Extreme Event and Transmission Analysis in MISO's Probabilistic Modeling

ESIG Spring Workshop 2024

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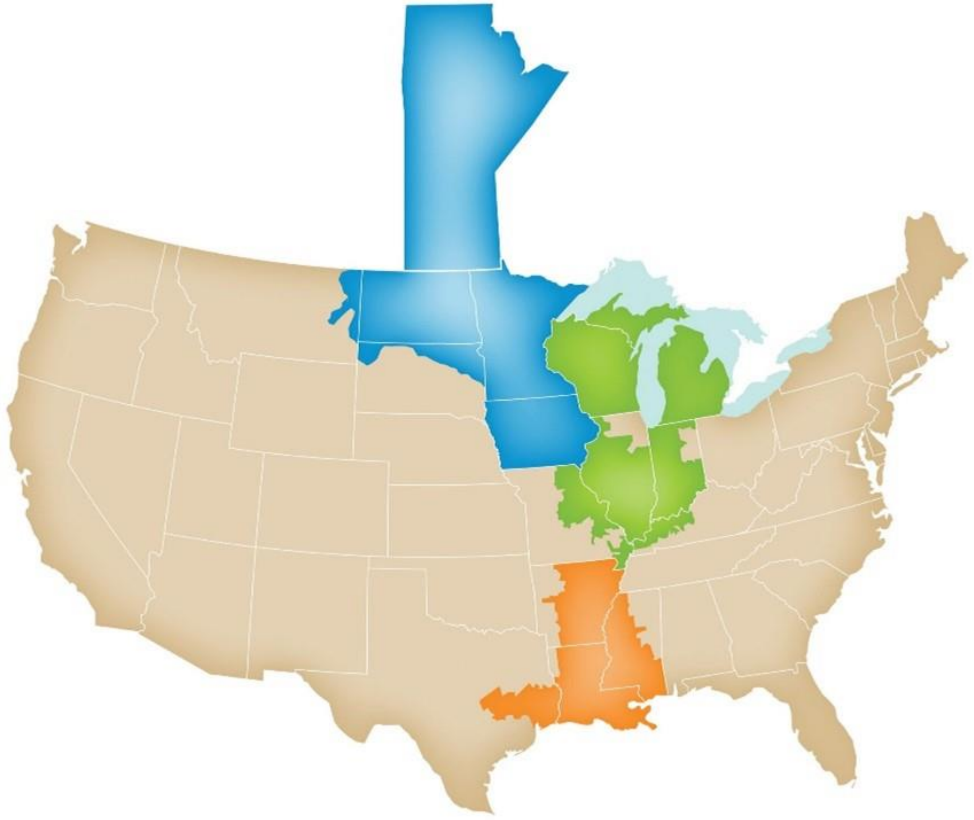
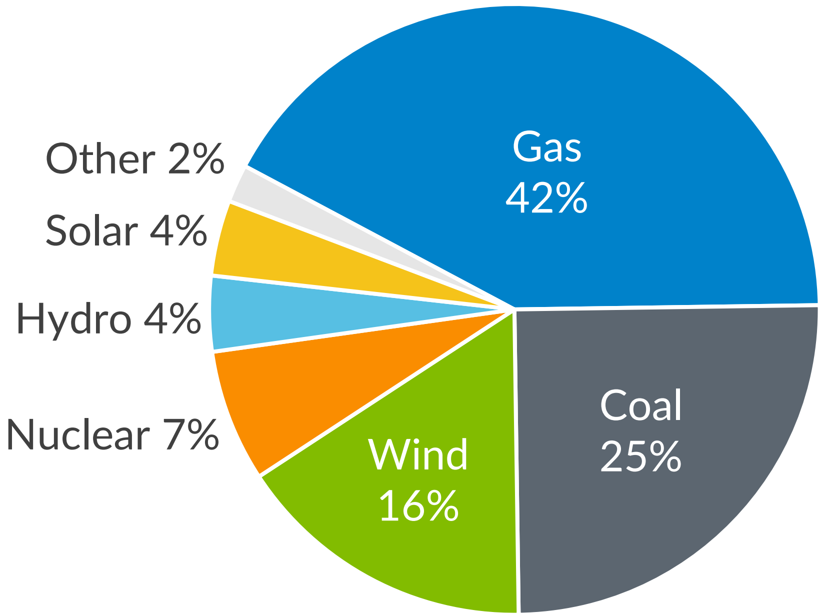
About MISO

- MISO's core responsibilities:
  - **Operations** - Managing the flow of high-voltage electricity across 15 states and Manitoba
  - **Markets** - Facilitating one of the world's largest energy markets
  - **Planning** – Planning the grid of the future



