# Extreme Event and Transmission Analysis in MISO's Probabilistic Modeling

ESIG Spring Workshop 2024

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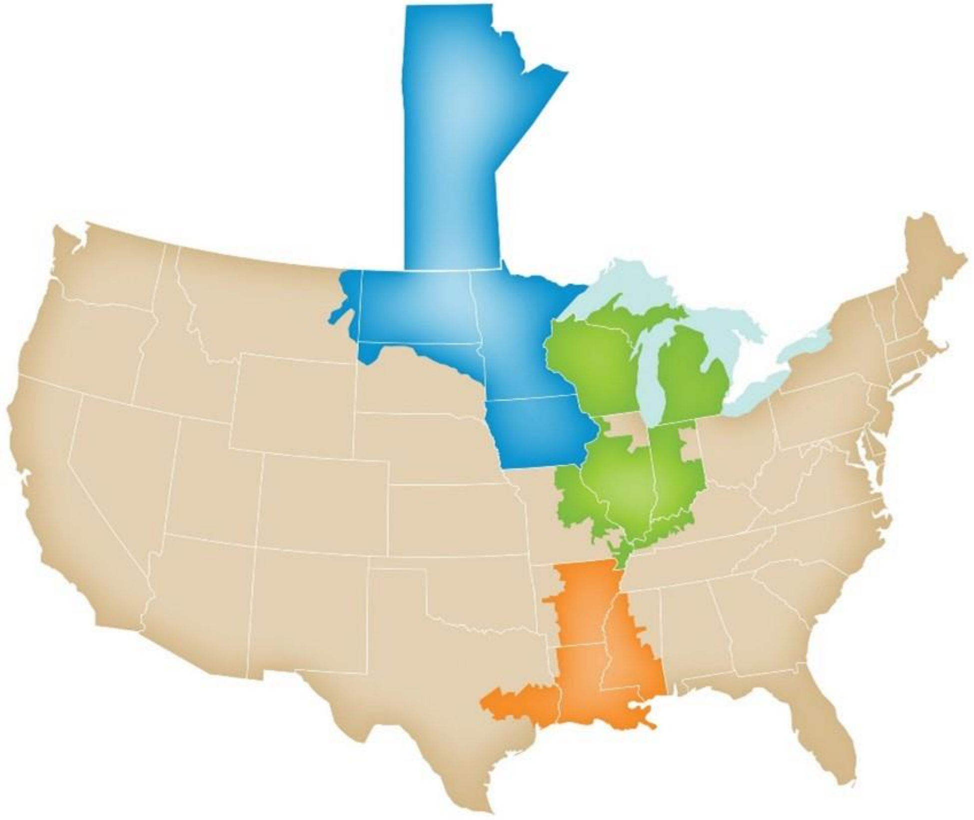
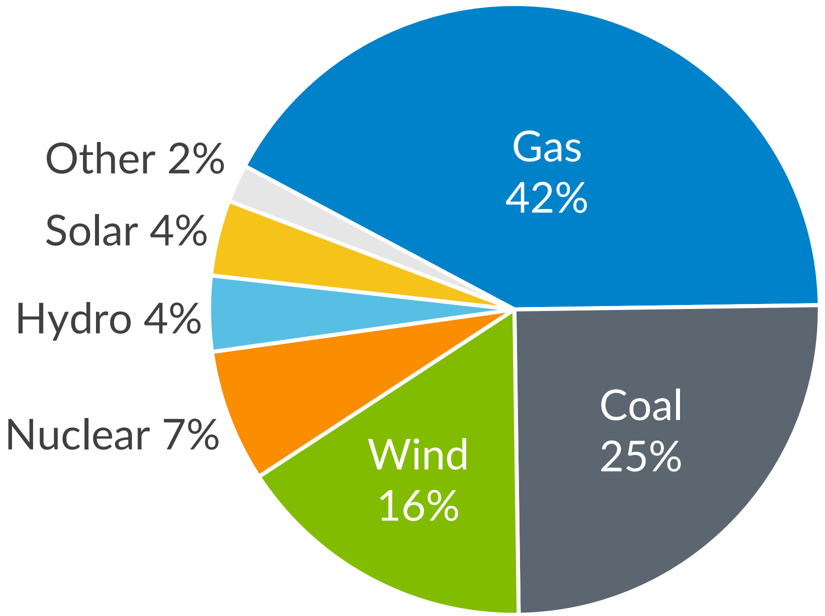
# About MISO

