



The Energy Transition: Addressing the Reliability Imperative

MRO Midwest Regional Meeting

June 15, 2023

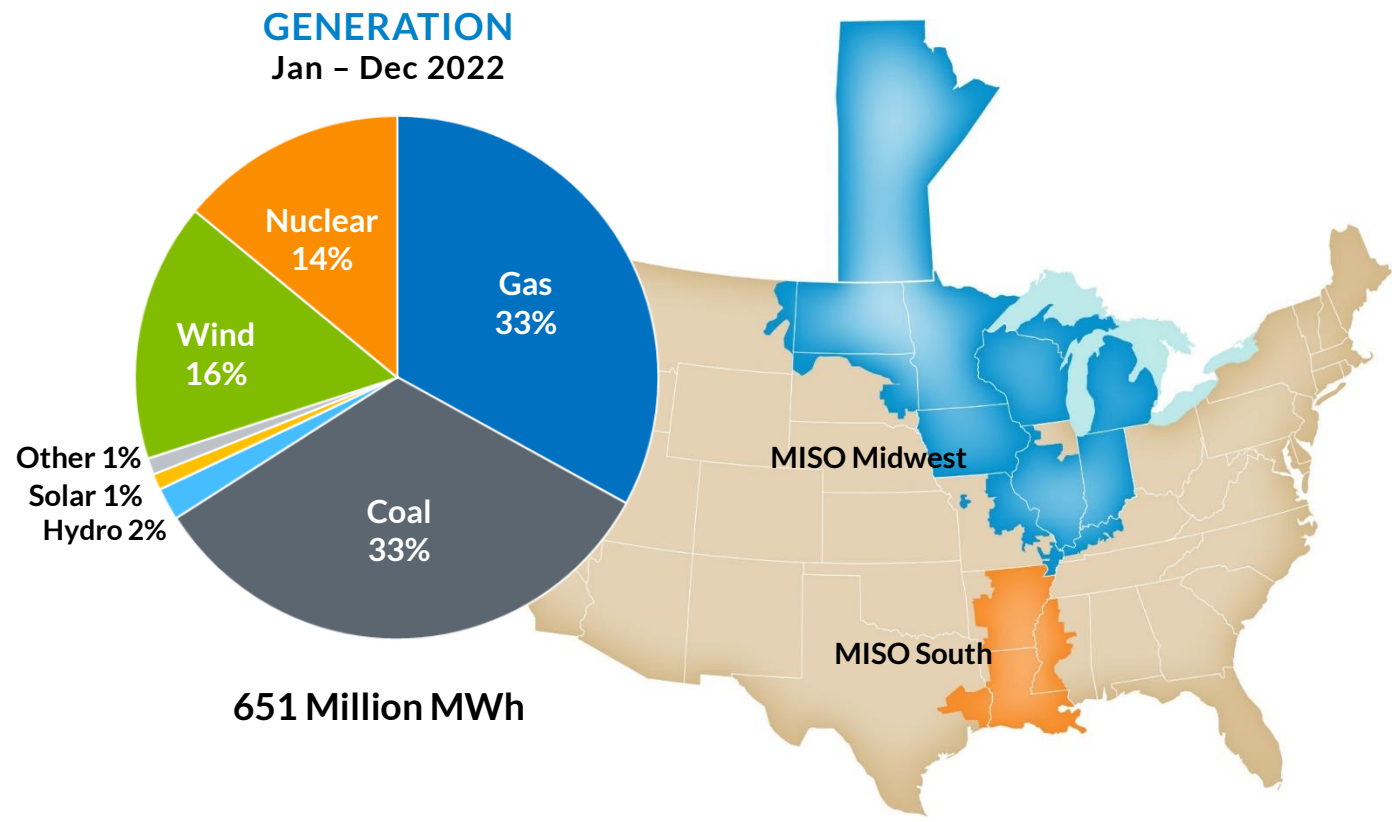
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Executive Summary



- Ambitious decarbonization strategies, accelerated policies and other factors are driving rapid change in MISO's region
- As the evolution of the resource fleet accelerates, operational complexities increase along with the gap in needed resources with the necessary reliability attributes
- Through its Reliability Imperative initiative, MISO is preparing the region to navigate from the present to the future

As an RTO, MISO works collaboratively and transparently with stakeholders to enable the reliable delivery of low-cost energy through efficient, innovative operations and planning



WHAT WE DO

- Provide independent transmission system access
- Deliver improved reliability coordination through efficient market operations
- Coordinate regional planning
- Provide a platform for wholesale energy markets

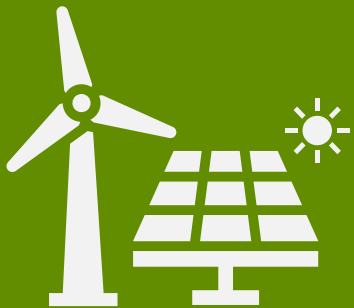
MISO BY THE NUMBERS

- 15 states + Manitoba
- 45 million customers
- \$40 billion market
- 189,000+ MW generation capacity
- 72,000 miles of high voltage transmission lines

Transformation is progressing at an astonishing pace and will speed up over the next several years

Fleet Changes

MISO members and states have set ambitious goals to partially or fully decarbonize



Fuel Assurance

Availability of resources may be challenged by economic, supply chain or other issues