MISO's reliability footprint

Installed Capacity – December 2023

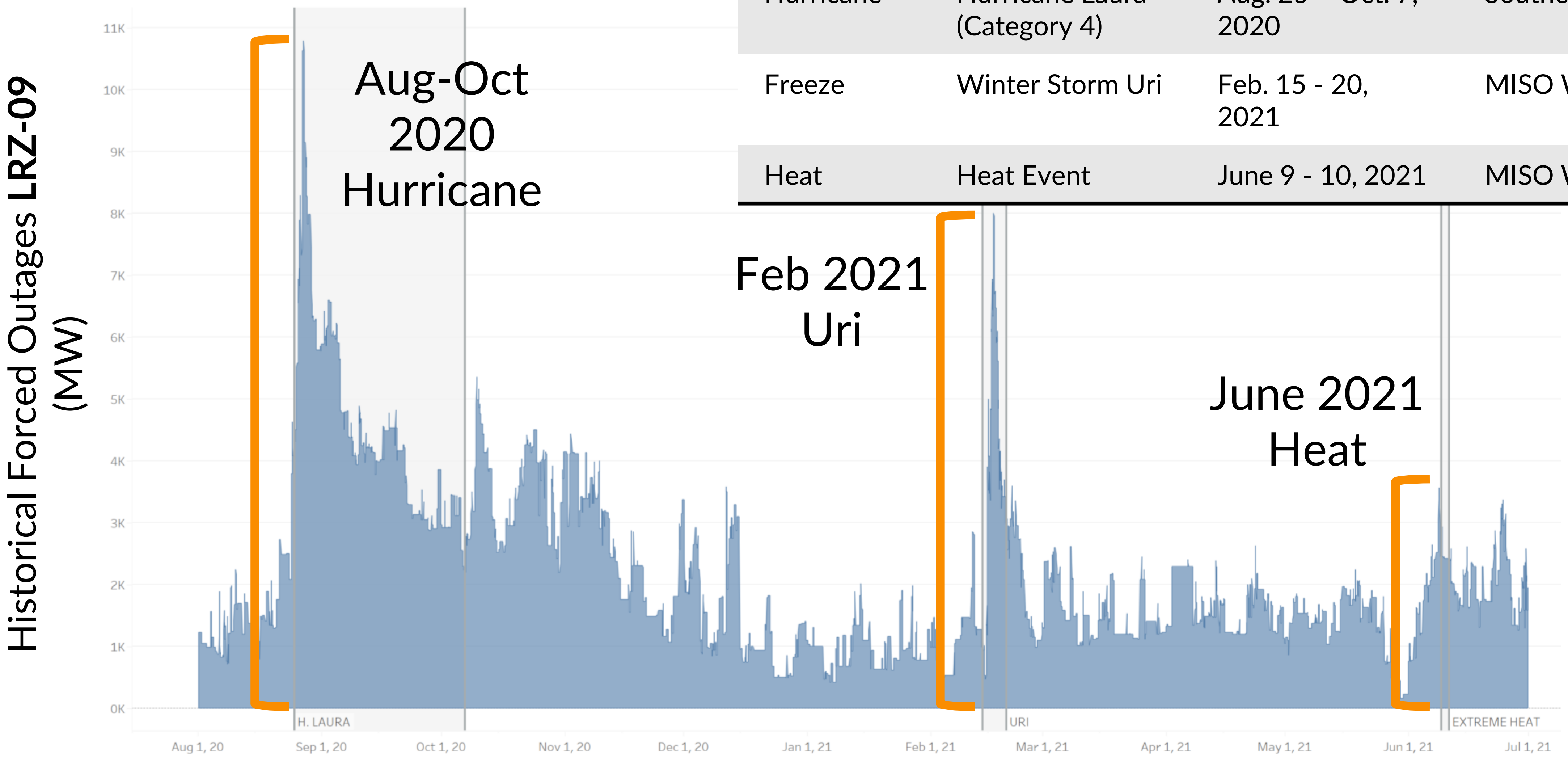


191 GW Total Installed Capacity

Extreme Event Analysis – Using Historical Data

Three historical weather events that caused an increase in forced outages were analyzed

Event Type	Event	Date	Affected Region
Hurricane	Hurricane Laura (Category 4)	Aug. 25 – Oct. 7, 2020	Southern (LRZ9)
Freeze	Winter Storm Uri	Feb. 15 - 20, 2021	MISO Wide
Heat	Heat Event	June 9 - 10, 2021	MISO Wide