- 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**

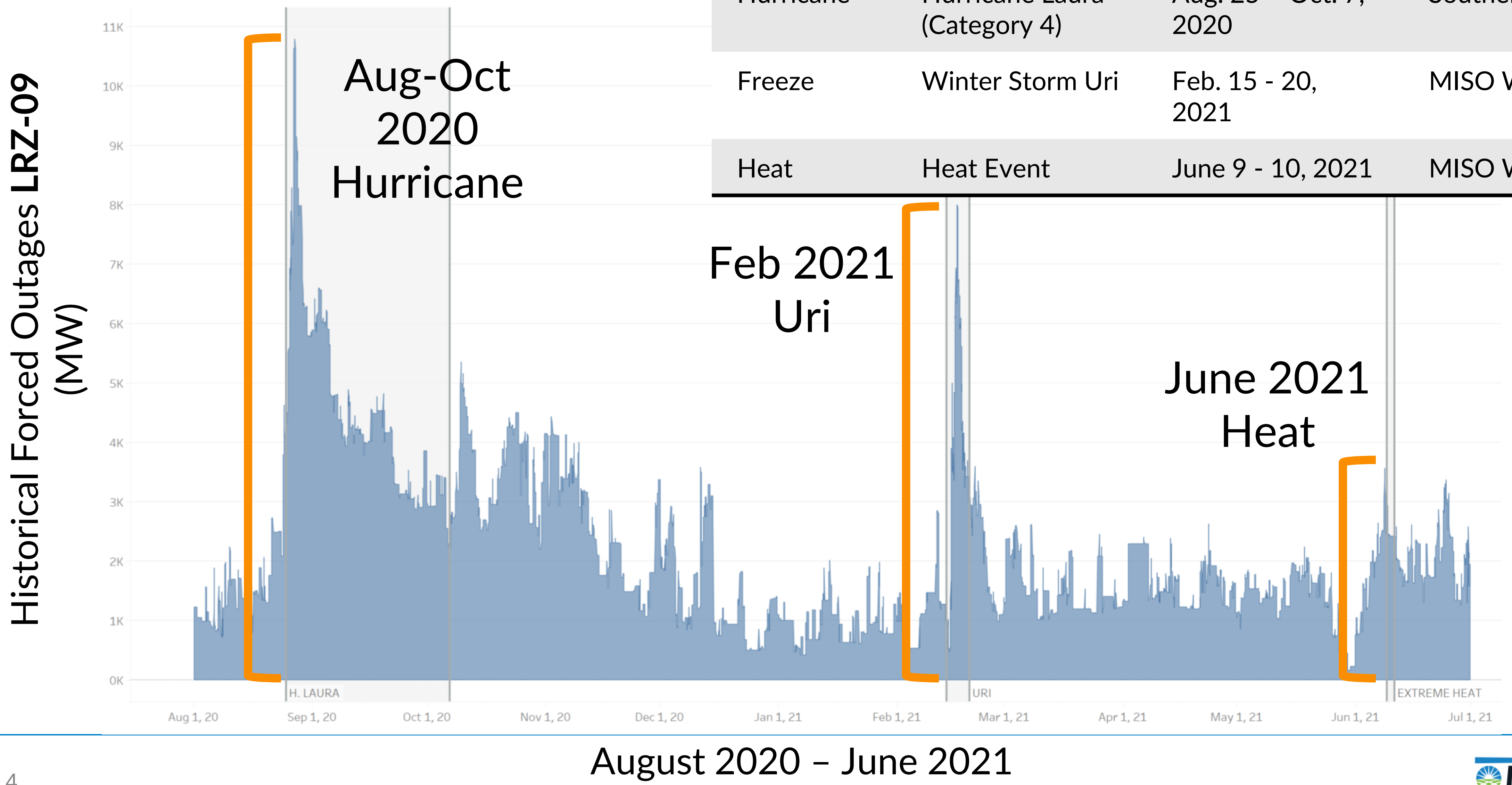



191 GW Total Installed Capacity

# 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 |






LRZ: Local Resource Zone

