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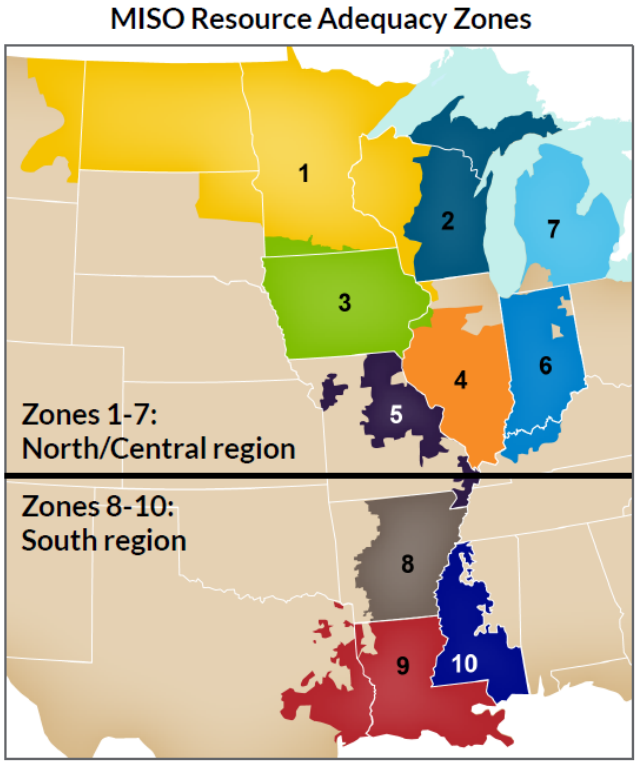

MISO Zone 5 Capacity Needs and Potential Solutions

Water and Light Advisory Board

March 12, 2025

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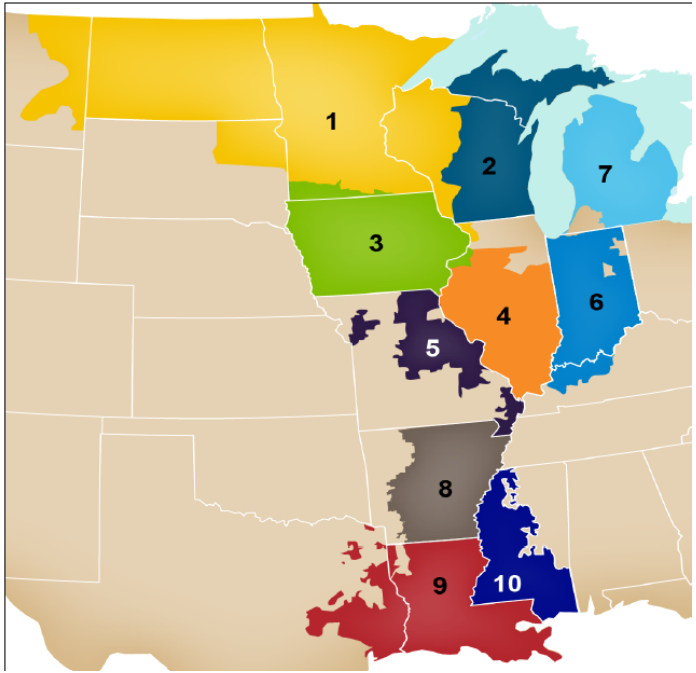
Resource Adequacy Requirements

- Load Serving Entities (LSE) are required to have enough accredited capacity to cover their forecasted seasonal peak demand plus a reserve amount
- Planning Resource Auction (PRA) provides a mechanism for LSEs to obtain or demonstrate that they can meet requirements

Local Resource Zone



- MISO footprint separated into zones for PRA calculations
- Capacity in separate zone from load is exposed to zonal price separation risk

Historical Volatility in PRA

- Historical auction clears have varied significantly
  - Example: the Missouri zone priced at $719.81/MW-day in Spring 2025 and only $10/MW-day the year before
  - Zonal separation in the footprint has been present in every year except one