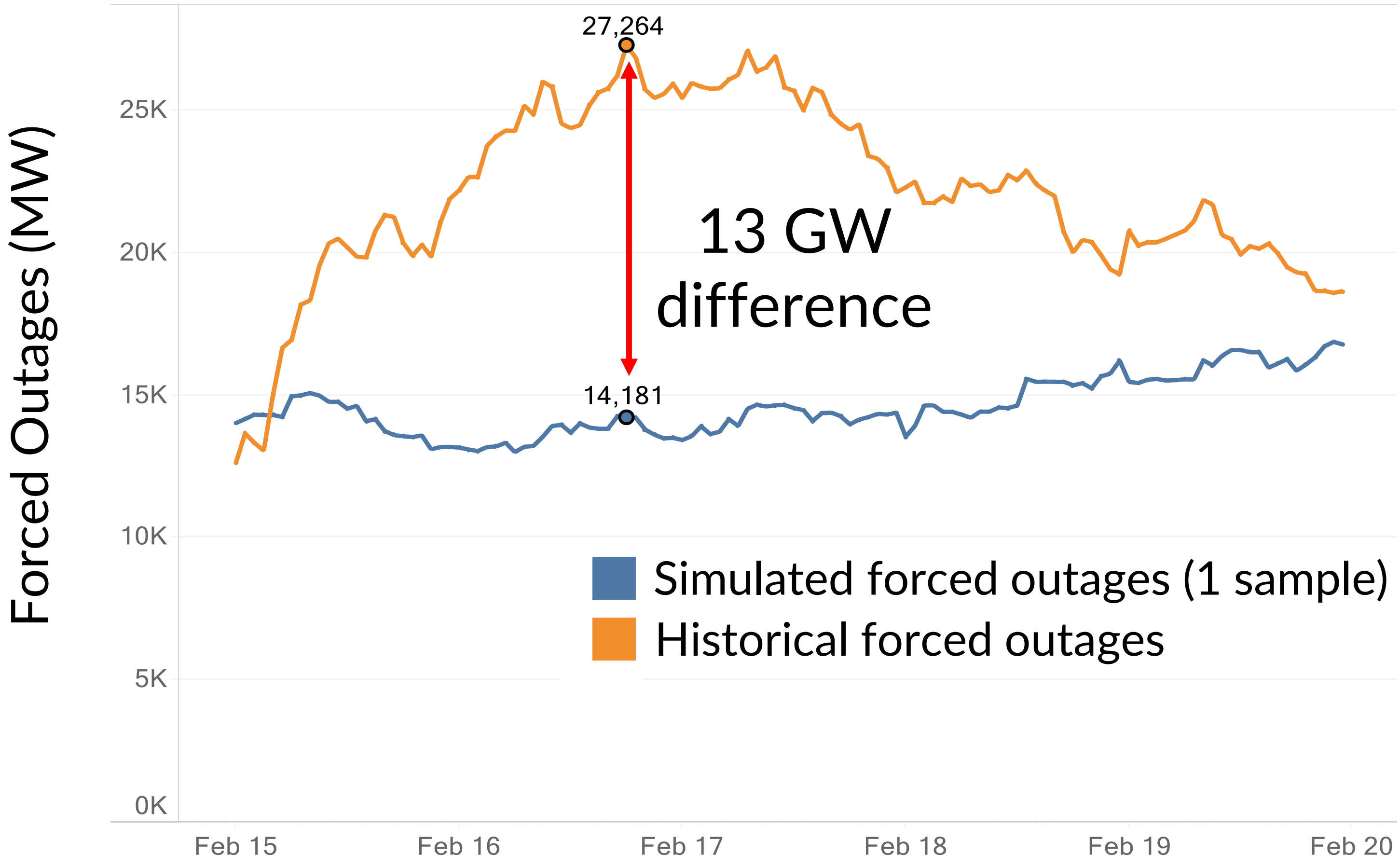


August 2020 – June 2021

LRZ: Local Resource Zone

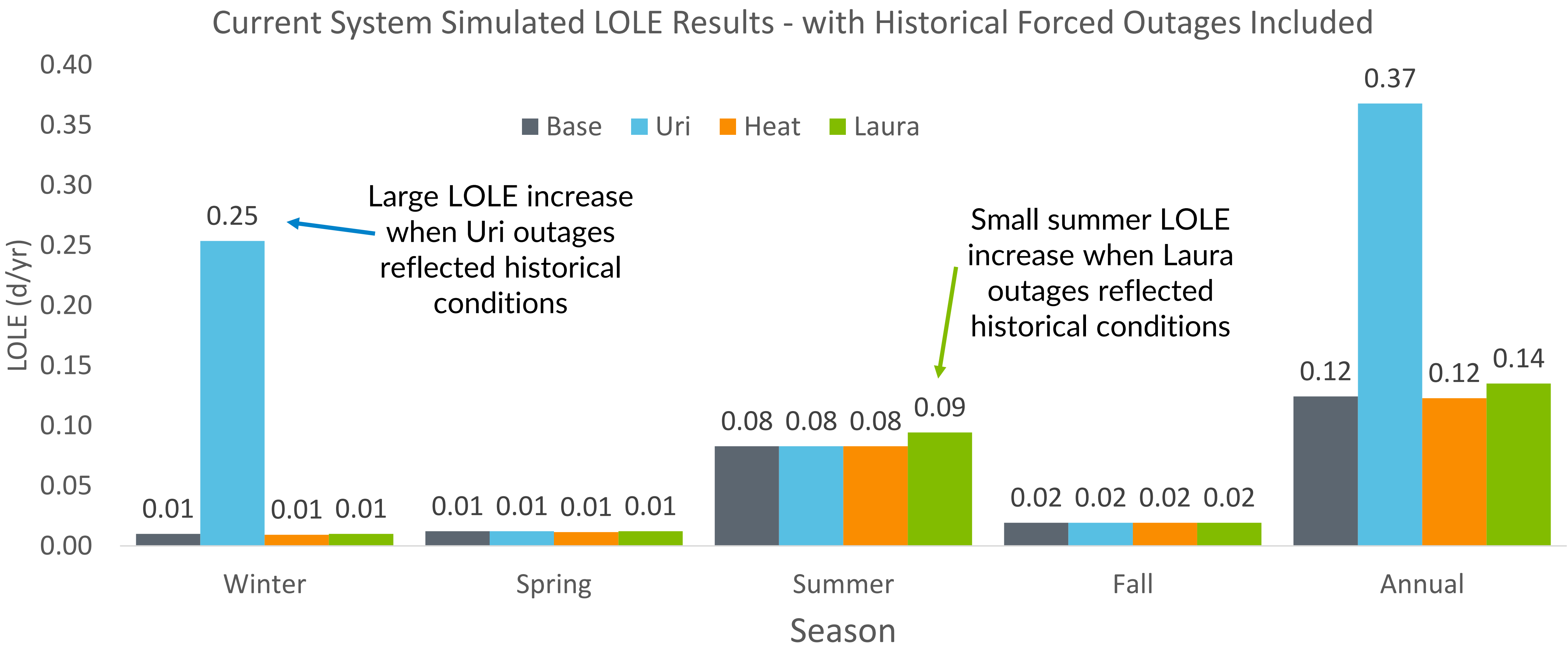
Comparison of event characteristics in the LOLE model to the actual event indicate a gap in extreme event modeling

Winter Storm Uri example: modeled versus historical forced outages



Simulated Outage Data: randomized values determined by a single sample run of the LOLE (loss of load expectation) model, based on seasonal forced outage rates
Historical Outage Data: Generating Availability Data System (GADS) data

When actual forced outage values were input into the LOLE model for the length of the event, it led to LOLE increases



LOLE Model Assumptions: 14 weather years (2007-2021 ex. 2013), load shapes from MISO load training process, wind shapes from normalized historical data

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For the Planning Year 23-24 LOLE study, MISO incorporated incremental temperature-dependent forced outages into the model