Extreme Weather

Severe weather events are becoming more extreme and occurring more frequently

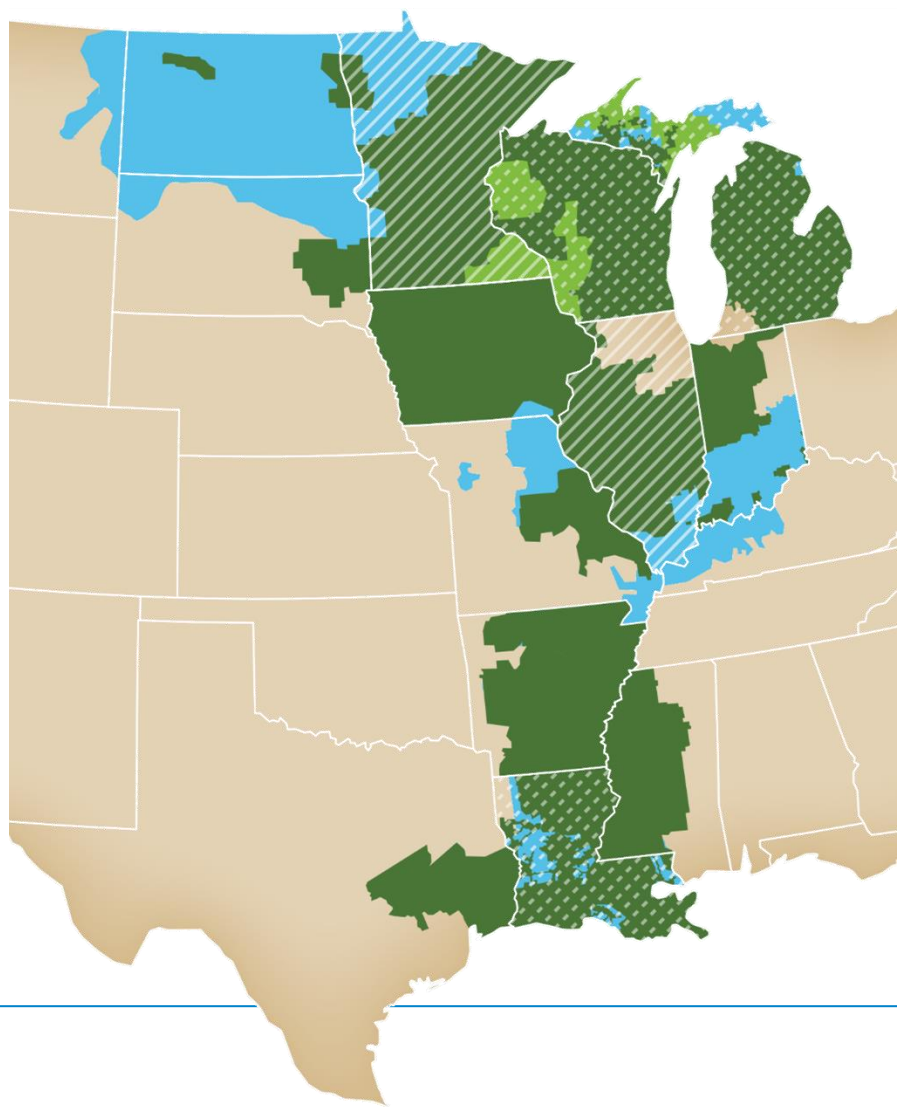


Electrification

Demand for electricity will grow as electric vehicles increase, industry sectors trend towards renewables



Ambitious decarbonization goals have been announced, accelerated or increased, signaling significant changes we can expect

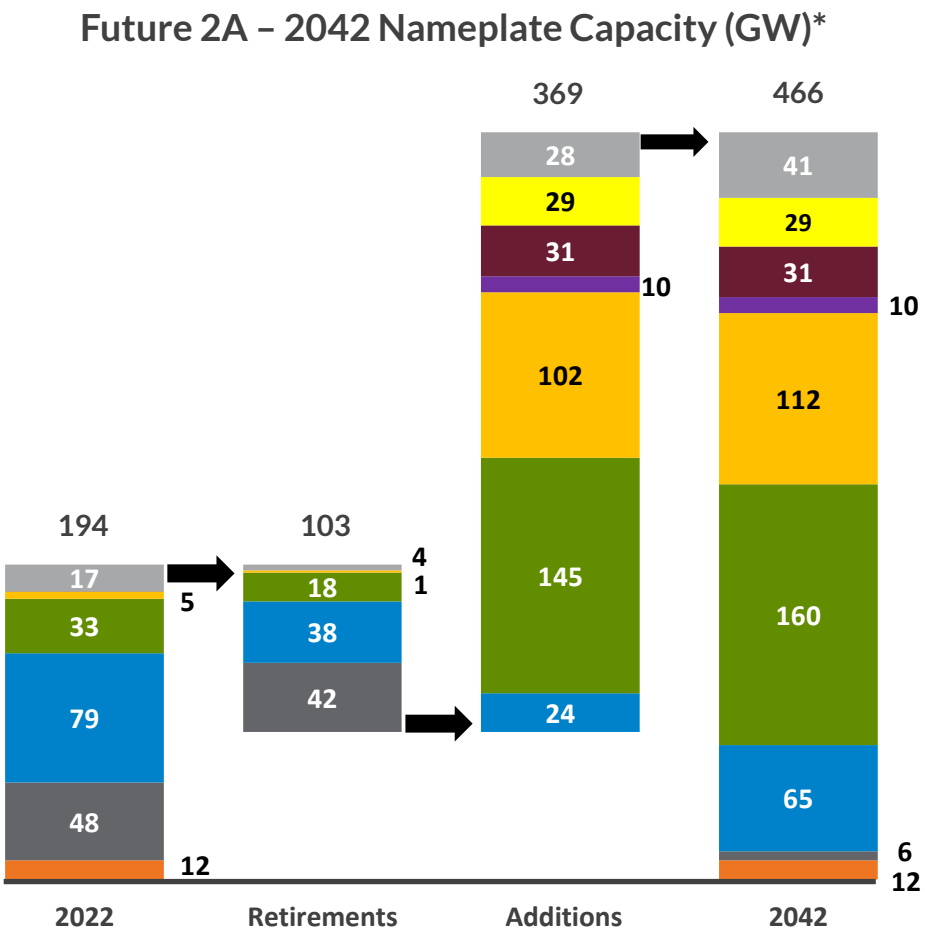
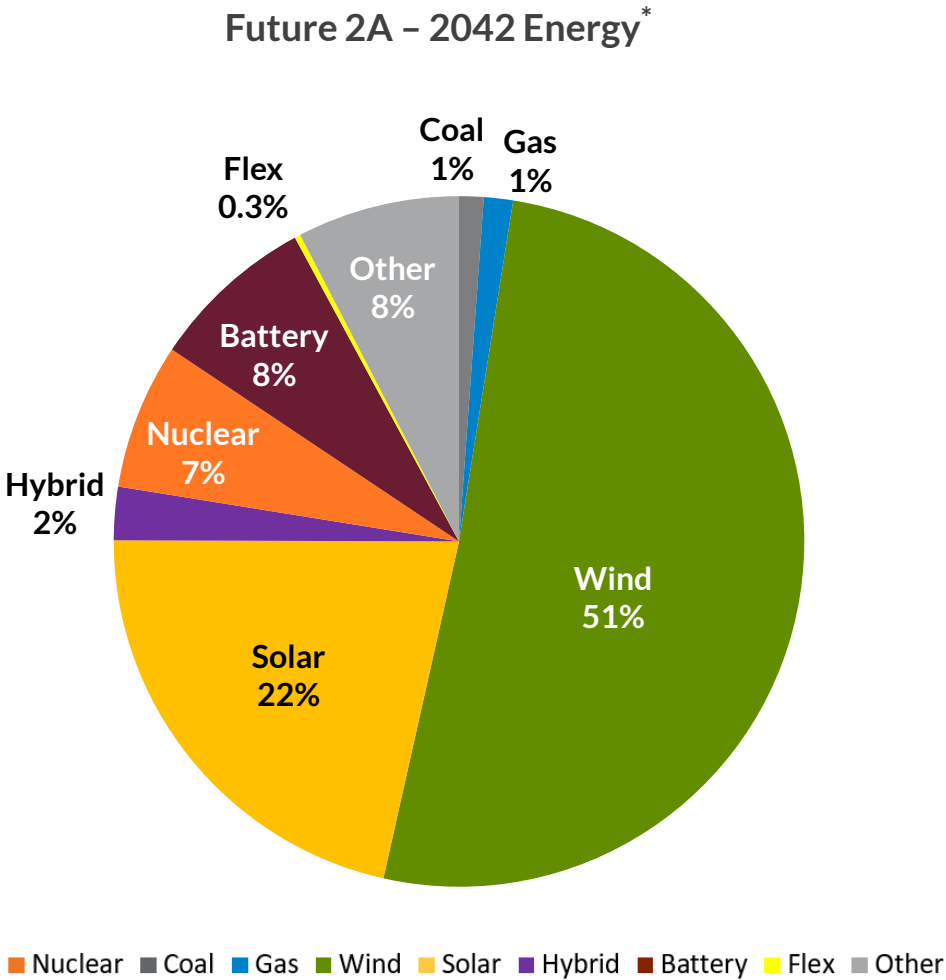


