# Regulation Reserve Forecasting at MISO

## Dynamic Operating Reserve Methods: Forecasting Reserve for Improved Operations

**Christine Ross**

**MISO Markets Research and Development**

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# Purpose & Key Takeaways

## Purpose:

Share recent and ongoing work at MISO to enhance reserve products to prepare for increased uncertainty and variability with more weather-dependent generation

## Key Takeaways:

- Operational challenges are magnifying as the resource mix evolves and have materialized on discrete days
- MISO is developing reserve enhancements and leverages AI/ML to strengthen our ability to manage uncertainty and variability

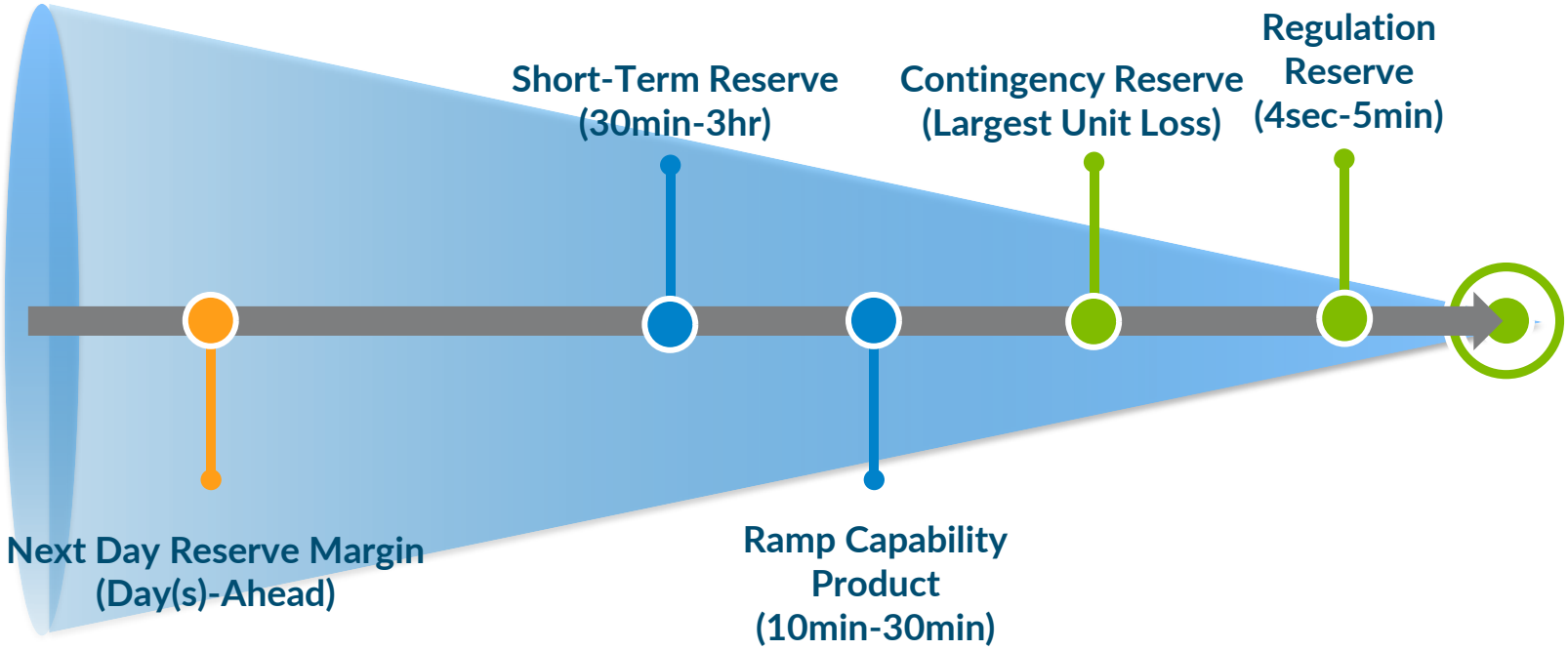
# MISO is an independent, not-for-profit, member-based organization responsible for keeping the power flowing across the region reliably and cost-effectively.


