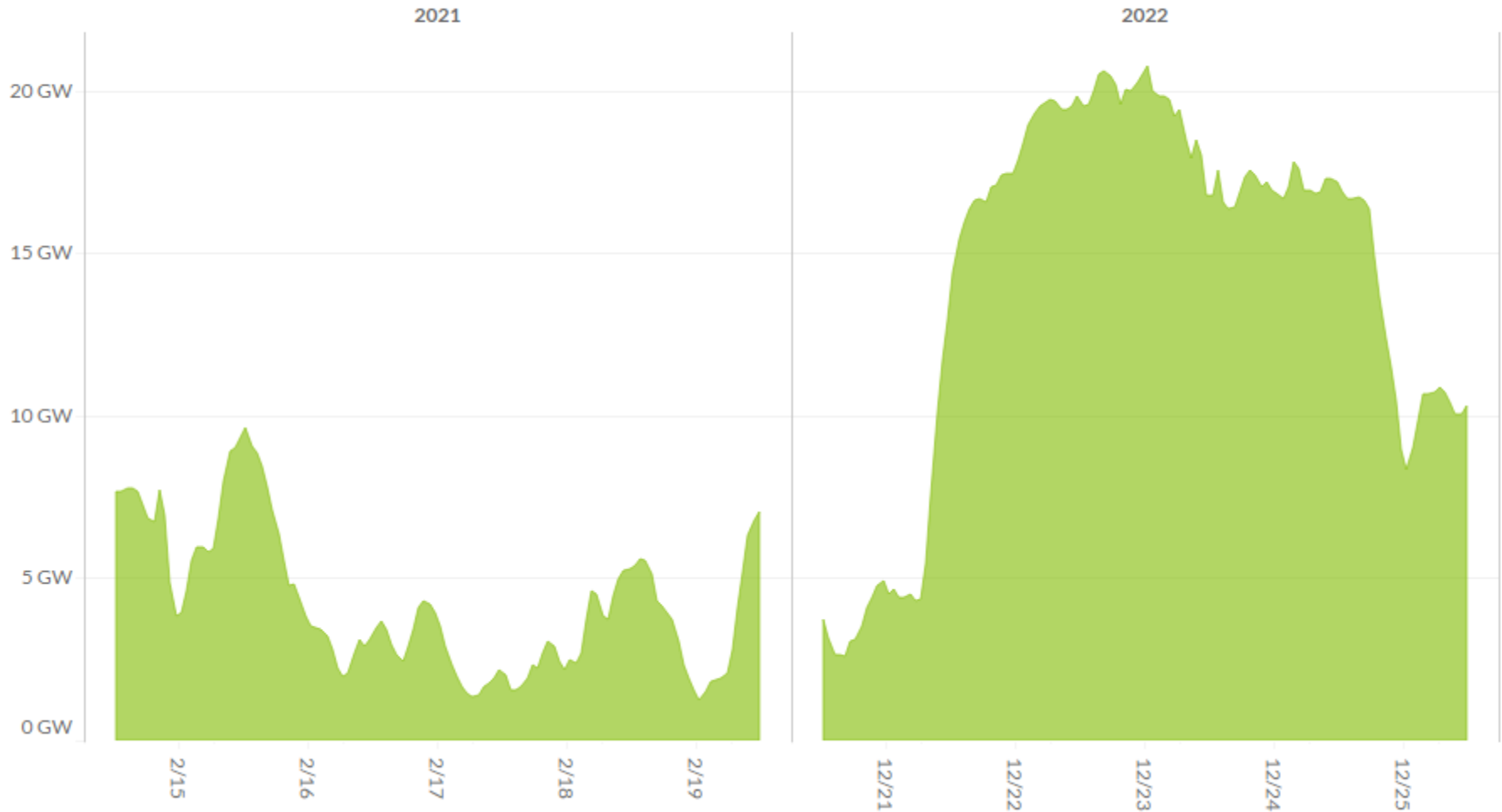
\*Unplanned = forced outages and derates