Decarbonization goals*

- MISO Region
- Utilities with 80%+ targets
- Utilities with 50%+ targets
- States with enforceable decarbonization goals
- States with aspirational decarbonization goals

* Map as of Feb 2023. Decarbonization goals are targets for reducing human caused carbon dioxide emissions. Clean energy and/or renewable goals comprise decarbonization goals.

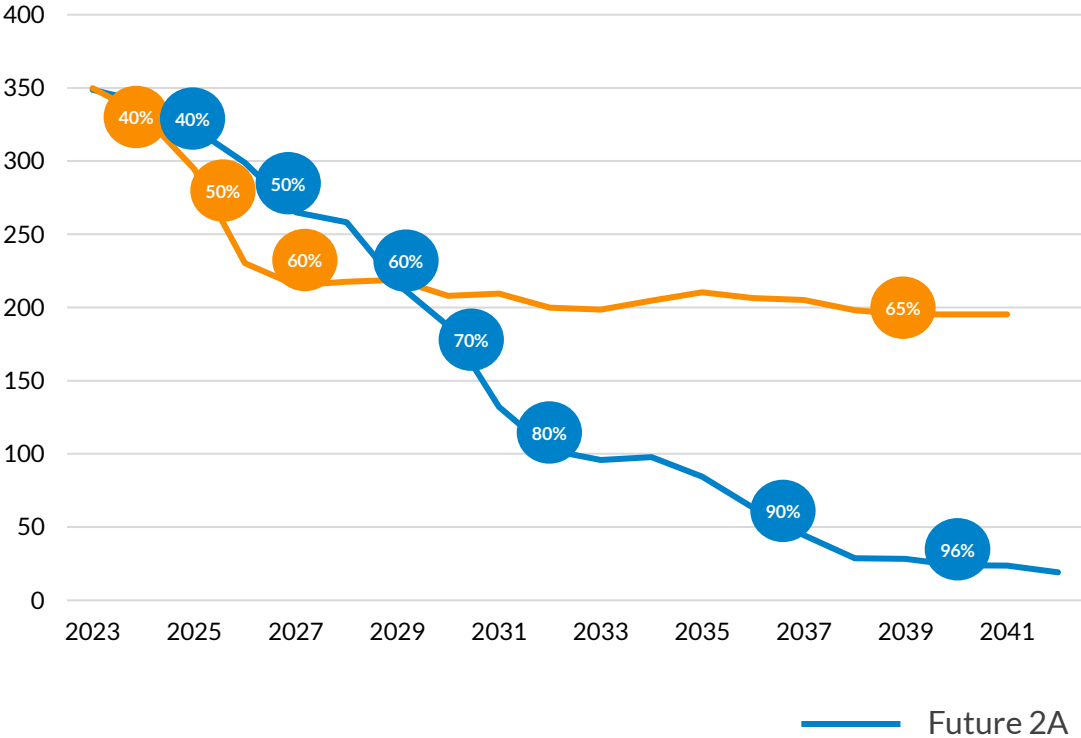
MISO Futures - planning scenarios that bookend system possibilities to inform planning - anticipate significant resource additions, retirements and load growth with a trend towards increasing renewables