MISO's reliability footprint and regional control center locations

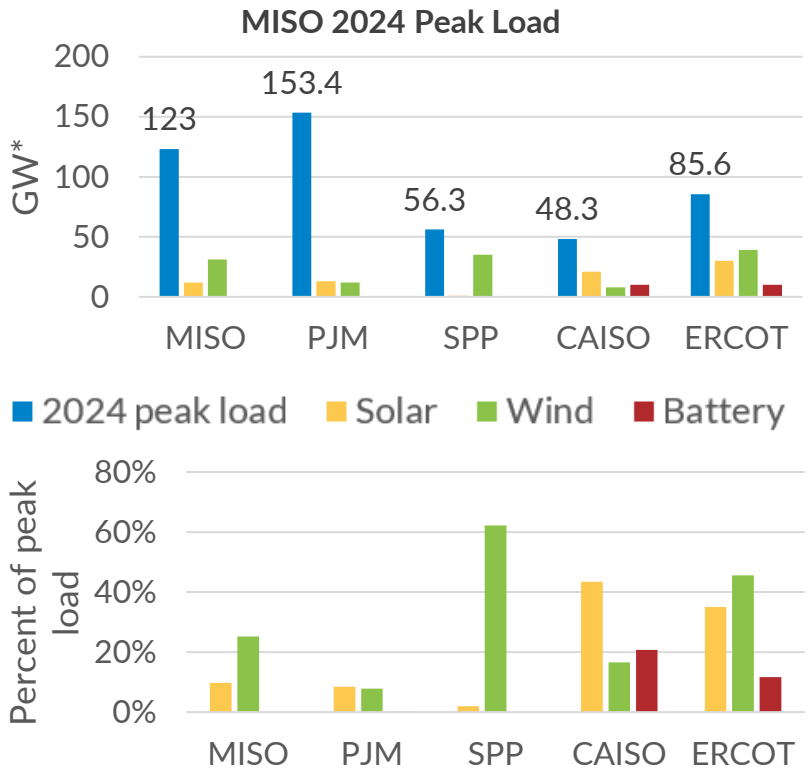
## MISO KEY FACTS

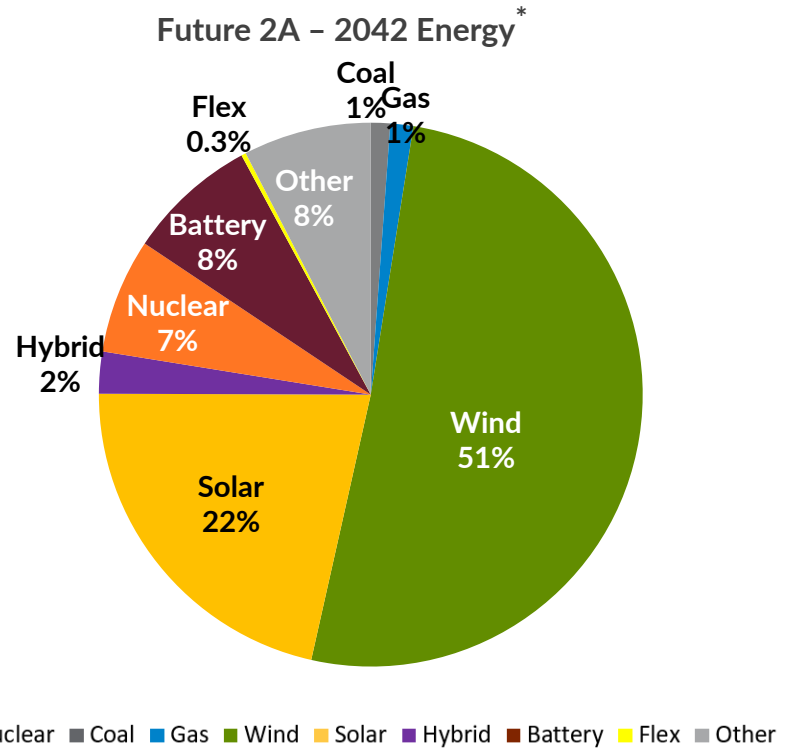
| | |
|---|---|
| **Area Served** | 15 U.S. States and Manitoba, Canada |
| **Population Served** | 45 Million |
| **Transmission Line** | 77,000 Miles |
| **Generating Units** | 1460 |
| **Record Demand** | 127.1 GW 7/20/2011 |
| **Members** | 60 Transmission Owners |
| | 144 Non-transmission Owners |
| **Market Participants** | > 500 |
| **Market Transactions** | > $40 billion |
| **Carbon Reduction** | Approximately 32% since 2014 |