Charts reflect data in the CROW outage system on January 5, 2023

Wind often reported as derated over the time period

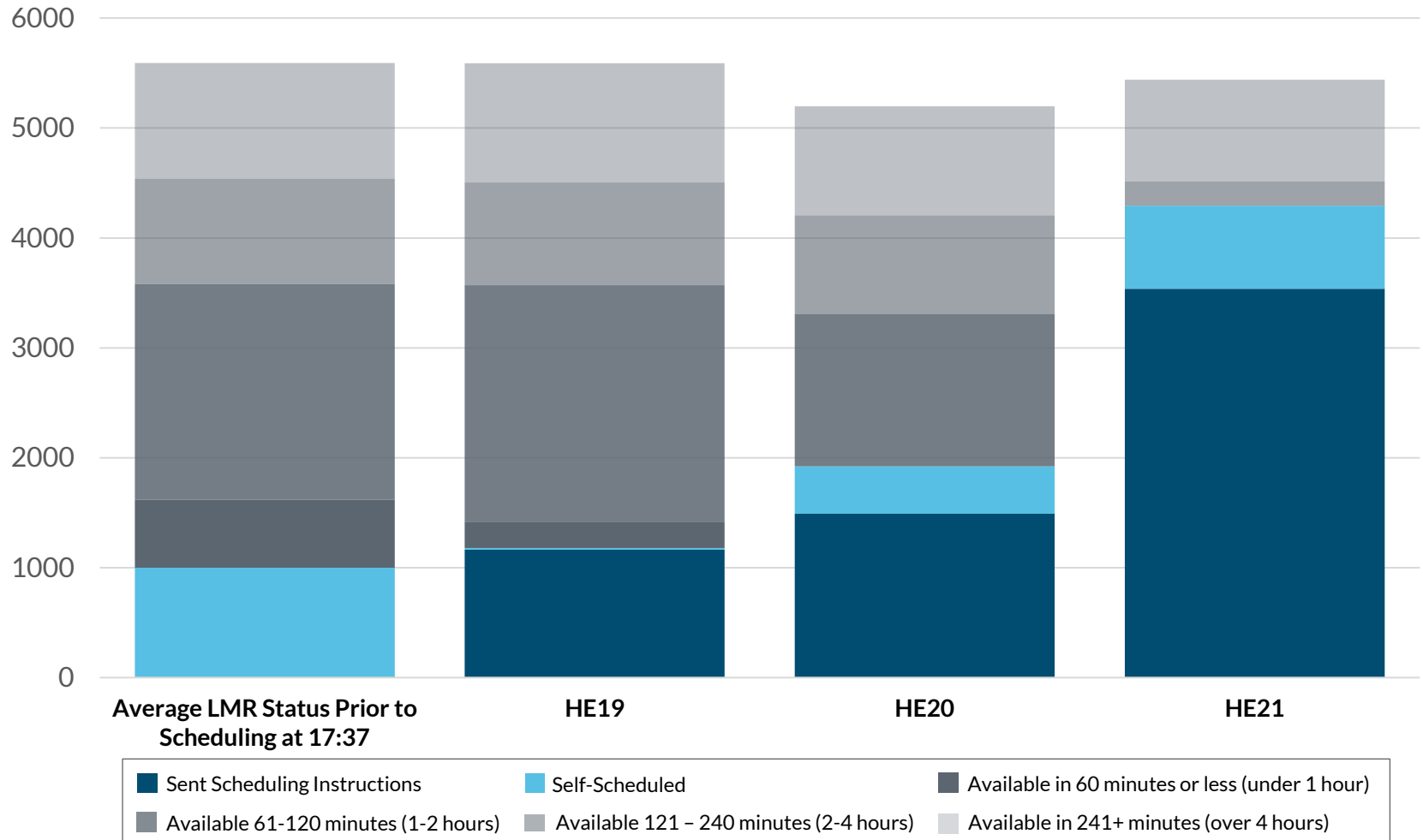
# Wind production remained high during Winter Storm Elliott, providing support to the transmission system