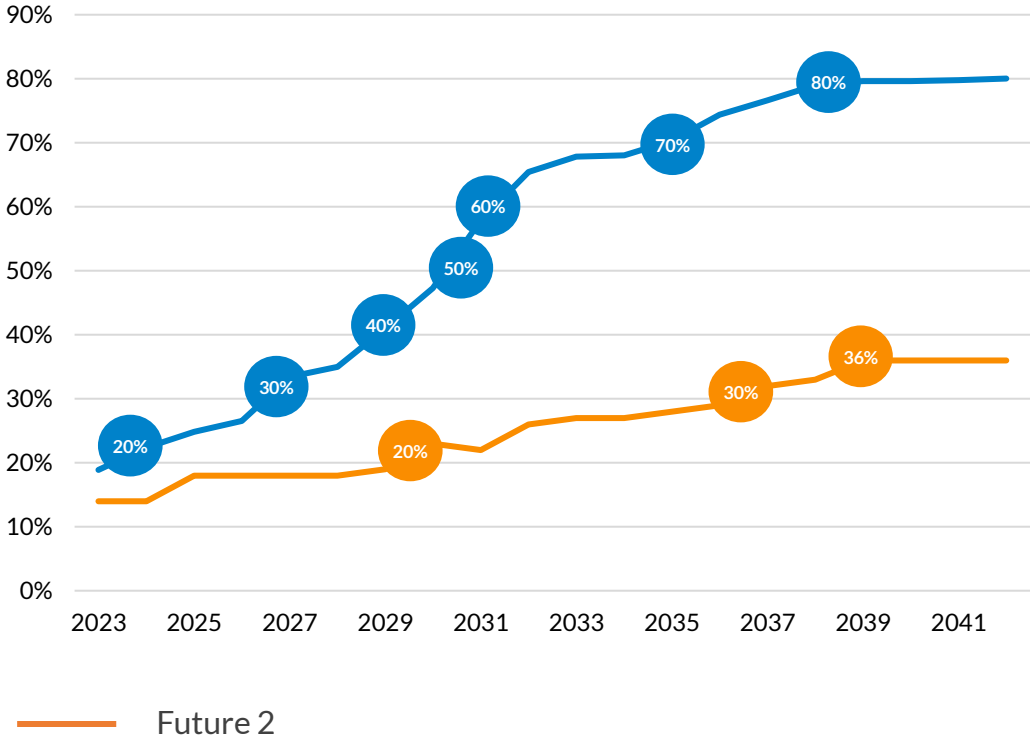
* Data as of April 26, 2023. Futures don't account for all operational level reliability needs and attributes that may require different levels of dispatchable resources. Resource additions may adjust based on new accreditation rules. "Other" includes biomass, geothermal, hydro, oil, pumped hydro storage, demand response and non-PV distributed generation (and energy efficiency for installed capacity). The 2022 solar value is actual installed/registered capacity.

The Futures also show decarbonization continuing as wind and solar reach 30% penetration 10 years earlier than what we anticipated just three years ago

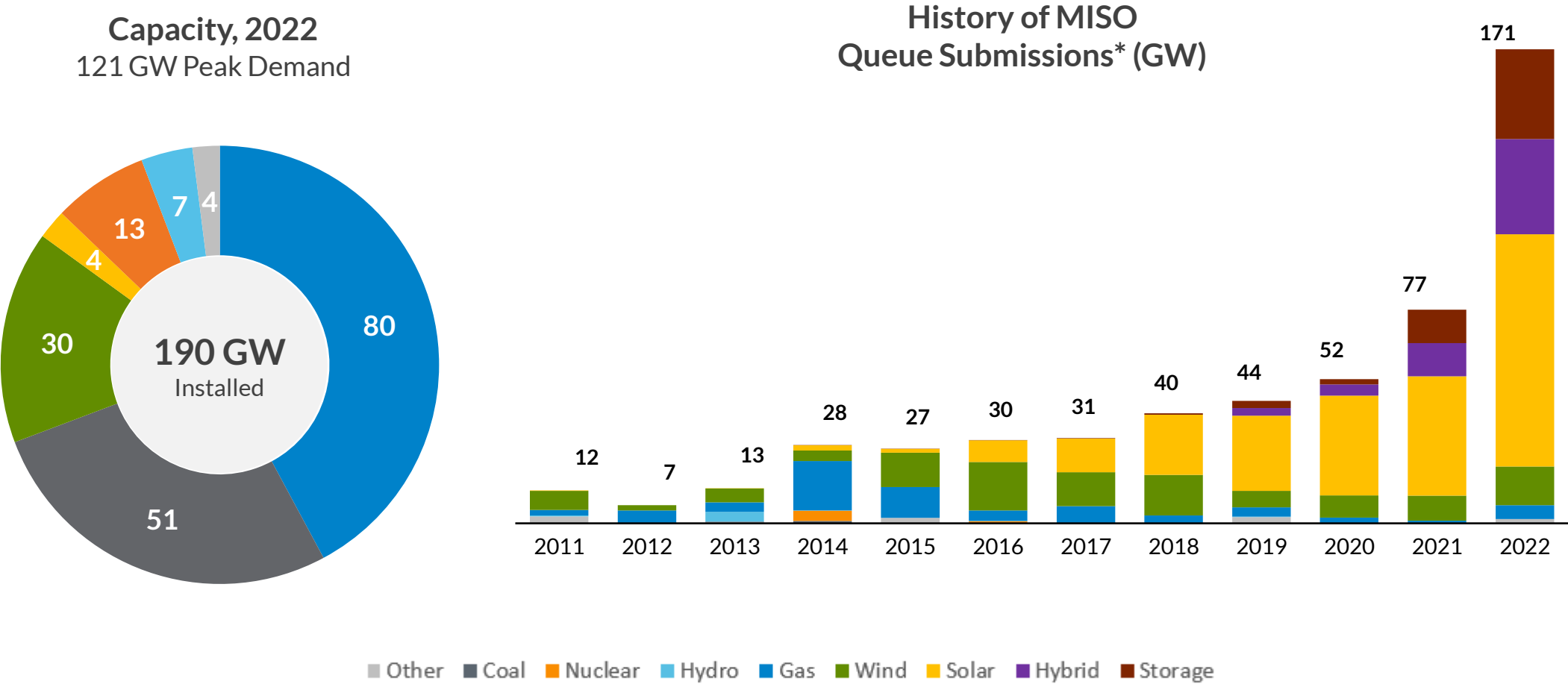
Future 2A (Updated) vs. Future 2
Carbon Emissions
(million short tons)