Figure 18. LRZ2 Average Coal Outages

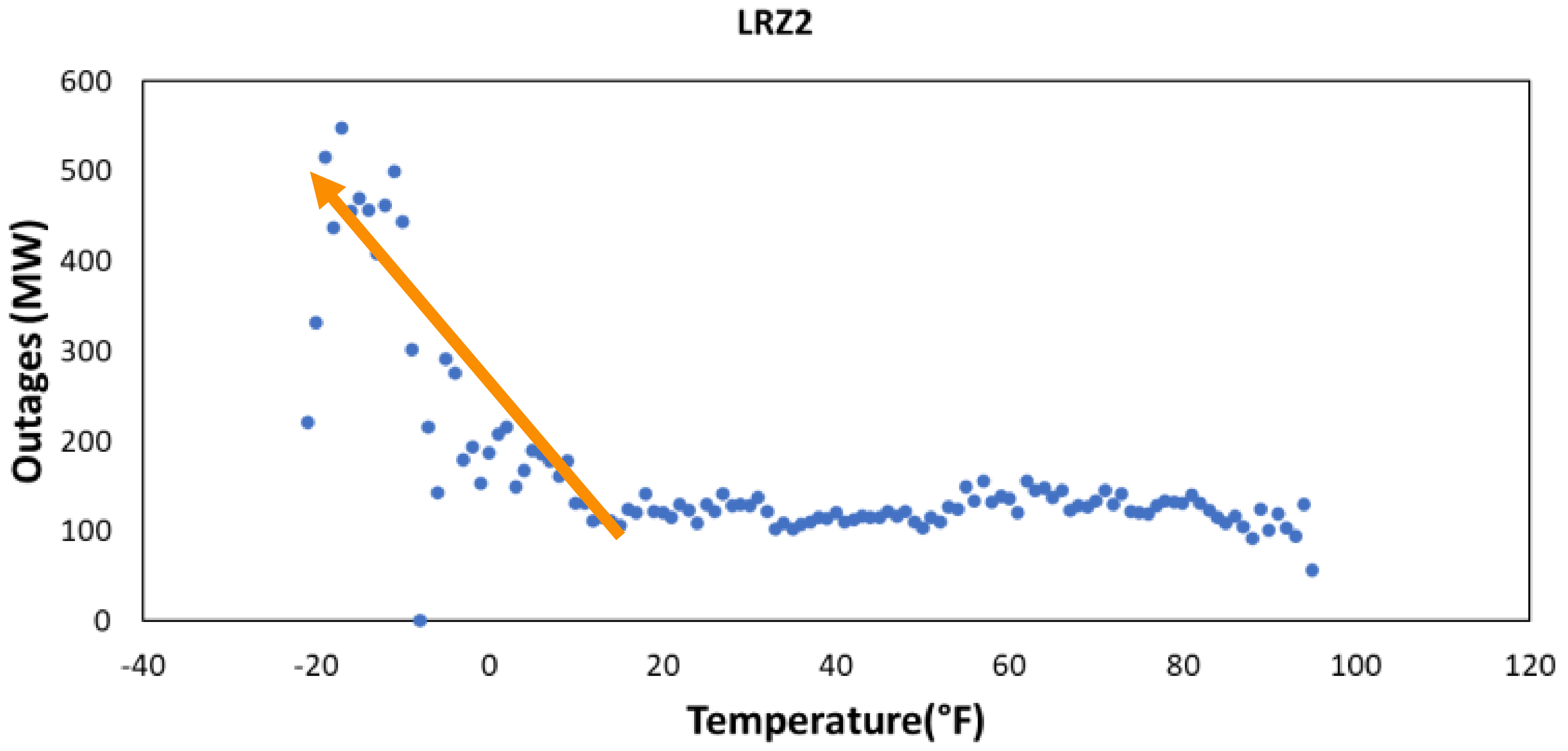
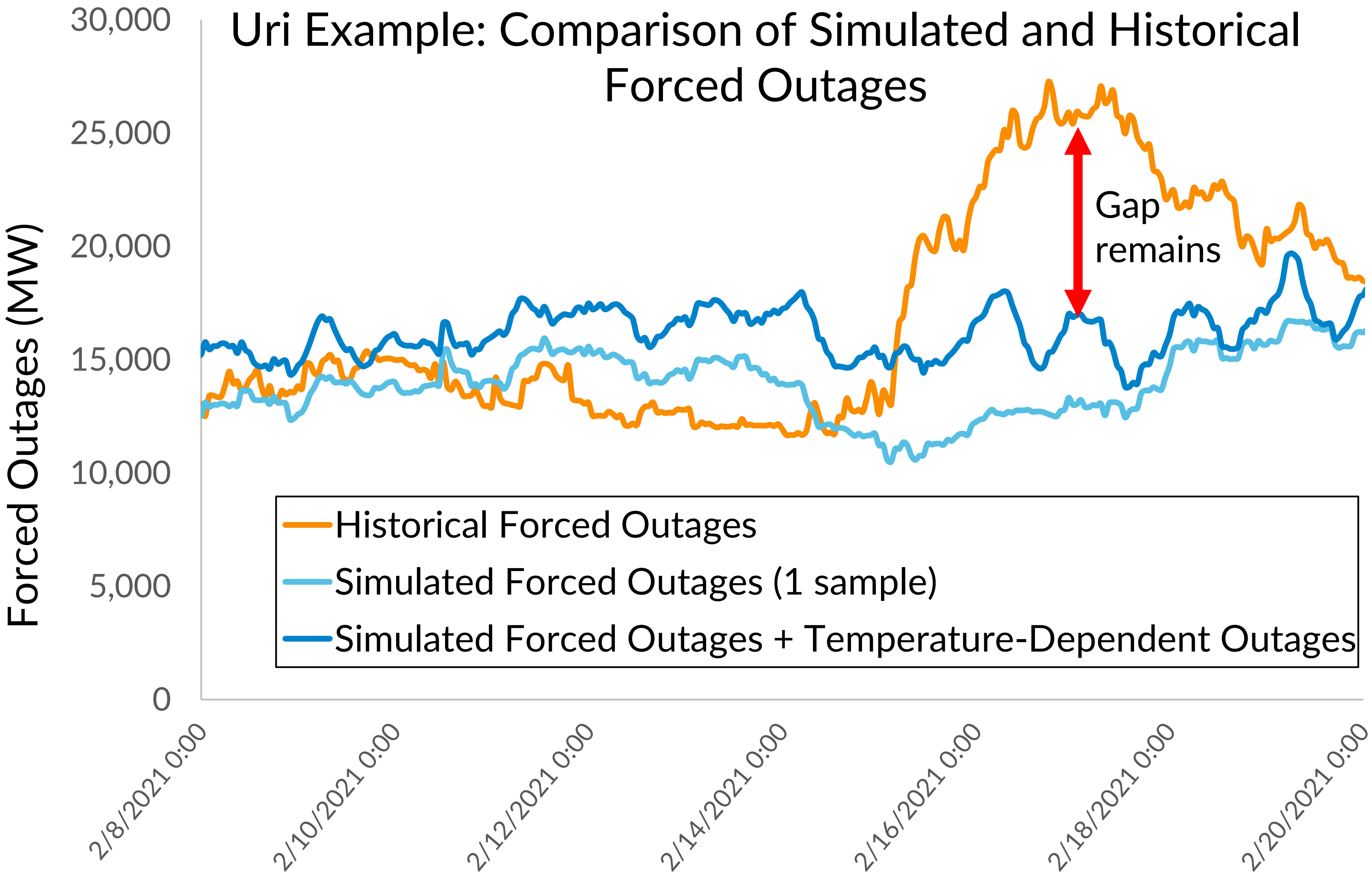


Table 7. Coal Cold Weather Outage Relationships

Zone	Starting Point	MW/° Added
LRZ2	10	14
LRZ3	10	3
LRZ4	21	4
LRZ6	35	2
LRZ7	20	7
LRZ9	42	1

https://cdn.misoenergy.org/20220707%20LOLEWG%20Supplemental%20MISO%20Seasonal%20Inputs%20Documentation%20Astrape625466.pdf

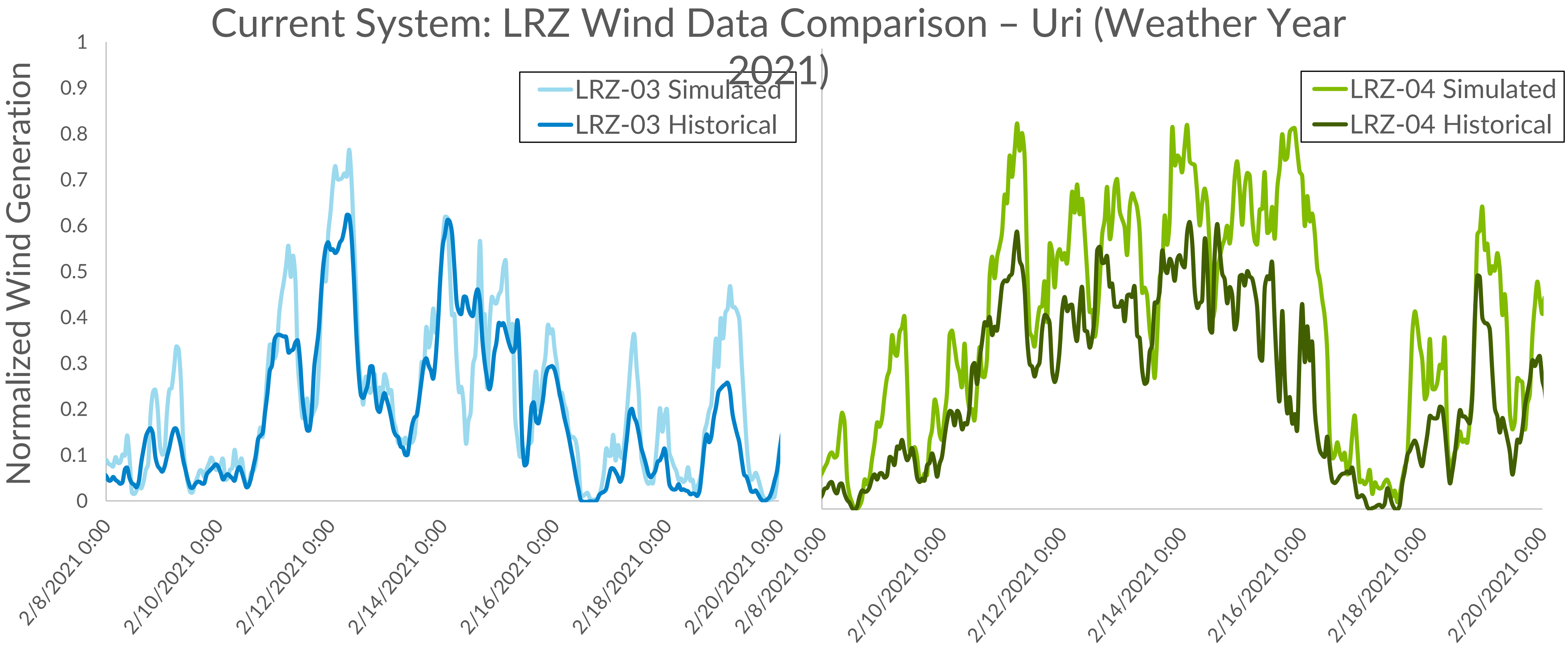
Inclusion of temperature-dependent outages increases total forced outages during cold events, but still falls short of matching historical forced outages for simulated event