See Appendix A for full history of PRA prices

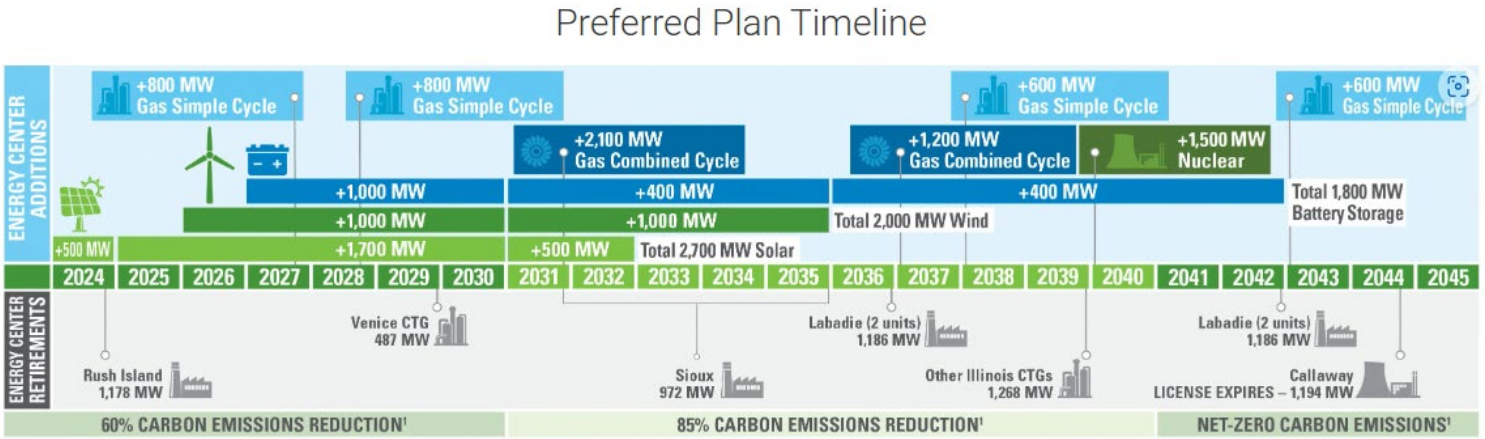
Future Volatility in PRA

- New changes in resource adequacy construct expected in 2025-2026 (and likely more in the future)
  - MISO re-ran the 2024-2025 and 2023-2024 auctions with this new construct, the prices in Missouri were higher in every season as compared to the status quo

See Appendix B for PRA prices

Future Volatility in PRA

- Future of Missouri zone depends largely on Ameren's plan, which includes significant retirements of dispatchable resources and additions of wind/solar



NOTE: Reductions are presented as of the end of the period indicated and based off 2005 levels. Wind and solar additions, energy center retirements by end of indicated year.

1. Ameren's goals encompass both Scope 1 and 2 emissions including other greenhouse gas emissions of methane, nitrous oxide and sulfur hexafluoride. This goal is dependent on a variety of factors including cost-effective advancements in innovative clean energy technologies as well as constructive federal and state energy and economic policies.

MISO's Regional Resource Assessment

- *Members and states may need to add capacity at an unprecedented rate of 17 GW/year (over three times the recent average ICAP of 4.7 GW/year1) for 20 years to meet future demand and policy goals. Achieving this pace will require overcoming supply chains, permitting, labor and interconnection queues delays.*
- *Under MISO's new Direct Loss of Load accreditation methodology, thermal resources will continue to provide the bulk of the region's accredited capacity even while RRA modeling indicates that lower-accredited wind and solar will account for 62% of installed capacity and 87% of the region's energy by 2043.*
- *Greater reliance on solar power is shifting the region's net load ramp from morning to evening, which is increasing the region's 1-hour ramp need by 2-3 times by the early 2030s.*