Future 2A (Updated) vs. Future 2
Wind and Solar Energy Generation
(million short tons)

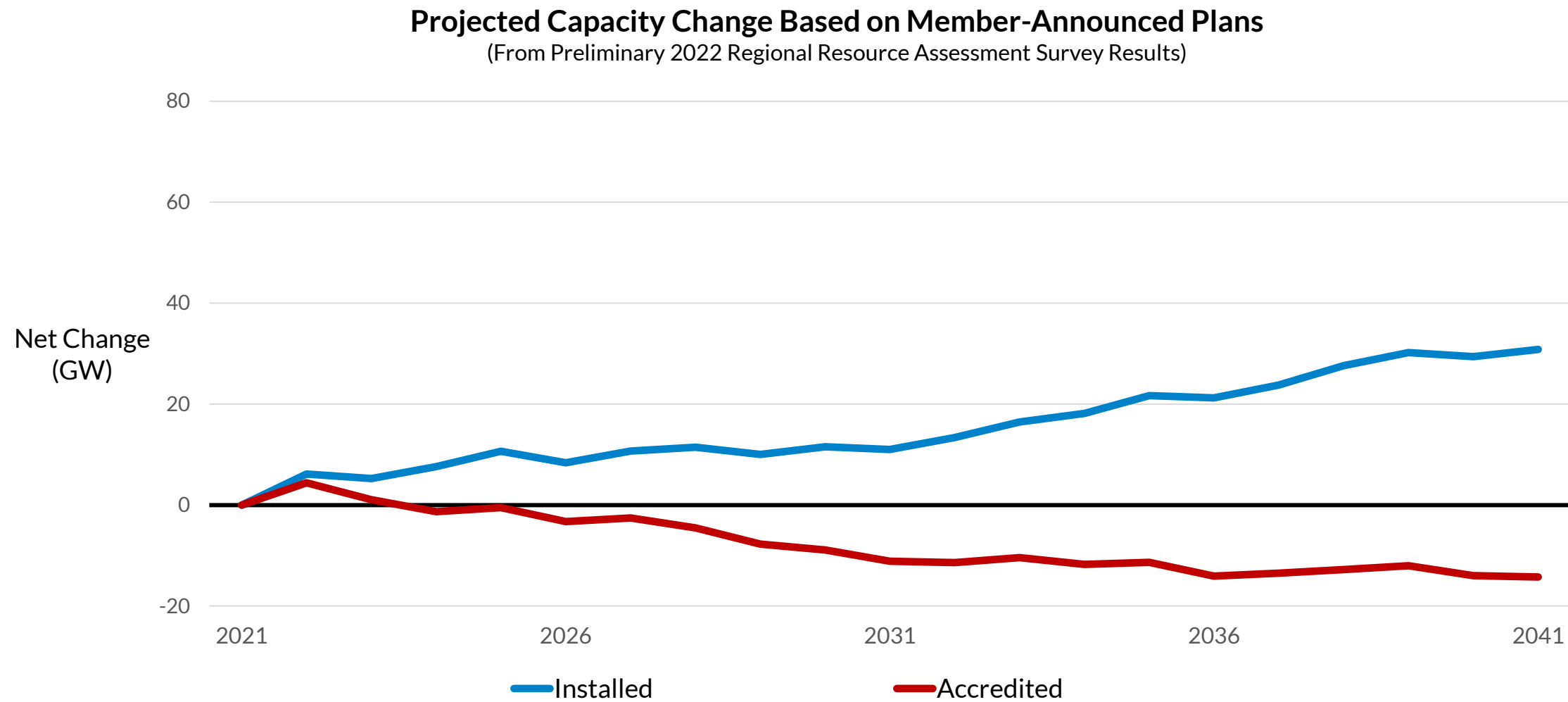


MISO's generator interconnection queue reveals continued, significant growth in renewable resources and limited duration storage resources



Queue data as of 11/1/2022. All values shown in **Nameplate Capacity**.
Data does not reflect additional nameplate capacity from repowering existing generating facilities.

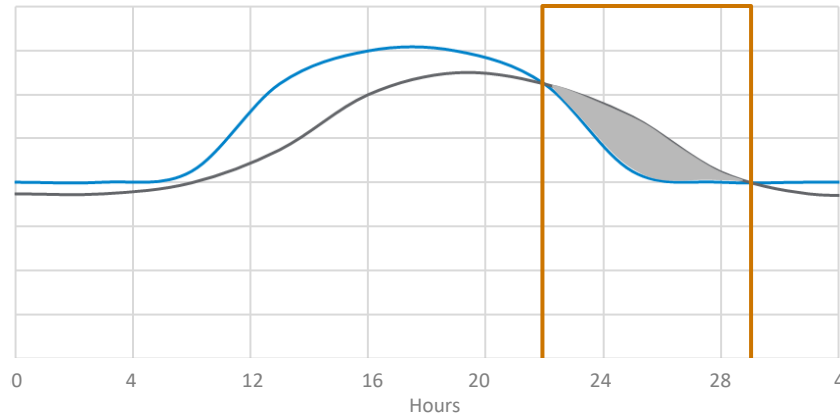
While installed capacity steadily trends upward, accredited capacity moves in the opposite direction because of the capabilities of the resource types selected