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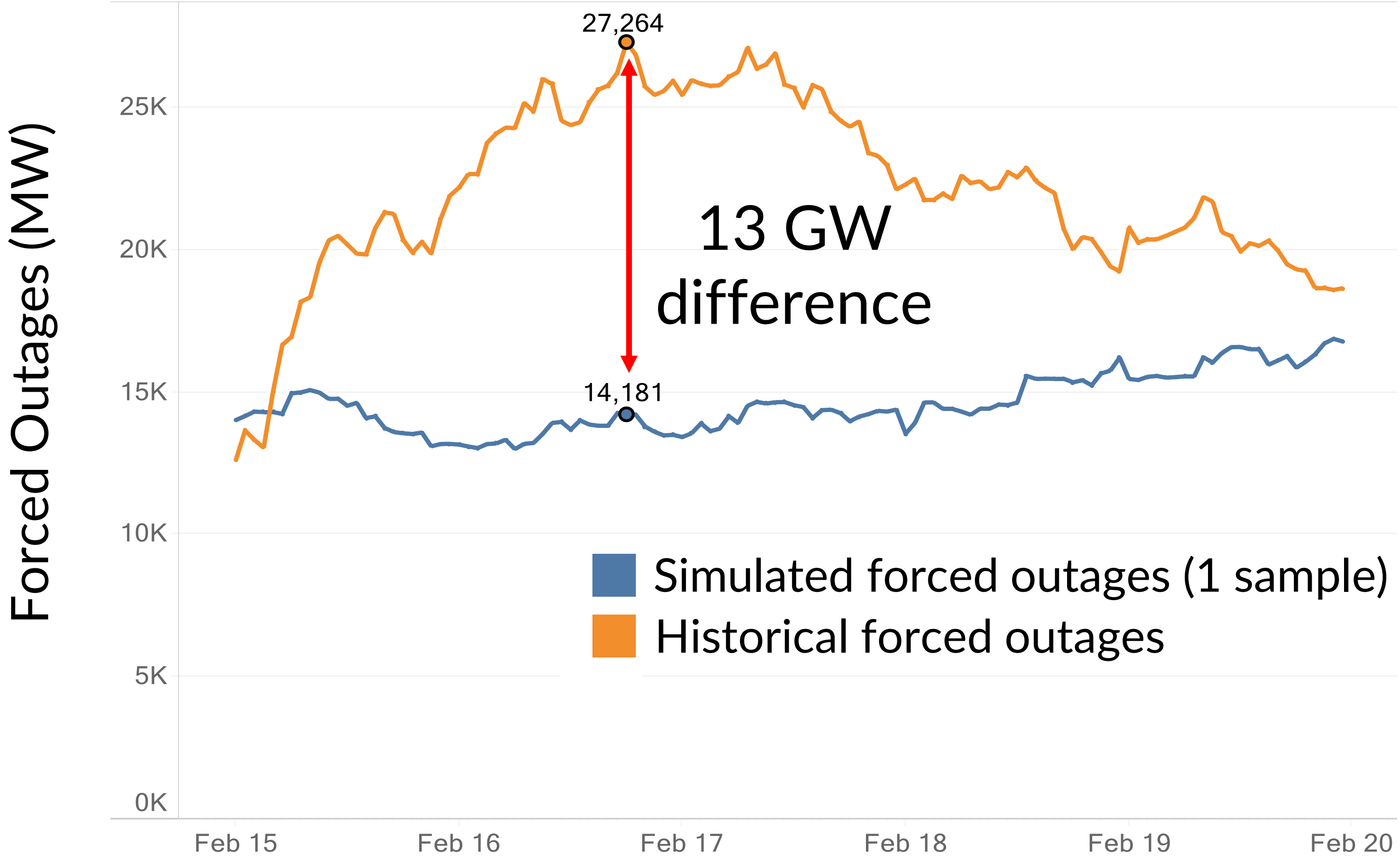
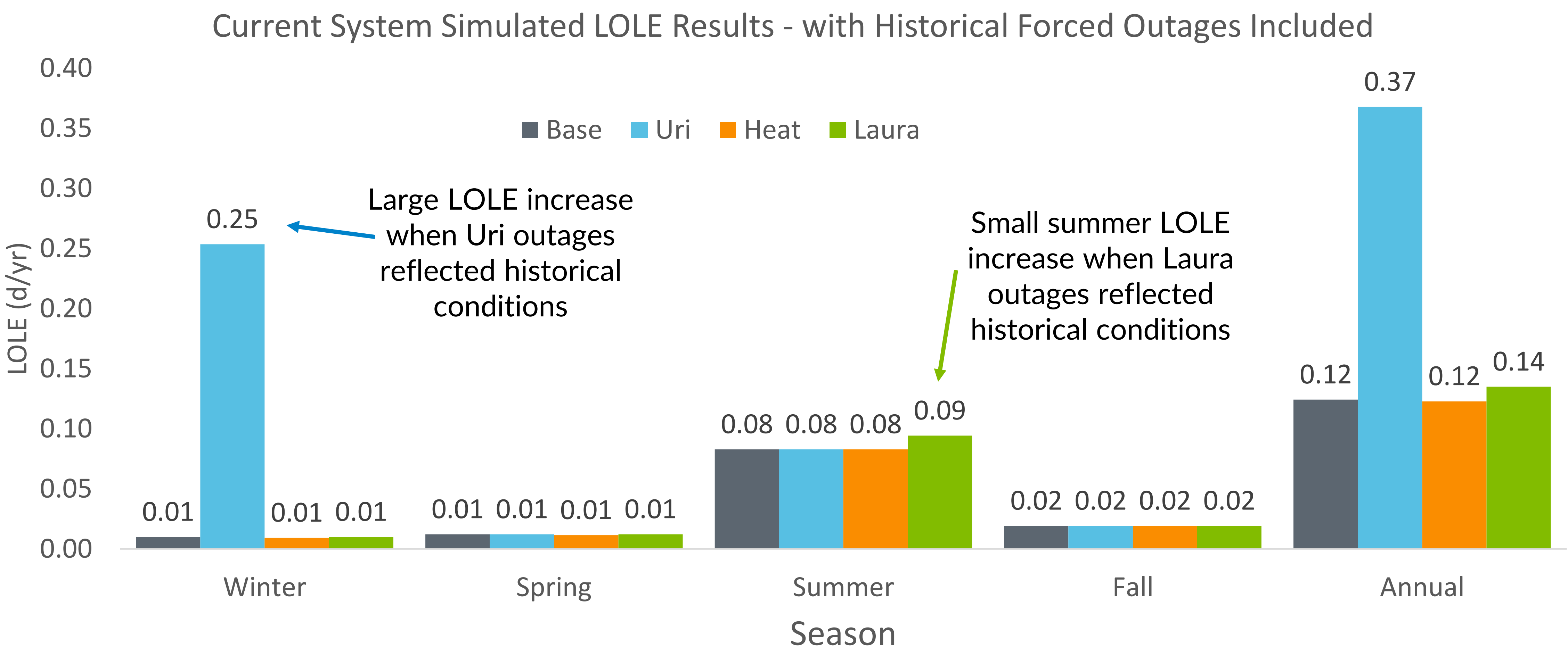
# Comparison of event characteristics in the LOLE model to the actual event indicate a gap in extreme event modeling