# The Energy and Ancillary Service markets co-optimize Energy and reserve products that cover uncertainties across different timeframes



# The region is experiencing rapid energy transition toward decarbonization, decentralization and digitalization



# Reserve product enhancements are needed to prepare for increased uncertainty and variability with more weather-dependent generation

## Uncertainty management

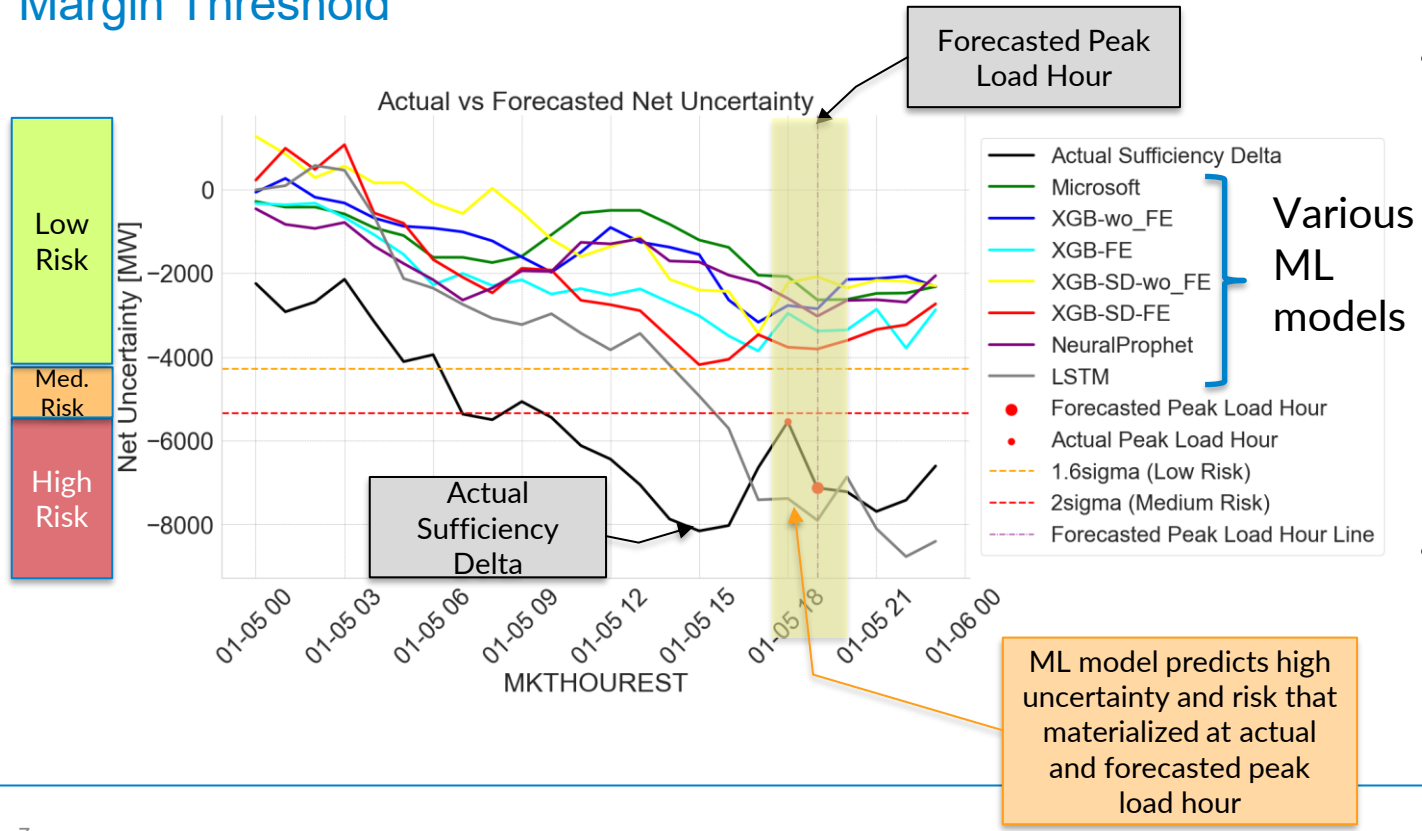
Day-ahead net load uncertainty prediction Machine Learning (ML) model to dynamically set Short-Term Reserve requirement and next-day reserve margin threshold