- Additional modeling improvements could further reduce the gap between historical and simulated outages
  - MISO plans to include correlated outages as a near-term resource adequacy modeling enhancement

https://cdn.misoenergy.org/20240228%20RASC%20Item%2005c%20RA%20Model%20Enhancement%20Presentation631891.pdf

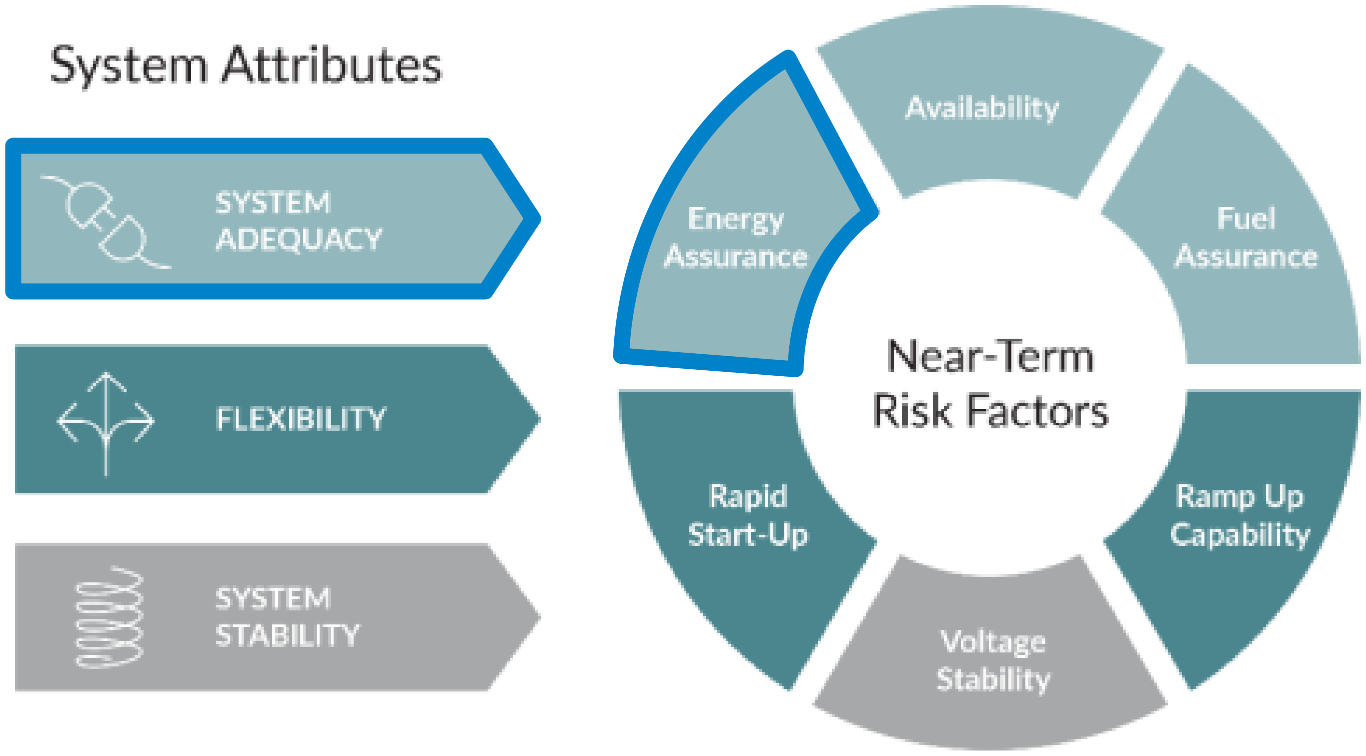
For some MISO LRZs there were large differences between historical generation and vendor predicted generation



Simulated wind data source: vendor-provided dataset used to predict wind and solar generation for forward looking studies (5-20 years in future)

Transmission-Constrained Probabilistic Modeling

In 2023, MISO identified three priority system reliability attributes and their near-term risk factor focus areas



- Energy assurance was identified as a near-term risk factor for system adequacy
  - Ability of the system to adequately manage and deliver energy supply 24/7
- Addition of transmission constraints into the probabilistic LOLE model was used to determine how deliverability impacts energy assurance

Attributes Roadmap Publication: https://cdn.misoenergy.org/2023%20Attributes%20Roadmap631174.pdf
Attributes Technical Appendix: https://cdn.misoenergy.org/2023%20Attributes%20Technical%20Appendix631176.pdf