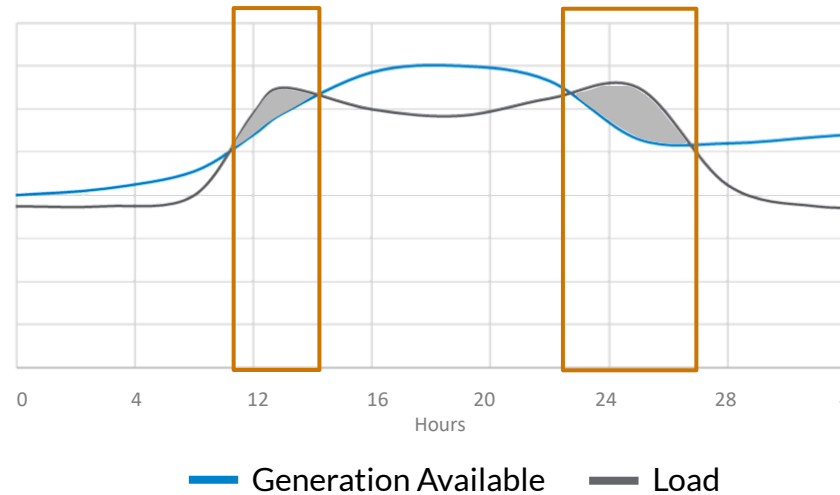
*Future projections calculated as change from Future 1 2022 load assumption
Estimated accredited capacity: 16.6% for wind; 35% for solar, 87.5% for battery, 90% for coal, 90% for gas, and 95% for nuclear

Future 2A reinforces the complexity of planning as supplemental capacity additions are needed to ensure no energy shortfall, especially for twilight hours with low wind output

Hot Summer days with low wind: After Sunset



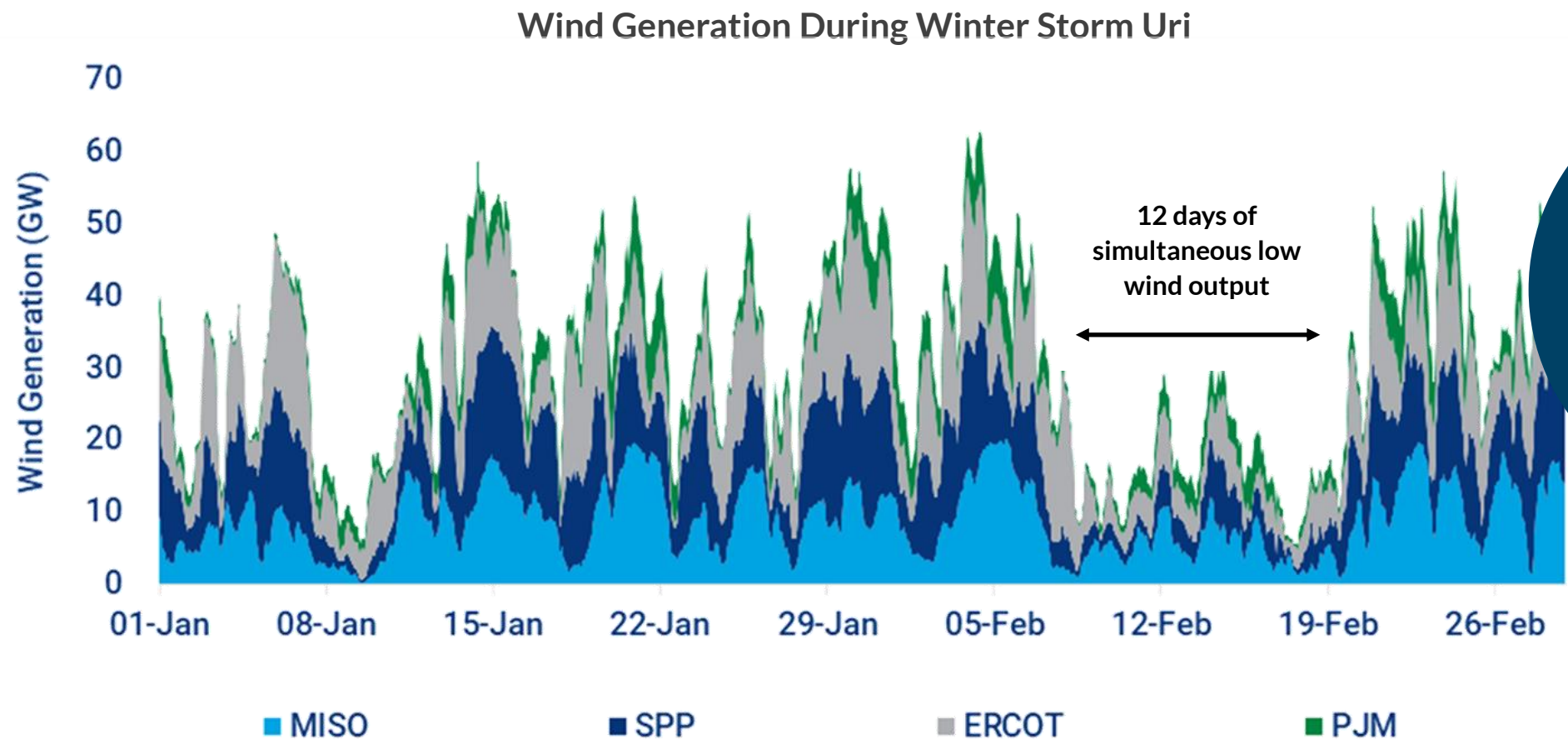
Winter diurnal peaks: Before Sunrise and after Sunset