## Dynamically determine reserve needs

1. Set reserve product requirement dynamically
2. Hour(s) ahead net uncertainty prediction Machine Learning model to dynamically set Regulation and Ramp Requirements

## Ensure reserves can be delivered where needed

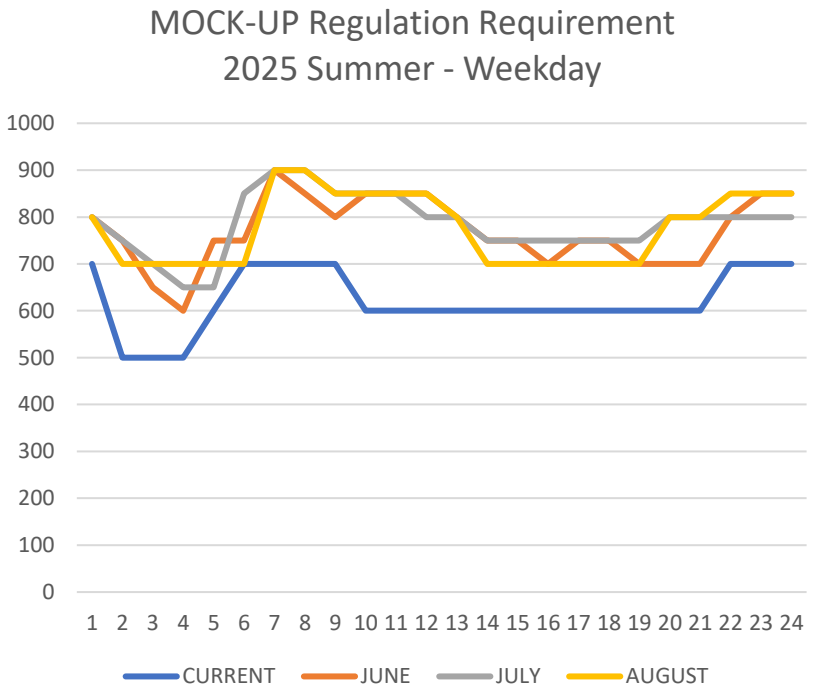
# **Uncertainty Management**: Day Ahead Net Load Uncertainty Prediction ML model to Dynamically Set Short-Term Reserve Requirement and Next-Day Reserve Margin Threshold




- MISO uses <u>deterministic</u> day ahead net load uncertainty prediction ML model to dynamically set Short-Term Reserve requirement and Next-Day reserve margin threshold.
- Markets R&D is exploring <u>probabilistic</u> day ahead net uncertainty prediction models

# **Dynamically determine reserve needs**: MISO is developing a dynamic process to set Regulation Requirement based on quantified net uncertainty

- Task 1: Uncertainty quantification
  - Quantify the uncertainty that should be covered by Regulation Reserve product
- Task 2: Derive Regulation Reserve Requirement
  - Seasonal requirements (Low/Medium/High): vary by hour and weekday/weekends
- Task 3: Dynamic Process
  - Design a process to dynamically set requirement (Low/Medium/High) based on predicted uncertainty
    - Near term: dynamically set requirements through operating process/procedure based on 1) CPS Real-Time performance; 2) system patterns of key drivers (load/wind/solar/weather).
    - Longer term: develop an uncertainty prediction Machine Learning model in Uncertainty Platform