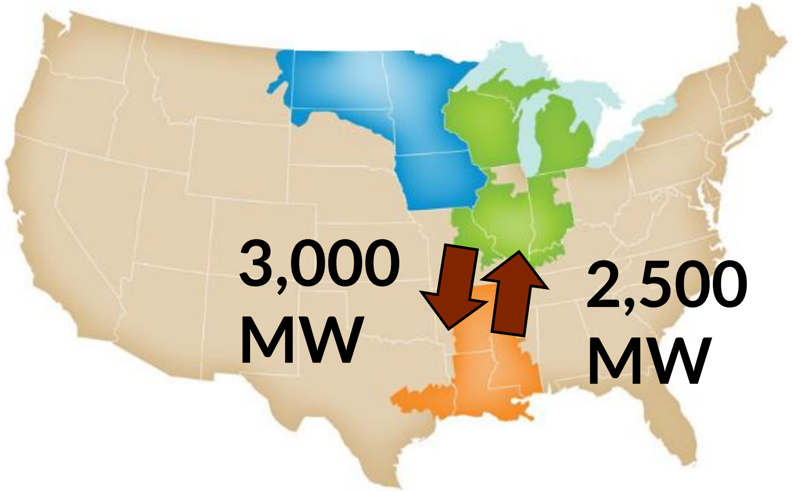
The Regional Directional Transfer (RDT) constraint between MISO North and South regions was incorporated into the LOLE model to explore deliverability considerations

"Copper Sheet" LOLE Model

No transmission included, doesn't explicitly capture attributes related to energy delivery

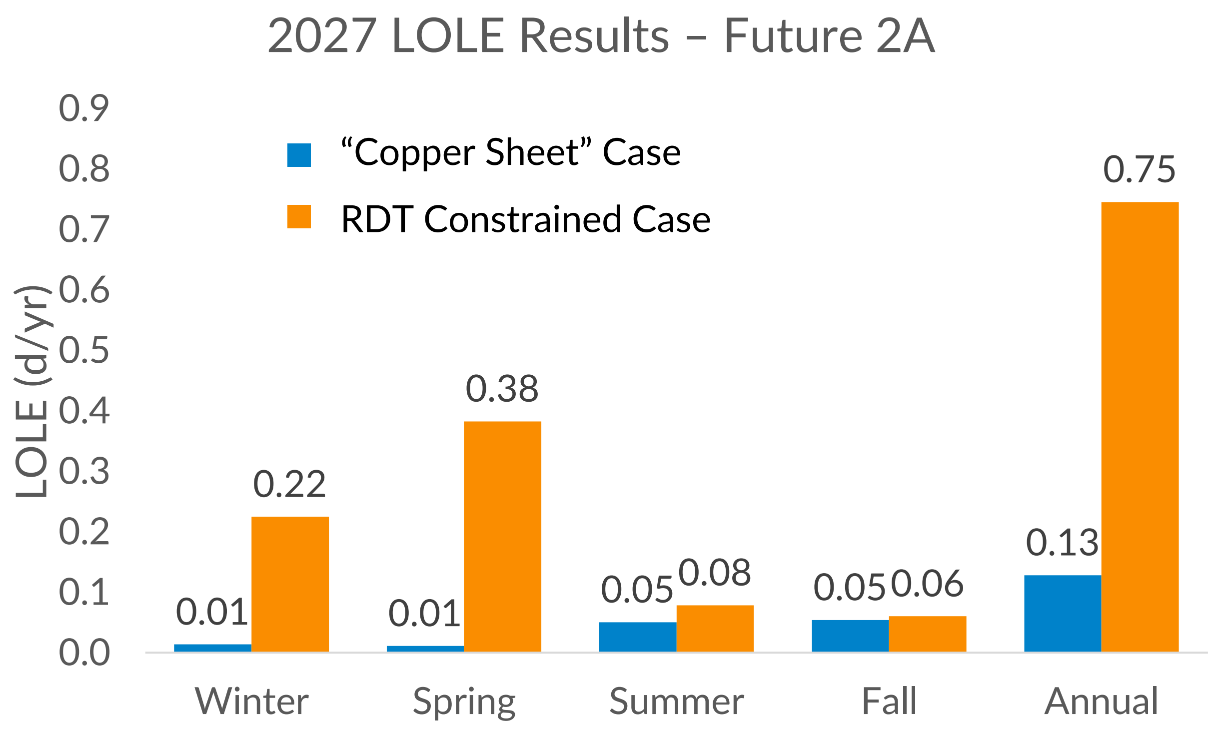
RDT-Constrained LOLE Model

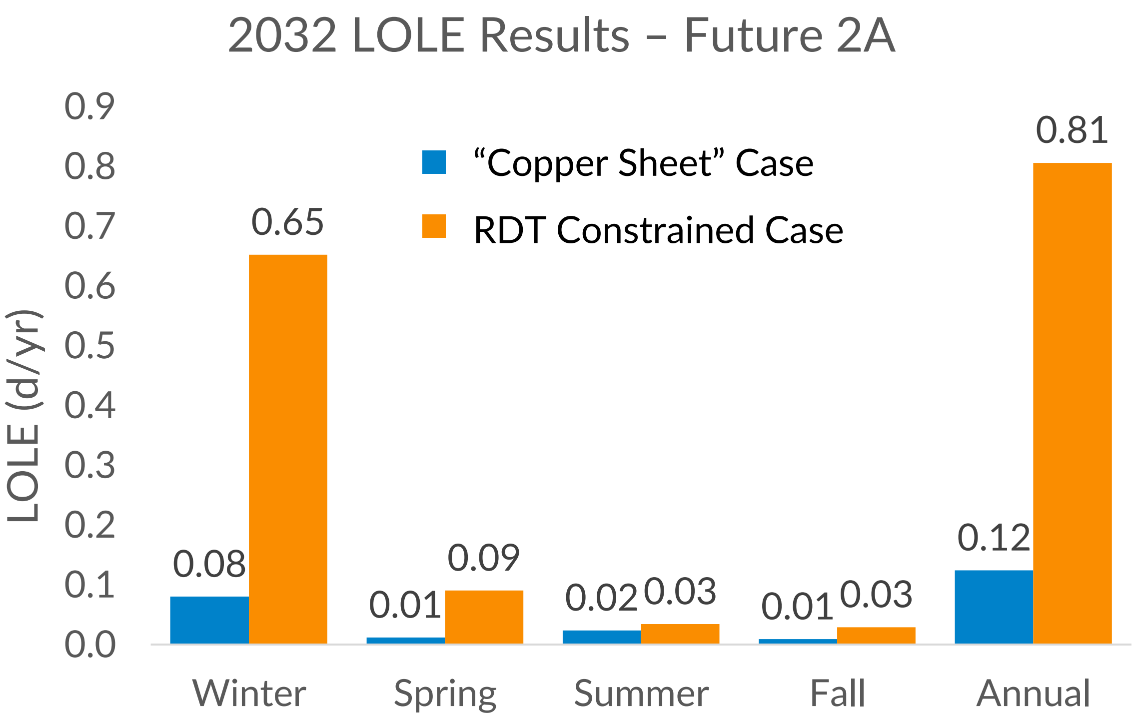
Explicitly captures attributes related to energy delivery between MISO North/Central and MISO South



- Only the RDT constraint was enforced in the model
  - 3,000 MW limit from North/Central to South
  - 2,500 MW limit from South to North/Central
- Fixed load for the LOLE adjustment was distributed across the two regions (North/Central and South) based on LRZ contribution to MISO coincident peak

When the Regional Directional Transfer (RDT) constraint is included in the LOLE model, risk increases across all seasons in forward-looking models





Comparisons are between the "Copper Sheet" case at the 0.1 days/year LOLE target and RDT-constrained case at the same adjustment

The methodology used to adjust LOLE in the RDT-constrained case may have an impact on the results. However, the direction of the results (e.g., shift in risk) is expected to hold.