## 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

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

**Figure 18. LRZ2 Average Coal Outages**

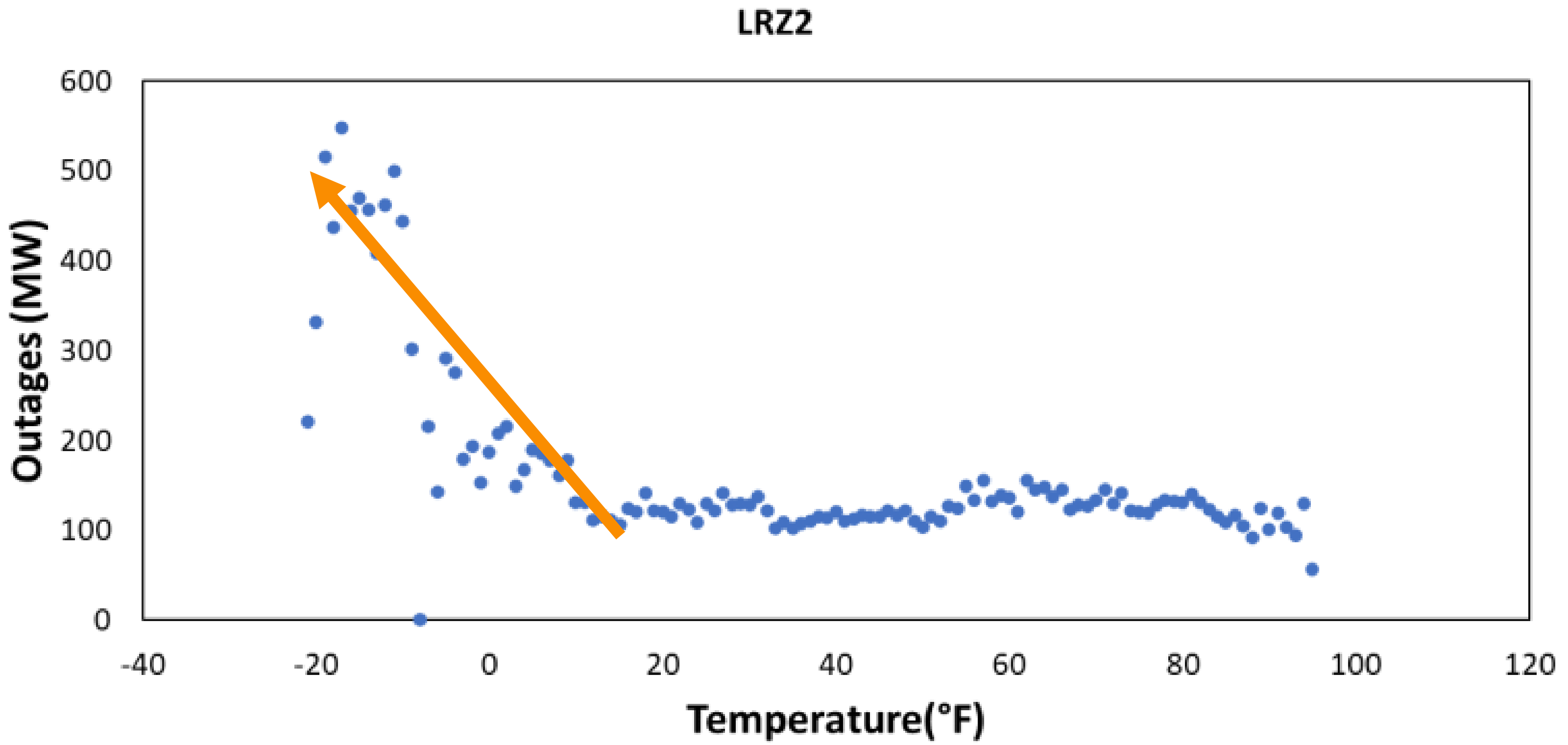
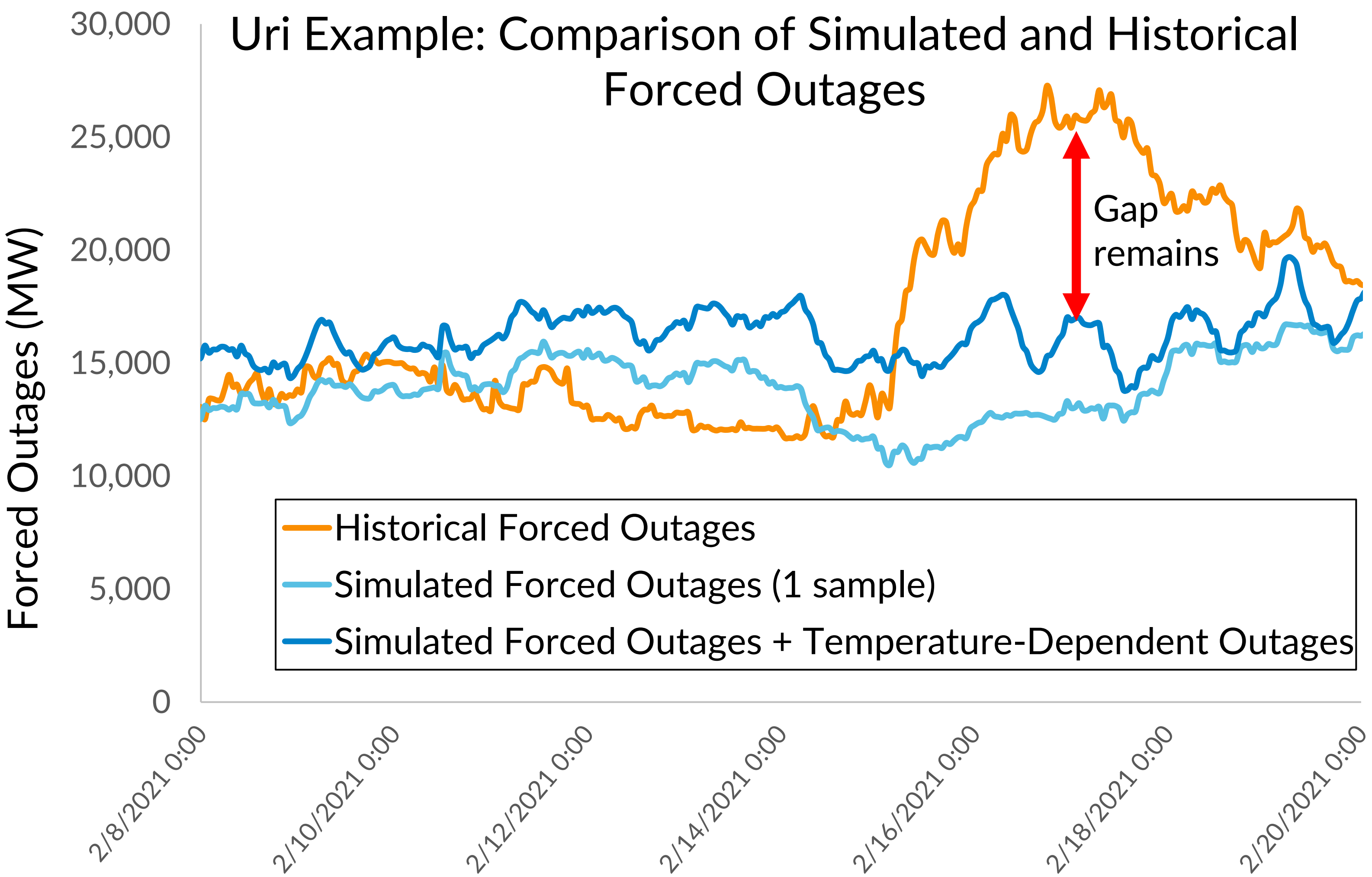