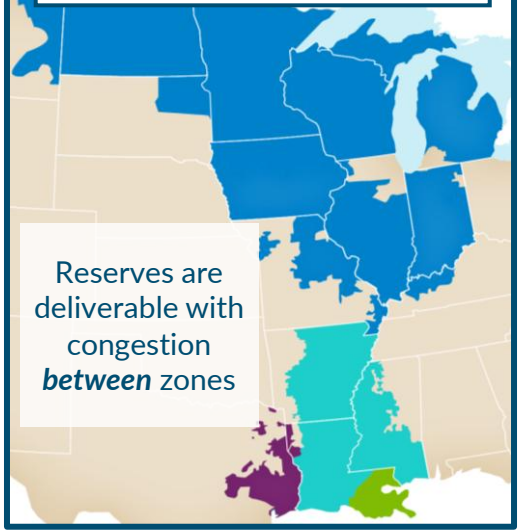

More details available [20250417 RSC Item 05 Dynamic Regulation Reserve (RSC-2024-1).pdf]

# Regulation Uncertainty Quantification and Requirement Formation: Comparison with other industry practices

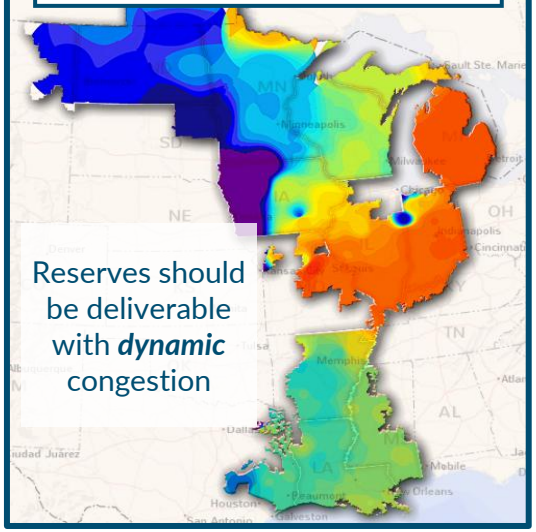
| | CAISO | ERCOT | MISO's Approach |
|---|---|---|---|
| How to measure uncertainty | Area Control Error (ACE) combined with Regulation Dispatched | Net load (load – wind – solar) forecast error | 1. (BA's Tie Error subtracting Actual Regulation) + 2. (Reg Shortage due to ramp sharing) |
| Historical dataset | same month last year + most recent 30 days | same month of the previous two years | same month of the previous two years |
| Calculation | Hourly values are determined by 95$^{th}$ and 98$^{th}$ percentiles | Hourly values are determined by 95$^{th}$ plus incremental MWs to account for growth of renewable capacity | Hourly values are determined by 95$^{th}$ (Normal) and 97$^{th}$ (High) percentiles plus a scaling factor to account for growth of renewable capacity |
| Cadence | Monthly analysis | Annual analysis | Quarterly analysis |

# **Ensure reserves can be delivered where needed:** More dynamic and complex congestion patterns require reserves that can be delivered where needed

RESERVE MARKET DESIGN




DYNAMIC CONGESTION




Research Questions:

- How can we characterize reserve needs not only for the whole system but also reflect locational needs?
- How can reserves be cleared such that it can be delivered where needed when uncertainty materializes?

MISO Markets R&D is studying candidate solutions and will propose future market enhancements to improve reserve deliverability