— Generation Available — Load

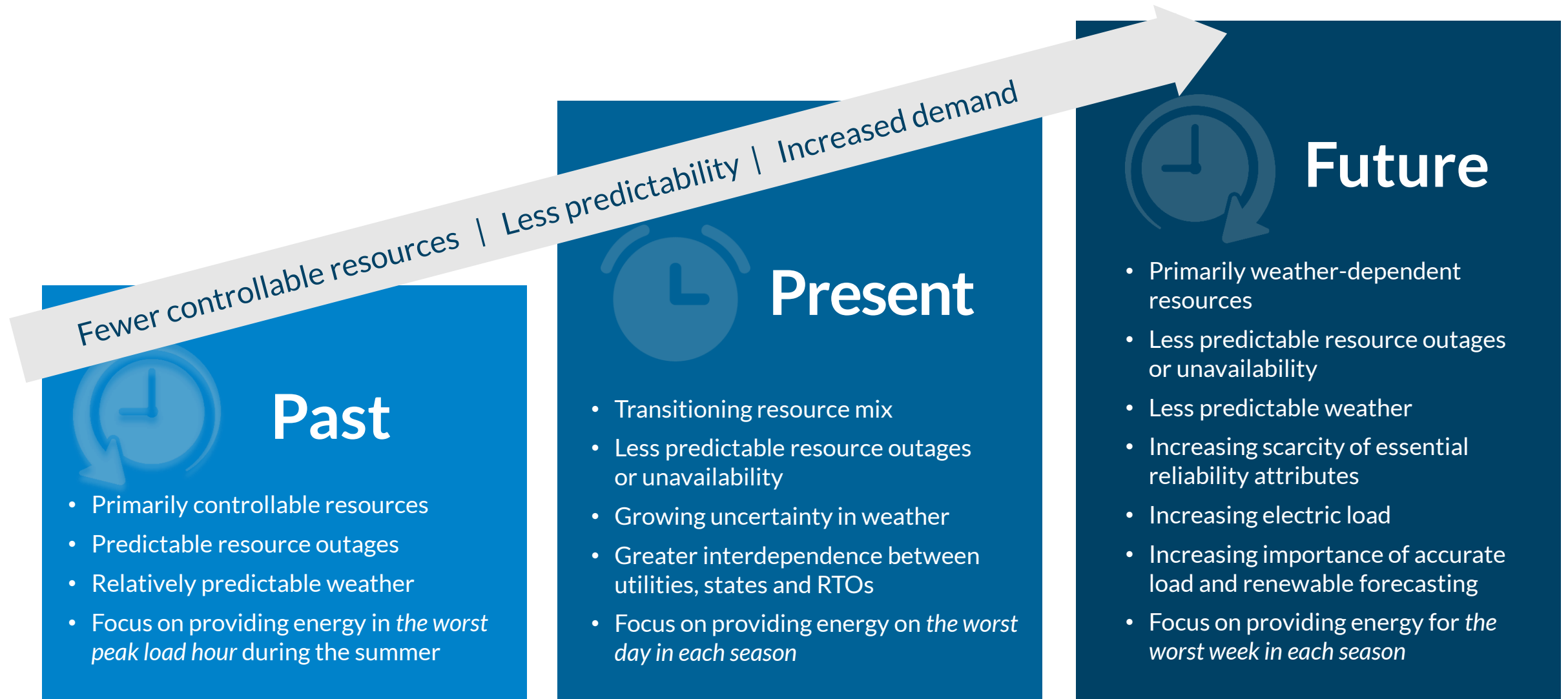
- 26 – 29 GW in Future 2A
 - 13-26 Unserved Energy days/year
 - 3-4 hours per Unserved Energy day
 - Battery charging behavior may shift risks
- Flexible Attribute Units have been added to the Futures to ensure adequacy during these hours

Volatility and uncertainty are significant reliability and operations factors during extreme weather events, which are occurring more frequently



Unplanned outages at dispatchable units are typically isolated to a single site, but weather-dependent renewables are subject to systematic shortages

As the pace of change in the electric system continues to accelerate, MISO, states, and members must collectively accelerate our actions to mitigate the growing risks



Through its Reliability Imperative, MISO is positioning the region to reliably support and enable the future system

Market Redefinition

Aims to ensure that resources with needed capabilities and attributes will be available in the highest risk periods across the year

Transmission Evolution

Assesses future transmission needs holistically, reflecting utility/state plans for new generation; considers potential cost-allocation changes



The shared responsibility of
MISO, utilities and states to
address the challenges to
electric reliability in our region