**Table 7. Coal Cold Weather Outage Relationships**

| 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

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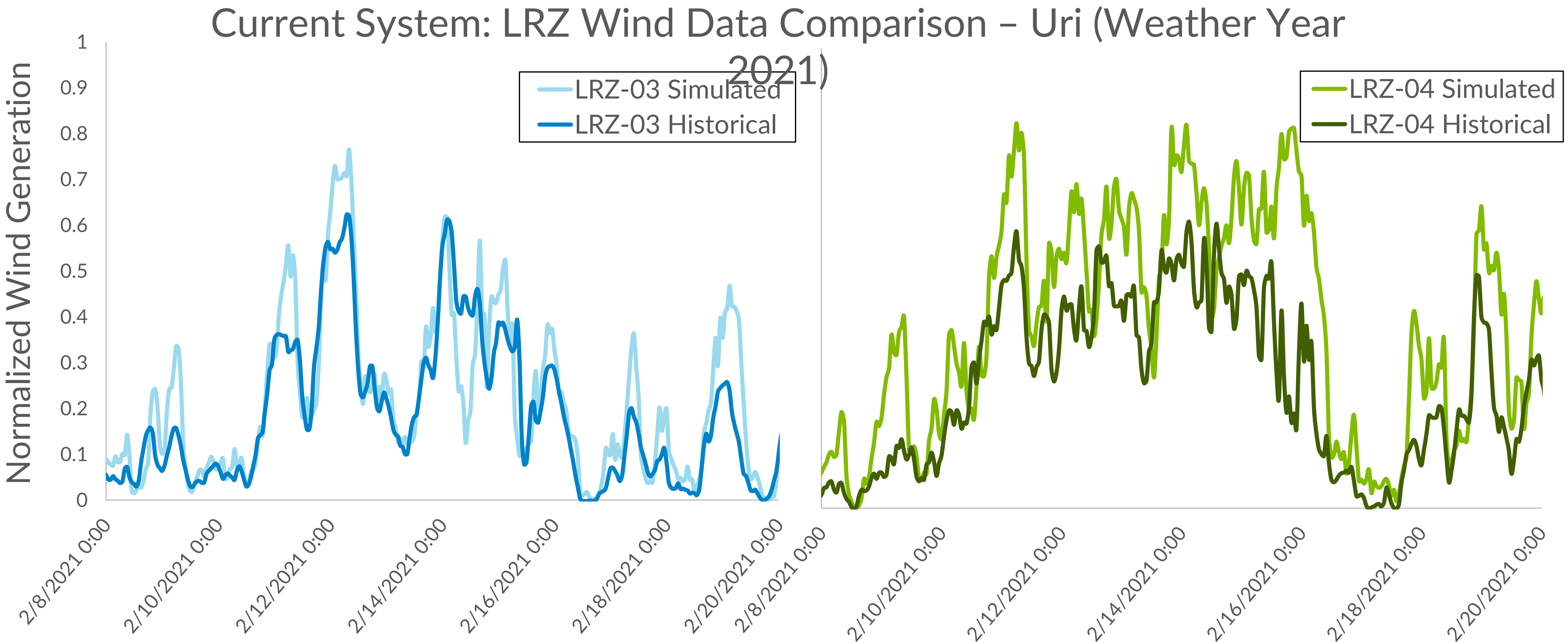
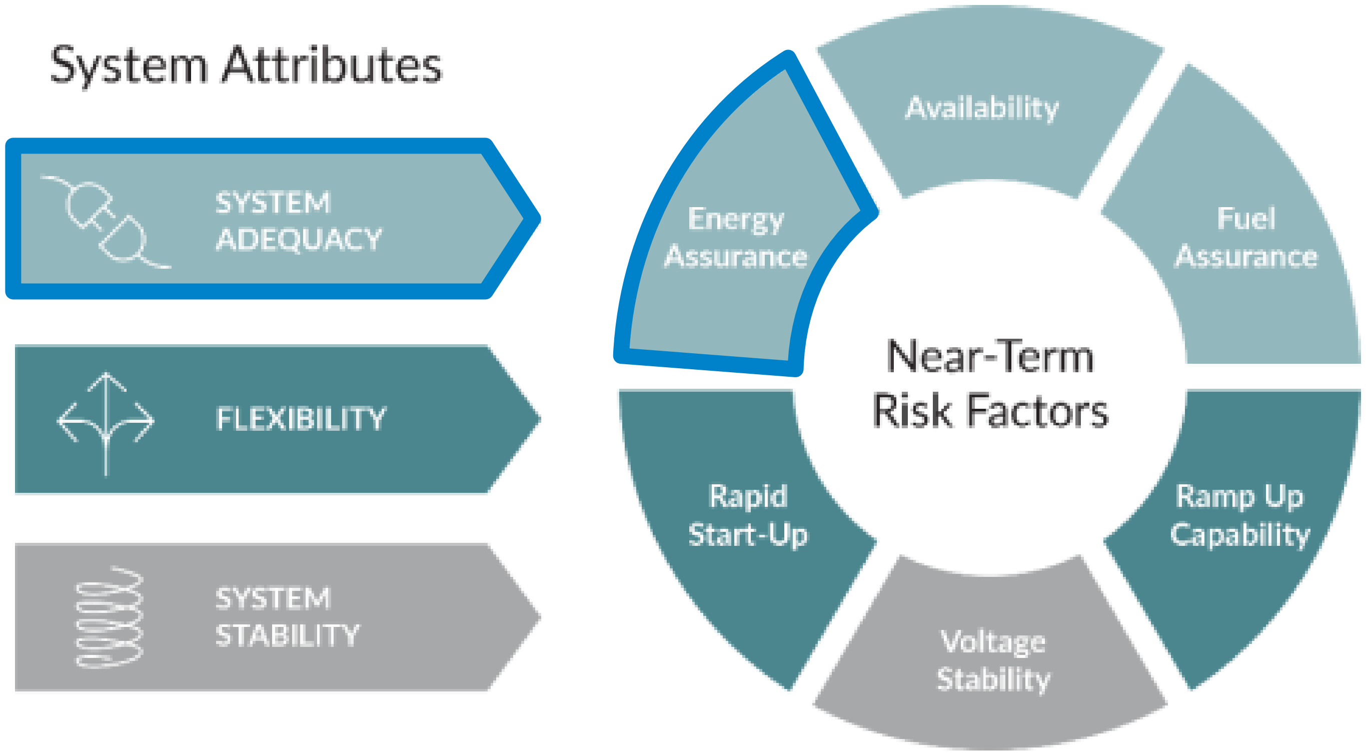
# For some MISO LRZs there were large differences between historical generation and vendor predicted generation




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

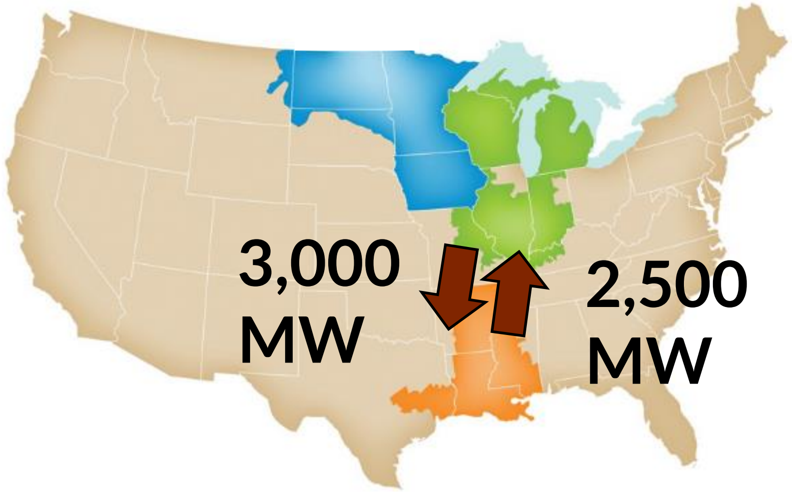
# The Regional Directional Transfer (RDT) constraint between MISO North and South regions was incorporated into the LOLE model to explore deliverability considerations