# Thank you!

# Appendix

# MISO operates Day-Ahead and Real-Time Energy and Ancillary Service markets with reliability commitments in-between

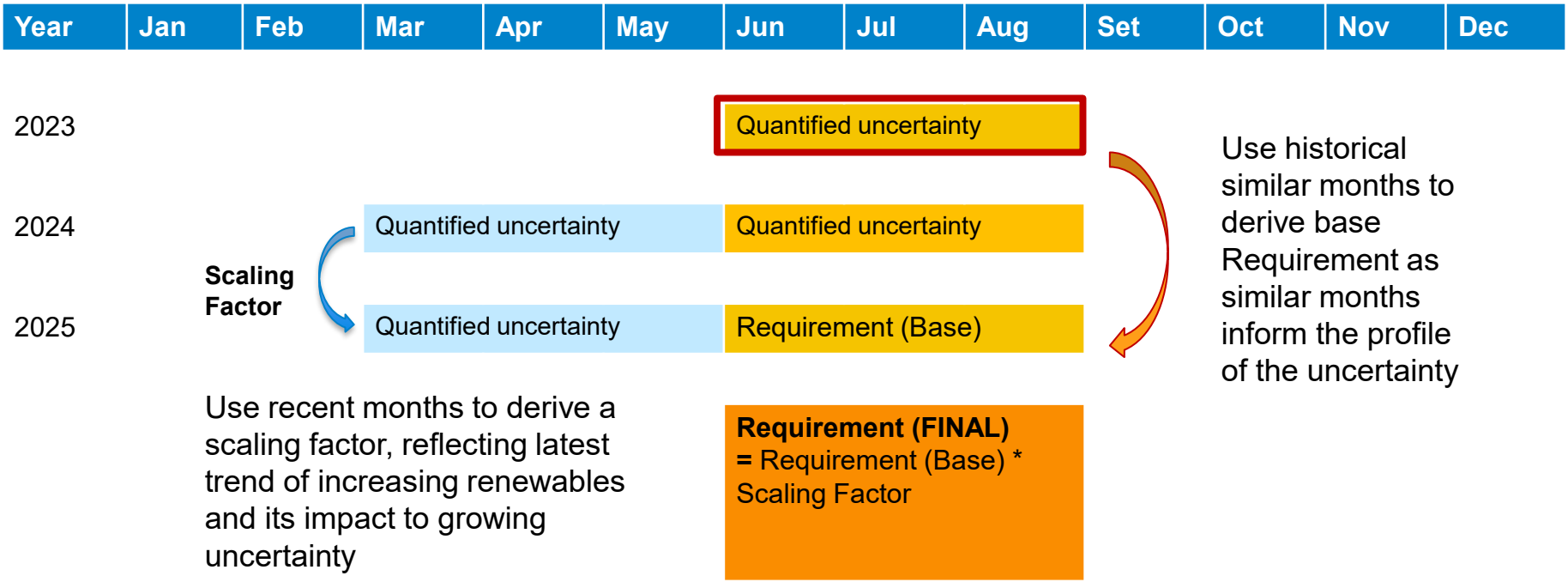
| | | | | | |
|---|---|---|---|---|---|
| Forecast Inputs | Hourly forecast up to 7-day ahead | Market Participant (MP) Offer | Hourly forecast Day-Ahead | Hourly and 5 min forecasts hours ahead | 5min forecast by MISO or MP |
| Market & Reliability Processes | Multi-Day Forward RAC | Day-Ahead Market | Next-Day Forward RAC | Intra-Day RAC and LAC | Real-Time Market and UDS |

- In addition to the operating horizon, MISO also administers markets in the planning horizon
  - Planning Resource Auction (PRA)
  - Auction Revenue Rights (ARR) and Financial Transmission Rights (FTR)
- After Real-Time market, Automated Generation Control (AGC) ensures generation is balanced with actual load every four seconds