Model Assumptions: 14 weather years (2007-2021 ex. 2013), future generation from MISO's Future 2A, load data is historical load scaled with forecasts from Future 2A, hourly wind/solar data from vendor

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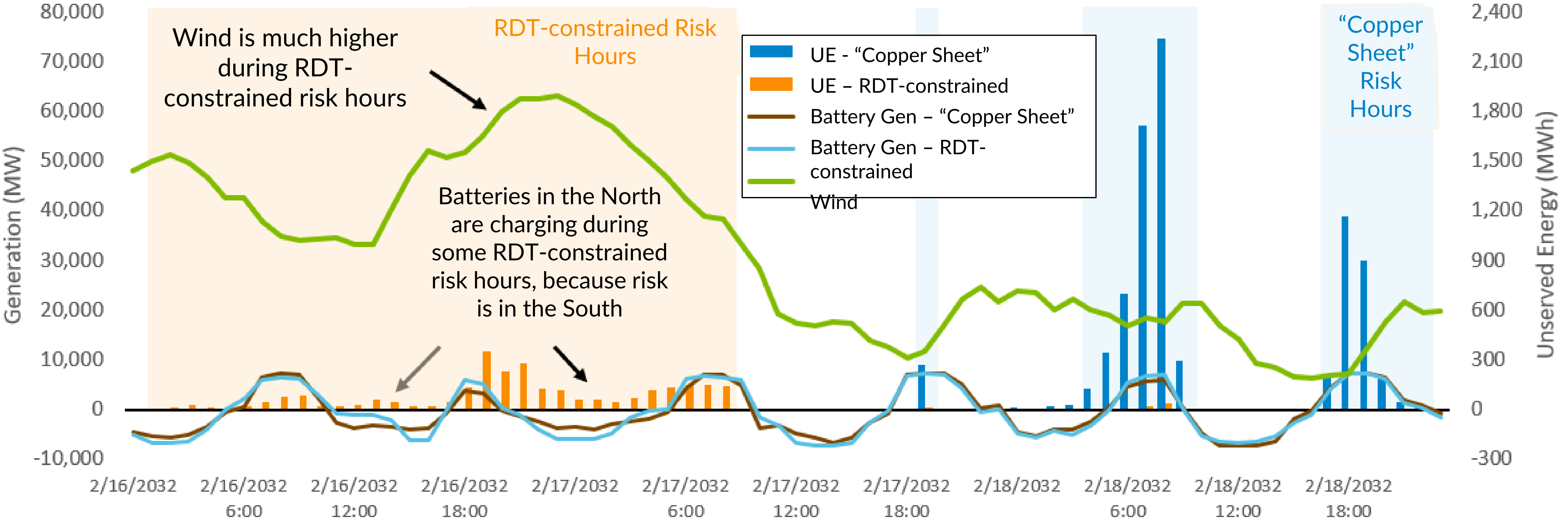
Extreme event example: risk hours shift from times of low wind in the "Copper Sheet" case to times of high wind in the RDT-constrained case

2032 Future 2A Model – Winter Storm Uri (Weather Year 2021)

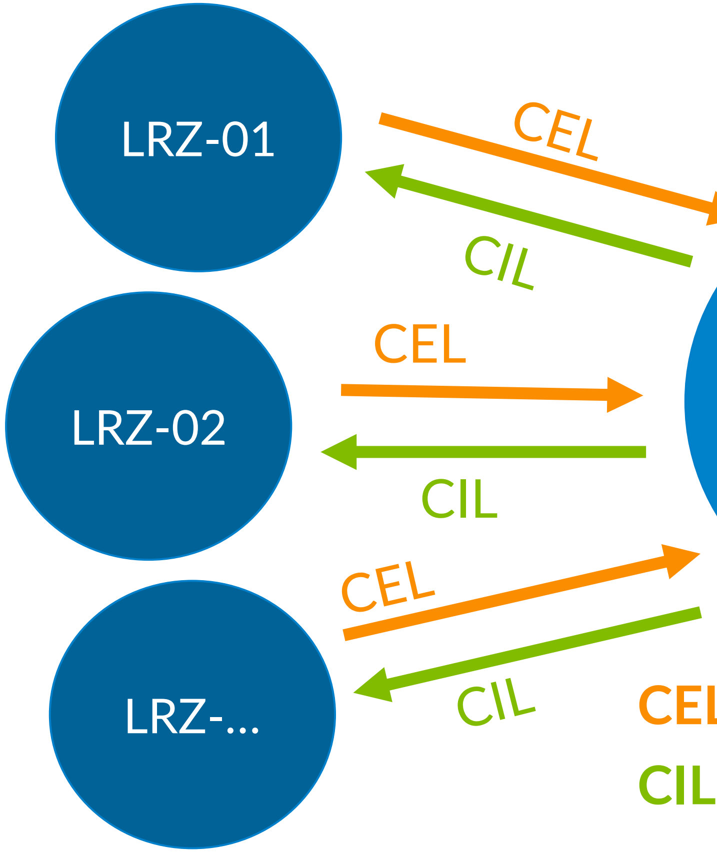


Comparisons are between cases when both are adjusted to 0.1 days/year LOLE

UE = Unserved Energy LOLE = Loss of load expectation RDT = Regional Directional Transfer

MISO Futures Series 1A: https://cdn.misoenergy.org/Series1A_Futures_Report630735.pdf