**"Copper Sheet" LOLE Model**

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

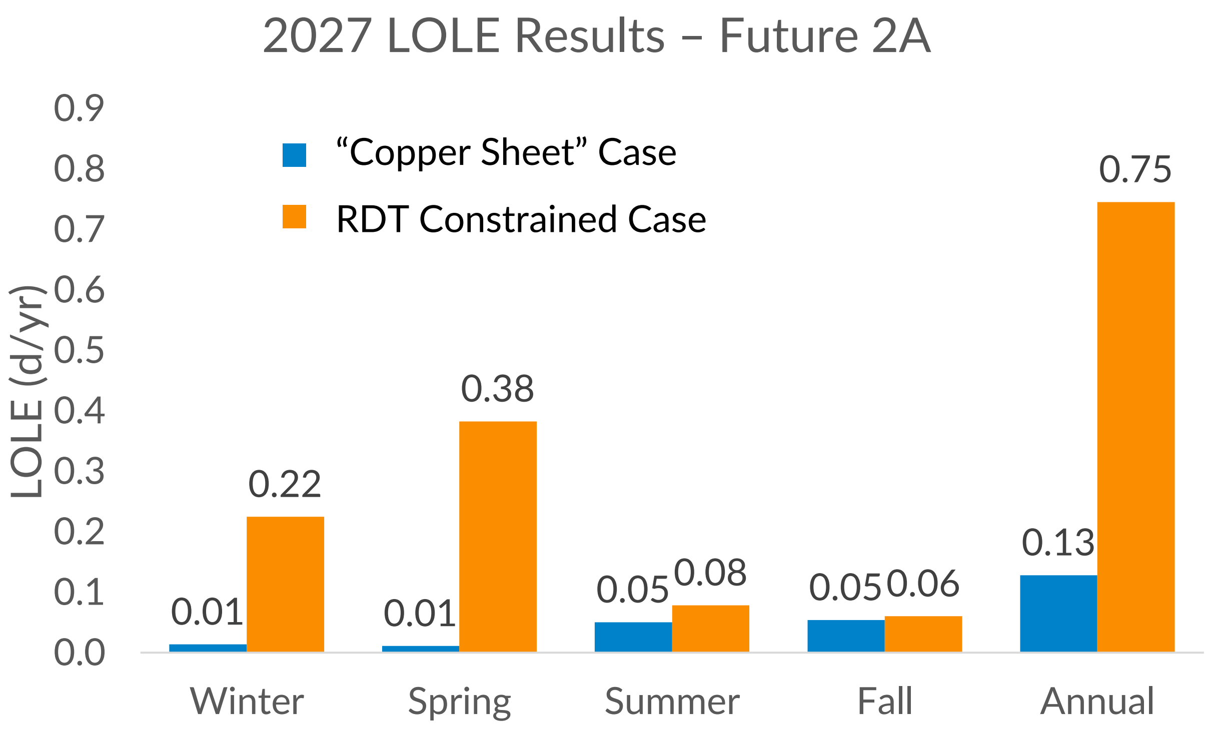
**RDT-Constrained LOLE Model**

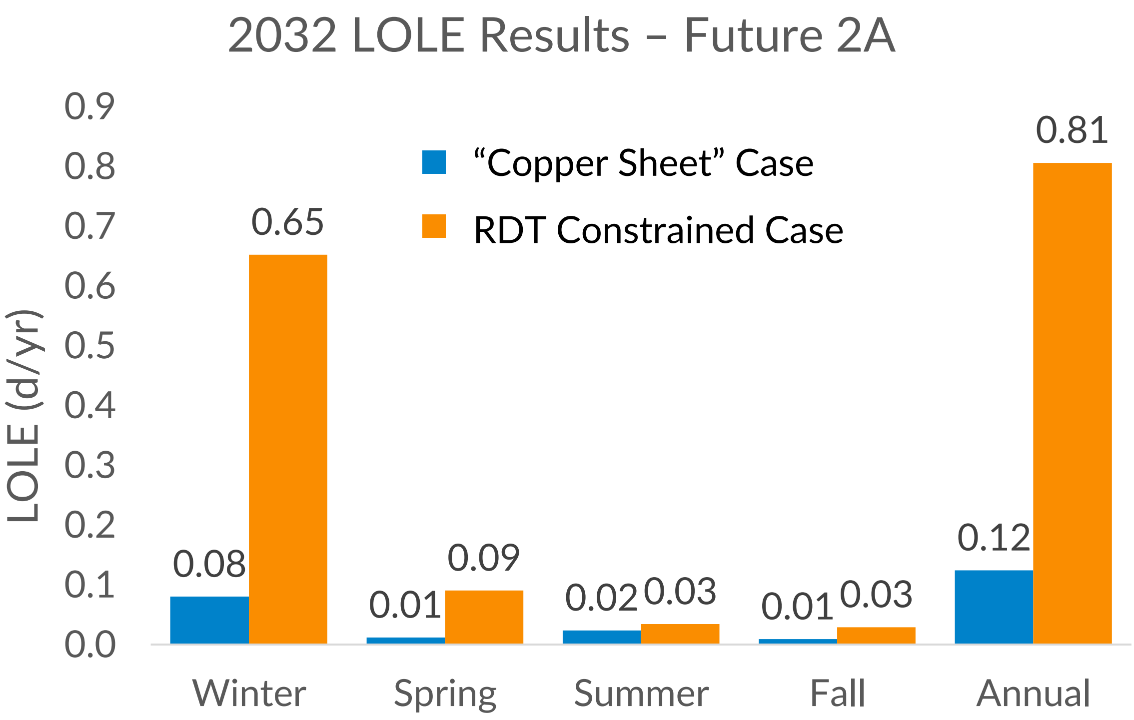
Explicitly captures attributes related to energy delivery between MISO North/Central and MISO South