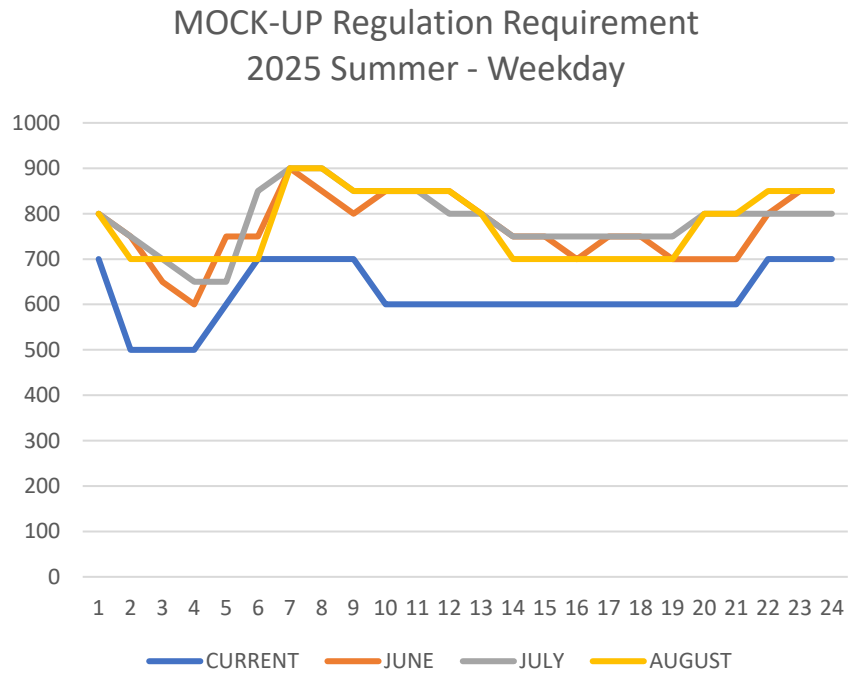


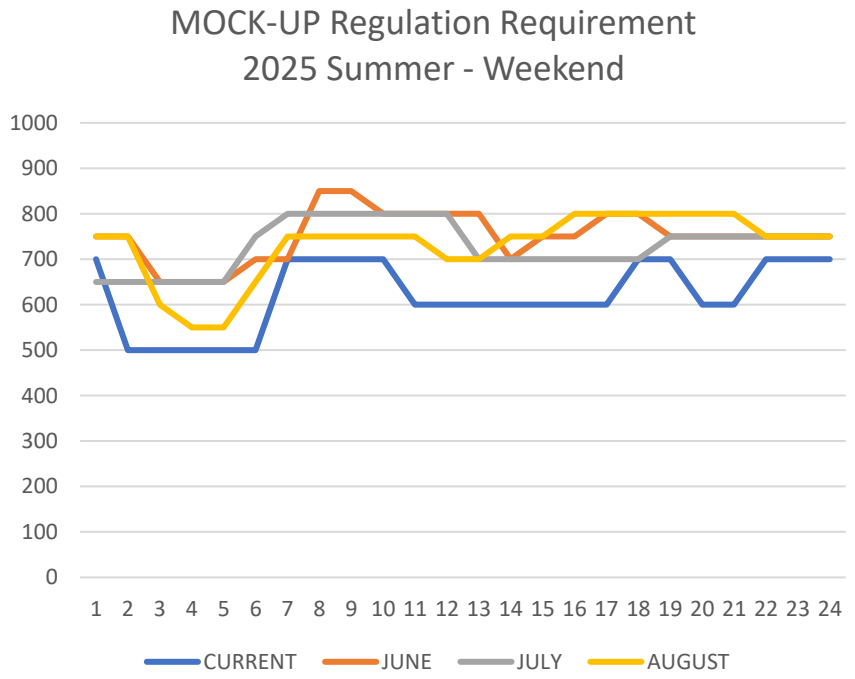
*Notes: RAC: Reliability Assessment Commitment; LAC: Look Ahead Commitment; UDS: Unit Dispatch System

# Regulation Uncertainty Quantification and Requirement Formation: Illustrative Flow



# MOCK-UP Summer 2025 Normal Regulation Requirement based on finalized methodology




*including a 1.1 scaling factor which is subject to update

# **Ensure reserves can be delivered where needed**: MISO's ancillary services market has evolved to reflect the impact of reserve post-deployment flows on interzonal transmission constraints

- MISO runs a co-optimized energy and ancillary services market
  - Operating reserves comprise of regulating reserve and contingency reserves (spinning and supplemental)
  - Additionally, we have a Ramp Capability Product and a Short-Term Reserve
- Energy is modeled on nodal basis, while reserves are modeled on mostly static zonal basis
  - Systemwide reserve requirements
  - Reserve Procurement Enhancement (RPE): zonal reserves requirements are solved as part of co-optimization. We consider the effect of deploying reserves on important transmission constraints *
- Reserve zone configuration studies are done quarterly with the network model updates to ensure reserves are dispersed to address reliability

**MISO Indicative Reserve Zones**




* Currently RPE is enabled only for STR on the Regional Directional Transfer (RDT).