Projected Changes to Accredited Capacity

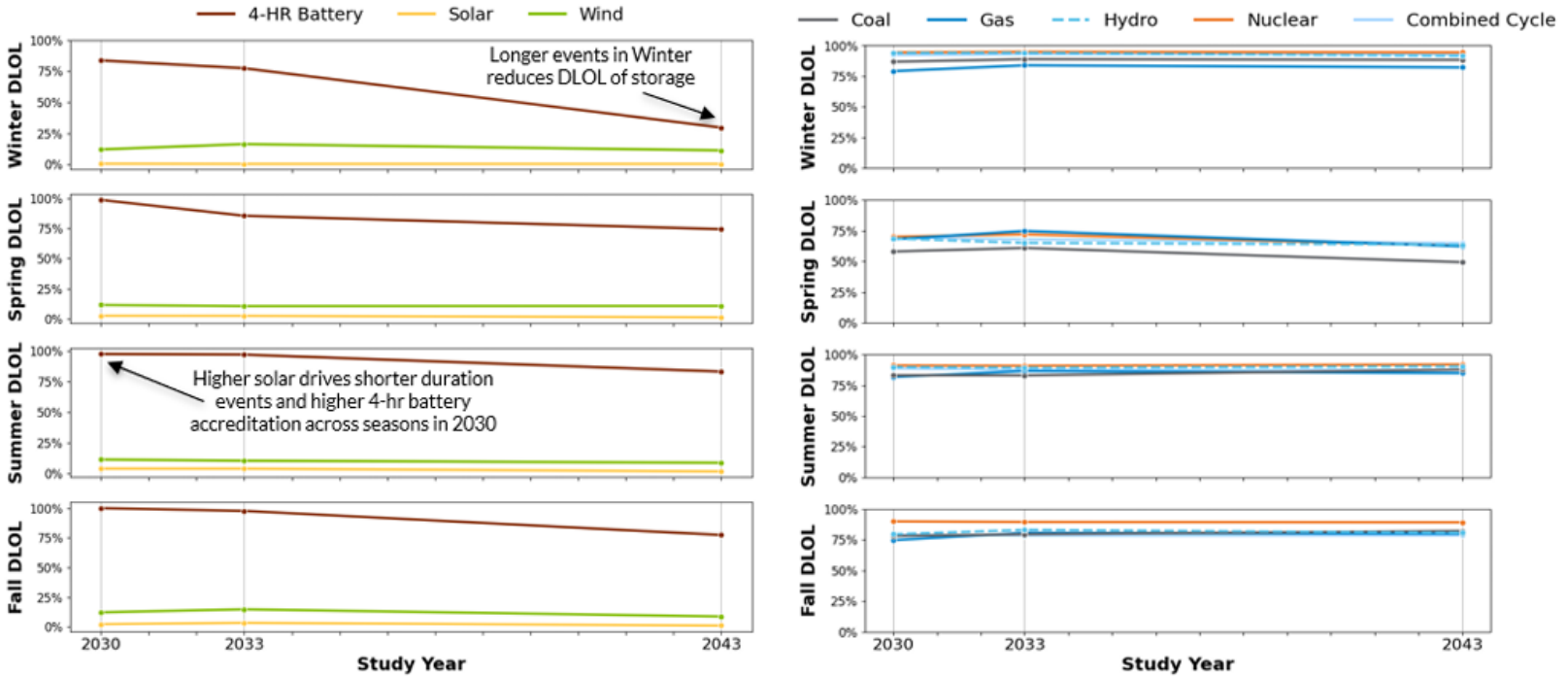


Figure 5: Change in resource class DLOL accredited value by study year

Highest Risk Hours Shift

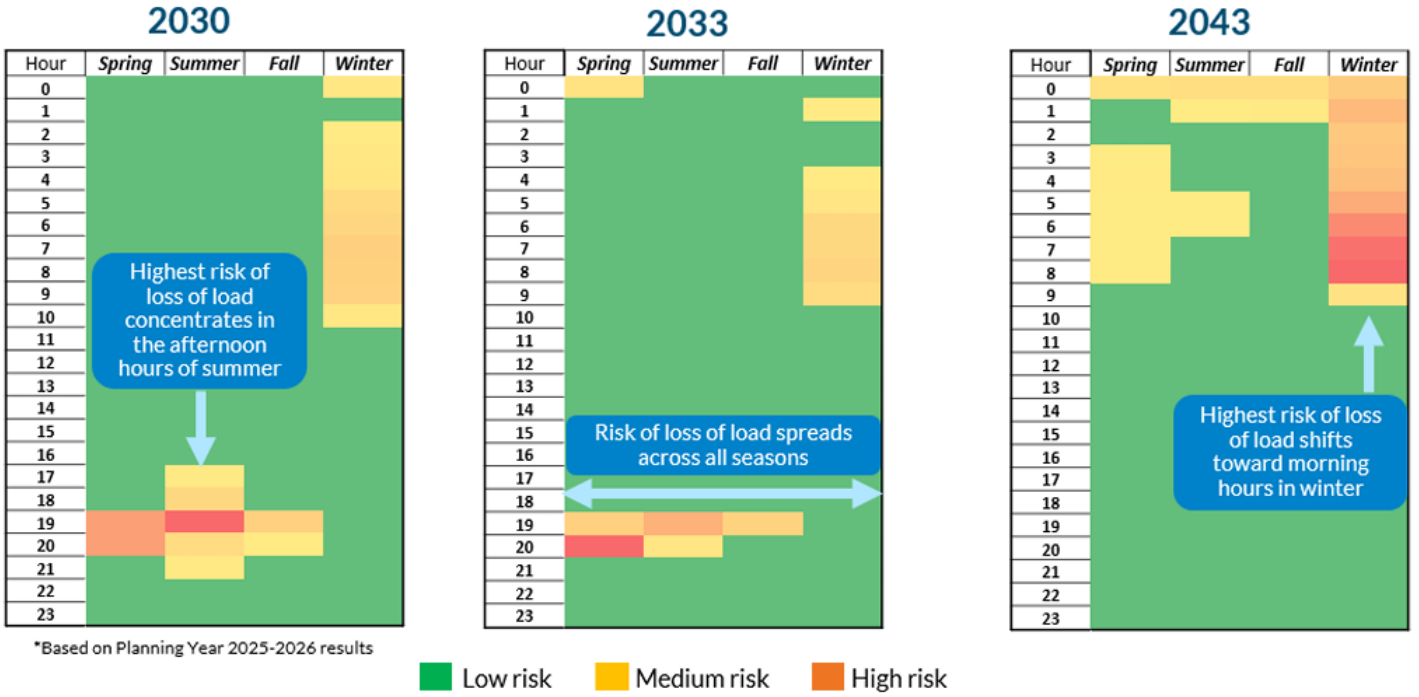


Figure 6: Projected shift in risk of loss of load between 2030 to 2043

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Potential Solutions

- Bilateral contracts: currently scarce, especially in Zone 5
- Building a physical asset has added benefit of energy hedge along with capacity

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MEC Northeast Generation Project

- Collection of Missouri Electric Commission (MEC) members interested in developing new generation in Missouri to meet resource adequacy requirements and provide a physical hedge against price volatility
- Working together provides better economies of scale and risk mitigation
- Targeting dual fuel natural gas generation with oil backup
- Capacity only PPA available

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Hedging against future risk

- Although building new capacity can have higher up-front cost, it does provide a more stable capacity price that can be controlled and planned such that it better aligns with a municipal utility's risk tolerance
- Simple cycle generation is not expected to run continuously, but instead, to fill in the supply needs of the market when more intermittent resources like wind and solar are producing at lower levels
    - It's quick ramping capability and flexibility of dispatch make this type of resource a good match for the future needs of the market

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Fulton Gas Turbine

- Titan Solar 130 Dual Fuel Gas Turbine
  - 13 MW (Summer)
  - 17 MW (Winter)
- Fuel Oil Storage Is Available On-Site
  - Two Existing 250,000 Gallon Tanks
- Natural Gas Lateral Would Need to Be Installed
- Fulton Has Staff On-Site
- Connecting Into Existing 69 / 13.8 kV Substation
- $25.5 Million Direct Cost ($1500 / kW)