- 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



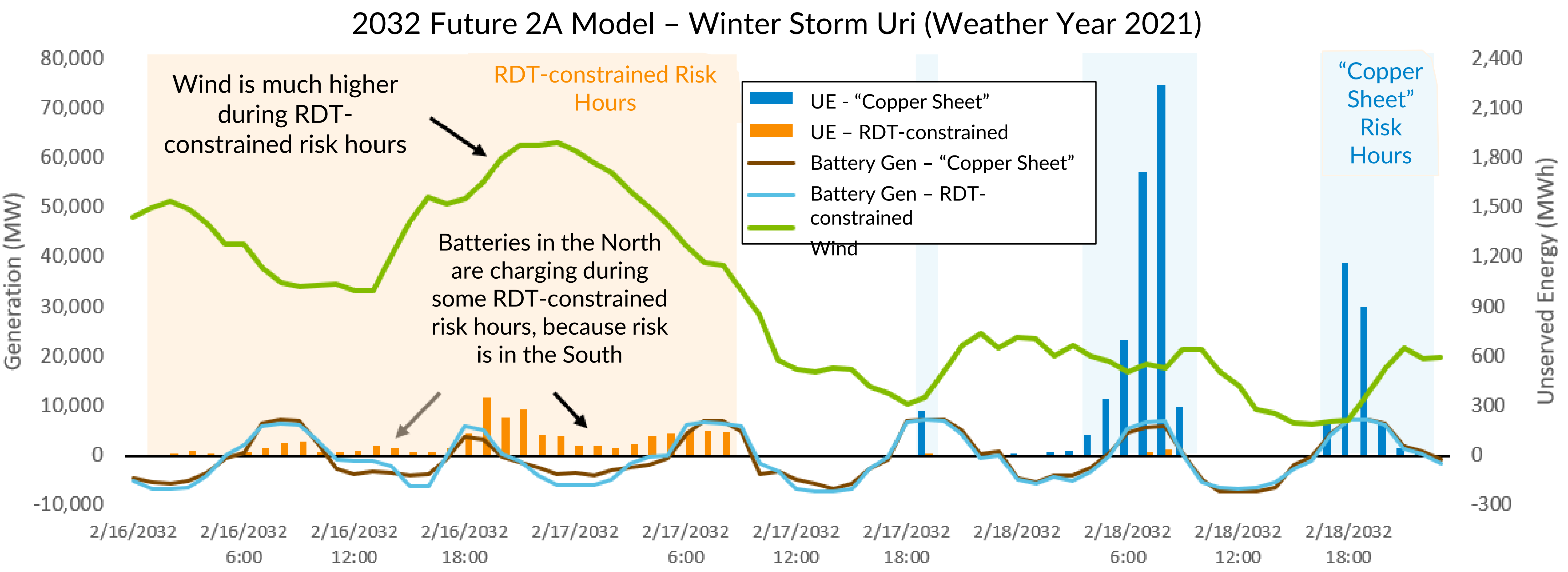




*Comparisons are between the "Copper Sheet" case at the 0.1 days/year LOLE target and RDT-constrained case at the same adjustment*