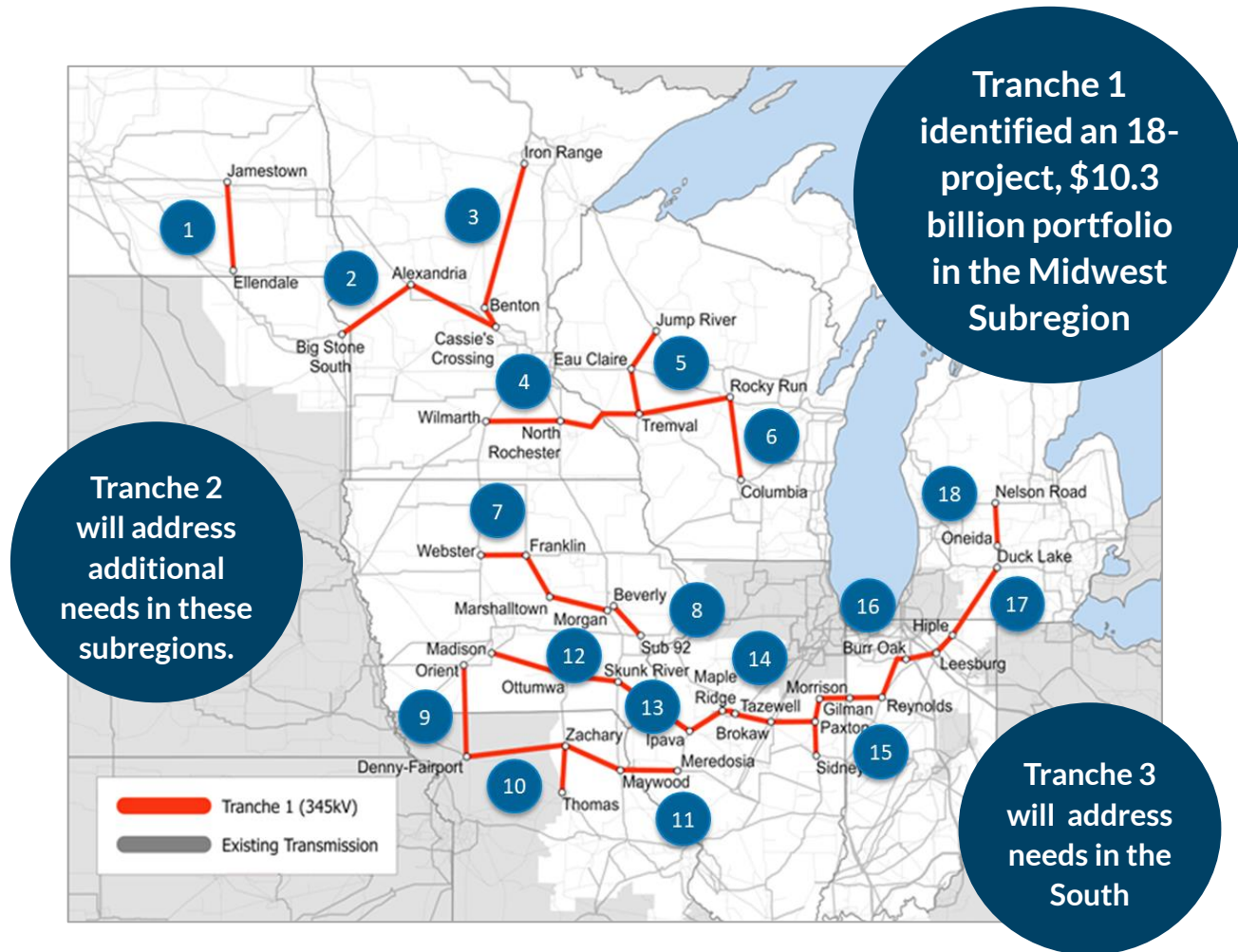
Operations of the Future

Focuses on the skills, processes, and technologies needed to ensure MISO Operations can effectively manage the grid into the future under increased complexity

System Enhancements

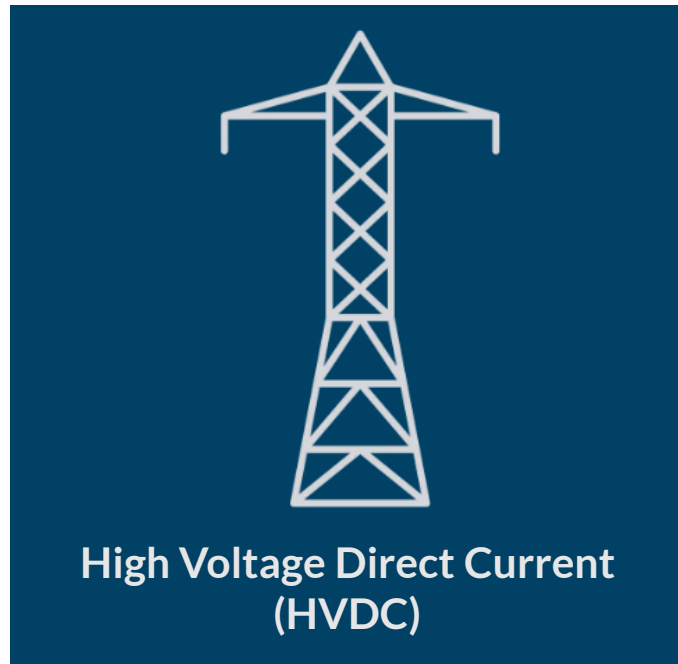
Transforms MISO's legacy platform into a flexible, upgradeable, and secure system that can evolve for years to come; will also integrate advanced technologies to process increasingly complex information

Long Range Transmission Planning seeks to ensure MISO's transmission system is optimized for the changing resource portfolio across the near- and long-term horizons



- Addresses regional economic and public policy transmission issues
- Looks out 20 years and addresses needs in phases or tranches
- Solutions resolve bulk regional issues as much as feasible to balance costs
- Developed by MISO with stakeholder input
- Considers Member plans

Among current and emerging technologies MISO is considering, High Voltage Direct Current (HVDC) is a potential solution to support more renewable resources



- Facilitates power delivery over longer distances
- More economical for more than 250 to 400 miles than legacy voltage lines
- Mitigates potential voltage and angular stability issues
- Voltage Source Converters mitigate short-circuit strength issues and provide bi-directional dispatchability
- Dispatchability allows HVDC lines to follow renewable outputs, minimizing congestion and system losses

The four pillars of the Reliability Imperative include other initiatives to address increasing variability and volatility

Some key initiatives of the Reliability Imperative



Move from annual to seasonal model, improve accreditation and update planned outage thresholds



Enhance tools and processes to react to volatility and variability



Evaluate approaches to value resource attributes that are critical to reliably operating the evolving portfolio



Educate policy makers on the impact of fleet evolution and timing



Refine how we work with stakeholders to enable both collaboration and timely action on important issues

MISO is confident its processes meet the broad, long-term planning objectives in FERC's Notices of Proposed Rulemaking (NOPRs)



Key FERC Objectives

- Include multiple long-term scenarios (i.e., 20 years)
- Involve state commissions in cost allocation process
- Modify Order 1000 requirements to permit a Federal ROFR
- Consider grid-enhancing technologies
- Improve retirement processes
- Speed up time to interconnect resources



Existing MISO Activities

- Advancing transmission to meet the needs of the future grid through the Reliability Imperative
- Leading the industry in scenario-based planning
- Following processes with robust stakeholder engagement
- Allowing flexibility in approaches to find the right paths
- Streamlining interregional coordination efforts
- Revising processes to interconnect resources to the grid and to retire resources

Questions?