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Hannibal Phase 1 and 2

- Four Titan Solar 350 Dual Fuel Gas Turbines
  - 128 MW (Summer)
  - 172 MW (Winter)
- Fuel Oil Storage Would Be Constructed
  - Four 220,000 Gallon Tanks
- Natural Gas Lateral Would Need to Be Installed
- Connecting Into Existing 161 kV Substation
- $210 Million Direct Cost ($1220 / kW)

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Appendix A (Historical Auction Clearing Prices $/MW-Day)

PY	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	ERZs
2015-2016		$3.48		$150.00		$3.48		$3.29		N/A	N/A
2016-2017	$19.72			$72.00				$2.99			N/A
2017-2018					$1.50						N/A
2018-2019	$1.00					$10.00					N/A
2019-2020				$2.99			$24.30		$2.99		
2020-2021				$5.00			$257.53	$4.75	$6.88	$4.75	$4.89-$5.00
2021-2022				$5.00					$0.01		$2.78-$5.00
2022-2023				$236.66					$2.88		$2.88-236.66
Summer 2023						$10.00					
Summer 2024						$30.00					
Fall 2023					$15.00				$59.21	$15.00	
Fall 2024			$15.00		$719.81		$15.00				
Winter 2023-24					$2.00				$18.88	$2.00	
Winter 2024-25						$0.75					
Spring 2024						$10.00					
Spring 2025			$15.00		$719.81		$15.00				

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Appendix B (Estimated Clearing for 2024-2025 using indicative RBDC)

Estimated *price* ($/MW-day) from PRA clearing for PY 2024-25 using indicative RBDCs

		ACPs from 2024 PRA ($/MW-day)	ACP Estimates with indicative Reliability Based Demand Curve ($/MW-day)
Zones 1-4, 6 and 7			
	Summer:	$30	$197
	Fall:	$15	$39
	Winter:	$0.75	$2.4
	Spring:	$34	$32
Zone 5			
	Summer:	$30	$197
	Fall:	$720	$758*
	Winter:	$0.75	$2.4
	Spring:	$720	$751*
Zones 8-10			
	Summer:	$30	$80
	Fall:	$15	$39
	Winter:	$0.75	$2.4
	Spring:	$34	$32

*For LCR shortage, ACP is calculated as RBDC Clearing plus LCR adder

For clearing with indicative RBDCs,

- Sub-regional Power Balance Constraint (SRPBC) is binding in Summer season only, hence, price separation between North (Zones 1-7) and South (Zones 8-10) in Summer
- All zones, except Zone 5, cleared at same ACP for Fall, Winter and Spring
- Zone 5 ACP reflects the LCR shortage in Fall and Spring season like the clearing in the 2024 PRA

NOTE: For PY 24-25, indicative RBDCs from 2023 were scaled based on the LF for PY 24-25; MRI and RBDCs for PY 24-25 are under development

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Estimated *price* ($/MW-day) from PRA clearing for PY 2023-24 using indicative RBDCs

		ACPs from 2023 PRA ($/MW-day)	ACP Estimates with indicative Reliability Based Demand Curve ($/MW-day)
Zones 1-7			
	Summer:	$10	$234.3
	Fall:	$15	$43.8
	Winter:	$2	$10
	Spring:	$10	$20
Zone 8, 10			
	Summer:	$10	$50.1
	Fall:	$15	$43.8
	Winter:	$2	$10
	Spring:	$10	$20
Zones 9			
	Summer:	$10	$50.1
	Fall:	$59.2*	$59.2*
	Winter:	$18.9*	$18.9*
	Spring:	$10	$20

For clearing with RBDCs,

- Sub-regional Power Balance Constraint (SRPBC) is binding only in Summer season
- Zone 9 binding on LCR like the clearing in the 2023 PRA

*Zone 9 was binding on LCR both in the PRA and in the analysis with indicative RBDCs

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