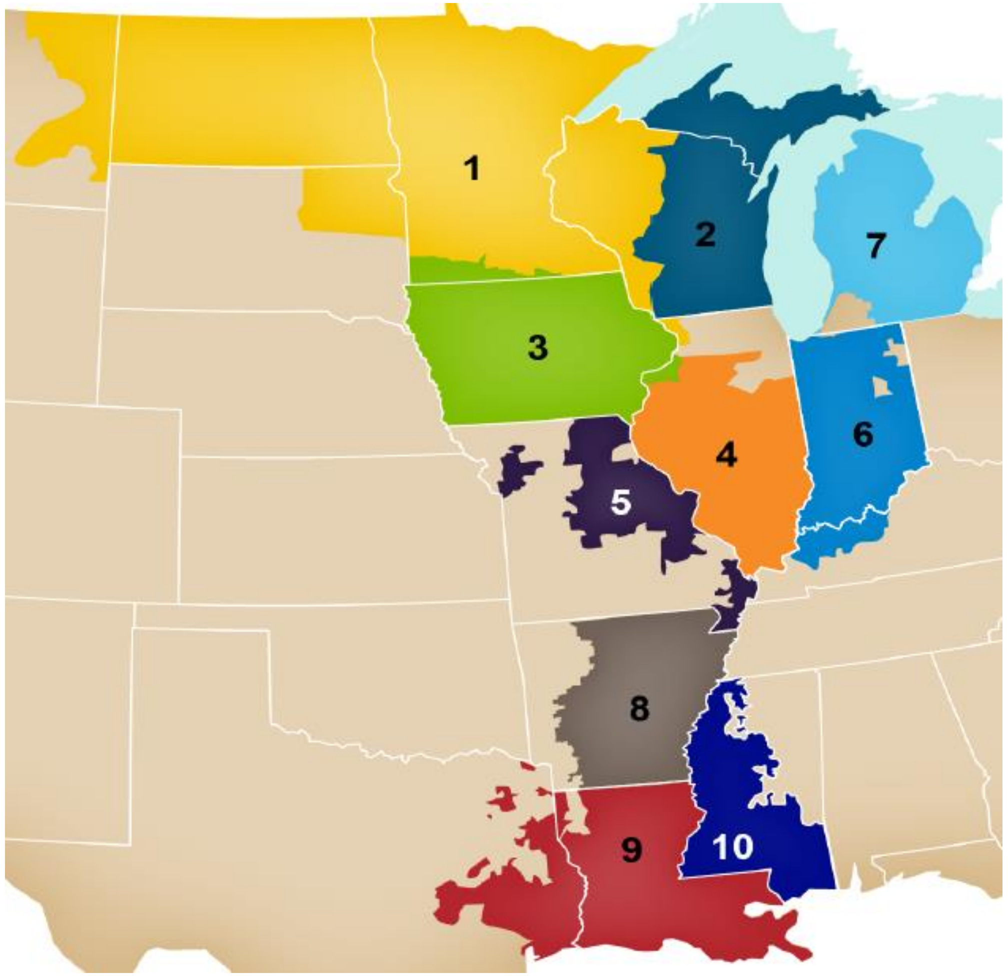
More granular zonal transmission will be added to the probabilistic model for the evaluation of benefits of the Long Range Transmission Planning (LRTP) Tranche 2 projects



CEL: Capacity Export Limit

CIL: Capacity Import Limit

Illustration of zonal transfer constraints in the LOLE model



Map of MISO's Local Resource Zones (LRZs)

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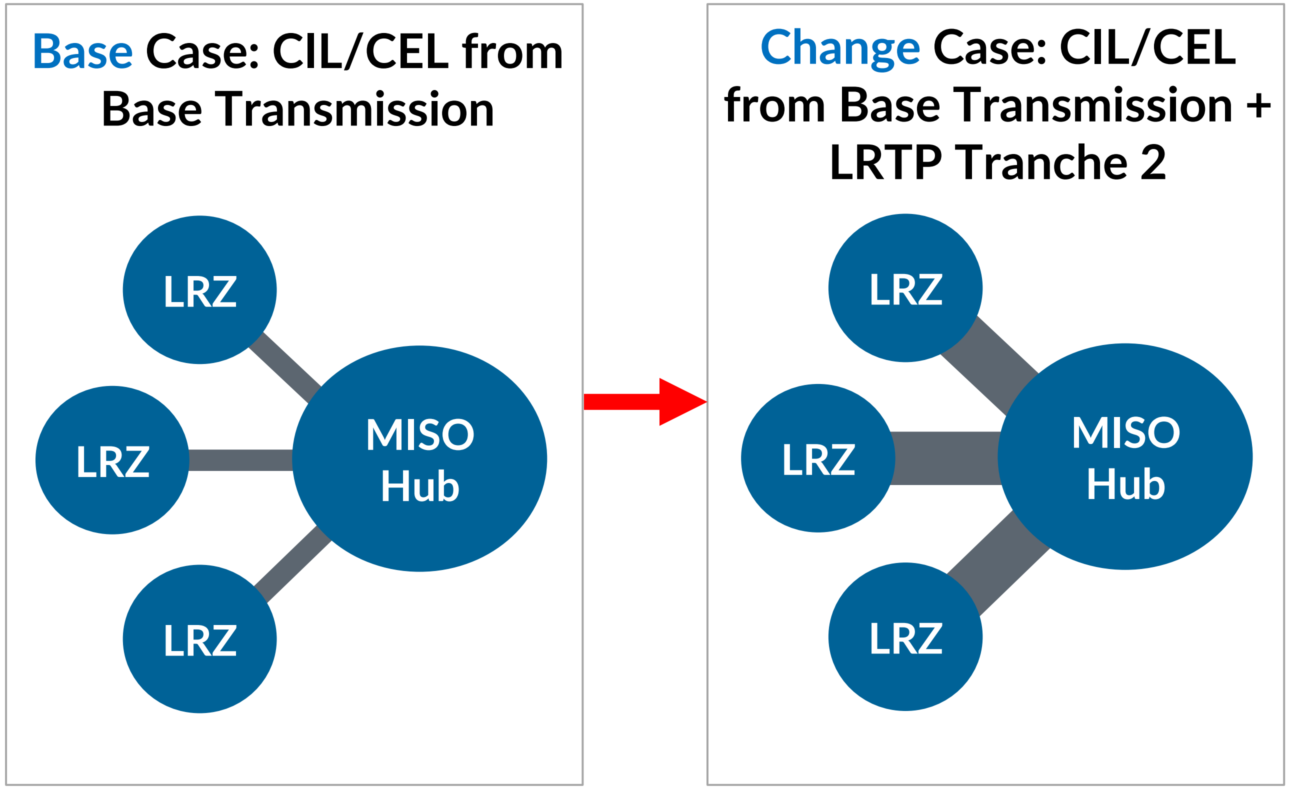
Differences in key metrics in the LOLE model will be seen as CIL and CEL increase due to the addition Tranche 2 projects

- Changes can potentially be used to quantify the economic benefits of the LRTP Tranche 2 projects:
    - Improvements in zonal constraints will lower the adjustment needed to reach the target of 0.1 day/year, impacting planning reserve margin
    - Decreases in unserved energy can lead to changes in expected unserved energy (EUE) or conditional value at risk (CVAR) metrics



CIL: capacity import limit
CEL: capacity export limit
LOLE: loss of load expectation

LRTP: long range transmission planning
LRZ: local resource zone

Discussions on LRTP Tranche 2 business case methodology are underway with MISO stakeholders and are subject to change

Questions?

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