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

# 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

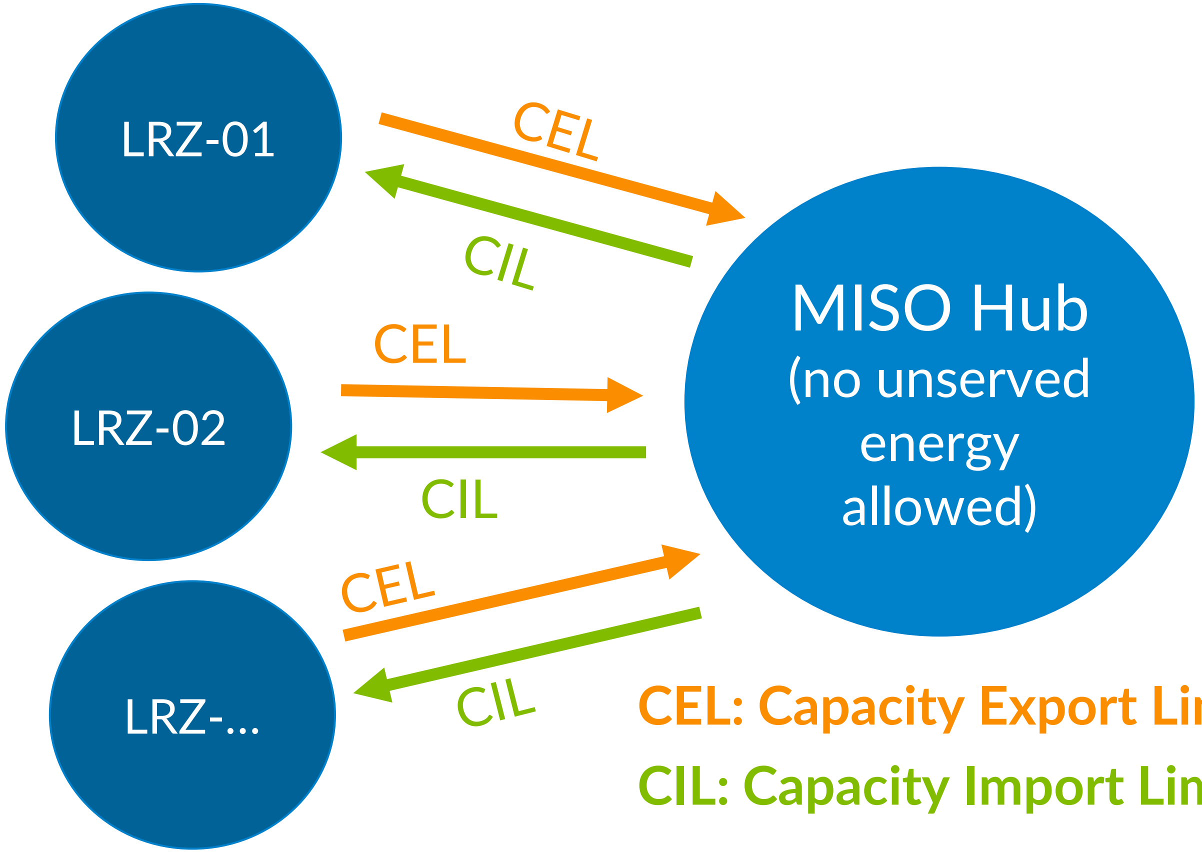



*Comparisons are between cases when both are adjusted to 0.1 days/year LOLE*

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

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

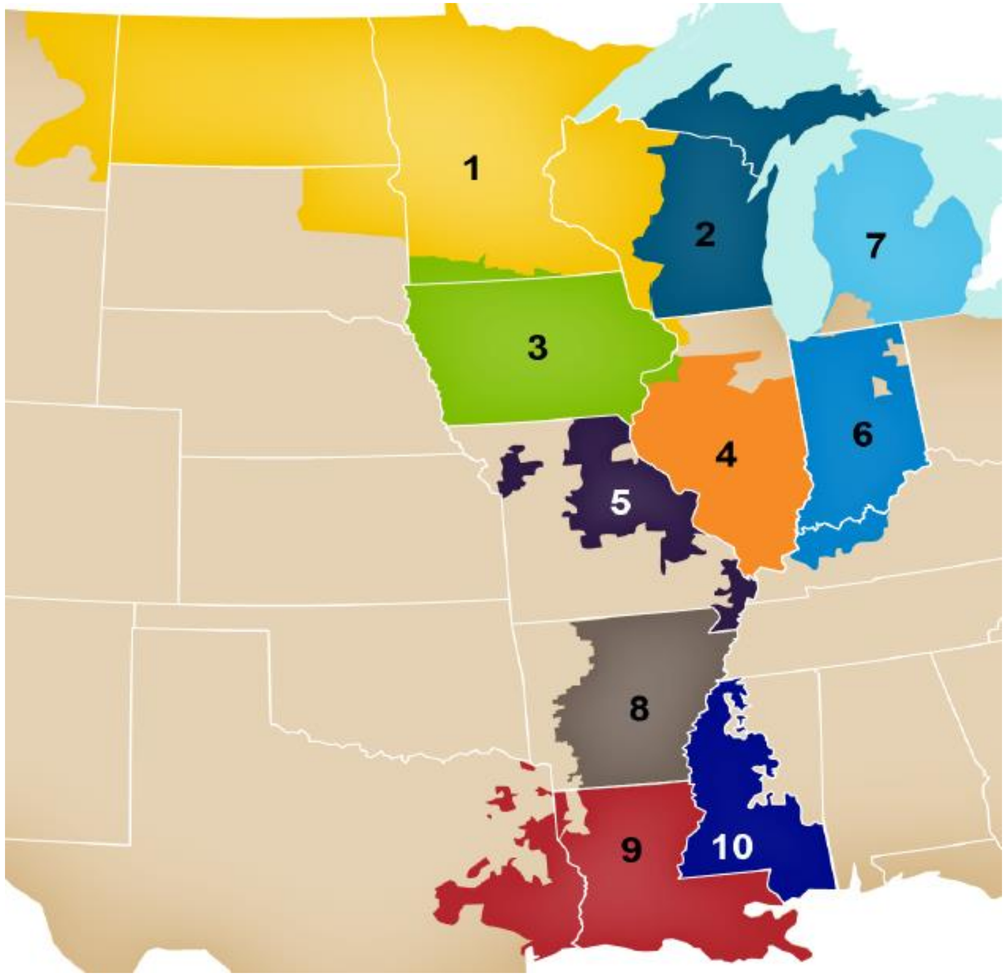
# More granular zonal transmission will be added to the probabilistic model for the evaluation of benefits of the Long Range Transmission Planning (LRTP) Tranche 2 projects




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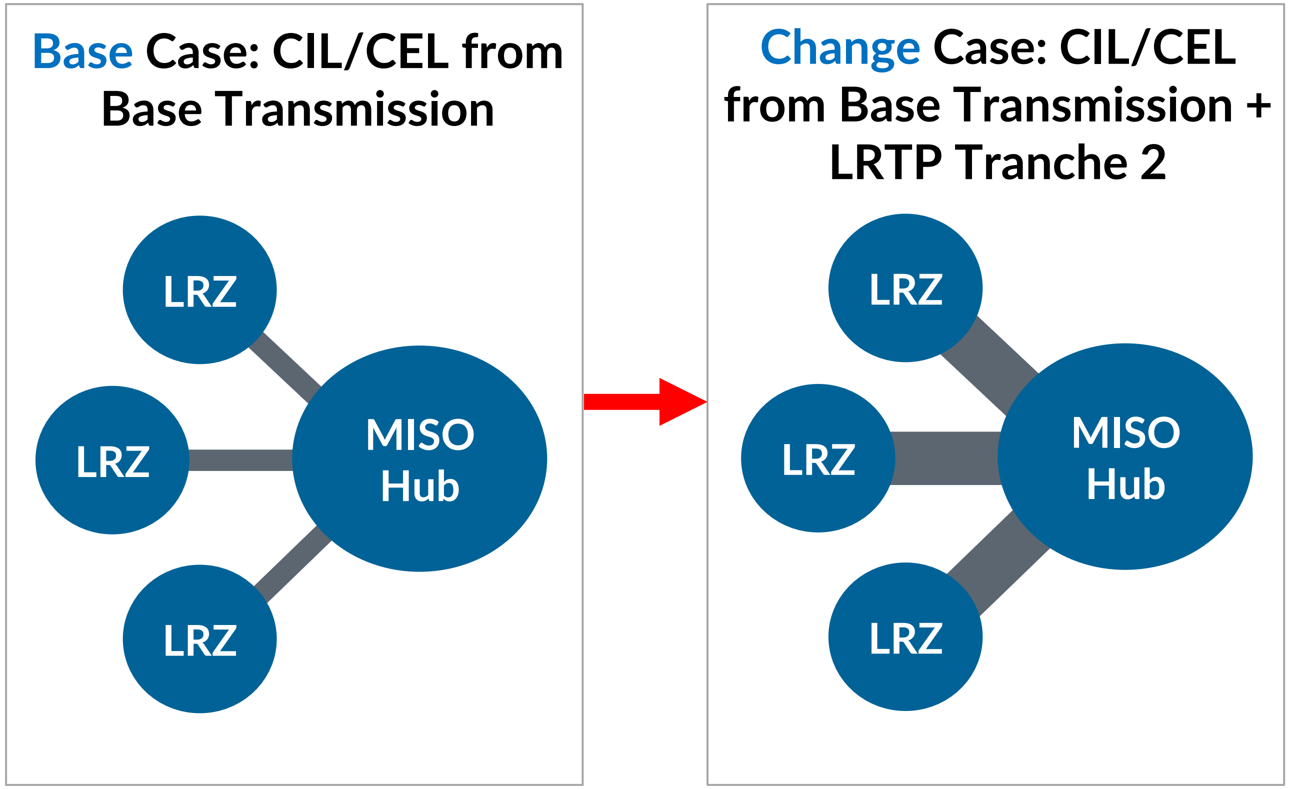
# Differences in key metrics in the LOLE model will be seen as CIL and CEL increase due to the addition Tranche 2 projects

- 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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