MISO System-Wide Actual Wind Generation  
Storms Uri (2021) and Elliott (2022)



# Requested 3 GW of Load Modifying Resources at 17:37 to meet increasing load and continue exports to neighbors

Load Modifying Resources (MW)  
December 23, 2022



# While each storm is unique, lessons learned from Winter Storm Uri in 2021 contributed to successful operations during Elliott

## REFINED WINTER READINESS ACTIVITIES

- Increased focus on extreme scenarios
- Improved understanding of generator winter preparedness through coordinated seasonal assessment and fuel and consumables data requests
- Implemented cold weather-specific operator drills in addition to emergency procedure drills and winter readiness workshops

## PROCESS IMPROVEMENTS

- Process Improvements to Unit Commitment Processes and Operator Situational Awareness improved our ability to respond to changing risk profile during the operating day

## IMPROVED COORDINATION

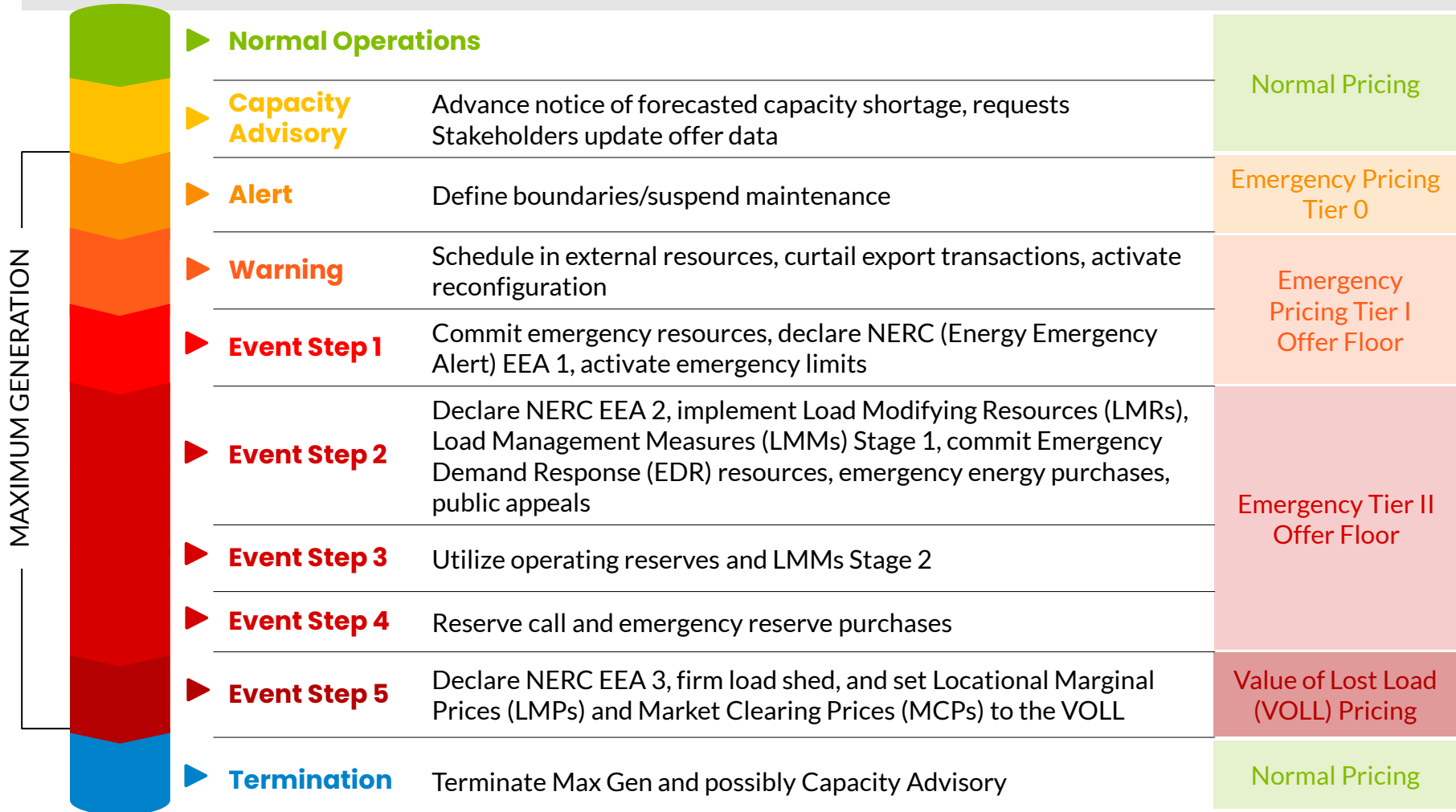
- Improved coordination activities with our neighbors that resulted in quicker decision making during the storm

# Appendix

# MISO's operating procedures ensure reliability and gain access to additional resources during extreme situations



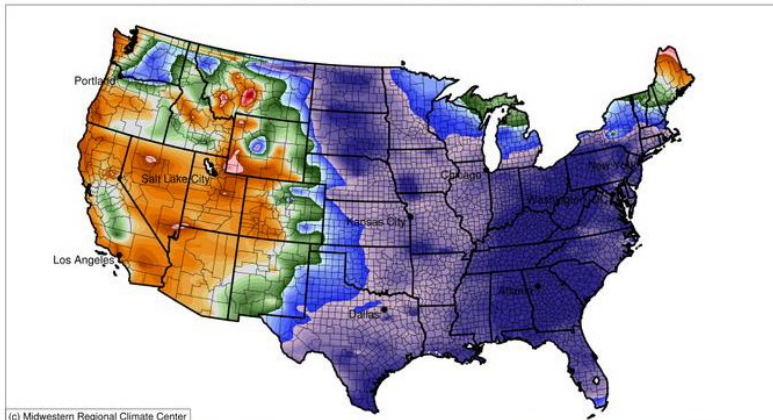
## MARKET CAPACITY EMERGENCY PROCEDURE STEPS



# Winter Storm Elliott continued to impact the Eastern Interconnect through December 25

## WINTER STORM ELLIOTT DECEMBER 24, 2022

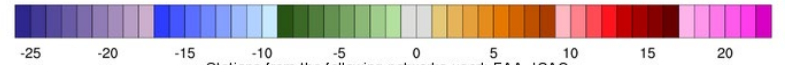
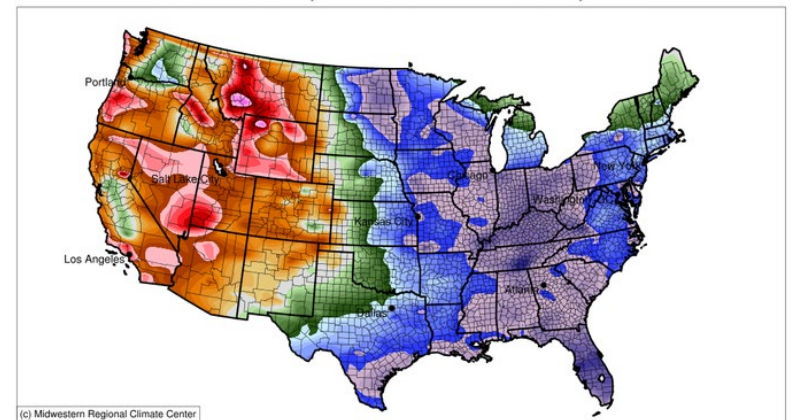
**Average Temperature:  
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Stations from the following networks used: FAA, ICAO,  
Midwestern Regional Climate Center  
cli-MATE: MRCC Application Tools Environment

## WINTER STORM ELLIOTT DECEMBER 25, 2022

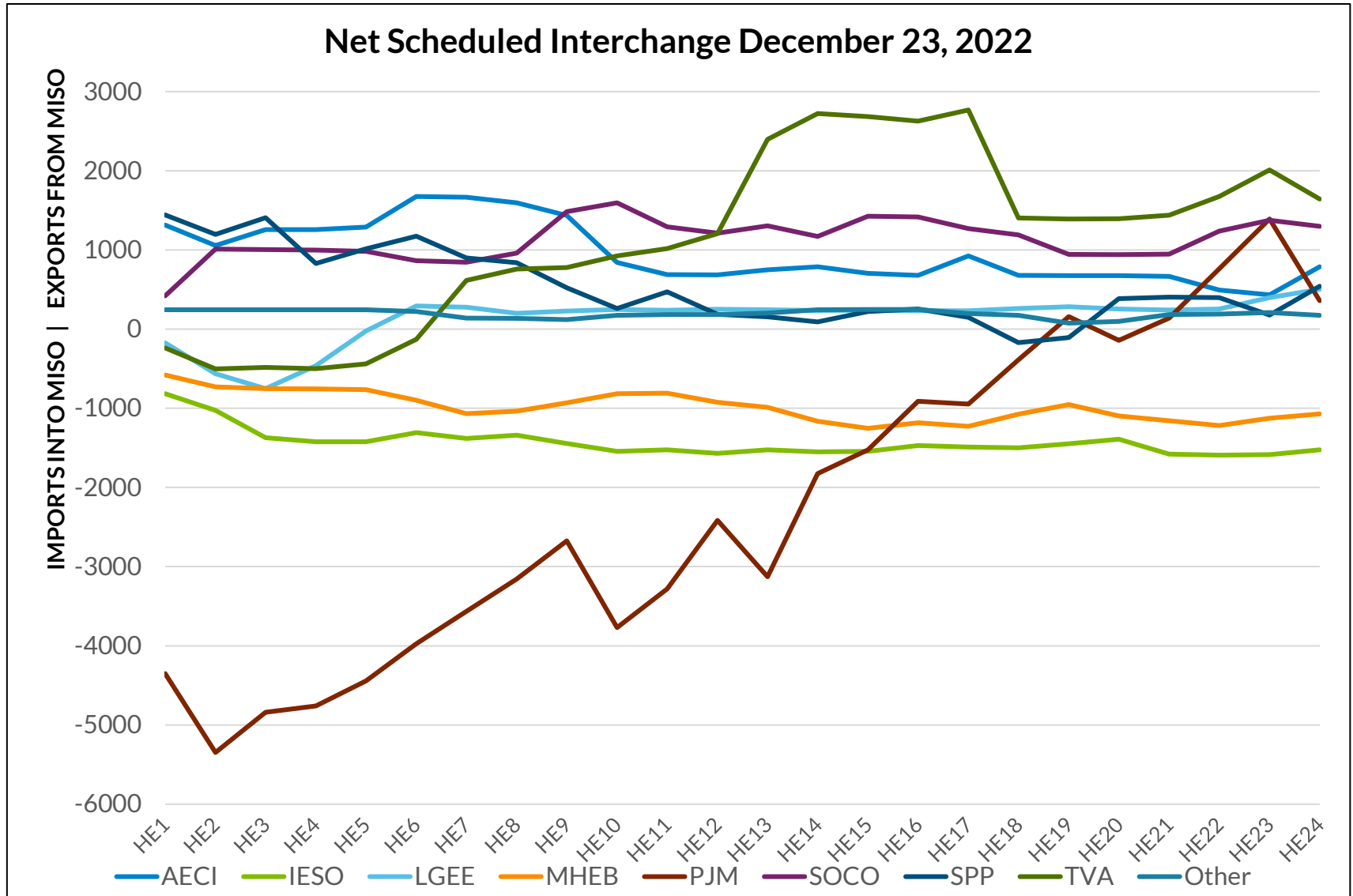
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# MISO maintained its support for neighbors December 23-24



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